
Profiling Technology Diffusion Categories

Empirical Test of Two Models

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The authors provide an empirical test of two models which predict the technological adoption categories of small businesses for Hewlett Packard laser printers. The two models tested were a psychographic model as proposed in the book, Crossing the Chasm, and a more traditional benefit-price model. The adoption categories were defined by the sequence of laser printer model changes from 1985 to 1990. The results suggest that the benefits model predicts the buyer adoption better than the psychographics model. The study represents an exploratory phase of a future conclusive research project. J BUSN RES 1994. 31.155-162

The research reported was conducted for the Hewlett Packard (HP) Peripherals Group in 1993. The purpose was to determine the relevance to the laser printer market of concepts presented in the book, *Crossing the Chasm* (Moore, 1991). The book applies the diffusion of innovations theory to technology driven products in general and does not claim that the propositions presented have been empirically tested with technology driven products. The thesis of the book is that there are distinct, identifiable differences in the psychographic and behavioral characteristics of business people and organizations who can be classified as innovators, early adopters, early majority, late majority and laggards in the adoption of technology products. These differences impose different requirements on the nature of marketing activities to these five market segments. This is especially true for the hypothesized chasm between early adopters and the early majority.

The research was conducted by the Michigan Business School for Hewlett Packard as part of their effort to facilitate close relationships among faculty, students and HP management. The research project was to involve in two phases. The first phase was exploratory research using focus groups composed of businesses who had purchased laser and dot matrix printers. The findings from the exploratory research would form the basis for formulating a questionnaire and designing the data analytic approach to be used in the conclusive research phase.

The exploratory research results are presented in this paper. The authors argue that the importance of the exploratory research phase has not been fully recognized by academic and business researchers. A series of steps are proposed for explora-

tory research which includes coding the responses of focus group participants and analyzing the association and directional relationship of the variables identified. This data matrix is used to evaluate the appropriateness of data analysis statistical tools for the management issues to be investigated in the conclusive research phase. Such analysis facilitates in-depth thinking as to the nature of the conclusive research results and provides a format to communicate potential scenarios of research results. These research scenarios allow management to more clearly evaluate the potential strategic usefulness of the conclusive research phase.

The scope of the study was defined as the U.S. laser printer market for small businesses. The small business segment was chosen for the study for two reasons. First, it is less likely the product purchase decisions will be made by a committee or a central purchasing agent, thus, the small business decision-maker should exhibit more psychographic traits in the purchase of a technology product like laser printers. Second, the small business segment represents the largest market potential for laser printers.

Hypotheses

Because of the complex nature of the subject under investigation, HP did not think it to be realistic to address all the issues related to the technology diffusion cycle in a single study. The most important strategic management issue related to the testing of the following hypothesis:

There are distinct, identifiable differences in the psychographics and behavioral characteristics of innovators, early adopters, early majority, late majority and laggards pertaining to the adoption of hard copy products. These differences are quantifiable and can be utilized by HP to more successfully market products based on their position in the product life cycle.

The strategic marketing issues addressed by this hypothesis would allow HP to profile purchasers of various hard copy products within each category, profile products moving through the adoption process to identify timing issues for replacement products, categorize HP's current customer base, and identify ways in which they can take advantage of these characteristics

to help in marketing products across the spectrum of technology adoption segments.

To emphasize the strategic marketing issues to HP, two competing hypotheses were formulated:

- H1: Psychographic variables are stronger predictors than benefit-price variables are of when in the diffusion cycle a buyer will purchase a new technology.
- H2: Benefit-price variables are stronger predictors than psychographic variables are of when in the diffusion cycle a buyer will purchase a new technology.

Conceptual Model

In Moore's book, *Crossing the Chasm*, he proposes a revised technology adoption life cycle (Figure 1). The five adopter categories are profiled in terms of their psychographic and behavioral characteristics as they related to technological innovations. The model postulates that businesses adopt an innovation at differ-

ent times after it becomes available. The order of adoption flows from innovators to laggards.

While differences in the characteristics of the adopter categories are seen as gaps to be crossed by different marketing groups, a big gap is hypothesized between early adopters and the mass market of early majority. Figure 2 presents the research team's interpretation of variables underlying the five adoption categories.

