ASSESSING CONSUMER PREFERENCES

IN THE CONTEXT OF NEW PRODUCT DIFFUSION

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ABSTRACT

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The possibility for different kinds of adopters, along Rogers' (1962) categorization, to display different preference patterns regarding a product's features, is investigated. The moderating role of diffusion-related variables, namely a product's newness and the extent of interpersonal communication, is assessed.

It is hypothesized that a respondent's evaluation of product descriptions can be influenced by the diffusion context which characterizes them. An attempt is made to show that such a context can be used to elicit different "best product" alternatives for different stages of the adoption curve and, prior to market introduction, can help predict time-dependent changes to be made to the product's features as adoption takes place.

Cette recherche tente de faire ressortir les différences susceptibles d'exister entre différents types d'adopteurs, suivant la distribution de Rogers (1962), en matière de préférences pour les caractéristiques d'un produit. Elle cherche à révéler l'effet modérateur de certaines variables de diffusion, telles que le degré de nouveauté du produit et l'étendue de la communication interpersonnelle, sur la formation de ces préférences.

Elle avance l'hypothèse que le contexte de diffusion qui caractérise l'offre d'un produit influence l'évaluation qu'en fait l'individu. Elle tente de montrer que le facteur contextuel permet d'indiquer les modifications à apporter au produit dans le temps, au fur et à mesure de sa diffusion, et ce avant sa mise en marché.

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I dedicate my work to my parents, Dr. and Mrs. Gilbert Cestre.

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CHAPTER I

PROBLEM SETTING AND RESEARCH OBJECTIVES

In the past, marketing scholars have approached the study of new product adoption from two broad angles. The first views adoption at the aggregate level, as the result of a diffusion process linking early and later adopters by way of a dichotomic (internal / external) influence structure. The other views adopters at the disaggregate level, as the outcome of individual attitudes toward and preferences for the product (or product features), based on one's perceptions and needs.

Indeed, the marketing literature on new product adoption abounds with studies purporting, on the one hand, to identify diffusion agents among potential adopters, to capture inherent differences between early and later adopters with respect to internal and external influence factors, and to predict the adoption curve for the new product. On the other hand, a full stream of research has focused on individual appraisals and assessments of new products in an attempt to uncover specific perception and preference patterns that could help better understand and predict consumer behavior, and assist managers in designing and marketing such products (or services).

However, little has been done so far to link the aggregate diffusion process with the disaggregate preference structures, and

to uncover the ways in which one may impact on the other. In the area of new product diffusion, the process is usually based on the assumed existence of a pre-specified product description. No account is made of the possible mediating effect of eventual preference differentials between early and later adopters. In the area of buying behavior, a unique "most promising" product alternative to be developed and marketed is usually arrived at (through perception and preference analysis), irrespective of the potential impact of the adoption context (or situation) in terms of expected individual times of adoption and of the new product's actual state of diffusion.

Two major marketing problems emerge from the above and are summarized below:

1) To date, little is known about possible differences in preference structures between earlier and later adopters (or between innovators and imitators), for given types of product concepts. Managers may have available information about who are the most likely early adopters for given product categories and thus decide to direct marketing efforts (advertising, media, distribution) toward them in an attempt to boost diffusion. They may also have information about consumers' preferences for different product features and thus develop that product alternative which appeals most to such consumers in general or to some target market.

What they usually lack, however, is the link between the two: Because new product development and concept testing have not been done in reference to adopter categories, managers lack information about how appealing their selected "best" alternative is to any specific adopter category, in particular to early adopters. The targeting of marketing efforts toward potential early buyers under such conditions can only be suboptimal at best, given that at least one of the marketing variables -product- does not take account of different adopter groups' possible preference specificities.

This affects later as well as earlier stages of product (or concept) management, since managers are unable to foresee the product adaptations possibly warranted by such differences, as diffusion takes place and later adopter categories enter the market. Further insight into adopter category differences in terms of preferences for product features would thus allow a manager to engage early in the planning of the new product's development and marketing, which could eventually impact on the PLC by maximizing the innovation's market potential through appropriate and well-timed adaptations.

2) Even determining preferences for given features that would be specific to some adopter group may still be misleading in the context of new product concept testing: If the fact of being more or less of an innovator can impact on one's preference for product features, one's knowledge about (or perception of) how new/old the

product is and about the extent to which interpersonal communication has taken place, is likely to affect one's perception of the product and thus one's preference for it.

For example, the perceived level of risk associated with new products can be expected to decrease as the product ages, which could explain that a later adopter may shun high price/low warranty products if these are known (perceived) to have been introduced recently and are unheard of, but not if they are known (perceived) to have been on the market for some time and to be widely talked about. Since later adopters tend to purchase in the latter time/communication context, an out-of-context appraisal of their preferences lacks realism. Similarly for other adopter groups.

In view of the above, the following research objectives were set:

1) to investigate whether earlier and later adopters display different utility patterns for product features and for overall product alternatives;

2) to investigate whether the moderating effect diffusion-related variables may have on individual evaluations of product descriptions can help uncover more accurate individual preference structures that take account of the time dimension of purchase behavior;

3) to investigate whether differences in utility patterns can serve as a basis for longitudinal segmentation based on adopter group membership, and for signalling, at the concept-testing stage

of new product development, desirable time-specific changes in the product's features to adapt to the anticipated evolution of market composition, and for forecasting the profitability of a new product concept at the concept-testing stage, over a substantial part of the PLC.

Such an insight could not only (1) add to our current understanding of consumer evaluation processes and eventual behavior, and (2) assist managers in determining, at the stage of new product concept testing, which product design to develop, but also, still at the concept-testing stage, help managers foresee (3) which post-introduction product modifications will be most desirable in terms of profitability or market share, and (4) at what points in time they will need to be implemented, as the new product gains market acceptance.

CHAPTER II

LITERATURE REVIEW

Both research streams mentioned above, namely the diffusion of new product acceptance at the aggregate level and the assessment of mediated consumer preferences at the disaggregate level, are covered here, with particular emphasis on those areas most relevant to the above-stated marketing problems. Efforts to circumscribe the fundamental constructs of diffusion theory and attempts to appraise their underlying constructs are first reviewed. Modelling developments aimed at capturing the dynamics of the diffusion process are covered next, leading to an appraisal of those contributions which capitalize on individual consumer input by combining aggregate and disaggregate approaches. The latter are then reviewed more extensively by looking at the state of research in the field of mediated consumer preferences.

A. Innovativeness and the diffusion process

The diffusion of new product acceptance has been extensively researched by marketing scholars in the past two and a half decades, following Rogers'(1962) seminal work on the subject. In general terms, diffusion is viewed as the process by which a new product (innovation) progressively becomes adopted by the market.[1]

[1] In the present context, adoption is used as a synonym for trial [Midgley (1977)]. A number of authors have also referred to adoption as meaning repeat purchasing, reflecting continued use of a new product [Rogers (1962)].

The basic concept of innovation encompasses a number of realities to which newness is central. Indeed, marketing scholars have given several meanings to the concept, ranging from a new product or service that has not yet been offered to the consumer, to a new brand of an existing product, and finally to a change in some attribute level of an existing brand. Robertson (1967, 1971), for example, distinguishes between continuous, dynamically continuous and discontinuous innovations, while Hirschman (1981) talks about symbolic versus technological innovations. The "softer" categories of continuous or symbolic innovations remain fuzzy sets, and although most new market introductions seem to belong to this category [Dickerson & Gentry (1983)], we will henceforth lend the meaning of discontinuous innovation when talking about new products, in line with Rogers' (1962, 1983) work on technological innovations.

The central concept in diffusion theory is that of innovativeness which can generally be defined as "the propensity of consumers to adopt a new product" [Hirschman (1980)], or more specifically "the degree to which an individual is relatively earlier in adopting an innovation than other members of his social system" [Rogers & Shoemaker (1971)].

Implicit in such definitions is the potential influence exerted by early adopters on later adopters, especially through implicit

or explicit communication, a dimension which Midgley & Dowling (1978) have brought out in their own definition of innovativeness as being "the degree to which an individual is receptive to new ideas and makes innovation decisions independently of the communicated experience of others".

It also clearly comes out in Rogers' (1983) description of the "diffusion effect" as being:

> "the cumulative increasing degree of influence upon an individual to adopt or reject an innovation resulting from the activation of peer networks about the innovation in the social system. (...) Adoption of a new idea is the result of human interaction through interpersonal networks. (...) The process is similar to that of an unchecked epidemic."

which states the essential role of innovators as diffusion agents.[2]

Earlier buyers (innovators and early adopters in Rogers' (1962) categorization), because they communicate with and influence potential buyers in their purchase decisions, are considered the primary diffusion agents. On the other hand, later adopters (early majority, late majority and laggards in Rogers'(1962) categorization), although some may also in turn contribute to the diffusion of the product, are usually characterized by the fact that they seek reassurance before making a purchase decision, due to their greater aversion for risk, and are thus essentially imitators. Their time of adoption will then depend in part on the amount and perceived significance of (or degree of influence

[2]No distinction is made at this point between innovators and first adopters. Conceptual differences will be reviewed later on.

exerted by) interpersonal communication regarding earlier buyers' experience with the new product, the pace at which such communication takes place and the degree of contradiction present in the messages thus received [Rogers & Shoemaker (1971)].

While innovators, for convenience purposes, can be thought of as one of the five arbitrary adopter categories referred to above, the concept of innovativeness more appropriately reveals the true nature of the diffusion process, with diffusion agents displaying the highest degree of innovativeness and later diffusion agents displaying increasingly lower degrees of innovativeness [Bass (1969)]: As we move from one adopter category to the next, the need for reassurance and conformity increases, directly affecting consumers' propensity to buy the new product early, and thus pushing further in time the eventuality of a purchase.

Beyond the fact that innovators and later adopters differ in their propensity to buy early (time of adoption) and in their need for reassurance (especially through interpersonal communication), marketing researchers have extended considerable efforts to establish practical classification grounds. Much adopter categorizing effort has been undertaken **a posteriori**, once the new product had been purchased, based on factors such as the actual (or recalled) time of purchase [Bell (1963), Arndt (1967), Midgley (1974), Mittelstaedt et al. (1976), Schmittlein & Mahajan (1982)], or on how many and what kind of personal contacts one had

established prior to making a purchase decision [Coleman et al. (1966), Engel et al. (1969), Robertson & Myers (1969), Summers (1971), Mahajan et al. (1984), Johnson-Brown & Reingen (1987)].

A number of **a priori** studies were also undertaken by first identifying demographic, socio-economic and psychological characteristics that would be specific to given adopter categories [King (1963), Zuckerman (1964), Mittelstaedt (1976), Midgley & Dowling (1978), Raju (1980), Dickerson & Gentry (1983), Bearden et al. (1986)]. Another popular approach has been to analyze differences in individual perceptions of given product descriptions along a number of dimensions, later attempting to match such perceptions with degree of innovativeness, derived from actual buying behavior [Cox & Rich (1964), Rogers & Shoemaker (1971), Ostlund (1974), Brooker (1983), Gardial & Zinkhan (1984)]. Most of such research efforts were made with one major objective in mind: that of finding better ways to identify and categorize adopters, and to validate such classification grounds with real purchase data. These different approaches are reviewed in more detail below.

1. Linking innovativeness to personal characteristics.

Efforts to identify personal characteristics that would be specific to each adopter group have led to mitigated results. Some common grounds in demographic and socio-economic variables have been uncovered to differentiate among adopter groups and more

specifically with respect to innovators. Factors such as higher education, income and social status, for example, are thought to have an impact on one's risk perception and understanding of the product [Bell (1963), Kegerreis & Engel (1969), Rogers & Shoemaker (1971), Adcock et al. (1977)], although contradicting results have repeatedly been documented[3], especially with respect to age, in relation to which the nature of the product plays an important role. Such is the case of complex and financially risky technological innovations [Rogers & Shoemaker (1971), LaBay & Kinnear (1981)].

Psychographics remains the area in which least cohesiveness is found, due to the wide variety of concepts discussed and of suggested operationalizations, and the complexity of human nature itself [Kotler & Zaltman (1976)]. Among the concepts most widely elaborated upon are those of "predisposition to seek experience" [Zuckerman (1964), Mittelstaedt et al. (1976)], "exploratory tendency" [Raju (1980), Bearden et al. (1986)], "dogmatism" [Midgley & Dowling (1978), Bearden et al. (1986)], "inner-other directedness" [Riesman (1950), Kassarjian (1962), Kassarjian (1965), Arndt (1967)], "personality and personal needs" [Evans (1959), Koponen (1960), Robertson (1967), Robertson & Myers (1969)], "novelty seeking" [Hirschman (1980), Carlson & Grossbart (1984)], "independent judgment making" [Midgley & Dowling (1978),

[3]Lack of standardization in the operationalization of variables such as social class accounts for some of the variation in the results [King (1963), Frank & Massy (1963), Raju (1980)].

Carlson & Grossbart (1984)] and "creativity" [Welsh (1975), Hirschman (1980)].

These concepts' uniqueness has not always been conclusively demonstrated and some scale items have served to measure different constructs, as illustrated in Kassarjian (1962), Raju (1980) and Carlson & Grossbart (1984). Such overlapping, combined with the multiplicity of measurement instruments presently available, has contributed to the somewhat anarchical appraisal of innovativeness as a central concept in the diffusion process. A huge effort of integration thus remains to be accomplished for a more rationalized use of psychographics.

2. Linking innovativeness to individual perceptions of new products, along innovation dimensions.

Only relatively recently have researchers given more attention to such individual perceptions, despite Rogers' (1962) early contributions in identifying some of the major dimensions on which perceptions could be based, and in suggesting their potential importance for determining one's degree of innovativeness.

Major operationalization efforts in this area have centred around six innovation dimensions [Tornatzky & Klein (1982)], the first five of which were proposed by Rogers (1962) as being conceptually distinct and generally relevant. They are:

1. perception of the product's relative advantage;
2. perception of the product's compatibility with one's values and needs;
3. perception of the product's complexity in terms of use;
4. perception of the product's trialability (or divisibility);
5. perception of the product's communicability (or observability), i.e. the degree to which it is visible to others;
6. perceived risk.

Fliegel & Kivlin (1966), Robertson (1971) and Rogers & Shoemaker (1971) have contributed to circumscribing and operationalizing the first five concepts, to which Ostlund (1974) added the concept of perceived risk, based on previous work by Bauer (1960), Cunningham (1960), Cox & Rich (1964) and others. All six concepts were shown, by their respective authors, to correlate significantly with an individual's degree of innovativeness, i.e., that those who bought earlier also tended to perceive the new product as scoring high on attributes 1., 2., 4. and 5. and low on attributes 3. and 6. The relationship was not clearly established for the divisibility and observability factors, but a tendency in the positive direction was indicated in Rogers & Stanfield (1968).

Analyzing individual scores on the above six attributes, Ostlund (1974) succeeded in correctly identifying up to 77% of innovators. Best and most consistent results throughout studies have been linked to perceptions 1., 2., 3. and 6. [Holak & Lehmann (1990)].

A number of other dimensions have also been proposed (social approval, profitability, cost, for example) but have led so far to fewer developments and mitigated results [Dickerson & Gentry (1983)].

Generally speaking, compared to the lack of discriminant power of demographic/socio-economic/psychographic variables (education, income, social status, creativity, enthusiasm, etc..) due to their lack of generalizability, as reported earlier, individual product perceptions along dimensions such as product complexity, compatibility, trialability, etc. appear more promising in identifying adopter group membership [Dickerson & Gentry (1983)]. However, we are unaware of any attempt to differentiate adopter groups on the basis of individual preferences (and strength of preferences) for specific actionable features of a particular innovation.

The above studies are concerned with establishing a link between individual characteristics and/or perceptions and degree of innovativeness, in an attempt to understand better what characterizes different types of adopters and to establish grounds to identify them **a priori**. By contrast, a number of authors have chosen to focus instead on the adoption process itself by looking at time elapsed between product introduction (or awareness) and purchase, and extent of interpersonal communication prior to purchase. Such developments represent the stepping stone for

deriving models of diffusion by integrating individual adoption patterns with the more encompassing scheme of the product life cycle.

3. Linking innovativeness to the time dimension of purchase behavior.

a) Adoption as first purchase.

As one of two diffusion-related factors characterizing adopters, time is central in determining one's degree of innovativeness. Attention has been given to the determination of 1) the timing of introduction of a product, and 2) the timing of an individual's product adoption. The standard approach has been to consider the timing of adoption as the time elapsed between product introduction and an individual's first purchase. When time of introduction has been difficult to establish (in the case of fashion, for example), perceptions of product availability have sometimes been used [King (1963)].

Recently, however, a number of authors have criticized that approach for having falsely categorized earlier/later adopters. They argue that "time of awareness" should be substituted for "time of introduction" to assess purchase behavior, with awareness occurring either prior to or after actual product introduction [Kotler & Zaltman (1976), Mahajan, Muller & Sharma (1984)]. The timing of awareness being the earliest stage in the adoption process and a key link to a consumer's perception of newness, it

serves as an indicator of a company's marketing effectiveness (advertising, promotion and distribution efforts) in getting its product known.

This applies specifically to innovators since they rely to a greater degree on mass media information (rather than on interpersonal communication) for making a purchase decision. However, the literature reveals a much greater use of time of introduction, as the standard of reference, due to the appeal 1) of the uniqueness of the time being measured (the same for all individuals), and 2) of the objectivity with which it can be determined (observed rather than recalled),[4] an advantage which must be accounted for when deciding on a standard of reference.

While inaccuracies are less important, for obvious reasons, in studies based on timing of product introduction, the true extent of innovators' impact may not be revealed. In that respect, researchers have had to trade off greater accuracy in terms of timing of adoption and greater accuracy in terms of categorizing individuals, which may have a definite impact on the determination of diffusion patterns, as mentioned above.

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[4]Only few studies have measured actual time of awareness, through the use of redeemable coupons, for example [Arndt (1967)]. Some authors have used "perception of product age" as a proxy [Midgley (1974)].

In an attempt to avoid discrepancies inherent to the recalling of time of awareness or of purchase, some authors have linked degree of innovativeness with new product ownership level [Robertson & Myers (1969), Summers (1971), Baumgarten (1974)]. Two problems are associated with this approach: First, it has been shown that individuals do not demonstrate the same degree of innovativeness for all products, even when all products considered belong to a relatively homogeneous category, such as cosmetics, food items, etc.. [Midgley (1977)]. Categorizing individuals according to the number of items owned may thus lead to an underestimation of fewer-item owners' innovativeness with respect to those particular items. This, to our knowledge, has not been investigated. Second, when using such a categorization scheme, no standard is available to determine who are the innovators: A rule of thumb must be used in terms of number of items owned.

All approaches reviewed above were conducted **a posteriori**, once purchasing had taken place. Another approach, suggested by Kotler & Zaltman (1976) consists in enquiring **a priori** about one's assessment of one's own most likely time of purchase, assuming intention to buy. If reference is made to one's usual purchase behavior in eliciting such information, the procedure may provide a valuable insight about potential behavior at the concept-testing stage of new product development. In such cases, however, some degree of uncertainty remains as to the actual timing of an individual's (eventual) purchase, the emerging adopter

categorization being an approximation at best, to be used with caution in the forecasting of sales [Tauber (1977)].

b) Adoption as repeat purchasing.

In appraising the diffusion process through time, authors have often restricted their framework to the trial phase of buying behavior. A more complex scheme has emerged from Rogers' (1962) work, however, which predicts success/failure of a new product by tying-in repeat purchasing and thus, by integrating diffusion, adoption and life cycle concepts [Midgley (1977), Silk & Urban (1978), Kalwani & Silk (1980)].

More specifically, considering the intricate relationship between the adoption process and the shape of the PLC curve[5], several authors have insisted on the importance of determining the pace and extent of repeat purchases triggered by the frequency of need for the product and the level of satisfaction/ dissatisfaction related to prior expectations [Mahajan & Muller (1982), Mahajan, Wind & Sharma (1983), Goering (1985)]. A number of authors came to the conclusion that overall, innovators seem to have a greater propensity to repeat purchases than do later adopters [Fourt & Woodlock (1960), Parfitt & Collins (1968), Massy (1969), Nakanishi

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[5]The PLC concept has met with difficulties in the past. Studies by Levitt (1965), Cox (1967), Polli & Cook (1969) and Buzzell (1970) are among those which have provided early empirical evidence supporting more complex shapes of the PLC curve. Dhalla & Yuspeh (1976) also caution against a hasty interpretation of the curve's plateaus and declines as falsely indicating stages of maturity or decline.

(1973), Eskin (1973), Blattberg & Golanty (1978)]. An excellent review of contributions up to 1980 is provided by Kalwani & Silk (1980).