Research on adopters is nested in the diffusion literature (Rogers, 1983). Consumer research has viewed the diffusion process as being conceptualized in an S-Shaped logistic pattern reflecting an exponential growth pattern from innovators and early adopters to majority acceptance in the marketplace (Robertson, 1984). Studies of adopters in terms of diffusion categories have focused on psychographic profiles of individuals in each category (Gatignon and Robertson, 1989). These research paradigms have been challenged as derived from rural sociology (Rogers, 1983) and of being overly simplistic for most consumer and industrial products.

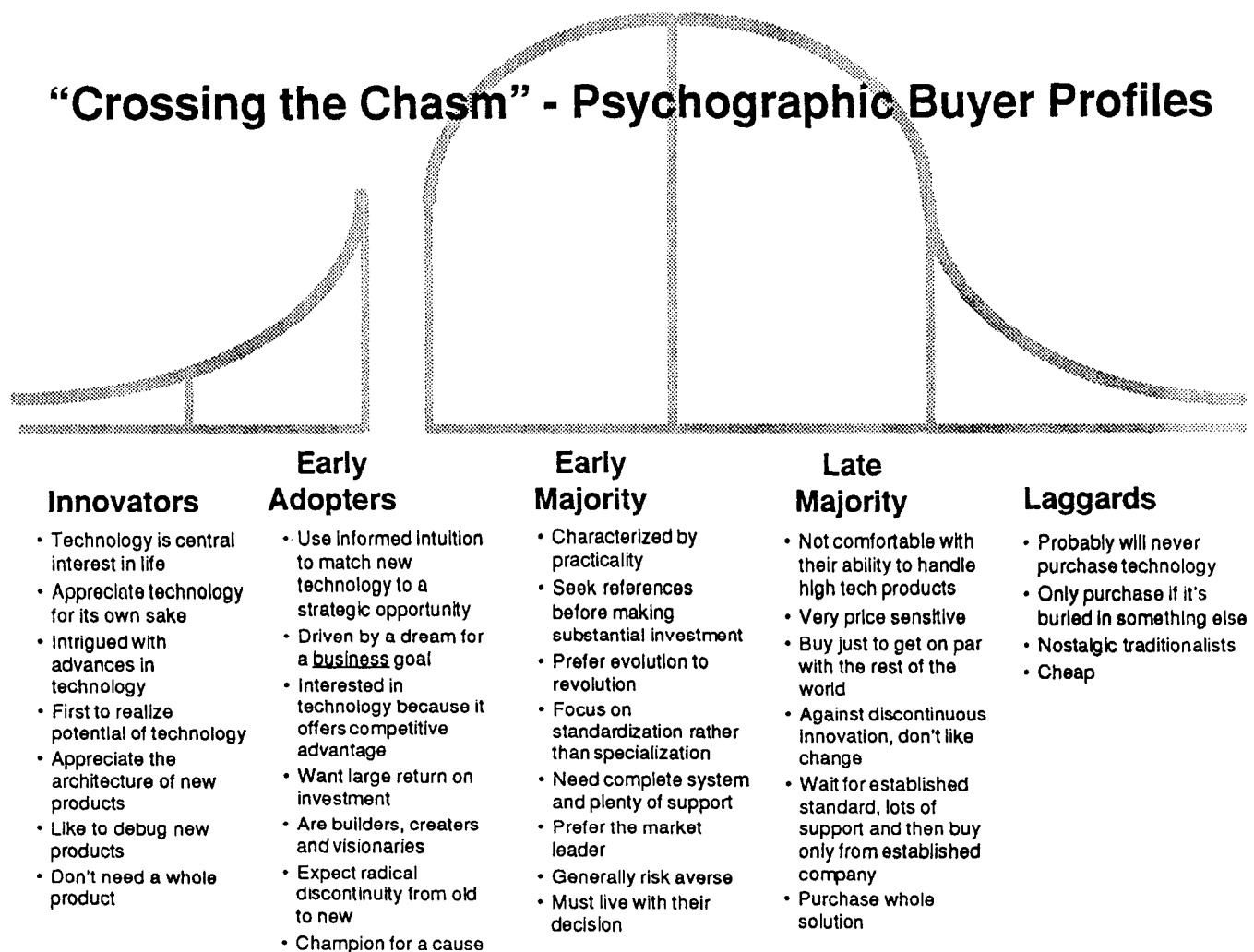
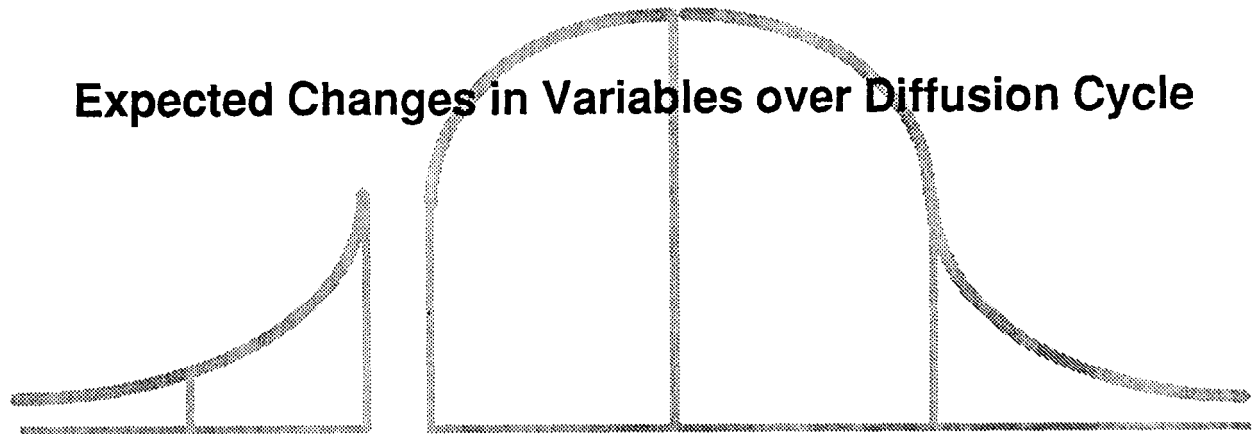