However, the pattern for durable goods appears very different from that of frequently purchased consumer products in that first-time purchasers may not replace the product before most of the population has adopted it. In such cases, the study of diffusion is thus usually limited to the trial phase [Bass (1980), Easingwood, Mahajan & Muller (1983)]. Finally, the frequency of introduction of new products (brands) is also important in that respect since it bears directly on the PLC as increased introductions shorten the lifespan of previous brands which tend to become obsolete faster.

4. Linking innovativeness to interpersonal communication patterns.

Rogers & Shoemaker (1971) provide us with an excellent overview of earlier contributions in the field of diffusion of innovations, underlining interpersonal communication (as opposed to mass media) as the central process. As opposed to earlier adopters, later adopters' time of adoption depends more heavily on the amount and perceived significance of (i.e., the degree of influence exerted by) interpersonal communication taking place. This is a voluntarily partial view of the communication process that characterizes diffusion, to allow us to concentrate on what

characterizes different types of adopters.

Efforts in the area of interpersonal influence have mainly consisted in attempts to link leadership and influence to innovativeness, i.e., to determine how and to what extent perceptions and behavior of early adopters affect other individuals through interpersonal communication. The sociometric content of surveys in the recent literature reflects the greater emphasis being put on relational analysis, or the investigation of communication patterns, as opposed to the monadic view of human behavior that earlier work tended to emphasize.

The concept of influence through interpersonal communication was operationalized long ago by Lazarsfeld, Berelson & Gaudet (1944). These authors led the way to further questioning about the effect of word-of-mouth on both awareness and purchase decision, as illustrated in the 1950's and 1960's by Caplow (1952), Whyte (1954), Menzel & Katz (1955), Ferber & Wales (1958), Coleman, Katz & Menzel (1966), Bauer & Wortzel (1966) and Engel et al. (1969).

With the exception of Whyte (1954)[6], these early studies attempted to assess the impact of word-of-mouth through direct probing of respondents, by asking them to recall particular instances of influence. In more recent years, researchers went

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[6]Whyte (1954) proceeded by observing on which houses of Philadelphia air conditioning boxes were located.

beyond such topical approaches to assess an individual's propensity (as perceived by the respondent) either to seek others' advice before making a purchase decision, or to give out advice after adopting the product. Marketing contributions in that field include those of Bell (1963), King (1963), Arndt (1967), Robertson & Myers (1969), Sheth (1971), Summers (1971), and, more recently, of Mahajan, Muller & Kerin (1984), Leonard-Barton (1985), Johnson-Brown & Reingen (1987) and Bearden et al. (1989). With the exception of Summers (1971) and of Bearden et al. (1989), these studies do not use sophisticated measures of either opinion leadership or of susceptibility to interpersonal influence.

With respect to leadership, it does not appear necessary to resort to more advanced investigations of the concept in the context of diffusion. Indeed, what is important here is not to investigate the specific characteristics of opinion leaders, but rather to identify these individuals in the most simple way and monitor their influence as diffusion agents, as it was shown that only a relatively small proportion of innovators need be opinion leaders for the diffusion process to operate successfully [Summers (1971), Midgley (1974), Baumgarten (1974)].

As for the assessment of one's susceptibility to interpersonal influence, Kotler & Zaltman (1976) suggest eliciting information from consumers about their usual or most likely purchase behavior, in the context of interpersonal communication as well as in the

context, mentioned earlier, of time of adoption. Although in reality, individuals' actual behavior may not be in conformity with usual patterns thus revealed, either because of a change in behavior patterns or because of inaccurate individual assessments, such insights are valuable when market data is unavailable, especially at the concept-testing stage of new product development. This approach is being followed by authors such as Bearden et al. (1989) who probe consumers' usual purchase behavior in regard of one's need for prior reassurance and approval from peers as to the final choice.

B. Modelling the dynamics of the diffusion process

Most of the studies reviewed above, whether investigating personal characteristics or perceptions, or seeking a better understanding of time/communication patterns, do not attempt to address the dynamics of the diffusion process. They often rely on one-time surveys and thus remain essentially static.

Parallel to these, however, a number of contributions have attempted to capture the dynamic nature of adoption and diffusion by considering the flow rates and transfer mechanisms from untapped market to potential market to current market, as well as reverse flows. Recent developments incorporate the time-varying impact of product awareness, purchase capacity, marketing variables, repeat purchasing, forgetting, brand switching, competition, negative communication, and other factors, on the diffusion process. Recent

reviews of such developments can be found in Mahajan & Peterson (1985), Mahajan & Wind (1986) and Mahajan, Muller & Bass (1990).

Among the transfer mechanisms considered, word-of-mouth, mass media and other marketing efforts, individual experience and exogenous factors such as the economic environment and technological change have been generalized throughout modelling efforts.

A number of contributions have focused on the market itself, with more sophisticated models allowing for complex transfer patterns among the different markets (untapped, potential, current), and for market expansion/contraction [Dodson & Muller (1978), Mahajan & Peterson (1978, 1985), Mahajan et al. (1979), Horsky & Simon (1983)]. We need not elaborate on these for the purpose of our research. Rather, we will concentrate on the modelling efforts regarding the time/ communication dimensions of diffusion dynamics.

1. The basic model.

Modelling efforts in diffusion research started by considering only two sources of influence, or two basic transfer mechanisms: mass media (or marketing activities) and interpersonal communication (or word-of-mouth). These efforts resulted in two early models which are the external-influence model and the internal influence model.

The **external-influence** model: $dN_t/dt = \mathbf{a}\ (N - N_t)$, deals exclusively with the mass-media communication process through the coefficient of innovation **a**, where N_t is the current market, and $N - N_t$ is the potential market. In marketing, such an approach is attributed to Fourt & Woodlock (1960) who sought to forecast sales of grocery products. The corresponding distribution function was represented by a modified exponential curve (negative exponent). The underlying assumption is that the rate of diffusion at time t is dependent only upon the number of potential adopters, with no interaction between potential and prior adopters.

The **internal-influence** model: $dN_t/dt = \mathbf{b}\ N_t\ (N - N_t)$, is based on the contagion paradigm such that diffusion occurs solely through interpersonal contacts and thus represents a pure imitation process (the $N_t\ (N - N_t)$ interaction term above). The corresponding cumulative adopters distribution function is represented by a logistic diffusion curve. This approach is illustrated by the work of Mansfield (1961) who investigated the diffusion of several industrial innovations. Revised forms of the Mansfield model were later proposed by Fisher & Pry (1971) and by Blackman (1974). This approach seems particularly appropriate when the innovation is complex (risk bearing) and socially visible, and where there is a need for experiential or legitimizing information prior to adoption [Mahajan & Peterson (1985)].

These two approaches were later integrated into what is known as the **mixed-influence** model: $dN_t/dt = (\mathbf{a} + \mathbf{b}\ N_t)\ (N - N_t)$ which can accommodate the assumptions of both earlier approaches. The initial application of the mixed-influence model is attributed to Bass (1969) who used the model to forecast sales of consumer durable goods. The "two-step" flow [Robertson (1971)] of 1) innovation through mass- media communication and of 2) imitation through word-of-mouth was modeled by Bass in the following way:

$$P(T) = \mathbf{p} + \mathbf{q}\ F(T)$$

where
- $F(T) = Y(T)/m$ = proportion of previous buyers;
- $Y(T)$ = number of previous buyers;
- m = ultimate number of buyers over the period (life of the product);
- $\mathbf{p}$ = coefficient of innovation (constant);
- $\mathbf{q}$ = coefficient of imitation (constant);
- $P(T)$ = probability of initial purchase at T.

Bass' (1969) model was later criticized by Lekvall and Wahlbin (1973) who suggested that both external and internal influences operated simultaneously, on any potential adopter, at varying degrees, depending on the prevailing situation.

Other authors have questioned the model's utility as a forecasting technique due to limitations inherent to its basic structure [Heeler & Hustad (1980) and Schmittlein & Mahajan (1982)]. Deficiencies were said to reside in two of the model's mathematical properties, namely point of inflection and symmetry. Several improvements have been proposed in that respect [Sharif & Kabir (1976), Jeuland (1981), Easingwood et al. (1983), Kalish &

Lilien (1983)], one consisting in letting the coefficient of imitation systematically vary over time to allow the diffusion curve to be nonsymmetrical, with the point of inflection responding to the diffusion process.

2. Extensions and refinements.

a) External and internal coefficients as functions of marketing variables.

A number of extensions have aimed at relaxing the model's basic assumption that diffusion is a function of time only. The effect of a number of variables such as the firm's marketing efforts, or the demand elasticity, was explicitly entered into the model by setting the coefficients of **a** external and **b** internal influence and the total number of potential and current customers as functions of a vector of the relevant variables. Examples of relevant variables for N_t are: price [Chow (1967), Bass (1980), Horsky (1990)], advertising [Dodson & Muller (1978), Mahajan & Peterson (1978)], distribution and population growth [Mahajan & Peterson (1978), Sharif & Ramanathan (1981)], product benefits and income [Horsky (1990)]. Mahajan & Peterson (1978) have also incorporated the effect of exogenous factors such as economic conditions and changing individual characteristics.

Some argument has taken place about whether **a** or **b** should be represented as a function of such diffusion-influencing variables. Robinson & Lakhani (1975), for example, argued that because **a** was

found to be relatively small for consumer durables, **b** rather than **a** should be developed as a function of marketing decision variables in that case. Others such as Horsky & Simon (1983) suggested that both external and internal coefficients should be set as functions of marketing variables and allowed to fluctuate to reflect changes in their relative importance that take place with the passage of time and as diffusion expands, which reflects the fact that imitators are subjected to more than just internal influence.

b) Expansion of model scope.

Having integrated into the model the impact of marketing variables and of exogenous factors on the diffusion process, marketing researchers have pursued several avenues to expand the scope of the model, four of which represent major advances in diffusion research and are briefly reviewed below.

One has to do with the direction -positive or negative- of personal influence being exerted. In most model developments up to the mid-seventies, no account was made of possible negative influences on the flows from one category of individuals to another. Midgley (1976), Sharif & Ramanathan (1982) and Mahajan, Muller & Kerin (1984) provide such extensions by considering the effect of positive, negative and neutral word-of-mouth.

Another interesting development by Peterson & Mahajan (1978) consists in incorporating the effect of the relationship among

products into the coefficient of internal influence: having identified four product relationships (independent, complementary, contingent and substitute), they model the influence that adopters of a product may have on the potential adopters of another product. Furthering research in that direction could give valuable input to managers who wish to take account of consumer perceptions of other products introduced by the firm itself or by competitors (and thus account for possible switching or cannibalization) in positioning their own innovation.

The third area of scope expansion consists in the account recent modelling efforts have made of the complexities of pricing and advertising strategies of competing firms launching new products and who seek to reach market equilibrium [Eliashberg & Jeuland (1982), Mate (1982), Teng & Thompson (1983), Fershtman et al. (1983), Rao & Bass (1984)]. However, these are more analytically oriented and mathematically sophisticated contributions which pose greater implementation difficulties due to data requirements, and thus present limitations with respect to the empirical testing of hypotheses.

Finally, stochastic models of diffusion have appeared in the past decade. Tapiero (1983), Eliashberg et al. (1985), Böker (1987) and Eliashberg & Chatterjee (1988), among others, have considered that (1) there is a probability associated with people coming into contact with advertising and/or buyers; (2) if contact is

established, there is only a chance that the information about the new product will be transmitted and received; and (3) if people are informed and thus influenced, there is a probability associated with resulting purchase behaviors (trial and repeat). In that respect, various stochastic approaches have been used, such as the Markov process adopted by Tapiero (1983).

So far, empirical validation of such models is scarce, and the improvement they may represent over deterministic approaches remains to be more fully assessed. However, probabilistic approaches are intuitively appealing, particularly at the concept-testing stage of new product development. They also gain support from new developments on stochastic processes of purchase behavior [Chatterjee & Eliashberg (1990), Wheat & Morrison (1990)], as will be reviewed below.

c) The categorization of adopters.

In addition to these models' foremost value as predictive and diagnostic instruments of new product diffusion, a recent contribution has shown how adopter categorization can benefit from them as well: Mahajan, Muller & Srivastava (1990) have demonstrated the usefulness of Bass'(1969) model to refine Rogers'(1962) convenient but somewhat arbitrary categorization, especially in cases where the normal distribution diffusion pattern assumed by the author appears questionable. They also provide empirical evidence about significant fluctuations among products in the

percentage of total adopters that each category represents.

Their approach, in line with Ziemer's (1985) earlier suggestions, consists in examining trends in both the non-cumulative adopter distribution [df_t/dt] and its rate of distribution [d^2f_t/d^2t]. Using such trends, one can categorize adopters into four groups based on time of adoption, respectively characterized by:

1. a trend increasing faster at an increasing rate;
2. a trend increasing slowly at a decreasing rate;
3. a trend decreasing slowly and then faster at an increasing rate;
4. a trend decreasing faster and then slowly at a decreasing rate.

The category limits are then derived from the inflection and peak points.

When no prior data is available at the concept-testing stage of new product development, for example, estimation of the potential market size **m**, time of non-cumulative adoption peak **T*** and adoption level at peak time **n*** [Mahajan & Sharma (1986)] or of the potential market size **m**, number of adoptions in first time period S_1 and sum of external and internal influence coefficients **p+q** [Lawrence & Lawton (1981)], necessary to calibrate the model, can be done by way of managerial judgment of actual or anticipated figures or through analogical approaches [Srivastava et al. (1985), Gatignon et al. (1989), Montgomery & Srinivasan (1989), Sultan et al. (1990)].

d) Accounting for market heterogeneity.

All developments reviewed to this point share a major modelling restriction in that they deal with the aggregate market, decomposed into time periods: Consumers are assumed to be homogeneous in their expected utility for (or benefits sought from) the product, if not in other personal characteristics. Recently, however, a number of authors have factored-in the heterogeneity of the market by specifying adoption decisions at the individual level, thus attempting to integrate further adoption and diffusion theories by deriving diffusion models from individual adoption decisions.

Such an approach considers that each potential adopter has uncertain perceptions about the new product's performance, value or benefits which affect one's utility for the product. The level of utility can either increase or decrease as learning takes place through mass media or interpersonal communication. When faced with different product alternatives, it is then assumed that an individual will purchase the alternative for which he has the highest utility, following a deterministic choice pattern.

Aggregation across potential adopters is then realized on the basis of criteria such as the mean of individual perceptions about the product's profitability [Feder & O'Mara (1982), Jensen (1982)], incremental benefit [Lattin & Roberts (1989)] or price/performance tradeoff [Chatterjee & Eliashberg (1990)], sometimes integrating

a risk-aversion parameter [Oren & Schwartz (1988), Chatterjee & Eliashberg (1990)], consequently yielding the cumulative adoption curve. A brief review of such contributions is provided in Mahajan, Muller & Bass (1990).

In the same research context, an interesting model was developed by Zufryden (1988). The author proposes a stochastic model to predict trial and repeat purchases of a new product over a specified period of time, given a respondent's utility function derived from his stated preferences for different product profiles, by way of a conjoint analysis. He derives purchase probabilities based on these individual utilities and conditional upon the occurrence of a number of purchase occasions and a mean product category purchase rate. An aggregation of purchase probabilities across individuals then allows to derive demand curves over time for each product alternative, and thus to evaluate new product market opportunities.

From the general perspective of consumer behavior, such approaches are warranted by the considerable evidence on market heterogeneity of perceptions and preferences provided in consumer measurement studies. Particularly relevant here are recent contributions on the stochastic process of interpurchase timing [Wheat & Morrison (1990), Gupta (1991), Gupta & Morrison (1991), Jain & Vilcassim (1991)]. From the point of view of diffusion theory, in conjunction with the stochastic developments mentioned

earlier, they contribute to viewing the process of innovation acceptance in direct relation to idiosyncratic utilities and probabilistic patterns of behavior through time.

However, they fall short of capturing the possible differences between adopter categories in terms of preferences for given product characteristics and consequently may not capitalize fully on the diffusion process that takes place. They also fail to extend the stochastic developments to the timing of purchase of subjects being categorized in different adopter groups, which would account for the inherent uncertainty characterizing **a priori** measurement, as mentioned earlier [Kotler & Zaltman (1976)].

While market heterogeneity has often been defined in terms of intrinsic individual characteristics, such as those mentioned earlier, a number of attempts have also been made to explain it through prevailing purchase contexts and situations. One may view the diffusion -or market status- variables which are of interest to us, i.e., time of introduction of the product and degree of interpersonal communication having taken place, within such a framework. A review of relevant situational dimensions of preference analysis is thus presented below, and implications with respect to adopter categories are drawn.

C. Consumer preferences and the role of moderating variables

In the context of new product development, preference analysis has aimed at providing managers with some essential ingredients for successfully positioning their innovation and better targeting their market, by uncovering consumer perception and preference patterns for new product alternatives and specific product features. It has progressively recognized the importance of viewing the market as essentially heterogeneous to avoid the "majority fallacy" of average consumer preferences, by promoting what is now well known as benefit segmentation.

In that perspective, several customer-based approaches for product concept evaluation and generation have been developed, multiattribute approaches being among the most popular and widely used [Shocker & Srinivasan (1979)]. Multiattribute research can be viewed in the general framework of compositional vs. decompositional approaches which differ in the way individual preferences are assessed, either by deriving an overall evaluation of the product based on fragmented consumer judgments about its components (attributes), or by deriving scores for the parts based on judgments about the whole. The latter approach is well illustrated in applications of conjoint analysis, possibly the analytical approach most widely applied commercially today [Wittink & Cattin (1989)].

While considerable efforts have been extended to elicit and measure consumer preferences, the role of moderators such as situational variables or individual perceptions of intangible attributes have yet to be fully assessed. A number of marketing scholars have investigated their potential impact, based on major contributions of the past two decades in social psychology.

In both literatures, environmental and situational variables now emerge as potentially strong explanatory factors of individual attitudes, preferences and behavior [Sandell (1968), Belk (1974), Hustad et al. (1975), Miller & Ginter (1979), Dickson (1982), Shaw et al. (1989)]. In marketing, research in this area has followed two major axes, one focusing on the "secondary", "subjective" or "intangible" product attributes, the other, closely related, on situational variables. Both approaches are reviewed below.

1. Tangible and intangible product features.

The "secondary", "subjective" or "intangible" product characteristics consist in general perceptions individuals have of given products, along a series of dimensions. In their review of 75 studies of innovation characteristics over the past three decades, Tornatzky & Klein (1982) mention the following dimensions as those most often measured: Rogers'(1962) five general attributes: relative advantage, complexity, compatibility, divisibility (trialability) and communicability (observability), perceived risk [Ostlund (1974)], cost, profitability, and social

approval, all mentioned earlier as potential determinants of innovativeness. Elaborate operationalizations of most of these variables can be found in Holak & Lehmann (1990) who show that up to 15 different constructs have been used concurrently to derive perceptions about a particular intangible attribute.

The major contribution of authors such as Downs & Mohr (1976), Tornatzky & Klein (1982), Rogers (1983) and Holak & Lehmann (1990) lies in the impact perceptions of "secondary" variables are shown to have on individuals' overall product evaluations, choices, intentions to buy and purchase probabilities. In particular, Rogers (1983) points out various studies which show that up to 89% of the variance in the rate of adoption can be explained by such variables. Also, Holak & Lehmann (1990) reveal the importance of interactions and establish a number of causal links among those variables.

In their inter-disciplinary summary of innovation research, Gatignon & Robertson (1985) call for increased efforts in that direction. Indeed, very few of the earlier studies had attempted to analyze the inter-dependence of such variables [Tornatzky & Klein (1982)]. Furthermore, researchers have neglected to directly relate "secondary" attributes with "primary" (actionable) product features, and to pay adequate attention to the distinction between the two, so that the former's discriminant validity is not well established [Downs & Mohr (1976), Tauber (1981), Robertson (1984)].

Downs & Mohr (1976) have well stated the problem when writing:

> "The crucial difference between secondary and primary attributes (...) indicates that we must build the idea of statistical interaction into our models of innovation. When we recognize that different organizations or individuals classify the same innovation into different categories (perceptions), and also that determinants vary in existence or strength depending upon the category in which the innovation is classified, we are recognizing the existence of interaction."

The earlier-mentioned characteristics of innovativeness, namely time of adoption and amount of interpersonal communication prior to purchasing, are closely linked to at least two of the "subjective" dimensions reviewed above, namely compatibility and perceived risk. Compatibility was defined by Rogers & Shoemaker (1971) as the degree to which an innovation is perceived as being consistent with existing values, past experiences and needs of consumers, or as the congruence with existing practices of adopters. Time of adoption (relative to time of introduction) and degree of interpersonal communication certainly appear to fit this definition. As well, they may be thought of as determinants of perceived risk (at least for later adopters).

In their review article, Tornatzky & Klein (1982) outline compatibility as one of the strongest predictors of adoption, which was confirmed by Holak & Lehmann (1990), who used purchase intention as the dependent variable in their empirical study. Compatibility was also shown to bear a statistically significant negative correlation with perceived risk, with the latter having

the strongest negative impact and the former the strongest positive impact on purchase intention.

The underlying rationale of the above is useful to understand the appeal of looking into possible interactions between diffusion or market standing variables such as those mentioned earlier, and a number of "primary" product characteristics. Indeed, the moderating effect that diffusion-related factors may have on an individual's perception of otherwise "objective" product alternatives (in terms of price, packaging, warranty, etc...)[7] and, by extension, on his preference structure, remains obscure. We refer here more specifically to the knowledge (or perception) an individual has about the newness of a product (how long it has been on the market) and about the extent of communication that has taken place with respect to it. The extent and direction of the eventual impact of such moderating variables should be reflective of whether an individual is more of an innovator or of an imitator, and help uncover eventual differences in their preference structures for product alternatives.

The potentially determinant relationship between perceptions of tangible and intangible product features can be fully realized only when based on a sound approach to elicit consumer judgments. In

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[7]While objectivity is always challenged by the different perceptions individuals may have of a given price level, for example, the term is used here in contrast to the subjective nature of situational variables such as the purchase context or product usage [Downs & Mohr (1976)].

that respect, multiattribute-based studies have sometimes been criticized for assuming compensatory choice patterns, by which consumers make tradeoffs between all relevant tangible attributes of the product, even in situations where they are likely to adopt non-compensatory, lexicographic or conjunctive approaches to making a purchase decision [Johnson, Meyer & Ghose (1989)]. However, such misspecifications are often thought not to jeopardize the validity of the approach, although further investigation of the choice process is advised if non-compensatory patterns are suspected [Shocker & Srinivasan (1979)].

Furthermore, Wilton & Pessemier (1981) show the vulnerability of such commonly used multiattribute choice models, when applied to the early phases of the product life cycle, because of the ill-structured perceptions individuals have of new products. Using different information levels and contents, they show that individual perceptions change as learning progresses, influencing adoption and other forms of choice behavior. In the context of adopter categories, changes in perceptions and overall affective and cognitive reactions of respondents could be greater for later adopters (imitators) than for innovators.

Of particular importance in such a context would be to consider at what level of the innovation hierarchy the new product appears: the further away from an incremental improvement and the closer to a radical innovation the product is, the lower the degree of likely

acceptance, the greater the distance between innovators and imitators [Lancaster & Wright (1983)]. One will want to undertake research based on a more radical innovation to test for adopter differences.

Based on the above account, possible extensions and improvements would consist in accounting more directly for the potential impact of a product's market status, such as its degree of newness, market penetration, competitive environment, etc..., (related to diffusion characteristics of time of adoption and interpersonal communication) on preference or choice. Indeed, given their apparent link with some of the intangible dimensions mentioned earlier, they appear as potentially determinant factors in shaping individual perceptions of a new product and in guiding their purchase decision, while concurrently revealing adopter categories to which individuals most likely belong.

2. Situational variables.

The concept of situation has been at the center of a large number of studies, reviewed at length by Leigh & Martin (1981). The authors' selection of studies was based on Belk's (1975) classification of situational variables into physical surroundings, social surroundings, temporal perspective, task definition and antecedent states. But Belk's definition was considered too restrictive by a number of scholars, as it limited the scope of situational research to the outcome of extra-individual,

extra-stimulus influence [Kakkar & Lutz (1975)]. The definition was thus later extended to take into account individuals' internal psychological processes [Lutz & Kakkar (1975)], and has since remained the standard of reference.

Kakkar & Lutz (1975) stress that the growing emphasis in consumer research on the role of situational variables is the result of a concern among researchers that the environment surrounding a particular behavior needs to be investigated to more fully identify the determinants of that behavior. However, situational variables, like individual differences, were shown to be inadequate predictors of behavior when taken alone, thus requiring to be incorporated in a more complete research framework [Leigh & Martin (1981)].

Most situations under study are product usage and purchase context (including purpose of purchase such as gift giving). Supplier characteristics have also been considered (such as vendor support, credibility of supplier, supplier's market knowledge, etc...), although more often in an industrial context [Shaw et al. (1989)]. Common practice has been to provide respondents with a number of general situations and to elicit responses which reflect likelihood of purchasing, consuming or using specific brands, products, activities in those situations. The same products are used over all situations so that a response is obtained for each product-situation combination. A significant product-situation interaction indicates that respondents are relatively homogeneous

in their preferences for products in specific situations [Srivastava et al. (1978), Srivastava (1980), Warshaw (1980)].

Other interactions are of interest as well: A significant person-product interaction will reflect individual differences in preferences for specific products across situations, and a significant person-situation interaction will reflect individual differences in preference for specific situations across available product choices [Green & DeSarbo (1979), Dickson (1982)].

Most of the 40 studies surveyed (1968-1980) by Leigh & Martin (1981) show that the person-product and product-situation interactions are important predictors of product preferences, mainly in the context of frequently purchased consumer goods, but also in the case of some consumer durables, industrial goods, and services. Such findings have since been emphasized, an important contribution being that of Dickson (1982) which revives the concept of occasion-based (or person-situation) market segmentation introduced in the 1970's, itself having its theoretical foundation in Lewin's Field Theory [Lewin (1936), Kassarjian (1973)] and in modern interactionism [Ekehammer (1974)]. Such theories claim that each individual views each physical and sccial setting somewhat differently, which produces the variation in utility functions and consumption behavior that market segmentation attempts to harness.

Person-situation segmentation is thus viable when different groups have distinctly different demand schedules for different situations. This produces demand functions of the form:

$$Q_{ij} = F_{ij} (x1, x2, x3, ... xn)$$

where i = ith group of individuals;
j = jth situation;
x1, x2 ... = product characteristics.

[Dickson (1982)].

Another contribution in the field of market segmentation was initiated by Green, Carroll & Carmone (1976) and expanded by Green (1977) and Green & DeSarbo (1979) who introduced the "componential segmentation" approach to look at person x object, situation x object, person x situation and person x situation x object interactions. Its primary objective was to predict how a consumer, described in terms of a multiattribute profile, would choose among a set of alternative products, also described as multiattribute profiles.

The technique was later implemented by requiring from respondents to forecast what their personal situation would be after a certain event took place (graduating from college, for example), in terms of several background variables, and then to rate their preferences for a number of product descriptions, in the manner usual to conjoint measurement [Moore (1980)].[8] Attributes of the two

[8]A variant consists in providing respondents with a number of person descriptions along with product descriptions and asking them to match persons with products in a way they think most

profiles were then integrated in a single prediction model displaying product features main effects, person characteristics main effects and interactions between each product feature and each person characteristic.

Such a regression approach to the analysis of interactions via dummy variables presents great flexibility in that it can accommodate a number of different interactions involving product, person and situation, although restricted in its potential due to the larger number of observations required to estimate additional parameters.

In an industrial setting, Ettlie & Vellenga (1979) studied measures of adopting organizations as well as of new product characteristics. They examined the interaction between innovation features and decision-maker (organization) characteristics in predicting the time lag between stages in the adoption process, thus determining the different adopter categories. This is one of few contributions in which adopter categories have been integrated to the study of product-person interactions. The study did not go so far as to attempt uncovering possible differences in choices under alternative organizational features, however.

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appropriate. This approach may be weak on validity, however, given the respondent must imagine what product a particular individual (person description) different from himself would prefer.

The above review of research contributions reveals the increasing attention being given to the role such factors play as potential moderators of consumer product evaluations, choice patterns and purchase behavior [Moore (1980), Leigh & Martin (1981), Rogers (1983), Robertson (1984), Srivastava et al. (1984), Holak & Lehmann (1990)]. In this context, the differential impact of diffusion-related variables such as time of introduction and interpersonal communication remains to be investigated for the different adopter categories.

D. Summary

In the area of new product diffusion, authors have focused either on the actors (adopters) or on the diffusion process itself. A number of dimensions are common to both and have served either to identify and characterize individual adopters or to determine the process. Such is the case of the time and interpersonal communication factors, modeled as time-dependent internal and external influences. Other "actor" dimensions were later integrated in modelling efforts to more precisely capture and refine the diffusion process. Such is the case of individual characteristics (demographic, socio-economic and psychological), perceptions and preferences. A more complete integration of the "actor" and "process" approaches is thus being realized, with a recent trend in modelling efforts toward disaggregate (vs. aggregate) approaches to capture market heterogeneity (vs. earlier assumed homogeneity). However, potential differences between

adopter groups in terms of preferences for different product features and their possible impact on diffusion still need to be investigated. As well, probabilistic approaches to deriving **a priori** the timing of adoption has retained little attention.

In the area of preference analysis, individual characteristics have been investigated as potential determinants of consumer behavior, as have individual perceptions of products along dimensions representing intangible product attributes, a number of which are similar to those mentioned in the diffusion area. These were shown to bear on the adoption rate, either directly or by interacting with other intangible or tangible (actionable) attributes of the product. These can be viewed in relation to the more general context of situation-mediated preferences, where two-way and -at times- higher-order interactions between purchase, usage or other types of situations, person (consumer) and product, have proved in the past to be significant in a number of instances. However, diffusion factors related to a product's market status, such as time of adoption or degree of interpersonal communication, have yet to be appraised as potential mediators of preferences.

CHAPTER III

THEORETICAL FRAMEWORK

The theoretical framework on the basis of which this study was developed draws from both new product diffusion and mediated consumer preference research areas, reviewed above. In an attempt to link further diffusion research and preference research, two diffusion-related factors were retained, time of adoption (related to time of introduction) and interpersonal communication, both as determinants of adoption category and as "situational" moderators of individual preferences.

The possibility for differences to emerge between adopter groups in terms of preferences for given product features stems from a confirmation of adopter group differentiation on the basis of new product perception along a number of general dimensions, as revealed by the diffusion literature. As mentioned earlier, the dimensions most widely referred to are relative advantage, compatibility, complexity, communicability, trialability and perceived risk.

These dimensions have been operationalized in the past by using product-related factors such as physical features of the innovation and items related to its use and maintenance, as illustrated below:

Concept definition	Past operationalizations
Relative advantage: Degree to which innovation is perceived to be better than the idea it replaces (economic and non-economic considerations)	.availability of service .reliability of item in operation .price of item .number of unique features .degree of difference from existing items .mechanical advantage .flexibility .capacity of operation .maintenance required & ease of repair .amount of after-sales service required .time & effort savings .monetary value
Compatibility: Degree to which innovation is perceived to be consistent with existing values, habits, needs	.customer sentiment toward manufacturer .item's fit with customer's existing system .in-keeping with existing habits .social approval .extent to which item alters customer process .environmental impact
Complexity: Degree to which innovation is perceived as difficult to understand/use	.skill required for assembly .skill required for installation .number of operating instructions .technical complexity to customer .general level knowledge required .ease of operation .ease of understanding operation
Perceived risk: Degree to which product performance and/or psychological risks are attributed to product	.health factors associated with use .durability .consequences of product failure .availability of product warranties .likelihood of item's discontinuation
[Rogers & Shoemaker (1971), Ostlund (1974), Tornatzky & Klein (1982), Rogers (1983), Holak & Lehmann (1990)]	

On this basis, one is then entitled to believe that adopters from different adopter categories will tend to display significant

differences in their preference patterns for specific new product features, as they were shown to do in their perceptions, along the above underlying dimensions.

In addition to such features, price is often considered a product characteristic as well, serving as a segmentation variable and a discrimination factor among adopter categories. Indeed, pricing strategies that discriminate on a time basis, "skimming" for example, have often been devised in view of inherent differences between early and later adopters in terms of price sensitivity, for decision-making purposes. Price was therefore included among the product characteristics to be considered. However, due to the difficulty in linking price to any one of the underlying dimensions in particular (especially risk and relative advantage), it was included as a separate variable. Based on the above, the following hypotheses were developed:

H1 a) For earlier adopters, product features related to relative advantage and to compatibility have greater relative importances than price and features related to complexity and to risk.

b) For later adopters, price and features related to complexity and to risk have greater relative importances than features related to relative advantage and to compatibility.

H2 Relative to other features, the complexity- and risk-related features and price have a greater importance in the case of later adopters than in that of earlier adopters. Conversely, the compatibility- and relative advantage-related features have a greater relative importance for earlier adopters.

In the above hypotheses, a relative importance is the importance

a particular product feature has in relation to the other features within a particular adopter group, allowing for comparisons within group (across features) and among groups (same feature), as will be described in Chapter IV (Methodology).

In relation to the moderating role of diffusion-related variables, the time/communication situation (or context), within which a consumer purchases a product, was considered likely to influence that consumer's perception of (and thus his preference for) given product alternatives. The contextual impact can be expected to operate differently for early adopters than for later adopters. Indeed, the newness of the product rather than interpersonal communication is important in early adopters' decision-making: As newness fades (i.e., as the product grows old), the relative importance of changes in other product features can be expected to increase. Conversely, interpersonal communication rather than the product's newness is the important factor in later adopters' decision-making: The more reassurance one gets, the less important changes in other features are likely to become, relatively speaking.

Provided that the relative importance of a product's newness is greater in the case of early adopters, and that the relative importance of interpersonal communication is greater in the case of later adopters, it appears likely that the diffusion-related variables would have a differential impact on preferences,

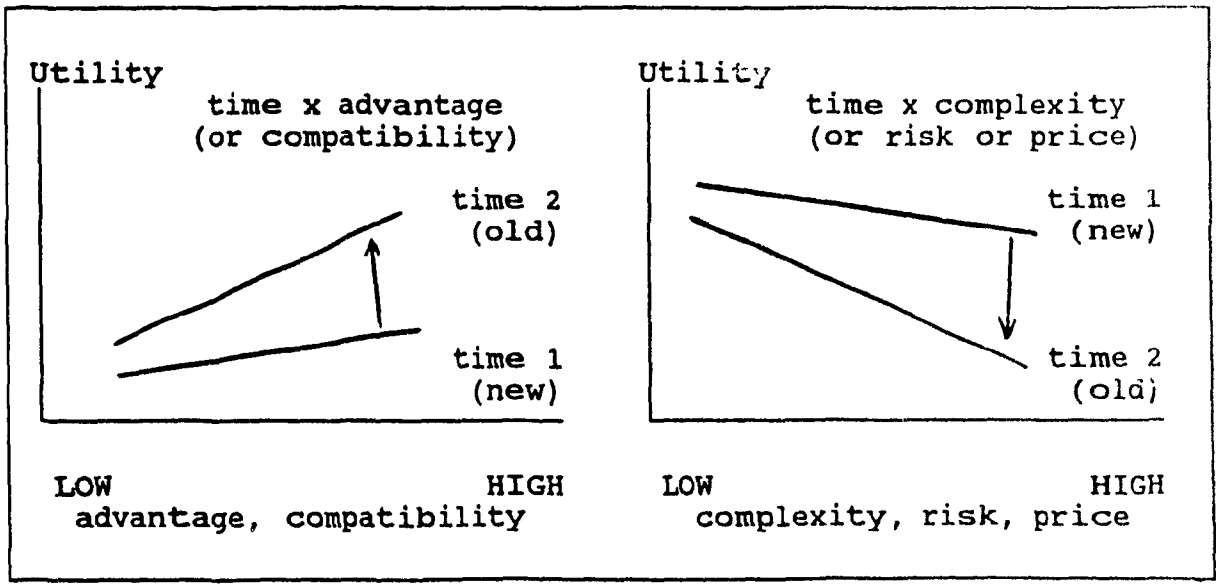
depending upon one's adopter category, and therefore that individuals from different adopter groups would display different interaction patterns. It is suggested that earlier adopters will be less sensitive to changes in product features in the case of newer vs. older products, while later adopters will be less sensitive to changes after much vs. little (or no) interpersonal communication has taken place:

H3a) **For earlier adopters:** Significant interactions occur between "time of introduction" and features related to relative advantage, compatibility, complexity, riskiness and price (SIGNIFICANCE).

They are positive for features related to relative advantage and compatibility, and negative for price and features related to complexity and risk (DIRECTION).

They are relatively more important than interactions between "interpersonal communication" and such features (RELATIVE IMPORTANCE).

Figure 1: Graphical illustration of anticipated interaction effects for earlier adopters (interactions with "time")

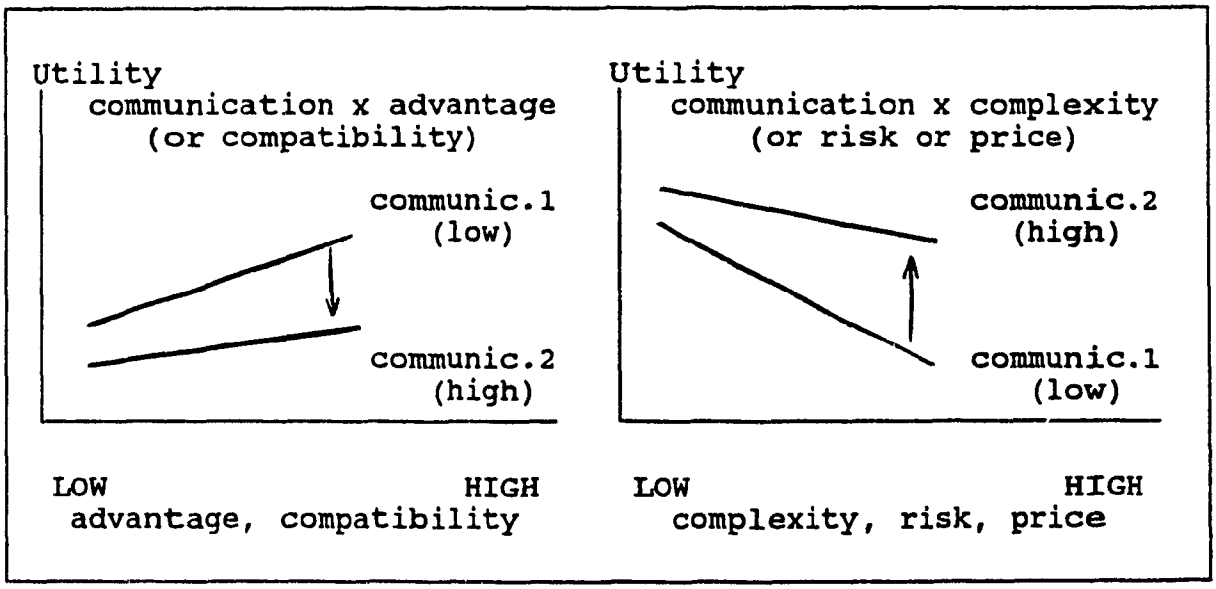


H3b) **For later adopters:** significant interactions occur between "interpersonal communication" and features related to relative advantage, compatibility, complexity, riskiness and price (SIGNIFICANCE).

They are negative for features related to relative advantage and compatibility, and positive for price and features related to complexity and risk (DIRECTION).

They are relatively more important than interactions between "time of introduction" and such features (RELATIVE IMPORTANCE).