Figure 1. Crossing the Chasm—Psychographic Buyer Profiles

Expected Changes in Variables over Diffusion Cycle



	<i>Innovators</i>	<i>Early Adopters</i>	<i>Early Majority</i>	<i>Late Majority</i>	<i>Laggards</i>
Benefits Model					
PRICE SENSITIVITY	Low	Low/Medium	Medium	Medium/High	High
PRINT QUALITY	Very High	Very High	High	High	High/Moderate
PRODUCTIVITY	High	High/Medium	Medium	Medium/Low	Low
Psychographic Model					
RISK ATTITUDE	High	High/Medium	Medium	Medium/Low	Low
COMPUTER IMPORTANCE	Low	Low/Medium	Medium	Medium/High	High

Figure 2. Expected Changes in Variables over Diffusion Cycle

Robertson notes that the original diffusion studies of hybrid corn (Katz, 1961) and medical treatments (Coleman, Katz, and Manzel, 1966) provided a weak basis for generalization to consumer and industrial products. These studies deal with innovations which were highly recommended by scientific experts and were of central importance to their users. Further, each innovation came with a clear and unambiguous measurement indicator which allowed adopters to quickly discern the benefits achieved from adopting the innovation (Robertson, 1984). Other criticisms were that S-Curve studies of innovation typically focus on a single innovation or product and ignore the role of making a designed pattern of controlled communication regarding product benefits to targeted audiences.

Marketing literature has also been criticized for being too "consumer goods oriented" (Gatignon and Robertson, 1989) and needing more emphasis on the diffusion of high technology innovations as is consistent within the marketing field (Capon and Glazer, 1987). Clearly, research is needed to extend the basic diffusion and adopter category paradigms to encompass decision patterns of adopters of high technology products.

Methodology

Laser Printer Market Evolution

Hewlett Packard introduced the industry's first desktop laser printer in 1984. This LaserJet Classic Series revolutionized desktop printing, and customer demand for the printer catapulted HP from an insignificant market share to a position of industry leadership. The laser printer used a Canon engine that was an outcome of a joint research relationship the two companies had since 1975. In 1987, HP introduced the LaserJet Series II printer, which created a new industry standard for price and performance trade-offs. At a list price of \$2,695 and widely available selling prices just over \$1,600, it offered 300 dots per inch resolution, eight pages per minute speed, and the HP reputation for reliability and software compatibility.