Figure 2: Graphical illustration of anticipated interaction effects for later adopters (interactions with "communication")

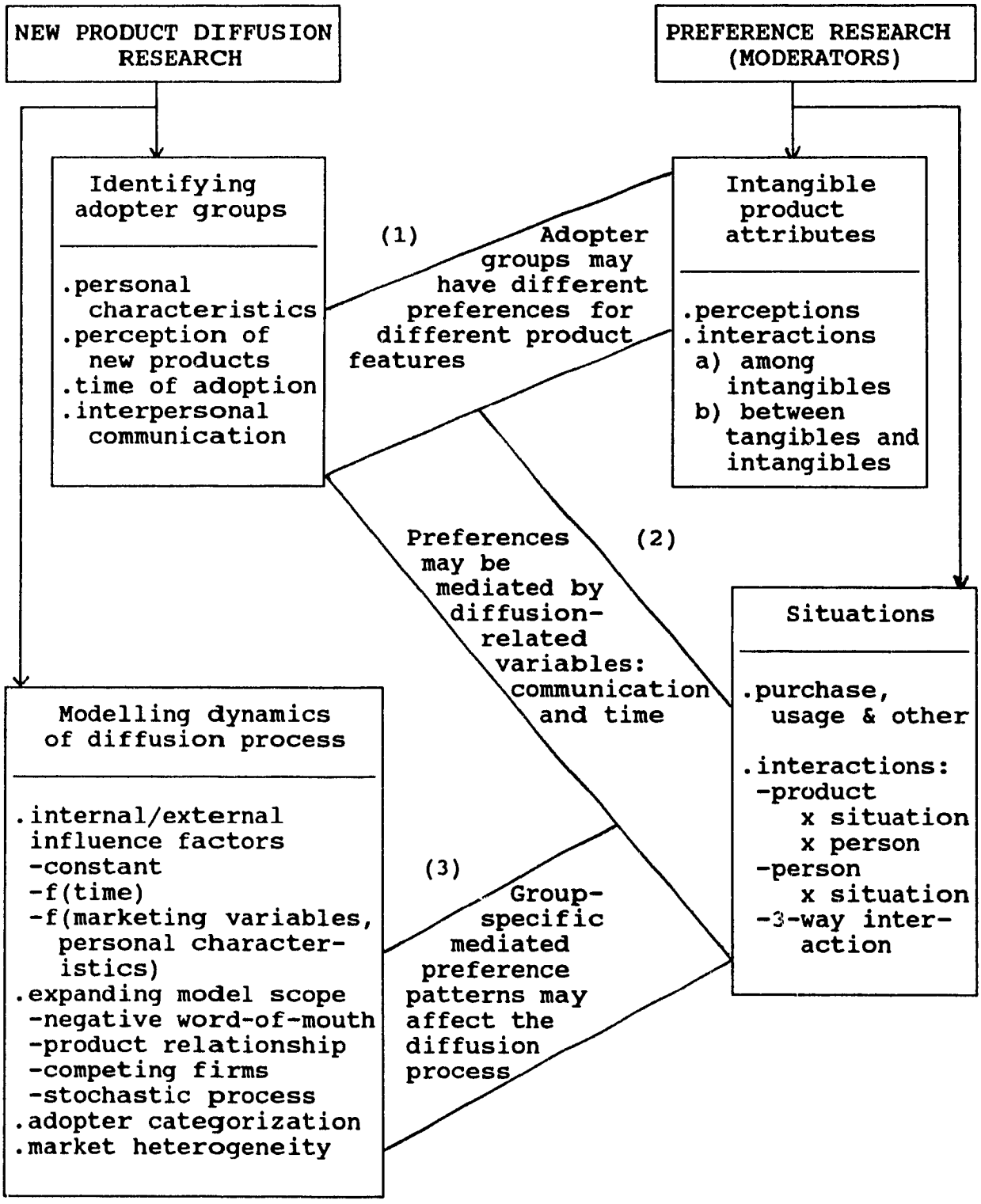


If both the above can be shown, i.e., that (1) different adopter groups tend to differ in their preference structures with respect to given product features, and that (2) time/ communication factors mediate one's preferences for such features, one may then conclude that both diffusion and consumer preference fields of research could gain in scope and depth from viewing consumer preferences in the light of adopter categories, and vice-versa, from viewing the

diffusion process in the light of differentiated consumer preferences.

Assuming differences in preference patterns do emerge, by extension one may expect to derive different "best alternatives" for each adopter category. One can then think of segmenting the market through time, in a longitudinal fashion, and of adapting the product accordingly, based on such disparities between adopter groups. For the purpose of the above, a probabilistic approach to deriving the timing of purchase may be retained, given the uncertainty which characterizes one's estimation of future behavior, as is the case at the concept-testing stage of new product development [Kotler & Zaltman (1976)].

The diagram below illustrates the current state of development in both the new product diffusion and consumer preference research areas, as well as the links this study attempts to establish between the two (numbered corridors), within the above framework, where (1) is addressed by hypotheses H1a), H1b) and H2, (2) is addressed by hypotheses H3a) and H3b), and (3) represents the market extensions such findings may lead to.


NEW PRODUCT DIFFUSION RESEARCH
PREFERENCE RESEARCH (MODERATORS)
Identifying adopter groups
.personal characteristics
.perception of new products
.time of adoption
.interpersonal communication
Intangible product attributes
.perceptions
.interactions
a) among intangibles
b) between tangibles and intangibles
(1) Adopter groups may have different preferences for different product features
Preferences may be mediated by diffusion-related variables: communication and time
(2)
Situations
.purchase, usage & other
.interactions:
-product x situation x person
-person x situation
-3-way interaction
Modelling dynamics of diffusion process
.internal/external influence factors
-constant
-f(time)
-f(marketing variables, personal characteristics)
.expanding model scope
-negative word-of-mouth
-product relationship
-competing firms
-stochastic process
.adopter categorization
.market heterogeneity
(3) Group-specific mediated preference patterns may affect the diffusion process

CHAPTER IV

METHODOLOGY

A multiattribute approach to eliciting respondent preferences was retained. This required: **step 1-** to choose an appropriate product and decide how to describe it to respondents (using information from the manufacturer); **step 2-** to determine which attributes were to be tested (focus group) and to select the sample (convenience).

A number of pretests were then conducted prior to the main data analysis (hypothesis testing). They consist of: **step 3-** ascertaining the appropriateness of the sample and refining the selection of important attributes and the product description; **step 4-** ensuring that perceptions of major factors were in conformity with reality, and finalizing the choice of attributes and product description; and finally, following the development of the analytical model (**step 5**) and experimental design (**step 6**) to be used, **step 7-** testing the appropriateness of a proxy for one of the variables to be analyzed. Multiple pretesting was required for several reasons: to allow for the integration and testing, in a structured setting, of earlier answers to open-ended questions; to avoid over-burdening respondents with lengthy and complicated questionnaires that could have become unmanageable; and because testing the content of product profiles (step 7) required prior determination of attributes to be retained.

Data analysis related to hypothesis testing was undertaken in the next two steps: **step 8-** consisted in categorizing respondents into adopter groups and testing hypotheses H1a), H1b) and H2, based on conjoint utilities derived from an OLS-calibrated main-effects model, after conducting the appropriate reliability and validity tests; and **step 9-** consisted in testing hypotheses H3a) and H3b) about interaction effects, with the calibration and selection of reduced interaction models being performed at the group level. Finally, the estimation of purchase probabilities and determination of the best product alternative through time were undertaken in **step 10-** by way of a multinomial Logit model.

The table below summarizes these steps. The comments on the right side of the Table give the broad lines of the procedures and approaches that were used.

1.	Choice of product and product description	secondary information sources
2.	Choice of respondents and determination of important attributes	convenience sample, focus group
3.	First pretest of product description, of product attribute importances and of adequacy of choice of product and respondents	respondents' stated importances for product attributes; measure of familiarity and interest in product; perceptions about products

4.	Second pretest of product description and attribute importances and tests of reality vs. perception	as in 3. & comparison of real & perceived time of introduction & market penetration levels for 5 consumer electronics goods; split-half sample for 2 markets
5.	Development of the conjoint model	choice of attributes, levels and interactions to be retained
6.	Development of the experimental design	size & balancing of fractional factorial compromise design
7.	Third pretest: conjoint profiles using information on market penetration or word-of-mouth: test of perceived correspondence and difference in ratings between the 2 concepts	split-half sample to check for differences in preference judgments regarding "word-of-mouth" profiles vs. "market penetration" profiles; eliciting perceptions about which levels of one variable correspond to levels of other
8.	Conjoint analysis; main-effects model, idiosyncratic utilities & categorization scheme for determining adopter groups (testing of H1a), H1b), H2)	regression and correlation approaches used at individual levels, predictive validity on holdout profiles; analysis of individual utilities of diffusion-related variables; Rogers'(1962) categorization
9.	Analysis of interaction terms, choice of best model at group level (testing of hypotheses H3a), H3b))	regression and correlation approaches used at aggregate level, predictive validity on holdout profiles; stepwise procedures.

10.	Determination and aggregation of purchase probabilities across respondents at given time periods, for each product alternative, & development of an adoption curve	purchase probabilities derived from conjoint results, averaged across respondents, using a Logit choice model applied across time.

For convenience purposes, these steps will be covered by subject rather than chronologically, along the following outline:

A. Product description and choice of attributes (steps 1-4);

B. Respondent characteristics and perceptions (steps 3, 4, 7);

C. Conjoint model and experimental design (steps 5, 6);

D. Hypothesis testing: main effects and interaction effects (steps 8, 9);

E. Logit choice model for the determination of purchase probabilities (step 10).

A. Product description and choice of attributes

The product that was chosen for this study is a hand-held scanner, developed to facilitate the programming of VCR's. It was called SCAN-05. Although not an "independent" innovation in the sense that it is essentially an accessory product to be used in conjunction with some other piece of equipment (here a VCR), the product falls into a well-established category of consumer durable goods (consumer entertainment electronics), is designed to perform an essential function (programming) in the use of a popular

technological good (VCR), was conceived to be handled by individuals of average intelligence and dexterity, and thus can be considered as a typical item within its category. Consequently, results from a study based on such an innovation could be generalizable to durable goods in consumer electronics.

To our knowledge, this product, which is actually being manufactured by Panasonic, had not yet been introduced on the Canadian market and had been on the U.S. market for only a short while at the time this study was conducted. At the early stages of this research, it was thus estimated that few if any of the respondents would be likely to have heard about it. This was later confirmed with a specific question about one's knowledge of the product prior to the survey. It was therefore possible to avoid any bias resulting from one's prior awareness and knowledge of the product. The description of the product was prepared from printed material provided by the manufacturer.

In attempting to identify adopter groups and monitor their stated preferences for different product features, it was necessary first to determine the product attributes to be retained. A focus group session and two pretests were conducted with that objective in mind. Graduate (focus group) and undergraduate (pretests) students were used as respondents.

For the purpose of later determining respondents' degree of innovativeness and preference patterns, and classifying respondents into different adopter groups, it appeared that full-time students would not constitute an adequate pool of respondents: Indeed, they may not be representative of the population distribution of adopter categories, due to higher education and younger age, and also because of a lack of financial independence, as many full-time students still live with their parents, among other factors.

For these reasons, it was thought that the use of adult students (a large majority of whom work during the day) would help avoid the usual biases that occur with student respondents while retaining the convenience of conducting the pretests and final survey on campus. Respondents were therefore selected from evening classes.

1. Focus group.

A focus group composed of 6 graduate students was used to generate characteristics of the scanner that were thought to be important in making a decision to purchase. The participants were only provided with a short description and picture of the scanner. An exploratory approach was used, which allowed group members to talk freely and encouraged them to generate ideas in an informal manner [Wells (1974), Cox et al.(1976), Calder (1977)], the researcher's role being otherwise restricted to answering questions some group members had about the actual operation of the scanner, given no prototype of the scanner was available for participants

to operate. The focus group participants came up with a number of important attributes which are reported in Appendix 1A.

2. First pretest.

Seven of these attributes were pre-selected and incorporated in a questionnaire to elicit individual importances. 39 undergraduate students were used for that purpose. They were handed-out the same short description and picture of the scanner, followed by a four-page questionnaire (Appendix 1B) to determine:

- how familiar respondents were with VCR's and scanners;
- how interested they were in VCR's and scanners;
- how many respondents already had a VCR;
- how important the 7 pre-selected and other characteristics of the scanner would be in making a purchase decision;
- how the scanner was perceived in terms of novelty/innovation;
- whether respondents would consider buying such a device provided they had a VCR and the price was right.

The product characteristics retained were selected among those which the focus group had identified as most important. They are:

1. physical appearance of the scanner
2. ease of handling
3. capability to read poorly printed codes
4. compatibility with other VCR's and appliances
5. price
6. warranty
7. manufacturer's reputation.

A brief description of the first four items was provided. Respondents were asked to rate on a 5-point scale the importance each attribute would have in their making a purchase decision. They were otherwise encouraged to add and similarly rate any other items they felt would be important to them in a purchase context.

The use of self-stated importances has been criticized in the past for leading to a weaker predictive validity of preference models than statistically-revealed importance weights [Neslin (1981)]. It has also been suggested that different measurement approaches may in fact tap into different aspects of the concept of importance, if not into different concepts altogether. This could explain in part the lack of convergence in some of the results obtained when contrasting the methods [Heeler et al. (1979), Jaccard et al. (1986)].

However, there is a lack of general support for these findings. Furthermore, at this stage of the research, the purpose was to identify the attributes to be considered in upcoming analyses rather than to estimate precisely their relative contribution to an eventual purchase decision. Self-stated weights were thus thought to be appropriate to elicit attribute importances. Later use of conjoint analysis allows to take advantage of a potentially more accurate assessment.

The first pretest yielded the following results (Appendix 1C): Each respondent found at least some (3 or more) of the 7 pre-selected attributes to be particularly important (rated 4 or 5 on the 5-point scale) in making a purchase decision. In fact, 6 of the 7 attributes were rated 4 or 5 by more than 60% of respondents. "Physical appearance" was the exception with only

48% of the respondents. These results may be biased upward as respondents may have tended to systematically over-rate the importance given to attributes in general [Lehmann (1985)]. The use of a constant-sum scale was later considered for that reason.

16 additional features were also identified by respondents as being important, particularly the features "durable/unbreakable", "servicing" and "availability/price of coded TV program". Many of these additional features duplicate those which were identified by the focus group. Combined with the latter, they were content-analyzed and sorted. The elimination process was conducted in the manner described in Appendix 1D.

3. Second pretest.

The following 8 attributes were retained to conduct the second pretest:

1. Durability (robust, does not break easily);
2. Capability (can change TV channels like a remote control; can read bar codes easily, even where print is deficient);
3. Memory capacity (can scan several bar codes before beaming them; user can recall programmed information to check entries);
4. Compatibility (with other VCR's that can use a remote control and with some home appliances);
5. Ease of use (by providing flexibility in handling the device);
6. Price;
7. Warranty;
8. Physical appearance;

In addition to changes made to the description of the scanner and to the list of pre-selected features, the 5-point rating scale

was extended to a 7-point scale to allow for a better spread, and included a constant-sum scale as a second measure of self-reported attribute importance weights, for comparison purposes.

Appendix 1G presents the results of attribute importance estimation from both the 7-point and constant-sum scales. As was previously the case, "physical appearance" and "compatibility" remain two of the least important attributes. "Memory capacity", also appears weak although it had been signalled previously as a potentially important attribute in open-ended questions. In terms of rating consistency, the correlation table in Appendix 1G gives some support to the use of either scale despite the fact that most correlation coefficients lack strength, ranging from .44 to .53. Indeed, correlations between unrelated attributes are usually much smaller, the exception being for "memory capacity".

Although some counting errors were made by a few respondents when using the constant-sum scale, this scale gives a better idea of the relative importance of each attribute and informs the researcher more accurately about the spread of weights for a particular variable. This is of importance here for the following reason: although one would normally want to select those variables which are most important for most people (to include them in the product descriptions to be later subjected to respondents' evaluation), it is also important in the present case to consider that different adopter categories (innovators, later adopters) may display

different importance patterns; "price", for example, can be expected to prove a more important factor for later adopters than for earlier adopters. The spread of importance weights as well as their overall magnitude were thus accounted for.

Also, each product feature (except price) was viewed within the more general context of the underlying dimensions along which some of the research hypotheses were developed, and the selection of features was finalized accordingly. In addition to price, the four product characteristics which rated highest on the importance scale were retained: "warranty", "ease of use", "durability" and "programming capacity", which were associated with the previously-mentioned underlying dimensions in the manner shown in Table M1:

Table M1
Association between retained features and underlying dimensions

	Compatibility	Complexity	Perceived risk
.warranty			x
.ease of use		x	
.durability			x
.programming capacity	x		

Such an association is consistent with earlier definitions and operationalizations of the four dimensions, as previously illustrated, and were recently confirmed by Holak & Lehmann (1990). The authors conducted a survey, asking respondents to link features to the underlying dimensions. Three of the links considered here

were confirmed by over 80% of respondents, the fourth one by 54%. All five variables, including "price", could also have been associated with "relative advantage" on which each was shown to load heavily (>.50), as revealed by Holak & Lehmann (1990). Given this dimension's apparent lack of discriminatory power, the other classification dimensions with which each variable was most strongly associated were retained.

A number of the other features, used in the past to operationalize such dimensions, were also accounted for in this study as constants, by way of the scanner description, as illustrated in Table M2:

Table M2
Linkage between other features and underlying dimensions

	Relative advantage	Compatible	Complex	Perceived risk
knowledge required			x	
service availability	x			
brand name				x
item's fit with customer's system		x		
reliability in operation	x			
continuing cost	x			
degree of difference from existing items	x			
health factors				x
operating instructions			x	
time savings in use	x			
efficiency	x			
manufacturer reputation		x		
physical appearance	x			

Most dimensions are thus represented by a combination of fixed

and variable features, although some dimensions are covered more scarcely than others. Such differences will be kept in mind when assessing the role of specific product features in determining individual preferences, based on conjoint-derived part-worths of attribute levels.

B. Respondent characteristics and perceptions

1. Respondent characteristics.

Looking at the answers provided in the first pretest to questions of ownership, familiarity and interest by the 38 respondents retained,[9] it appeared that the sample from which they were drawn would be adequate for further data analysis and hypothesis testing: Indeed, 79% of respondents indicated they were quite or very familiar with VCR's and 76% said they were quite or very interested in them, which was consistent with the fact that over 80% said they had a VCR at home (Appendix 1E).

As expected, figures were significantly different for scanners, with only 21% of respondents saying they were quite or very familiar with them and 39% having more than just some interest in them, all but 2 of whom were among the 68% that said they would consider purchasing such a device. Given the focus of this research (anticipating different adopter groups' reaction to the introduction of a new product), it was essential to establish that

[9]One questionnaire was discarded due to apparent lack of seriousness in answering the questions.

the chosen product was indeed perceived as an innovation by most respondents. In fact, 42% of respondents perceived the scanner as a "truly new product", 42% as a "product marginally different from currently available remote controls", and only 16% as a "gadget that does not present any functional advantage" over currently available devices.

Similar information elicited from the 41 respondents in the second pretest coincided with the above findings with respect to familiarity and interest for both VCR's and scanners (Appendix 1H). Of some concern may be the fact that this time, more respondents perceived the scanner as a marginally new rather than truly new product (although the difference was not significant at .05), and that fewer respondents (51% vs. 68%) said they would consider purchasing a scanner.

A number of respondents commented on the fact that they would not consider purchasing a scanner because they mainly used their VCR to view rented videos rather than to make recordings of TV shows, which may have accounted for some of the difference in results. Another explanation of such discrepancies in the results may be the relatively small sample sizes which have been used.

2. Respondent perceptions.

In addition to the above product features, the two diffusion-related variables mentioned earlier, "time of introduction" and

"degree of market penetration" (as a proxy for interpersonal communication, see below) were included in the product profiles to be later evaluated and subjected to conjoint analysis. Given that, in real life, this kind of information usually remains unknown to consumers, it would be erroneous to provide respondents with such information as part of the product descriptions unless it could be shown that people usually have relatively accurate perceptions of market reality in that respect.

"Market penetration" was chosen over "interpersonal communication" in consideration of the difficulty a commercial user would face in having to periodically reassess the individual levels of word-of-mouth, whereas market penetration (ownership) data are usually readily available (or perceived). Using one as a proxy for the other was thought possible, given how closely the two are related in reality. We shall come back to this later.

a) Perceptions of real time of introduction and market penetration.

For the purpose of the above, a few questions to elicit respondents' perceptions of the newness and degree of market penetration of several consumer durable goods were incorporated in the second pretest questionnaire, in order to measure how accurately respondents perceived the length of time certain products had been on the market and the extent to which they had been adopted (number of households).

To measure perception accuracy, a number of popular and relatively new consumer goods were selected among the "home electronics" category, to which VCR's belong. They are:

- VCR
- microwave oven
- compact disc
- home personal computer
- camcorder

Because it was unknown which of the local, national or North American market respondents were more familiar with, half of the respondents were subjected to questions about the Quebec market, and the other half to questions about North America in general. Respondents' perceptions were checked against real time (years) of introduction and market penetration data obtained from Government statistics and business publications.

The modified product description and one version of the questionnaire for the second pretest appear in Appendix 1F. The ordering of pre-selected attributes was modified for half the respondents to control for sequence effect.

Real market data are presented in Appendix 1I. The frequency tables in Appendix 1J reveal close matches between respondents' perceptions of product age and market penetration and reality. With respect to "time of introduction", the largest groups of "North American" respondents (40-50%) concentrated in the

appropriate categories for 4 of the 5 products. In each case, another 25-50% concentrated in an adjacent category. For "Quebec" respondents, the largest groups were found in the appropriate categories twice (40% and 70%) and in adjacent categories in the remaining three cases (45-50%). Very few respondents were completely out of line. No obvious pattern of systematic bias (over-under estimation) was apparent.

In the case of "market penetration", the largest groups of "North American" respondents were in the appropriate category twice (50% and 35%) with other largest groups being in adjacent categories (20-45%). Largest groups of "Quebec" respondents were found in the appropriate category in 3/5 cases (33-43%), and in adjacent categories in the remaining 2 cases (33% and 67%).

Real "time" being the same for North America and Quebec, tests were run for measuring differences between unrelated proportions. No statistically significant differences could be detected (at .05) when comparing the two markets' proportions. In dealing with "market penetration" data, proportions could not be compared because of differences in real market penetration levels between Quebec and North America. A direct comparison revealed that significantly more "Quebec" than "North American" respondents thought that microwave ovens were adopted by fewer households than reality, and that compact discs were adopted by more.

We also found that five out of the most important eight adjacent categories mentioned earlier represented levels of market penetration that were significantly different (at .05) from the true levels. "Quebec" respondents were again particularly at fault here, although the way in which categories to be checked by respondents were set in the first place may explain some of the discrepancies.