Hewlett Packard had surprised competitors by repositioning its entire product line in 1989 with greatly reduced prices on laser printers. The new LaserJet IIP printed four pages per minute and had a list price of \$1,495, but sold in many retail stores for about \$1,000. HP's pricing spurred industry wide price reductions averaging 25%. In 1990, HP again introduced

an improved laser printer called the LaserJet III. It had a list price of \$2,400, printed eight pages per minute, and produced the impression of print resolution of 600 dots per inch. Again, HP was able to "leapfrog" the competition with major technological improvements while lowering the price.

Sample Design

The sample was randomly drawn from HP's warranty card database of small business (under 50 employees), operating since 1985, which had purchased the Classic, Series II, or Series III laser printer model (Table 1). The sample of Laggards, defined as small business who had purchased a dot matrix or daisy wheel printer, but not a laser, was randomly drawn from the telephone directory. The sample profile covered a wide variety of business types.

The sampling frame for each adopter category was based on a sequential time range starting in 1985 when the Classic series warranty card data was first available. Table 1 also indicates the time frames sampled for each category. The research design assumes that businesses who bought a Classic LaserJet from 1985 to 1987 are most likely innovators. Businesses who bought the LaserJet II series from 1987 to 1989 are potentially Early Adopters, while businesses who bought the LaserJet IIP series from 1989 to 1990 are potentially in the Early Majority category. LaserJet III purchasers would be classified in the Late Majority category.

Data Collection Procedure

The first phase of the project involved in-depth telephone interviews with small business owners/managers. These interviews were ~20 to 40 minutes in duration using open-ended questions in a semi-structured format. The purpose was to explore the purchase decision process of hard copy technologies and the adoption (or non adoption) of laser jet technology. These interviews, conducted nation wide, allowed the research team to "hear" the customer and formulate the issues to be explored in the focus groups. Based on these interviews and the objectives of the research project, a focus group interviewer's guide was developed.

This first phase identified a potential source of non-response error in the phase two sample selection plan. The phase one interviews had a high proportion of Classic owners who were

in the law, accounting, and medical fields. Apparently, this type of business has greater longevity than other firms which characterize the small business profile. Consequently, the phase two sampling plan restricted the number of law, accounting, and medical firms to 30% of the focus group sample.

Coding and Operationalization of Variables

The variables were operationalized by coding the respondent's responses during the focus group sessions. An array of variables were measured including (1) type of business, (2) position of respondent, (3) business goals, (4) software applications, (5) adoption category assessment, (6) price sensitivity, (7) print quality importance, (8) productivity importance, (9) risk attitude, and (10) importance of computers to the business.

Figure 3 presents the variables selected for inclusion in the competing models. The Benefits-Price model contains three variables:

- print quality
- productivity
- price sensitivity

The Psychographic model includes the variables of risk attitude and the perceived importance of computers to business. The other variables were found to have weak relationships with the time of purchase and printer type. The correlation between the adoption category assessment and risk attitude was very high ($r = 0.86$) and consequently only the risk attitude variable was included.

Our models are specific to printer technology adoption, and may not be completely applicable for all new high technology products. Figure 2 provides a summary of the expected directions of the variables for both the Benefits and Psychographic models.

Benefits Variables

Price sensitivity measures the relative importance of the price criterion in the adoption decision. This variable is coded on three levels:

1. Low (less sensitive)
2. Medium
3. High (more sensitive)

Table 1. Sampling Plan

Category	Model	Purchase Date	Size	Focus Group Location
Innovators	Classic	1985-1987	9	San Francisco, CA
Innovators	Classic	1985-1987	9	Farmington Hills, MI
Early adopters	LaserJet II	1986-1988	8	San Francisco, CA
Early adopters	LaserJet II	1986-1988	8	Farmington Hills, MI
Early majority	LaserJet II-P	1988-1989	8	Farmington Hills, MI
Late majority	LaserJet III	1990	7	Farmington Hills, MI
Laggards	Dot matrix/daisy	N/A	8	Farmington Hills, MI
			57	

<i>Product</i>	<i>Adoption Profile</i>	<i>Psychographic Model</i>	<i>Benefits Model</i>
Classic	Innovator	Risk Attitude	Print Quality
LaserJet II	Early Adopter	Importance of PC	Productivity
LaserJet II-P	Early Majority	Growth Rate	Price
LaserJet III	Middle/Late Majority	Payback Period	Quietness
Non-Adopters	Laggards	Adoption Category	

Figure 3. Variable Definition

P1: The less sensitive to price, the more likely a firm will adopt a new printer technology.