Test results appear in Appendix 1K. While not very precise, these data are nevertheless reassuring as to "North American" respondents' perception accuracy. It can therefore be suggested that the use, in the product descriptions, of time of introduction and market penetration information for North America, although not normally available to consumers, would not lead to disruptive perceptual distortions.

b) Perceptions of market penetration vs. word-of-mouth.

In considering the incorporation of the diffusion-related variables in the product descriptions, "market penetration" appeared as a potential source of distortion as it remained unknown how differently people were likely to react when provided with information about "word-of-mouth" feedback and when they were told about the product's level of "market penetration". The diffusion literature provides numerous accounts of the role played by word-of-mouth in a consumer's new product purchase decision. The impact of interpersonal communication has indeed been well documented, as

reviewed earlier.

The impact of some knowledge or intuition about a product's market penetration has been overlooked, however. Although one is clearly linked to the other in that the extent to which people talk about a product reflects the extent to which diffusion has taken place, and vice-versa[10], it remains uncertain whether respondents would adopt different evaluation patterns when presented with one piece of information rather than the other.

A third pretest was thus designed to test for possible differences in perceptions by using split-sampling, submitting half of 23 respondents to profiles with "market penetration" information and the other half to profiles with "word-of-mouth" information. Such profiles were derived from a master design which will be discussed in the next section. Each profile was evaluated on a 10-point rating scale, measuring the extent to which one would like to buy that particular scanner if one were considering the purchase of such a product.

Each respondent evaluated 44 descriptions, a sample of which appears in Appendix 1L. The order was rotated to control for

[10]The controversy of whether negative word-of-mouth has a greater impact in convincing people not to buy than positive word-of-mouth may have in convincing them to buy, and the problem of evaluating the overall net impact, need not be addressed here. The argument is limited to the fact that word-of-mouth needs to take place for more consumers to purchase the new product.

sequence effect. Given the difficulty respondents usually have in dealing with such large sets of descriptions, the task was split in two with a one-hour slack in between. For that reason, validity problems due to information overload, usually the case when product descriptions contain a large number of features [Green & Srinivasan (1978)], were not expected here.

Also, it remained possible that some respondents would tend to adopt lexicographic or conjunctive rather than compensatory approaches, either to simplify further their evaluation task, or as part of a selection process normal to them [Olshavsky & Acito (1980), Srinivasan (1988)]. However, the impact of such evaluation approaches was not thought to be significant due to the nature of the product (high-involvement, requiring complex information processing), assuming some interest in the product, which the questionnaire also tested.

Since it was not clear which levels of one variable should be used to correspond to levels of the other, and because individual perceptions are determinant in this case, matches were elicited from respondents, by asking them what different levels of one variable suggested to them in terms of levels of the other: Half the respondents were asked to indicate levels of word-of-mouth corresponding to levels of market penetration, the remainder having to work the other way around. The relevant questions appeared at the end of each of two questionnaires, in order to avoid any

contamination of profile evaluations (Appendix 1L).

Answers to these questions are tabled in Appendix 1M. Common classification grounds were identified and suggested three general categories linking word-of-mouth and market penetration levels, as shown in Table M3:

Table M3
Correspondence between word-of-mouth
and market penetration levels

word-of-mouth	market penetration
1. Never heard about the new product	less than 10%
2. Heard a few times about the new product	30% - 40%
3. Heard a lot about the new product	more than 60%

A series of t-tests were then conducted to determine whether differences between group means ("word-of-mouth" vs. "market penetration") were significant at the profile level. For 41 out of 44 descriptions, the hypothesis of equal means could not be rejected (at .10), under the appropriate assumption of variance equality or inequality. Appendix 1N summarizes test findings. They give support to using "market penetration" as a proxy for "word-of-mouth" in the product descriptions, and tend to indicate that the concepts are indeed closely related in respondents' minds.

C. Conjoint model and experimental design

1. Estimation procedure.

In attempting to differentiate between early and later adopters in terms of the product features individuals tend to prefer, individual utilities were derived for the different levels of each product feature being considered.

Conjoint analysis was retained for this purpose. It is particularly appropriate for this kind of undertaking, being specifically designed to derive individual attribute level part-worths from preference judgments about total product profiles [Green & Rao (1971)]. It presents a much appreciated flexibility in that it can be applied to rank-ordered as well as rated preferences. Preference ratings of product descriptions are dealt with here, in accordance with the prevailing trend in the literature and commercial applications [Wittink & Cattin (1989)].

A major trend in conjoint analysis is the use of additive models. Interactions can still be estimated in such cases, however, by introducing additional dummy variables in the model. Another somewhat restrictive assumption is that of a compensatory model. Indeed, conjoint analysis assumes that individuals trade-off the different attributes rather than follow a non-compensatory choice process.

While the latter can be expected in some purchase instances, as mentioned earlier, (one would want children's toys to meet certain minimum security standards, for example), the predictive validity of the technique has been empirically tested in many different contexts, through the use of holdout samples, and was generally shown to be good, with correlations larger than .75 [Green et al.(1972), Carmone et al.(1978), Green & Srinivasan (1978), Moore (1980)].

In terms of internal and predictive validity, a number of tests have been reported in the marketing literature relative to the form of input data [metric/non-metric: Carmone et al. (1978), Wittink & Cattin (1981)], the kinds of designs being used [full/fractional: Carmone et al. (1978), Darmon & Rouziès (1987)], data collection and estimation procedures [Cattin & Bliemel (1978), Jain et al. (1979), Darmon & Rouziès (1987)], attribute importance [Heeler et al. (1979), Neslin (1981), Leigh et al. (1984), Jaccard et al. (1986), Darmon & Rouziès (1988)] and attribute levels and spacings [Green & Srinivasan (1978), Darmon & Rouziès (1989)]. Generally speaking, they lend support to the choice of a semi-metric conjoint model to be calibrated by OLS, based on a full-profile fractional design approach.

With respect to the previously selected attributes to be used in the present study, 3 levels were determined for each of the continuous variables (time of introduction, market penetration,

price and warranty) and 2 levels for each of the discrete variables (programming capacity, ease of use and durability). The attributes and number of levels that were retained and used for further analyses are presented in Table M4:

Table M4
Attribute levels retained

Time of introduction:	6 months 2 years 5 years
Market penetration:	under 10% 20-40% over 60%
Price:	$ 50 $ 100 $ 150
Warranty:	3 months 1 year 3 years
Ease of use:	. some care required . very easy
Durability:	. fair resistance to normal use . added durability: child-proof
Programming capacity (TV selector):	. cannot . can

Some of these levels were slightly modified after the third pretest, for use in the final questionnaire, to allow for the coverage of wider and more specific ranges, as will be addressed later. Levels for "price" and "warranty" were set to reflect reality, while keeping in mind that wide enough ranges and level spacings were necessary for more revealing preference patterns to

emerge and for parameter estimation to gain in accuracy. In the case of "time", 5 years rather than a higher figure (10 years, for example) were set as the upper bound because of the anticipated psychological impact the perception of a product as being old and outdated could have on respondents' evaluations, and because 5 years appeared to cover a wide-enough range to capture a significant part of the diffusion.

Unequal level spacings were used in the case of "time of introduction" and "warranty". The impact such combinations of attribute levels, ranges and spacings may have on the validity of the results may need to be addressed in the future [Green & Srinivasan (1978), Darmon & Rouziès (1989)]. As for the three discrete variables "programming capacity", "ease of use" and "durability", they were given two levels each to keep the number of interaction terms manageable.

2. Conjoint model and design.

In building the model, it was necessary to keep in mind the possible significance and eventual analysis of some of the first-order interactions. Of particular interest were interactions between the two diffusion-related variables on the one hand, and the five product features on the other. Indeed, as hypothesized earlier, one may expect to find differences between early and later adopters not only in the main effects of the selected product features, but also in the interactions between time/communication

factors and such features. The design was thus developed and balanced with these interactions in mind. Other interactions, such as those among product features or between the diffusion-related variables, were assumed non-existent.

With respect to main effects, the greater relative importance some product features are expected to have for a given adopter group [hypotheses H1a) to H2)] are to be reflected in larger relative discrepancies between feature level utilities; higher relative utilities for lower prices and longer warranties, for example, would be reflected in greater relative distances between utilities for high vs. low prices or short vs. long warranties, and similarly for other features.

As for the hypothesized interaction effects [hypotheses H3a) and H3b)], they were to be revealed from the greater relative importance of a product feature under conditions of remote rather than recent time of introduction in the case of early adopters, and under conditions of low rather than high market penetration level in the case of later adopters.

Accordingly, a mixed model containing 3 discrete and 4 continuous variables with interactions was developed. The continuous variables have a quadratic representation, as illustrated in Table M5, below:

Table M5
Characteristics of the mixed-model

Variables:	4 continuous variables, 3 levels each: . time of introduction: TIM . market penetration: PEN . warranty: WAR . price: PRI 3 discrete variables, 2 levels each: . programming capacity: CAP . ease of use: EAS . durability: DUR
Main effects: (11 terms)	TIM, PEN, WAR, PRI, CAP, EAS, DUR
2-way interactions: (28 terms)	TIM x CAP, x EAS, x DUR, x WAR, x PRI PEN x CAP, x EAS, x DUR, x WAR, x PRI
Model:	$U_1 = b_0 + b_1CAP_2 + b_2EAS_2 + b_3DUR_2 + b_4WAR + b_5WAR^2 + b_6PRI + b_7PRI^2 + b_8TIM + b_9TIM^2 + b_{10}PEN + b_{11}PEN^2 + b_{12}TIMxCAP_2 + b_{13}TIM^2xCAP_2 + b_{14}TIMxEAS_2 + b_{15}TIM^2xEAS_2 + b_{16}TIMxDUR_2 + b_{17}TIM^2xDUR_2 + b_{18}TIMxWAR + b_{19}TIM^2xWAR + b_{20}TIMxWAR^2 + b_{21}TIM^2xWAR^2 + b_{22}TIMxPRI + b_{23}TIM^2xPRI + b_{24}TIMxPRI^2 + b_{25}TIM^2xPRI^2 + b_{26}PENxCAP_2 + b_{27}PEN^2xCAP_2 + b_{28}PENxEAS_2 + b_{29}PEN^2xEAS_2 + b_{30}PENxDUR_2 + b_{31}PEN^2xDUR_2 + b_{32}PENxWAR + b_{33}PEN^2xWAR + b_{34}PENxWAR^2 + b_{35}PEN^2xWAR^2 + b_{36}PENxPRI + b_{37}PEN^2xPRI + b_{38}PENxPRI^2 + b_{39}PEN^2xPRI^2$

Reduced models were later considered, to decrease the number of parameters (12+28 = 40) to be estimated. However, the development of the experimental design was based on the full model to allow for the estimation of all main effects and 2-way interactions with the diffusion variables "time" and "market penetration", resulting in a more elaborate compromise design. Despite the added difficulty for respondents to evaluate a large number of product descriptions, the possibility for significant interactions to emerge was determinant in that respect. Such higher-order models and designs have been encouraged in the past [Carmone & Green (1981)]. The

resulting balanced asymmetric compromise design is presented in Table M6, below.

Table M6
Balanced asymmetric compromise design
(Profile reference number *)

	TIM	PEN	PRI	WAR	CAP	EAS	DUR	*
1	1	1	1	1	1	1	1	1
2	1	1	2	3	2	2	1	11
3	1	1	3	1	2	1	2	20
4	1	1	2	2	1	2	2	45
5	1	2	3	3	1	1	2	5, 30
6	1	2	1	1	2	2	2	17
7	1	2	2	2	2	1	1	25
8	1	2	1	3	1	2	1	42
9	1	3	2	2	1	1	1	9
10	1	3	3	1	1	2	2	14
11	1	3	1	3	2	2	1	23
12	1	3	3	2	2	1	2	28
13	2	1	3	2	1	2	1	12
14	2	1	1	1	1	2	2	21
15	2	1	2	3	2	1	2	47
16	2	1	1	2	2	1	1	4
17	2	2	2	1	2	2	2	18
18	2	2	3	3	1	2	1	43
19	2	2	1	1	2	1	1	6, 31
20	2	2	3	2	1	1	2	2
21	2	3	1	3	1	1	2	15
22	2	3	2	1	2	1	1	26
23	2	3	3	2	2	2	1	46
24	2	3	2	3	1	2	2	7
25	3	1	2	3	1	1	1	48
26	3	1	3	1	2	2	1	24
27	3	1	1	2	1	1	2	16
28	3	1	3	3	2	2	2	13, 32
29	3	2	1	2	1	2	1	10
30	3	2	2	1	1	1	2	19
31	3	2	3	3	2	1	1	27
32	3	2	2	2	2	2	2	44
33	3	3	3	1	1	1	1	22
34	3	3	1	3	2	1	2	41
35	3	3	2	1	1	2	1	8, 29
36	3	3	1	2	2	2	2	3

The fractional factorial design allows orthogonal estimation of all main effects and 2-way interactions [Carmone & Green (1981)]

Only 36 of the 648 combinations are required [Holland & Cravens (1973)]

The design reflects the fact that factors do not all have the same number of levels: each level of a factor occurs with each level of another factor with proportional frequencies [Addelman (1962), Green (1974)]

8 holdout profiles for validity testing

TIM	PEN	PRI	WAR	CAP	EAS	DUR	*
1	1	3	1	1	2	1	33
1	2	1	3	2	1	2	36
2	1	2	1	2	2	1	34
2	2	3	3	1	2	2	37
2	3	1	2	1	1	2	39
3	1	3	2	1	2	2	35
3	2	1	1	2	1	1	40
3	3	2	2	1	2	1	38

Only 36 of the 648 possible combinations were required. 8 holdout profiles were also developed to test the predictive validity of the full model and of a number of reduced models, and thus set the grounds for a preliminary estimation of the importance of interaction terms.

The design was slightly modified (profiles 9-12) to replace an unrealistic combination of levels ("time" at level 1 with "market penetration" at level 3) by more acceptable ones. This modification made the design slightly unbalanced, which will be addressed further on.

The model was calibrated using respondents' ratings of the 36 master profiles, by use of ordinary least squares with dummy variables, except for the continuous variables: Levels of "time" were set in months (3, 24 and 60) as were those of "warranty" (3, 12 and 36). "Market penetration" levels were set in percentages (3, 40 and 80) and "price" levels remained in dollars (50, 100 and 150). Lower and upper bounds for "time" and "market penetration" were set to provide a wide enough range while avoiding extremes for "time" that could render the description unattractive for everyone (a 10-year upper bound, for example, could have conveyed the impression of an outdated product.

D. Utility assessment and hypothesis testing

1. The use of "market penetration" in product profiles.

In the third pretest (Appendix 1L), it was also investigated whether the use of "market penetration" rather than "word-of-mouth" profiles could lead to a significant improvement or degradation of the conjoint model's predictive validity. Product-moment correlations between predicted and true ratings were derived, using the 8 holdout profiles, for two groups of respondents: One was submitted to "word-of-mouth" profiles, the other to "market penetration" profiles, in a split-half fashion. The full model with interactions was used for that purpose and respondents' ratings were standardized.

Correlation coefficients were found to be relatively low, as apparent in Appendix 1P, although approaching .50 for the "market penetration" group (versus .33 for the other). A test was conducted to compare the two correlation coefficients, using Fisher's Z transformation [Kleinbaum & Kupper (1978)]. The equality hypothesis could not be rejected (at .05). It thus appears that "market penetration" descriptions can be used in the upcoming conjoint analysis without creating significant biases or distortions in the assessment of utilities for product features.

2. The final questionnaire.

a) Questionnaire characteristics.

The final questionnaire appears in Appendix 2. It was pretested

on a small sample (8 respondents) and did not present major problems. The profile evaluation task was interrupted at mid-point to avoid fatigue throughout the evaluation task. The same questions regarding perceptions of familiarity, interest and ownership, which appeared in the first two questionnaires (earlier pretests), were then inserted and were followed by the second half of product descriptions.

Four of the descriptions were duplicated, one set appearing in the first part of the questionnaire (prior to mid-point interruption) and the other set appearing in the second part, for the purpose of testing reliability by way of a test-retest procedure. These profiles were randomly selected and checked to ensure they were different enough from one another. The following profiles were used for that purpose: 5 (duplicate 30), 6 (duplicate 31), 8 (duplicate 29) and 13 (duplicate 32), where the numbers refer to the profile reference numbers in Table 6.

When added to the 36 calibration profiles, the 4 duplicate and 8 holdout profiles brought the total number of evaluations to 48. Given sufficient time (over an hour) elapsed between the two parts of the evaluation task, concern as to a possible overload did not appear warranted, as the last pretest seemed to indicate.

To reflect the time/penetration ranges that were chosen for setting discrete states and deriving the corresponding purchase

probabilities for product descriptions, as provided for above, the "time" and "penetration" levels were slightly modified. The wording of the text introducing the evaluation task was also changed to account for the existence of substitute products on the market, by asking respondents to rate the scanner descriptions in reference to other market offerings (namely, usual remote controls).

As previously, profiles and within-profile descriptions were rotated to account for possible sequence effects. Also, the presentation of the evaluation task was slightly changed to offer each type of adopter a realistic purchase situation: The respondent was asked to imagine he had returned 3 months earlier from a long trip and was now about to evaluate the product. The purpose was to avoid having true innovators wonder why they were unaware of a product that was presented to them as having been on the market for a number of years, while giving later adopters some time (3 months) after their imaginary return to have feedback about the product from others.

b) Sample size.

The sample size was determined by taking into account the usual distribution of proportions of adopters throughout categories: In order to have an adequate representation of the smallest adopter groups (early adopters and laggards), and since these groups were shown in past studies to represent 10-20% of consumers, a sample

of 200 was thought to be sufficient to ensure proper representation. Since it was anticipated that a number of respondents would have to be eliminated because of unwanted characteristics (for example, those who do not own or are not familiar with the use of a VCR), or because of problems with filling out the questionnaire (for example, missing profile evaluations), about twice the sample size desired was aimed at.

460 respondents were finally subjected to the questionnaire. All were selected from evening classes taking place at McGill University and Concordia University, Continuing Education, during the Summer and early Fall of 1990. Class size ranged from 12 to 37 students, which was small enough to be manageable.

3. Testing reliability.

For the purpose of testing reliability, the standard approach based on Pearson's product-moment correlation coefficient was first thought of and pretested. This approach did not provide satisfactory results, however, due to the small number of descriptions available (4 pairs) to establish the degree of correlation, and because, in the case of some respondents, the 4 observations had very similar ratings. Anticipating possible problems with this measure, the following approach was used to derive correlation.

The variance of the difference between two random variables (in this case the original (OR) and duplicate (DU) ratings) can be expressed as:

$$Var_{(OR-DU)} = \sigma^2_{(OR)} + \sigma^2_{(DU)} - 2\,[rho]\,\sigma_{(OR)}\sigma_{(DU)}$$

where $\sigma^2_{(OR)} = \sigma^2_{(DU)} = 1$ by construction when dealing with standardized variables.

After deriving the variance of the differences in ratings $[Var_{(OR-DU)}]$, estimating [rho] becomes straightforward:

$$[rho] = 1 - [Var_{(OR-DU)} / 2]$$

The advantage of this approach is that, by using the population variance (=1) in the formula, only one degree of freedom is lost for the estimation of [rho], whereas Pearson's coefficient is based on the sample estimates of variances, resulting in the loss of 2 additional degrees of freedom. This is of particular importance here due to the small number of observations (4 pairs) available.

4. Categorization of respondents.

Categorization was undertaken in the way of Rogers'(1962) general scheme. The five adopter categories were collapsed into four, however, by combining innovators and early adopters to form a new "early adopter" category. Categorizing respondents into adopter groups was performed by examining the individual utility curves (based on the level utilities derived from the main-effects model), for each of the two diffusion variables "time of introduction" and "market penetration", and using three continuous criteria:

curvature, direction and importance.

A rigorous estimation of these criteria would normally require taking into account interaction effects with product features, given such interactions were hypothesized to have an impact on adopters' preference patterns. At this stage, however, interaction effects which are to be assessed at the adopter group level, cannot be integrated in the measurement of criteria that serve as the basis for the formation of these groups. For the purpose of categorization, we must therefore proceed as if interactions were non-existent. Each of the three criteria is described below.

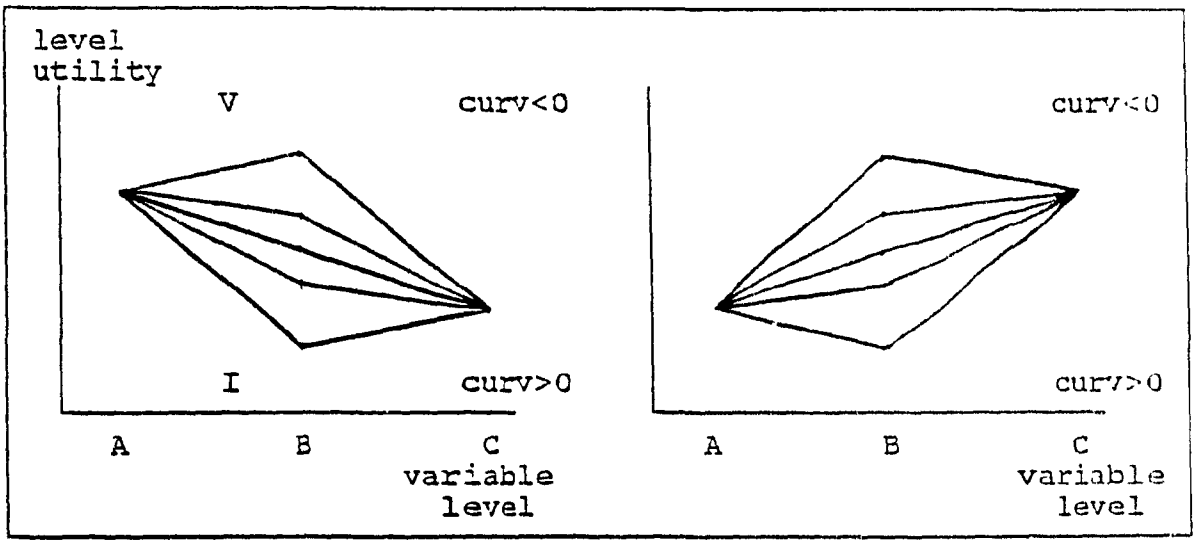
(1) **Curvature** was estimated by expressing each level part-worth for "time" and for "market penetration" as a quadratic function of that level's value, and solving for the parameters of that function. Taking "time" as an example, the following was solved:

$$U_{TIM_i} = a\ (TIM_i)^2 + b\ (TIM_i) + c$$

where U_{TIM_i} = part-worth of level i of "time"
a = measure of curvature
(TIM_i) = level i of "time"

For "time" and "market penetration", which have three levels each (A, B and C), the possibilities are illustrated in Figure M1, below:

Figure M1: Possible curvature patterns



Where utility A>C, the higher the curvature score (i.e. the more convex the curve), the greater the degree of innovativeness. Conversely, the smaller the curvature score (i.e., the more concave the curve), the lower the degree of innovativeness. For example, in the graph above, (I) is more innovator than (V) because utility is highest at level A and decreases fastest as larger figures are reached for "time" or "market penetration". On the other hand, where utility C>A, the higher the curvature score, the lower the degree of innovativeness (i.e., the higher the propensity to be a laggard), and vice-versa for smaller scores.

(2) **Direction** was derived by subtracting the utility of the first level from that of the third level, as illustrated below with "time":

$$TIM_{dir} = U_{TIM3} - U_{TIM1}$$

where TIM_{dir} = direction of "time"
U_{TIM3} = utility of "time" at level 3

For each of "time" and "market penetration", the smaller the direction score, the greater the degree of innovativeness, and vice-versa.

(3) **Importance** was derived in relative terms, as follows:

$$PEN_{imp} = [\max(U_{PENi}) - \min(U_{PEN1})] \; / \; \Sigma_j \; [\max(U_{j1}) - \min(U_{j1})]$$

where PEN_{imp} = importance of "market penetration"
U_{PENi} = utility of level i for "market penetration", where i = 1,2,3
U_{ji} = utility of level i of variable j, where j = 1, 7

With respect to "market penetration", the lower the score, the greater the degree of innovativeness. The interpretation of the importance of "time" is a more complex matter: Unlike "market penetration" which is sought (feedback) by later adopters but not by earlier adopters, "time" can emerge as an important factor, for opposite reasons, at both ends of the adoption spectrum, and thus does not provide appropriate grounds for discriminating between adopter groups. The additional psychological dimension of "time" also makes it more difficult to interpret given some individuals display "time" at level 1 and "market penetration" at level 3 as the respective levels they prefer (highest utilities), which seems to indicate that although they require large amounts of feedback

(market penetration), they also prefer to purchase the newest product, which is unrealistic. This combination was eliminated from the experimental design for that very reason.

For categorization purposes, respondents were ranked in ascending order on each of these criteria for "time" and "market penetration", with the exception of importance of "time", because of that measure's lack of discriminatory power in the classification process, as discussed above. Since there are 3 measures for "market penetration" and 2 for "time", more weight was given to "market penetration" in the final score, which is intuitively appealing given the greater discriminatory power of that variable for classification purposes.

With respect to the measure of curvature, the score signs were reversed whenever utility A>C (as illustrated above), in order for an overall ascending ranking procedure to be meaningful and compatible with the other two criteria (direction and importance). Indeed, originally, larger rather than smaller scores (convexity rather than concavity) indicate greater innovativeness under the A>C situation, as illustrated above. These scores were thus rescaled and ranked in the "reversed" ascending order. Original scores under C>A conditions were separately ranked and then combined to A>C rankings, in order to preserve consistency in ranking curvature scores across all respondents.

Individual ranks for each measure were then summed across measures. Such a summation process was considered appropriate given the assumption of compensatory choice patterns made when using the main-effects model for categorization purposes. A final ranking was based on that sum and respondents were categorized along Rogers'(1962) distribution: 16% "early adopters", 34% "early majority", 34% "late majority" and 16% "laggards".

5. Estimating the predictive validity of the main-effects model.

An out-of-sample predictive validity test was conducted for each respondent by deriving Pearson's product-moment correlation between ratings of the 8 holdout descriptions and their predicted values derived from the 36 calibration profiles. Pearson's coefficient did not present here the same limitations as for the reliability test, given the larger number of observations available (8 vs. 4 pairs). An overall validity measure (mean of individual correlations) was also derived for each adopter group.

6. Probing interactions.

Main effects (11 terms) were calibrated at the individual level. Given the limited number of observations per respondent (36 when holdout and duplicate profiles are excluded), interactions (28 terms) were calibrated at the adopter group level,[11] once the

[11]Calibration at the individual level was not possible due to lack of degrees of freedom.

categorization of adopters had taken place, using the residuals from the main-effects model as the dependent variable. Such a "juxtaposition" procedure was deemed appropriate given that each respondent evaluated all 36 descriptions of the experimental design, yielding unbiased estimators for the main-effects model. The slight change in the design, resulting from the substitution of four "market penetration" levels (which was required to provide realistic descriptions), was not expected to have a significant impact. The degree of design "unbalancing" resulting from such a substitution will be assessed later. The full conjoint model appears in Table M7:

Table M7
Full conjoint model

Assuming a group of n members, and following the specifications of the model (see above):

$$U_{ij} = b_0 + \Sigma(b_{1j}CAP_2) + \Sigma(b_{2j}EAS_2) + \ldots + \Sigma(b_{11j}PEN^2)$$

$$+ [b_{(11xn)+1}TIMxCAP_2 + b_{(11xn)+2}TIM^{2x}CAP_2 + \ldots\ldots$$

$$+ b_{(11xn)+28}PEN^2xPRI^2]$$

where:
- i = product alternative: 1, 36
- j = individual: 1, n
- b_j's = 11 main effects calibrated at the individual level (36 observations)
- [..] = 28 interaction terms calibrated across group members (36xn observations)
- CAP = programming capacity
- EAS = ease of use
- PRI = price
- TIM = time of introduction
- PEN = market penetration

Variable selection was then undertaken with respect to interaction terms, by way of stepwise procedures, to determine the best interaction model for each group. The predictive validity of each reduced interaction model was assessed by way of Pearson's correlation, on the basis of the 8 holdout profiles. This was performed by comparing the errors obtained for the holdout profiles under the main-effects model with the corresponding predicted errors obtained when using the interaction models.

7. Hypothesis testing.

In order to test hypotheses H1a) to H2, the relative importance of each variable was estimated, based on the main-effects model, at the individual and at the group level. At the individual level, relative importance was estimated by deriving for each variable the ratio of the range for that variable (the difference between the highest and lowest partial utilities) over the sum of the ranges for all variables. In order to have a "true" measure of the relative importance of each product feature, each feature's "net" impact was estimated after the effect of "time of introduction" and "market penetration" had been factored out. "True" relative importances were thus derived following the earlier procedure used in the categorization of respondents, with the difference that here, "time" and "market penetration" were taken out of the denominator.

The above approach does not account for possible interaction effects between diffusion-related variables and product feature variables. Should interactions emerge as having a significant impact on the overall estimation of preferences, a more complex approach would be required in order to integrate interaction effects in the measurement of importances, as described below, where the importance of "price" is used as an example:

$$PRI_{imp} = (\max - \min) \text{ of } \left| \begin{array}{l} PRI_1 + \text{avg}\,[(PRI_1 x TIM_j) + \text{avg}(PRI_1 x PEN_k)], \\ PRI_2 + \text{avg}\,[(PRI_2 x TIM_j) + \text{avg}(PRI_2 x PEN_k)], \\ PRI_3 + \text{avg}\,[(PRI_3 x TIM_j) + \text{avg}(PRI_3 x PEN_k)] \end{array} \right|$$

$$/ \; \Sigma \; (\max - \min) \text{ for all product features}$$

where the denominator does not include "time" or "market",

PRI_1, PRI_2, PRI_3 = main-effect utilities for the 3 levels of "price",

avg = average,

$(PRI_1 x TIM_j)$ = interaction effect between "price" at level 1 and "time" at level j, where j = 1,3

$= b_{12}\ PRIxTIM + b_{13}\ PRI^2xTIM + b_{14}\ PRIxTIM^2 + b_{15}\ PRI^2xTIM^2$

In the present case, the earlier approach based on main effects was retained, for reasons that will be provided in Chapter V (Data analysis).

At the group level, the individually-derived relative importances were aggregated, yielding an average relative importance for that feature, to be compared to that of other features within adopter category [hypotheses H1a) and H1b)] and among groups (hypothesis H2). Since relative importances are derived, within each group,

as a ratio of one feature over all features (i.e., as a proportion of a total importance of 1.00), scores can be compared within group (one feature compared to other features) and among groups (same feature).

Interaction effects were revealed for each adopter group by the respective interaction models, interaction terms having been estimated at the group level, as described earlier. Testing hypotheses H3a) and H3b) required assessing (1) the significance, (2) the direction, and (3) the importance of the interactions:

(1) **Significance** was ascertained by examining the regression outputs for the reduced interaction models, all variables remaining in such models being significant by construction. (2) **Direction** (positive, negative) was examined, for each product feature, by deriving the sum of all relevant partial interaction utilities (up to 4 in the case of continuous features, up to 2 in the case of discrete features, depending on which terms were kept in the reduced models), and subtracting summation results for the first level from those for the third level, at each level of "time" and "market penetration".

For example, a positive interaction of "time" with "warranty" (time x warranty) would mean that as the product grows old, with "time" going from level 1 (3mths) to level 3 (60mths), the total interaction effect (time x warranty) increases, i.e., the values

$$(TIMi \times WARj) = [b_{16}(TIMixWARj) + b_{17}(TIMi^2 xWARj) + b_{18}(TIMixWARj^2) + b_{19}(TIMi^2 xWARj^2)]$$

where i, j = levels for "time" and "warranty", respectively,
b's = part-worths of the interaction terms

become larger as (i) goes from level 1 (3mths) to level 3 (60mths), and conversely for a negative relationship. The interpretation of such interaction directions required taking into account the direction of the product feature's main effect as well, in order to give an accurate account of the overall impact. For that purpose, group averages of idiosyncratic partial utilities were derived for each level of each variable under the main-effects model, which provided confirmation of the anticipated general directions of the main-effect slopes: These turned out to be positive for all variables but "price", as expected.

Caution was required in interpreting the interaction results: The hypothesis statements H3a) and H3b) reflect the fact that, while "compatibility" is sought for, "risk" and "complexity" are generally regarded as characteristics to be avoided, i.e., where less is better than more. However, the last two dimensions were operationalized by using "desirable" factors: "ease of use", "durability" and "warranty", where more (levels 2 and 3) would normally be regarded as better than less (level 1). Therefore, when interpreting the results with respect to direction, conclusions had to be reversed for these three variables, in order for hypotheses about the "undesirable" dimensions to be tested.

Finally, (3) **Importance** was measured by deriving the difference between the maximum and the minimum interaction effects (sum of partial utilities, as in the measure of direction), occurring between a diffusion variable and a product feature, from among 9 interaction effects for the interaction with continuous features (3x3), and 3 effects for the interaction with discrete features (3x1).

Since the estimation of regression coefficients for continuous variables was based on level values (50, 100, 150 for price, etc..) rather than on their corresponding dummy (0,1), the importance scores, derived from the partial utilities (coefficient x level value), are independent of the chosen feature levels. However, they remain highly dependent upon the ranges and level spacings that were used for each feature, and thus can only be interpreted in the context of these specifications.

No attempt was made to interpret importance scores per se. Rather, they served to derive relative importances for comparison purposes, within groups (interactions of different features with same diffusion-variable, interactions between same feature but different diffusion variables) as well as among groups (same interactions across adopters). Utility graphs were also developed for a visual appraisal of importances.

E. Purchase probabilities and adoption curve

1. The multinomial Logit-based model.

Individual purchase probabilities were derived from conjoint utilities and aggregated across individuals. Several approaches have been proposed in the past to aggregate conjoint data [Currim (1982), Chapman & Staelin (1982), Louvière & Hensher (1983), Wiley & Low (1983), Malhotra (1984), Green & Krieger (1988)]. One of the most straightforward and widely used consists in averaging purchase probabilities as revealed by conjoint-derived utilities, for each product description [Wiley & Low (1983)].

This approach was expanded upon by first transforming conjoint utilities into "time-related" relative purchase probabilities, by way of a multinomial Logit choice model. Such a transformation was required to determine time-specific preferred product alternatives, while accounting for the number of time periods that would be used to divide the 5-year time frame. Indeed, unlike the usual case where conjoint analysis is applied to effect a choice among several product alternatives at a given time, choice probabilities here are derived for each product alternative at different points in time.

This approach requires the researcher to make the assumption that respondents believe a given product description will be and remain available on the market throughout the chosen time frame (5 years). Such an assumption can safely be made since each respondent is subjected to the full range for time (and likewise for market

penetration) when evaluating the product descriptions for conjoint analysis. The model is illustrated in Table M8:

Table M8
Logit-based probability model

Ex: for individual i, profile j, over k periods, the following utilities U_{ijk} are derived:

period(k)	1	2	3	4	5	6	7	8	9	10
U_{ijk}	.5	.6	.7	.5	.4	.4	.3	.2	.2	.2

Based on these utilities, the following purchase probability is derived for period k=5:

$$PP_{ij5} = \left[\frac{e^{.4}}{e^{.5} + e^{.6} + e^{.7} + \ldots\ldots\ldots\ldots + e^{.2}}\right] (.7)$$

where powers = U_{ijk} values,
multiplicator (.7) = individual i's highest utility for profile j across k periods (accounting for the fact that individual i's probability of purchasing item j overtime is <1).

An over-estimation of one's purchase probabilities may result from choosing the highest (U_{ijk}) through time as the multiplicative factor. However, given the possibility of large standard deviations related to individual utilities through time, it appeared to be a better approximation of one's "true" purchase probability overtime than measures of central tendency. Furthermore, the bias possibly resulting from such a choice will affect all respondents in a similar manner, thus contributing to maintaining the overall structure of aggregated probabilities.

Given the unusual way in which the Logit procedure was applied here, concern about the Independence of Irrelevant Alternatives (IIA) assumption [Currim (1982), Corstjens & Gautschi (1983), Malhotra (1984)], seemed unwarranted. Indeed, probabilities being derived for each product description within a bounded time frame, the IIA assumption can be realistically maintained as long as the time frame is partitioned into equal periods, in which case all possible time alternatives are being included in the choice model.

In order to generate realistic choices and allow compensatory patterns to emerge, the number of product descriptions to be subjected to the procedure was limited only to those combinations which would be consistent with an assumed "constant margin" marketing strategy. This was accomplished by setting the best possible profile (all features at highest standard) as most expensive ($150), and the worst profile (all features at lowest standard) as least expensive ($50). A valuation process was then devised by which an improvement from lowest to highest standard would have the same monetary value, whatever the product feature.

In order for each feature to be treated equally, it was necessary to differentiate between the 2-level and the 3-level features. This was accomplished by allocating $25 for an improvement in any of the 2-level features "programming capacity", "ease of use" and "durability", and $12.50 for each 1-level improvement in the 3-level feature "warranty", bringing the total possible improvement

to a value of $100. These specifications resulted in the following 3x2x2x2=24 descriptions (Table M9), where numbers represent levels (except for "price" in dollars):

Table M9
Descriptions used for deriving probabilities

	PRI	WAR	CAP	EAS	DUR		PRI	WAR	CAP	EAS	DUR
1	50	1	1	1	1	13	87*	2	2	1	1
2	75	1	1	1	2	14	112*	2	2	1	2
3	75	1	1	2	1	15	112*	2	2	2	1
4	100	1	1	2	2	16	137*	2	2	2	2
5	75	1	2	1	1	17	75	3	1	1	1
6	100	1	2	1	2	18	100	3	1	1	2
7	100	1	2	2	1	19	100	3	1	2	1
8	125	1	2	2	2	20	125	3	1	2	2
9	62*	2	1	1	1	21	100	3	2	1	1
10	87*	2	1	1	2	22	125	3	2	1	2
11	87*	2	1	2	1	23	125	3	2	2	1
12	112*	2	1	2	2	24	150	3	2	2	2

(* decimals dropped)

where PRI = price
WAR = warranty
CAP = programming capacity
EAS = ease of use
DUR = durability

2. The 7-step iterative procedure.

We present below a 7-step procedure, based on Logit-derived probabilities, as illustrated above, to determine time-specific preferred product alternatives, and to derive the adoption curve for a product that would be modified accordingly through time.

The algorithm's rationale is based on the following

considerations:

a) the central role of time and market penetration in determining the diffusion process;

b) the appraisal of purchase timing as a stochastic rather than deterministic process;

c) the relationship between conjoint utilities and purchase probabilities;

d) the flexibility that a Logit-type choice procedure provides in accounting for the measurement intervals (time periods) retained;

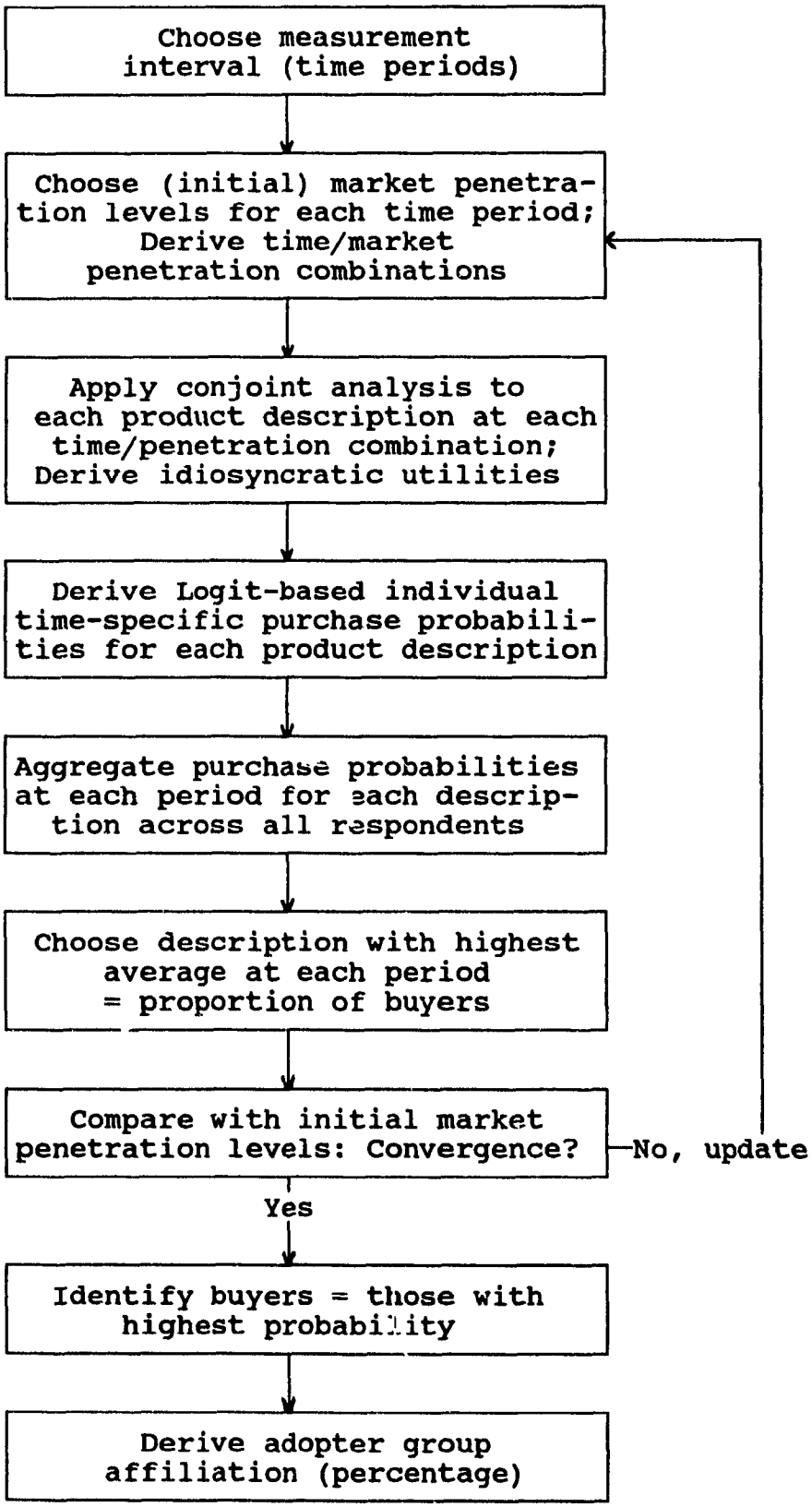
e) the assessment of market behavior through the aggregation of individual probabilities across respondents;

f) the flexibility that an iterative approach provides in deriving "actual" market penetration levels;

g) the intuitive appeal of accounting for purchase probabilities at all periods in the time frame for all individuals, to account for atypical purchasing behaviors;

h) the identification of adopter group affiliation allowing the assessment of time-related overlapping of purchase behavior.