Print quality measures the importance of print quality of output to the user. This variable is coded on three levels:

1. Low (less important)
2. Medium
3. High (very important)

P2: The more important print quality is to a firm, the more likely a firm will adopt a new printer technology.

Productivity measures the importance of a tangible productivity gain to the user. This variable is coded on three levels:

1. Low (less important)
2. Medium
3. High (very important)

P3: The more important productivity is to a firm, the more likely a firm will adopt a new printer technology.

Psychographic Variables

Risk attitude toward new technology is an aggregation of the risk perceptions about fax/modems, computers, printers, and software and measures the propensity to adopt new products in the specific product areas. This variable is coded on three levels:

1. Low (risk averse)
2. Medium
3. High (risk seeker)

P4: The higher the level of risk seeking, the more likely a firm will purchase a new printer technology.

Importance of computers to the business is a measure of the importance of computers to the operation of the business and is a proxy for the opportunity cost for adopting a new technology. This variable is coded on three levels:

1. Low (less critical)
2. Medium
3. High (very critical)

P5: The more important PC's are to the business, the more likely a firm will adopt a new printer technology.

Analysis

Verbatim transcripts from the focus groups were classified using protocol analysis. After the comments were organized by appropriate subject matter, the content was analyzed for each focus group member. The fundamental process of analysis is to compare each item with the previous incidents in the same and different groups coded in the same category. The participant psychographic adoption profiles were assigned through a systematic analysis of responses. A sample of the data matrix is found in Figure 4.

The hypotheses for each of the independent variables were tested, with the sign of the coefficient giving the direction for the relationship. The competing models' overall predictive ability was measured by how accurately each model classified subjects into their expected adoption category based on product adoption. A logit model involving an ordinal level dependent variable (McKelvey and Zavoina, 1975) of expected adoption category was applied to the data. Recognizing the size limitations of our sample and the requirements for the statistical techniques involved, the Laser II and III data was weighted double to more accurately represent the proportion in the buyer population. The actual coefficients are used in the graphical representations, but should be interpreted only for direction and not relative importance across variables. The models were tested with the appropriate variables coded as dummy variables. The Medium condition was chosen as the 0 value, Level 1 of the variable was the Low condition, and Level 2 was the High condition.

Results and Discussion

Benefits Model

The statistical results of the benefits model are presented graphically in Figure 5. The strongest directional relationship is found with print quality. The companies that need a higher level of print quality would seek out new printer technologies earlier. This finding supports Proposition 2. The low level of productivity is highly associated with the late adoption or non-adoption of printer technology ($p < .001$). There is a weak positive relationship between the high level of productivity and early adoption and this supports Proposition 3. Price sensitivity fluctuates across the adopter and non-adopter categories. This result indicates an inverted "U"-Shaped relationship which implies

San Francisco Focus Group
March 30, 1993
Tuesday 6:00 (Classic's) (Respondents ordered counter-clockwise from moderator)

Name	Member 1	Member 2	Member 3	Member 4	Member 5	Member 6	Member 7	Member 8	Member 9
Type of Company	Airport Consulting	Importer	Tech Consult.	Power Consult.	Printable Apparel Distrib.	Mkt. Consult.	Word Processor	Legal Non-Profit	Design Company
Position	Vice Pres.	Owner	Business Mgr.	Owner	Mgr Info Systems	Owner	Owner	Associate	Computer Manager
Total Employees	9	7	32	5	45	1	1	20	15
Business Goals	Aggressive Sales/New Markets	Grow National	Moderate Employee Growth	Spinoff Company	Aggressive sales + automation	Slow (add one support)	No, Retire	Grow if possible	Reduce employment by automating
Applications	Tech Reports	Accounts	WP, Graphics	WP, Graphics	WP	WP	WP	WP, Legal	WP, Graphics
First Laser Printer	Classic	Classic	Classic	Classic	Classic	Classic	Classic	Classic	Classic

Adoption Assessment	Early Adopter	Early Adopter	Early Majority	Early Majority	Innovator	Late Majority	Late Majority	Early Adopter	Early Adopter

Figure 4. Respondent Summary and Classification

that both innovators and laggards have low price sensitivity. This result refutes Proposition 1 that price sensitivity would increase across the adoption cycle. Rather, the findings indicate that the middle adopters are the most sensitive to price. This implies the middle category demands higher product quality and productivity gains in a printer, yet is more price sensitive than the laggard category. The laggard category appears to perceive few benefits from print quality and productivity, resulting in a lower intention of purchase.

The benefits model correctly classified 72% of the focus group participants into the product adoption categories. The variables of print quality, productivity, and price sensitivity has $\chi^2 = 40.14, p < .0002$ (Table 2).

Psychographic Model

The directional results for the psychographic model are presented graphically in Figure 6. A high level of risk seeking has a strong positive relationship ($p < .02$) with early adop-

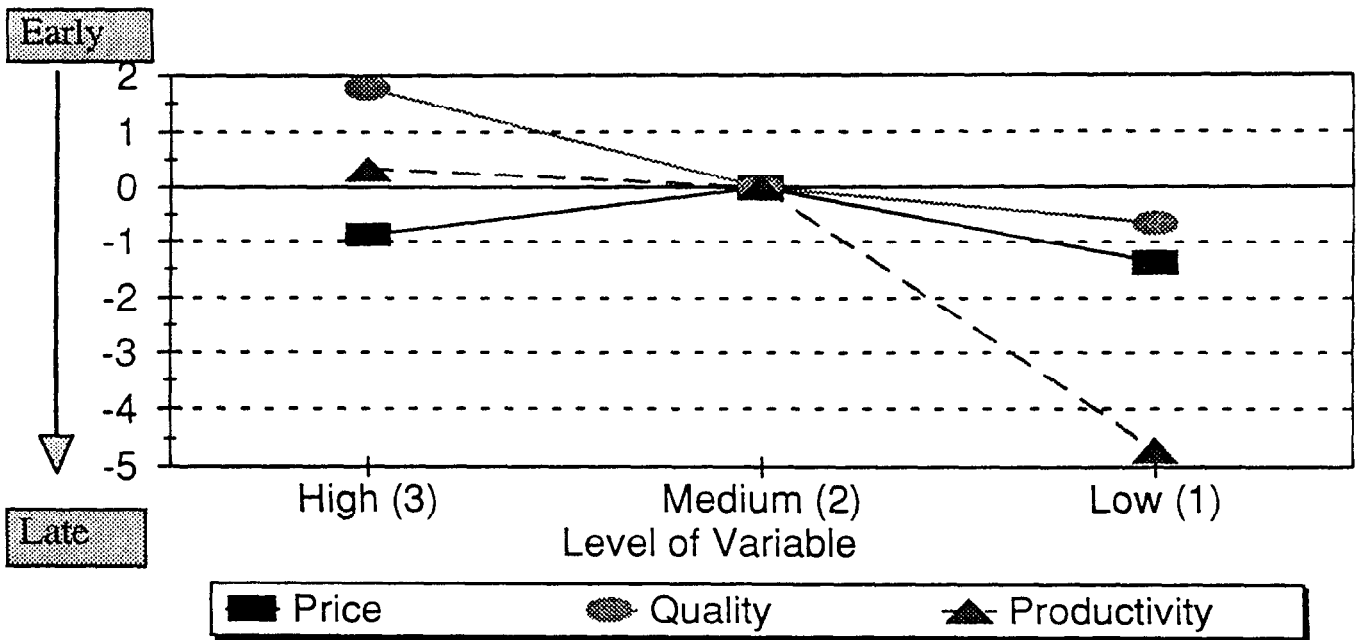


Figure 5. Directional Impact-Benefits Model

Table 2. Results of Logit Analysis

Variable	Low Level		High Level	
	Statistic	Direction	Statistic	Direction
Benefits Model*				
PRICE1	-1.37, <i>p</i> < .39	Negative		
PRICE2			-0.87, <i>p</i> < .42	Negative
OUTPUT1	-0.65, <i>p</i> < .59	Negative		
OUTPUT2			1.78, <i>p</i> < .23	Positive
PRODUCTIVITY1	-4.70, <i>p</i> < .000	Negative		
PRODUCTIVITY2			0.34, <i>p</i> < .76	Positive
Psychographic Model†				
RISK1	0.50, <i>p</i> < .47	Positive		
RISK2			2.26, <i>p</i> < .01	Positive
PC CRITICAL1	-1.73, <i>p</i> < .02	Negative		
PC CRITICAL2			0.002, <i>p</i> < .98	Negative

* Number classified correctly: 41/57 = 72%.
† Number classified correctly: 32/57 = 56%.

tion. This supports Proposition 4 that earlier buyers are more willing to accept the risk associated with early adoption. The high level of importance does not have any effect on time of adoption. However, the expected relationship from Proposition 5 holds in that the less important computers are to the business, the later new printer technology will be adopted (*p* < .001).

The psychographic model correctly classified 56% of the focus group participants into the product adoption categories.

The variables of risk attitude and importance of computers had a $\chi^2 = 2.15, p < .71$ (Table 2).

Conclusions and Implications

The central research question for this study was, "which of the two competing models is a better predictor of whether a person will adopt a laser printer?" Seven focus groups of small business owners were held and then the transcripts were analyzed