The algorithm is presented below, first in the form of a flow chart, then by describing each step in greater detail.


Choose measurement interval (time periods)
Choose (initial) market penetration levels for each time period; Derive time/market penetration combinations
Apply conjoint analysis to each product description at each time/penetration combination; Derive idiosyncratic utilities
Derive Logit-based individual time-specific purchase probabilities for each product description
Aggregate purchase probabilities at each period for each description across all respondents
Choose description with highest average at each period = proportion of buyers
Compare with initial market penetration levels: Convergence?
No, update
Yes
Identify buyers = those with highest probability
Derive adopter group affiliation (percentage)

1) Choose a measurement interval: for instance, 10 periods of 6 months. Set initial market penetration levels for each of these time periods, within the prespecified 3%-80% range. An approximation of Rogers'(1962) normal distribution was used as a starting point for that purpose, with marginal penetration levels linearly increasing up to period 5 and linearly decreasing afterwards up to period 10, in such a way that the total penetration level reached 80%

[The 80% penetration level corresponds to the upper bound of the levels used in the conjoint analysis. The 10 preset penetration levels were updated with "real" penetration data through an iterative process, as described in the following steps.][12]

2) For each of the 24 product descriptions (listed above), derive idiosyncratic utilities for each of the 10 time/market penetration specifications, using conjoint analysis.

3) Using the Logit choice model, derive the individual time-specific purchase probabilities for each product description.

[In the present context, the choice is not effected among the product descriptions. Derived probabilities are thus independent across alternatives].

4) At each time period: (1) Derive the average of individual purchase probabilities for each product description, across all respondents; (2) Choose the product description with the highest average. This average represents the proportion of buyers at that period (marginal market penetration), where the total number of respondents (307) is taken as the ultimate number of adopters.

[Since any number of alternatives can be estimated (in terms of their overall utility) based on the same set of conjoint part-worths, probabilities derived from conjoint utilities are independent of the number of alternatives being considered. The average probabilities derived in 4) are thus independent of the number and kind of alternatives retained.

The final choice of the highest average probability at each time period as the most profitable outcome is consistent with the viewing of purchase timing as a probabilistic process, whereby there remains a possibility for individuals categorized **a priori** as early adopters to purchase later and vice-versa].

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[12]Lower penetration levels of 50% and 60% were also attempted as a starting point, with no significant differences in the end results.

5) After completing the process over all time periods, go back to step 1) and update the marginal market penetration levels for each time period with the "actual" levels (proportions) derived in 4). Run several iterations until stability (convergence) in penetration levels is achieved.

> [Convergence can be expected based on the theory of diffusion, where "market penetration" is being used as a proxy for positive interpersonal communication: Indeed, idiosyncratic utilities for this variable can be expected to increase monotonically through time (across adopters), as diffusion takes place, with more respondents willing to buy (higher utilities) as higher levels of "market penetration" are reached. Structurally, the quadratic form of the function makes it well balanced and prevents erratic behavior].

6) Having reached convergence, choose the "buyers" as those with the highest purchase probability for that description, in a proportion equal to that derived in 4).

7) Determine the percentage of purchasers belonging to each adopter group, at each time period, by decomposing each period's retained average purchase probability into the different adopter groups.

The procedure reveals which product description should be put on the market at which time, and thus determines the best product/time combinations to be offered: It yields the adoption curve of the "best" product (among the 24 descriptions retained), one which is being modified according to incoming adopters' revealed preferences, the adaptation process taking place throughout the product's life.[13] This "ideal" adoption curve can then be compared with curves that would result for selected unmodified products.

Finally, partial validation of the above procedure was undertaken

[13]The chosen time frame ends at year five, which may be short of the product's actual life cycle. However, it appears wide enough to capture most of the required product modifications.

by using Bass'(1969) growth model, which was retained because of its characteristics: it was conceptualized with high-involvement durable goods in mind, its development is based on a generalized logistic curve, typical of diffusion patterns, and it integrates both the external (innovative) and internal (imitative) influence phenomena addressed by diffusion theory.

The 2-parameter model was used for that purpose, given that an estimation of the potential market was not required. Indeed, "actual" adoptions (dependent variable) were entered as the number of respondents retained for each period, as determined from the Logit-based probabilities, out of a "potential market" of 307 (sample size). The Bass model is presented below:

$$Q_t = (p + q\,(Q_T / \bar{Q}))\;\;(\bar{Q} - Q_T)$$

where Q_t = number of adopters at time t
Q_T = cumulative number of adopters up to time t-1

$\bar{Q}$ = potential market (307)
p = coefficient of innovation
q = coefficient of imitation

Although a number of modifications and extensions have been proposed in the past by a number of authors to improve the original model, the simpler initial version was retained here for convenience purposes. This choice was deemed appropriate given the objective of a general validation of the 7-step probability procedure, rather than a more rigorous estimation of its validity.

For the purpose of calibrating the model, the function was rearranged in the usual form $Y = a + b X$ as illustrated below:

$$Q_t / (\bar{Q}-Q_T) = p + q (Q_T / \bar{Q})$$

where Y = current sales as a proportion of untapped market
X = cumulative sales as a proportion of potential market

Successive regressions were run in order to allow for the incorporation, at each time period, of data from the previous period, and thus to "update" the model's predictive capacity, as would most likely be done in industry. More precisely, Bass' growth model was calibrated on the first four observations (i.e., market penetration data for the first four time periods, obtained from the probability procedure) to predict the fifth observation, on the first five to predict the sixth, etc... up to a last calibration on the first nine observations to predict the tenth, for a total of 6 calibrations. Validation was undertaken by deriving the sample correlation between the "observations" from the probability procedure and the predicted values obtained from Bass' model.

CHAPTER V

DATA ANALYSIS

A. Preliminary results

71 questionnaires were discarded because of obvious problems, such as missing profile evaluations, unacceptable response patterns (such as descriptions being all similarly rated), etc... Another 82 questionnaires were screened out in cases where respondents said they did not have a VCR at home or were not at all familiar with its operation. The remaining 307 respondents were subjected to further analysis.

Demographics were examined to determine possible biases in the choice of respondents: More specifically, respondents' cultural background (mother tongue), level of household income, age, sex, and student status (full-time/part-time) were examined. The frequencies appear in Table R1, below.

A large majority of respondents (90%) were part-time students, indicating that the use of evening classes was mostly successful in avoiding full-time students. Sex figures did not significantly depart from Quebec population statistics. While age and income data somewhat departed from official statistics (with a stronger presence of middle-aged and higher income individuals), all categories for these two variables were nevertheless well represented.

Table R1
General respondent characteristics*

language:	French	60/269 (22.3%)
	English	164/269 (61.0%)
	Other	45/269 (16.7%)
student:	full-time	26/268 (9.7%)
	part-time	242/268 (90.3%)
income:	< 25,000	68/263 (25.8%)
	25-40,000	71/263 (27.0%)
	41-55,000	48/263 (18.2%)
	> 55,000	76/263 (29.0%)
age:	< 25	82/263 (31.2%)
	25-35	152/263 (57.8%)
	> 35	29/263 (11.0%)
sex:	male	162/307 (52.9%)
	female	145/307 (47.1%)

*totals < 307 due to missing values)

A "higher education" bias remains a possibility, although it would affect the sample in a uniform way, unlike other variables, and cannot be appraised here. If anything, respondents' answers to the question on VCRyears (number of years one has had a VCR at home) seem to indicate that the sample tends to be more of a "later adopter" type, with 76% of answers showing ownership to be 6 years or less, out of a possible 13 years.

The major potential source of bias appeared to be language, as English-speaking respondents were over-represented in the sample, compared to the proportion of the overall Quebec population they

account for in reality (around 20%). Descriptive statistics were derived with respect to the above general characteristics, for each language group. A number of comparisons between language groups were also conducted to see if any significant differences among them could be detected with respect to one's familiarity with and interest in VCR's and scanners, the number of years one has had a VCR at home (indicative of one's degree of innovativeness), one's propensity to purchase a programming device such as the one described in the questionnaire,[14] and one's ratings of product profiles. The comparisons were conducted by way of an analysis of variance to test the equality of group means. The GLM procedure in SAS, which accounts for unequal cell sizes, was used for that purpose.[15] The Anova results revealed significant differences (at .05) with respect to the number of years of VCR ownership and the degree of familiarity with VCR's, but no difference in terms of the respondents' preference ratings. These and concurring results of other tests on language groups appear in Appendices 3A and 3B. For the main purpose of investigating possible differences in preference patterns, it thus appeared that considering language as a possibly influential extraneous factor was not warranted.

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[14]For a description of how these variables were measured, refer to Chapter IV (Methodology).

[15]A Manova procedure was considered but not retained because of the large number of observations that were discarded in the process due to missing values.

Further investigation of respondent characteristics did not appear necessary, considering the relatively greater emphasis to be given to qualitative rather than quantitative considerations and findings throughout this research. Indeed, given the general purpose of demonstrating the existence of differences among adopter groups and the usefulness of the approach retained in that respect, rather than of ensuring the generalizability of the results obtained, external validity considerations were not the main focus of this research.

B. Testing reliability

Reliability was estimated by way of a test-retest procedure, using the correlation measurement described in Chapter IV (Methodology). Out of 307 respondents, 84% had a reliability score $r>.50$, with an overall mean reliability of .73. Although some higher scores have been reported in the literature [Acito (1977), Leigh, MacKay & Summers (1984)], results comparable to the above were also reported as acceptable [Carmone, Green & Jain (1978), McCullough & Best (1979), Segal (1982)]. Given these findings, reliability-related errors were not expected to affect significantly further analyses.

C. Fitting the main-effects model and assessing the degree to which the experimental design is unbalanced

1. Model calibration.

The main-effects model was calibrated on standardized ratings at the individual level using OLS. First, the appropriateness of the model and its explanatory power were checked. To investigate the model's appropriateness, a residual analysis was conducted, testing the normality of error terms for each respondent by way of a Shapiro-Wilk test, appropriate when fewer than 50 observations (here=36) are available. Residual plots were also derived for visual check. Normality was rejected (at .05) for 14/307 respondents, representing 4.5% of the sample, less than would be expected by chance.[16] As for the model's explanatory power, 93% of respondents had $R^2 > .50$ and close to 50% reached $R^2 > .75$, with the mean of individual values producing an overall $R^2 = .724$. These results lend support to basing further analytical developments on the model above.

2. Experimental design.

We considered that some biases might affect results due to the fact that the experimental design was not perfectly balanced. Indeed, as described in Chapter IV (Methodology), the originally balanced 36-description design was slightly affected by the changes

[16]Normality should really be checked on each level of each variable, which is impossible here, given that each respondent evaluates each product alternative only once. If we assume normality at each level of each variable as well as homoscedasticity, we should have all errors distributed normally.

that had to be made to four of the descriptions in order to avoid unrealistic profiles. Rebalancing the design was made impossible because a particular combination of the levels of the diffusion-related variables "time" and "market penetration" had been eliminated in the process.

One way to estimate the extent to which the design is unbalanced is by looking at the differences in curve directions and relative importances of the product features[17] when the "full" main-effects model is compared to a "reduced" model from which the diffusion-related variables "time" and "market penetration" have been taken out. Indeed, under a perfectly balanced design, unbiased estimators and thus perfectly stable parameters would be obtained, yielding similar direction and importance scores under both a "full" and a "reduced" main-effects model.

A comparison of direction scores under the "full" and "reduced" models revealed that the directions of "programming capacity", "durability" and "warranty" had remained unchanged. Some differences were however detected in the case of "ease of use" and "price". They are illustrated in Table R2, below:

[17]For a description of these measures, refer to Chapter IV (Methodology).

Table R2
Means of directions for affected variables
under the "full" and "reduced" main-effects model

	ease of use	price
full	.179	-.730
reduced	.221	-.786

The variables "ease of use" and "price" in turn affected all "true" relative importances because of these variables' presence in the denominator of the equation, as described in Chapter IV (Methodology). The comparative means table for "true" relative importances appears below:

Table R3
Means of "true" relative importances
under the "full" and "reduced" main-effects models

	programming capacity	ease of use	durability	warranty	price
full	.295	.090	.085	.223	.306
reduced	.290	.100	.083	.212	.316

The average changes in the values of the directions of "ease of use" and "price" and of the "true" relative importances (all variables), between the "full" and "reduced" model, were tested and found to be significant at .05 in all cases. This can be due to the fact that the statistical procedure is more powerful when applied to matched pairs, as in the present case. However, a direct examination of the extent to which the values of the directions and "true" relative importances under the "reduced"

model departed from the original values, revealed that the magnitude of the changes was relatively small (<5%, except for "ease of use"), as shown in Table R3, above. These results indicate that, given the limited scope of the changes, the bias introduced in the computations is likely to remain minimal enough so as not to severely distort the results.

D. Categorization of respondents into adopter groups

Individual scores on each of the categorization criteria described in Chapter IV (Methodology) were ranked and summed across all measures. Individuals were then categorized along Rogers'(1962) distribution (16%/34%/34%/16%), yielding groups of 49, 104, 105 and 49 for early adopters, early majority, late majority and laggards respectively. Having categorized all individuals, possible differences between adopter groups in terms of the main-effects model's explanatory power were investigated. Table R4 shows the group means of individual R^2's, derived for each adopter category:

Table R4
Group means of R^2's (adjusted R^2)
for the main-effects model

Early adopters	.747 (.742)
Early majority	.721 (.720)
Late majority	.712 (.711)
Laggards	.733 (.731)

In each case, the model explained more than 71% of the variation in individual profile evaluations, with no significant difference in explanatory power: An analysis of variance (GLM) was performed

to compare adopter groups on the basis of R^2. The hypothesis of equal means could not be rejected at .05.

E. Testing the predictive validity of the main-effects model

Predictive validity was estimated at the individual level. Means of individual scores were then derived for each group. At the individual level, 87% of respondents had a correlation coefficient r>.5 and nearly 60% had r>.75. An overall validity measure (mean of individual correlations) of .723 was obtained. These results are consistent with those of cross-validity tests reported in the literature [Cattin & Weinberger (1980), Moore & Holbrook (1982), Srinivasan, Jain & Malhotra (1983)]. For each adopter category, group means were then derived for the reliability (test-retest correlation) measure and the validity (holdout sample correlation) measure, as illustrated in Table R5:

Table R5
Group means for validity (main-effects model)
and reliability measures

	validity	reliability
Overall	.723	.731
early adopters	.760	.783
early majority	.762	.753
late majority	.662	.681
laggards	.734	.740

As expected, measures of reliability and predictive validity were related: Respondents with lower validity scores also tended to have lower reliability scores. The scores suggested that the "late

majority" group might have significantly different results than the other groups, which was tested by way of pairwise comparisons using the t-test procedure. The "late majority" group's weaker scores were confirmed (significant at .05), although they appeared to remain acceptable.

Further investigation as to the degree to which the experimental design was unbalanced seemed appropriate to examine group differences on that basis as well. Comparative tests on directions and relative importances, similar to those reported in Tables R2 and R3 for the whole sample, were thus conducted on a group basis. Results are reported in Table R6 (directions) and Table R7 (relative importances) below:

Table R6
Comparison of group means of directions
for affected features "ease of use" and "price"
under "full" and "reduced" main-effects model

	ease of use		price	
	full	reduced	full	reduced
early adopters	.210	.234	-1.031	-1.044
early majority	.191	.229	- .843	- .885
late majority	.186	.221	- .596	- .659
laggards	.127	.192	- .476	- .592

We tested whether the average changes in the values of the directions of "ease of use" and of "price" were significant at .05 and found the changes to be significant in all cases. However, when examining the extent to which the values of the directions

under the "reduced" model departed from those under the "full" model, it appeared that the magnitude of the changes was fairly limited (<.20 for "ease of use", <.10 for "price"), with the exception of "laggards", for whom changes were larger. Percentage changes occurring for the "late majority" group being comparable to those of earlier adopter groups, they did not appear to have affected that group's validity scores in any particular way. Results for relative importances are reported below.

Table R7
Comparison of group means
of "true" relative importances
under full and reduced (red.) main-effects model

	CAPACITY		EASE/USE		DURABLE		WARRANTY		PRICE	
	full	red.	full	red.	full	red.	full	red.	full	red.
early adopt.	.339	.337	.090	.094	.069	.068	.134	.131	.367	.369
early major.	.319	.313	.086	.093	.077	.076	.206	.201	.311	.317
average	.326	.321	.087	.093	.074	.073	.183	.178	.329	.334
late major.	.286	.281	.093	.102	.092	.089	.246	.235	.283	.291
laggards	.220	.211	.093	.111	.101	.097	.300	.268	.285	.313
average	.265	.233	.093	.108	.095	.094	.263	.257	.284	.306

All differences between the "true" relative importances under the "full" and "reduced" models were significant at .05. But again, when examining the extent to which the values had changed, it appeared that the magnitude of the changes were relatively small (from <.01 to <.10), with the exception of "laggards" for whom changes were relatively larger. Score differentials for "late majority" being comparable to those of earlier adopter groups, they

did not appear to have affected that group's validity scores in any particular way. The relatively larger differences occurring in the case of "laggards", suggesting a greater impact of the design's weakness in orthogonality, called for additional caution in interpreting that group's further test results.

F. Probing interactions: selecting reduced models and testing validity

Interactions between the diffusion-related variables and the product features were calibrated at the group level, with residuals from the main-effects model serving as the dependent variable. Despite the large number of parameters to be estimated, the number of observations per group (at least 49x36) alleviated the usual concern about a loss of degrees of freedom. Coefficients of determination were narrowly spread, the model explaining 9%, 8%, 2% and 4% of the variance (adj.R^2), for "early adopters", "early majority", "late majority" and "laggards" respectively.

1. Selecting reduced models.

In each group, a number of parameters lacked significance (at .05), which called for the use of stepwise procedures to derive reduced models. The backward elimination approach was retained for that purpose. The selection procedure resulted in models with 22 parameters for "early adopters", 25 parameters for "early majority", 23 parameters for "late majority" and 18 parameters for "laggards", with all variables significant at .05. There was no

deterioration in explanatory power (adj.R^2) resulting from the reduction process. The reduced-model coefficients (all significant at .05) and adj.R^2 values appear in Tables R8 (A) and (B) below.

Table R8 (A)
Regression parameters (and standard error of estimates)
Reduced interaction models for each adopter group
(All variables significant at .05)

Early adopters 22 parameters				Early majority 25 parameters			
T^2P	.00000509	M^2P	-.00000340	T^2P	.00000453	M^2P	-.00000283
	(.000000)		(.000000)		(.000000)		(.000000)
T^2P^2	-.00000003	MP^2	-.00000044	TP^2	.00000074	MP^2	-.00000027
	(.000000)		(.000000)		(.000000)		(.000000)
TW	.00549624	M^2P^2	.00000003	T^2P^2	-.00000003	M^2P^2	.00000002
	(.000585)		(.000000)		(.000000)		(.000000)
T^2W	-.00011973	M^2W	-.00003263	TW	.00331737	MW	.00066225
	(.000011)		(.000004)		(.000650)		(.000077)
TW^2	-.00014081	MW^2	.00001828	T^2W	-.00008050	M^2W	.00004269
	(.000015)		(.000002)		(.000011)		(.000004)
T^2W^2	.00000303	M^2W^2	.00000046	TW^2	-.00009614	M^2W^2	.00000074
	(.000000)		(.000000)		(.000015)		(.000000)
TC	-.01615705	MC	.00928780	T^2W^2	.00002173	MC	.00510023
	(.004321)		(.001903)		(.000000)		(.001734)
T^2C	.00019553	ME	.00585764	TC	-.01329587	M^2C	.00006387
	(.000083)		(.002465)		(.003602)		(.000031)
TE	-.02488446	M^2E	-.00005776	T^2C	.00014585	ME	.00892038
	(.004344)		(.000033)		(.000066)		(.001869)
T^2E	.00053007	MD	-.02198428	TE	-.02384291	M^2E	-.00009055
	(.000090)		(.004416)		(.003768)		(.000025)
TD	.00226084	M^2D	.00056811	T^2E	.00046788	MD	-.03250955
	(.001154)		(.000078)		(.000075)		(.003555)
				TD	.01281807	M^2D	.00071282
					(.003117)		(.000061)
				T^2D	-.00018221		
					(.000048)		

where: T = time of introduction C = programming capacity
M = market penetration E = ease of use
P = price D = durability
W = warranty TW = interaction time x warranty, etc..