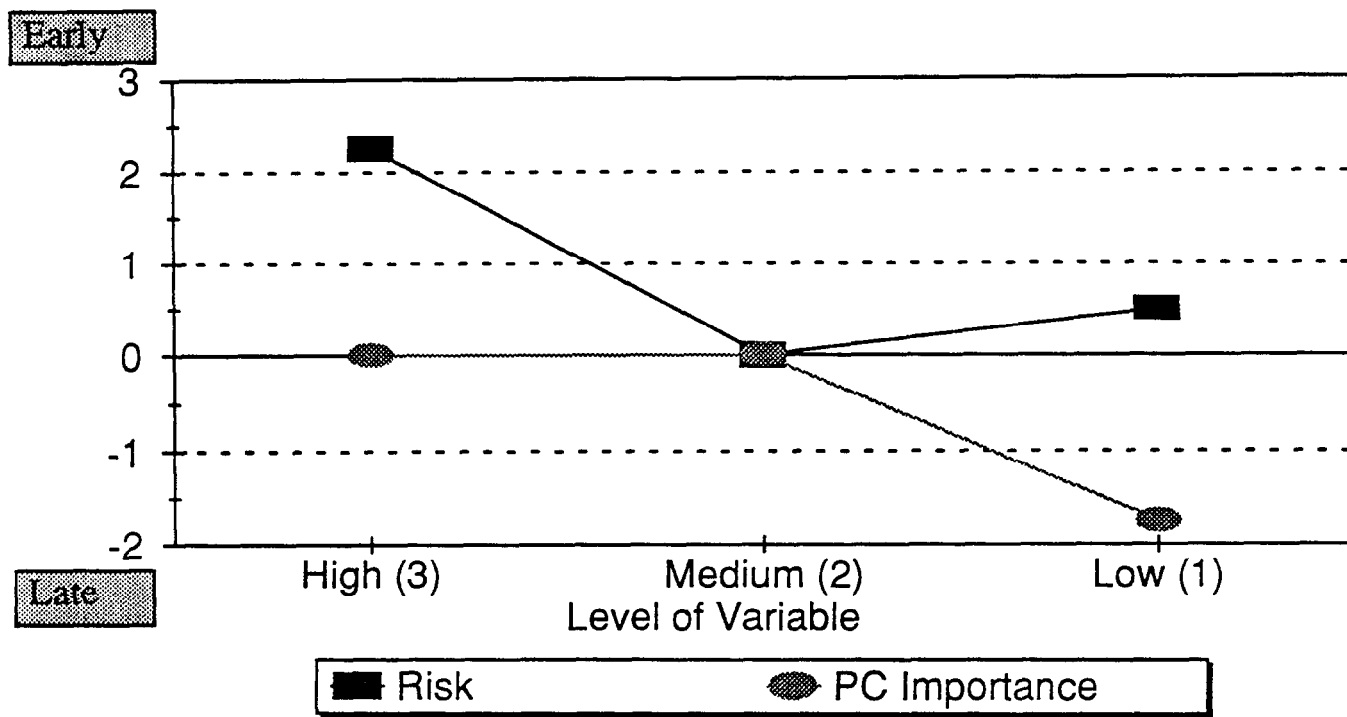


Figure 6. Directional Impact - Psychographic Model

using protocol techniques. The participants were classified on multiple variables developed from the research question.

The χ^2 test of the hypotheses (*H1* and *H2*), support the Benefits-Price model over the Psychographic model. While the purchaser's attitude toward risk and the importance of the personal computer (Psychographic model) plays a role in the new technology purchase decision process, the need for print quality, increased productivity, and price sensitivity (Benefits-Price model) are more important drivers of the adoption process. The Benefits-Price model also displays a high level of predictive power, correctly classifying 72% of the focus group members. In contrast, the psychographic model correctly classified only 56% of the subjects.

The managerial implications of this research study are that companies which pioneer new technologies must focus on the benefits desired by purchasers. Early adopters look for the benefits which meet their needs better than current technologies. If the benefits are significant, these early adopters are less price sensitive and are willing to take risks to acquire the benefits. There appears to be nothing magical about the diffusion of new technologies. Businesses which focus their product development and entry marketing strategy on identifying and meeting key customer needs will enjoy the advantages of a pioneer.

Innovations have been characterized in terms of the extent to which the innovation requires buyers to acquire new knowledge and/or change their behavior. Three categories of innovations have been identified: continuous, dynamic-continuous and discontinuous. Continuous innovations have the least impact on buyers in terms of changes in knowledge and behavior. Dynamic-continuous innovations have moderate impact while discontinuous innovations have the greatest impact on knowledge and behavior. Laser printer technology would be classified as a dynamic-continuous innovation. This category of innovation is typical of mainstream technological innovation and provides a significant test of the concepts presented in the book, *Crossing the Chasm*.

If there is a "chasm" in the diffusion process, it appears to be the high demands of the mass market. These demands are for superior benefits and lower price points. Designing a manufacturing and marketing strategy to lower the cost structure to meet the needs of the mass market is the challenge of the market pioneer. Whereas risk attitudes are important in this process, they should not divert the attention of management from the key drivers of innovation: benefits and price points.

The above conclusions are based on the measurement and analysis of respondent comments in focus group sessions. An important objective of this project was to demonstrate that this process adds important insight to the development of the conclusive research phase of the total project. As researchers, the process forces us to deal with issues of operationalizing vari-

ables, evaluating alternative data analysis approaches, and analyzing the exploratory data set plus addressing the key management information needs. For the management group, this process allows a "mock-up" of the potential conclusive research results. The constructive and insightful researcher-management interaction which results from this process can greatly facilitate the design of the conclusive research phase.

For the conclusive research design, finding members of the laggard category will be the most difficult. Laggards are often defined as people who will buy in the category, but in the decline phase of the product life cycle. These potential buyers must be separated from the non-buyers as there may be fundamentally different views with respect to price sensitivity and risk attitude. The quantitative phase of the project must address this issue more directly than was possible in the qualitative phase.

As a final observation, this study brings a new dimension to the diffusion of innovation literature. Prior research has tested the diffusion of innovation theory based on a single product innovation phase. Our project focuses on a series of innovations in laser printer technology across the five category diffusion curve. The results suggest that more research is needed to validate diffusion theory across high-technology innovations which come to market in rapid sequence. The comparison between the Psychographic and Benefits-Price models should also be explored. Hopefully, future cooperation between the academic and business community can close the gap between theory and practice in the field of strategic marketing management.

The authors wish to thank David Bufford and George Mulhern of Hewlett Packard for their support and assistance on this research project. In addition, special thanks to my colleague Venkatram Ramaswamy for his valuable advice and assistance in the data analysis modeling.

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