Table R8 (A) (end)

Late majority 23 parameters				Laggards 18 parameters			
TP	.00032730	M^2P	-.00000127	TP	.00010143	MP	.00030764
	(.000060)		(.000000)		(.000027)		(.000091)
T^2P	-.00000246	M^2P^2	.00000001	T^2P^2	-.00000001	M^2P	-.00000391
	(.000000)		(.000000)		(.000000)		(.000001)
TP^2	-.00000117	MW	-.00061553	T^2W	-.00001049	MP^2	-.00000193
	(.000000)		(.000199)		(.000002)		(.000000)
TW	.00110637	M^2W	-.00000409	TW^2	-.00001250	M^2P^2	.00000003
	(.000662)		(.000001)		(.000003)		(.000000)
T^2W	-.00003079	MW^2	.00002140	T^2W^2	.00000044	MW	.00032066
	(.000011)		(.000005)		(.000000)		(.000105)
TW^2	-.00003848	MC	.00450091	T^2C	.00017465	M^2W	-.00001593
	(.000015)		(.001485)		(.000034)		(.000003)
T^2W^2	.00000089	ME	.00703820	TE	-.00228517	M^2W^2	.00000021
	(.000000)		(.001934)		(.000137)		(.000000)
TC	-.02399892	M^2E	-.00008073			MC	-.01080604
	(.003881)		(.000024)				(.002701)
T^2C	.00043621	MD	-.01493332			M^2C	.00008753
	(.000068)		(.002771)				(.000039)
TE	-.02024061	M^2D	.00025821			MD	-.01865982
	(.004517)		(.000050)				(.003510)
T^2E	.00035086					M^2D	.00037174
	(.000086)						(.000064)
TD	.01186306						
	(.002981)						
T^2D	-.00018582						
	(.000047)						

where: T = time of introduction C = programming capacity
M = market penetration E = ease of use
P = price D = durability
W = warranty TW = interaction time x warranty, etc..

Table R8 (B)
Explanatory power of full and reduced interaction models (adj.R^2)

	Full	Reduced
early adopters	.087	.088
early majority	.078	.078
late majority	.024	.023
laggards	.038	.041

A residual check was performed for each of the reduced models by way of a normality test on residuals, using the Kolmogorov D statistic for large samples (smallest sample = 49x36 observations). The following plots were derived in order to conduct a visual check: $Y_{observed}$ against $Y_{predicted}$, and Residuals against each of "warranty", "price", "time" and "market penetration".

The hypothesis of error normality was rejected (at .05) for "early adopters" and "early majority". Departure from normality appeared limited, as indicated by the measures of skewness and steepness (kurtosis), which remained <.20 and <1 respectively.[18]

2. Testing validity.

The Pearson correlations were derived for each group's reduced interaction model, and compared to the group means of individual correlations previously obtained under the main-effects model, in order to establish each interaction model's contribution to the improvement or deterioration of predictive validity. The results obtained are illustrated in Table R9 below, where:

"Improvement" = (group validity score under interaction model)
- (group validity score under main-effects model).

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[18] Skewness $= [n/(n-1)(n-2)]\ \Sigma(xi-\bar{x})^3\ /s^3$

and kurtosis $= [n(n+1)/(n-1)(n-2)(n-3)]\ \Sigma(xi-\bar{x})^4\ /s^4 - 3(n-1)(n-1)/(n-2)(n-3)$

Table R9
Overall and group validity scores under interaction models and main-effects model; Improvement in predictive validity

	validity under interaction model	validity under main-effects model	improvement (deterioration)
Overall	.67	.72	-.05
early adopters	.70	.76	-.06
early majority	.66	.76	-.10
late majority	.65	.66	-.01
laggards	.69	.73	-.04

These results indicate that, while validity scores under the reduced interaction models appear acceptable per se, incorporating interactions into the full conjoint model significantly deteriorates predictive validity (negative improvement scores). Such results suggest that in all cases, and particularly for earlier adopter groups, interaction terms should not be combined with main effects when deriving the utilities that serve to estimate the importances of product features.

However, these reduced interaction models still make an interesting contribution on their own, in terms of explanatory power (adj.R^2 scores), significance (all coefficients at .05) and even predictive validity (correlation scores). Therefore, while most upcoming analyses were based of the main-effects model to avoid a possible (but difficult to estimate) bias in the results, tests on interaction effects alone [hypotheses H3a) and H3b)] were

carried-on in an attempt to assess the general direction -if not the precise extent- of these interactions' impact.

G. Testing the importance of product features: hypotheses H1a), H1b) and H2

We conducted a number of tests on the five product features for the purpose of testing hypotheses about these variables' relative importances, within-group [H1a) and H1b)] and among-groups (H2), as summarized below, in condensed form for convenience purposes:

H1 a) For earlier adopters, the "compatibility" factors have a greater relative importance than the "complexity" factors, the "risk" factors and price.

b) For later adopters, the "complexity" factors, the "risk" factors and price have a greater relative importance than the "compatibility" factors.

H2 Relative to other features, the "complexity" and "risk" factors and price have a greater importance for later adopters than for earlier adopters. Conversely, relative to other features, the "compatibility" factors have a greater importance for earlier adopters.

The means of the "true" relative importances of all product features were presented earlier, in the "full" columns of Table R7. Each feature was considered on its own merit: It was thought that since only the "perceived risk" dimension had been operationalized with more than one descriptor (durability and warranty), a combined measure (sum of relative importances) for this dimension would not allow for a uniform treatment of dimensions. Furthermore, it was useful to keep the two descriptors apart due to the reported stronger and cleaner perceptual

association of "warranty" with the "perceived risk" dimension, as opposed to "durability" which also tends to weigh on the "relative advantage" dimension [Holak & Lehmann (1990)].

Before testing hypotheses H1a) and H1b) on the basis of these relative importance scores (Table R7), the degree of significance of the within-group differences between such scores had to be established for conclusions to be meaningful. Pairwise comparisons were thus conducted by way of t-tests, and significance results (at .05) are reported in Table R10.

Table R10
Within-group differences between
product feature importances (from Table R7)
t-test results (at .05)

	ease / use	durability	warranty	price
capacity	signif. all groups	signif. all groups	signif. except for late majority	not signif. all groups
ease / use		not signif. all groups	signif. all groups	signif. all groups
durability			signif. all groups	signif. all groups
warranty				signif. except for late majority and laggards

Given the results above and those in Table R7, hypotheses concerning within-group differences were partially supported:

H1a): For earlier adopters (early adopters and early majority), the "compatibility" variable (programming capacity) has a greater relative importance than the "complexity" factor (ease of use) and "risk" factors (durability and warranty), as hypothesized. The expected greater relative importance of "programming capacity" with respect to "price" could not be confirmed, but although the difference was not significant in both groups, it pointed in the right direction for "early majority". A possible explanation as to the relatively strong presence of "price" is proposed below.

H1b): For later adopters, the hypothesized relationship was confirmed in the case of "laggards" for the stronger "risk" variable (warranty) and for "price". For both "late majority" and "laggards", the hypothesized greater relative importance of the "complexity" factor (ease of use) and of the weaker "risk" factor (durability) was not supported. An explanation for such unexpected results may reside in later adopters' perception of these features' lower levels as lacking the degree of risk or complexity that would deter them from considering a purchase. Indeed, whereas "capacity" was presented as being available or not, the lowest levels of "ease of use" (= some care required in handling) and of "durability" (= resistant to normal wear and tear) may have been perceived as already acceptable by a number of later adopter-type respondents, leading to the feature levels' weak discriminatory power.

Another possibility is for "programming capacity" to have been perceived more as a "relative advantage" than as a "compatibility"-related factor, with a number of respondents perceiving the incorporation of the scanner within the TV-selector (level 2) as a condition for the scanner to become a possible buy (lexicographic rather than compensatory evaluation process).

With respect to the among-group hypothesis H2, a pairwise comparison of group means (t-test procedure) was conducted on each feature's relative importance. Results are reported below:

Table R11
Comparison of group means
Relative importances of product features (from Table R7)
t-test results (at .05)

	Early majority	Late majority	Laggards
Early adopters	not significant except for WARRANTY	significant except for EASE OF USE	significant except for EASE OF USE
Early majority		not significant except for WARRANTY	significant except for EASE OF USE, PRICE
Late majority			not significant except for CAPACITY, WARRANTY

H2: From Table R11, the significant group differences in the relative importance of "warranty" indicate that this is a good discriminating variable for all groups. The relative importance of "programming capacity" also discriminates well between

"laggards" and the other groups and the relative importances of "durability" and of "price" allow for some discrimination between the "early adopter" group and later adopters.

Earlier relative importance scores (Table R7) indicate that for four of the variables (programming capacity, ease of use, durability and warranty), the signs of the differences between group means are as hypothesized: Relative to other features, the "compatibility" feature (programming capacity) is more important in the case of earlier adopters than in the case of later adopters, while the reverse is true for the "risk" factors (durability and warranty) and for the "complexity" factor (ease of use), although statistical significance (at .05) could not be established for the latter (Table R11).

The major surprise concerns "price", with earlier adopters accounting for the highest relative importance scores (Table R7). The perception of "price" as a risk factor could not be retained, given the anticipated and confirmed trend of the two risk descriptors (durability and warranty) from early adopters to laggards (Table R7). The perception of "price" as an indicator of quality could not be retained either, given that individual group scores for the direction of "price" (Table R6) clearly indicate that all groups prefer lower prices (negative scores), with the most negative values being recorded for the "early adopter" and "early majority" groups.

It appears that the perception of a lower price as being a "relative advantage" may have prevailed, given the nature of the product, in the case of earlier adopters, which would support the original statement of hypotheses H1a) and H1b) in Chapter III (Theoretical Framework). In the case of later adopters, the relatively high importance scores for the first "risk" factor (warranty), and the possible interaction between that factor and "price", may have played down the scores for the latter, contributing to a reverse relationship with earlier adopters.

H. Testing interactions: hypotheses H3a) and H3b)

Hypotheses relating to interactions are summarized below, in condensed form for convenience purposes:

H3a) In the case of earlier adopters, significant interactions occur between "time" and all non-diffusion factors. They are positive in the case of the "compatibility"-related factor and negative in the case of the "risk" and "complexity"-related factors and of "price". Interactions between "market penetration" and other variables are less important than those with "time".

H3b) In the case of later adopters, significant interactions occur between "market penetration" and all non-diffusion factors. They are negative in the case of the "compatibility" -related factor, and positive in the case of the "risk" and "complexity"-related factors and of "price". Interactions between "time" and other variables are less important than those with "market penetration".

The following developments are to be viewed in the context of the results reported earlier on the validity of the reduced interaction models: The deterioration in predictive power that resulted from the incorporation of interaction terms in the

conjoint model calls for a cautious interpretation of the results and conclusions presented below, and explanations provided should be considered as tentative.

1. Earlier adopters [hypothesis H3a)].

Significance: The regression tables for the reduced models (Table R8, above) indicate that, for both the "early adopter" and "early majority" groups, significant interactions emerge between "time" and all 5 product features, as hypothesized. Significant interactions also emerge between "market penetration" and these 5 variables, revealing the moderating role of that variable as well. Although the emergence of "market penetration" as a significant moderator was not anticipated here, especially in the case of "early adopters", it can be explained by the composition of that group which comprises very few "true" innovators (normally 2-3% out of the 16% of adopters that this category represents). The fact that the greater number of significant interaction terms involving that variable is found under "early majority" rather than "early adopters" illustrates that variable's growing moderating role as later adopters enter the market, lending support to a possible "contamination" of the "early adopter" group.

Direction: The complete numerical and graphical results based on regression analysis appear in Appendix 4. For the purpose of testing hypothesis H3a), only interactions with "time" were considered. Graphical representations of the interactions with

the two continuous variables "price" and "warranty" are presented in Figure R1, and numerical results (level 2 utilities) for the 3 discrete variables appear in Table R12, below.

Figure R1: Interactions with "time of introduction":
X-axis= 3 levels of product feature
Y-axis= utility of product feature
3 curves for 3 levels of time

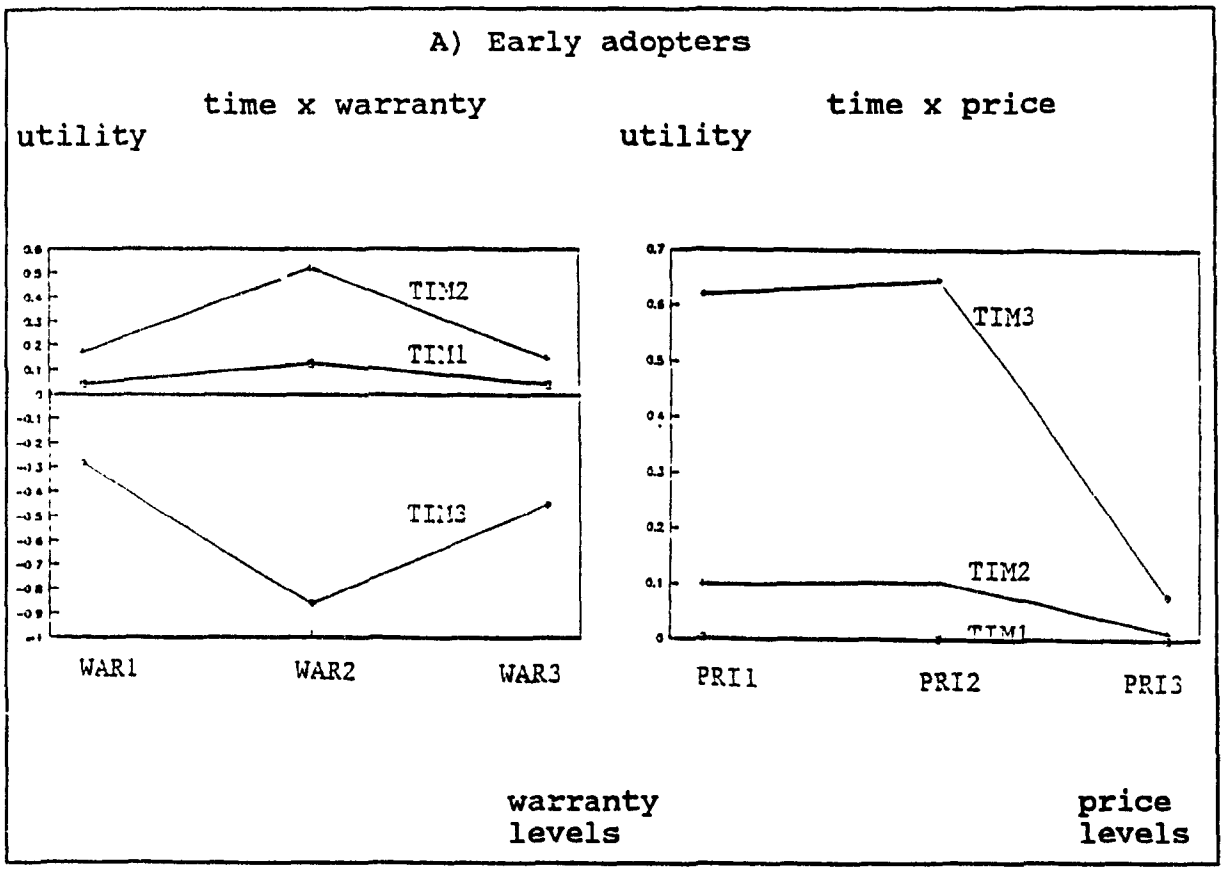


Figure R1 (end)

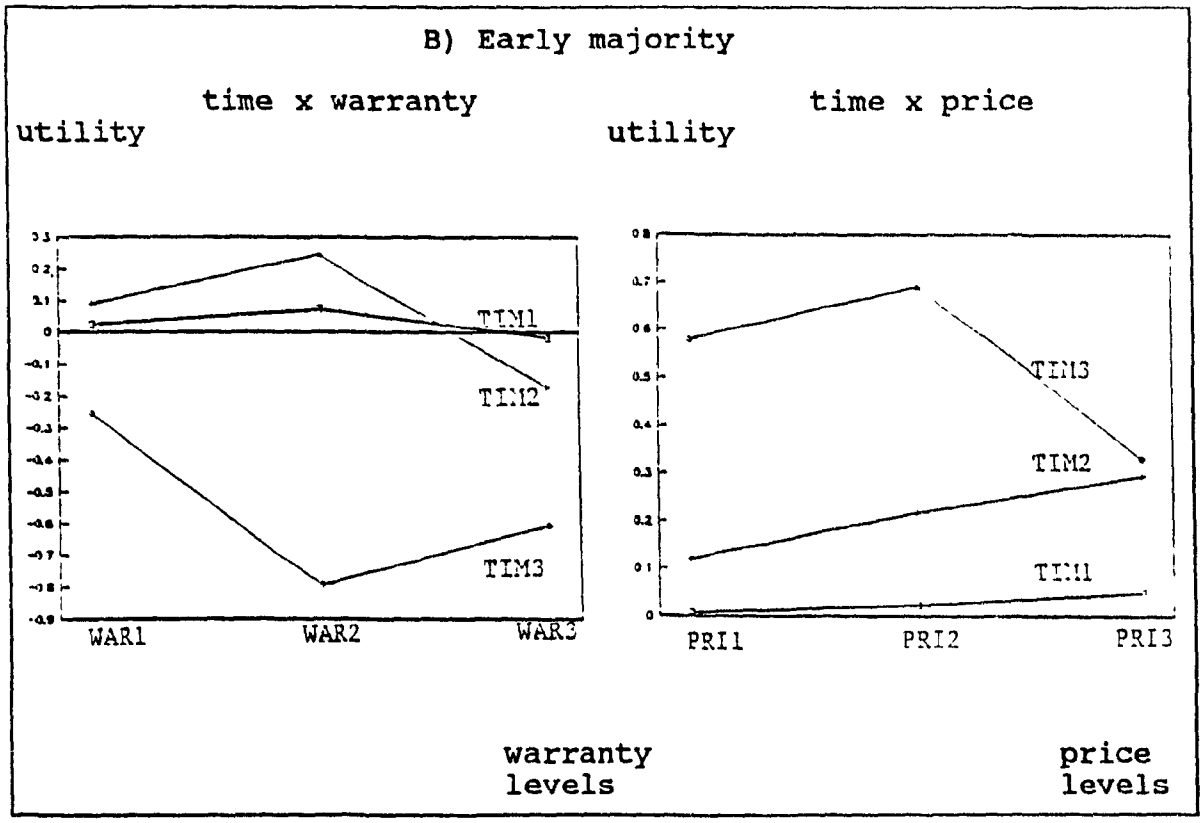


Table R12
Interactions between "time of introduction" (TIM1, TIM2, TIM3) and programming capacity (CAP), ease of use (EAS), durability (DUR)

	Early adopters	Early majority
CAP x TIM1	-.0467	-.0386
x TIM2	-.2751	-.2351
x TIM3	-.2655	-.2727
EAS x TIM1	-.0699	-.0673
x TIM2	-.2919	-.3027
x TIM3	.4152	.2538
DUR x TIM1	.0068	.0368
x TIM2	.0543	.2027
x TIM3	.1356	.1131

Comments will be made in reference to the graphical illustrations of anticipated interaction relationships, appearing in Figure 1 of Chapter III (Theoretical framework), in which the change in direction (arrow) reflects the wording of the hypothesis statements: Having anchored variables at level 1 for regression purposes (dummy variables), reversed conclusions should be reached in the case of "ease of use", "durability" and "warranty" in order to support hypotheses about "risk" and "complexity" factors, as explained in Chapter IV (Methodology).

Mixed results were obtained: the direction was positive as expected for (time x durability) and for the higher levels of "time" in (time x ease of use). However, it was negative rather than positive for (time x capacity) and for (time x warranty). Finally, while higher utilities for lower "price" levels at higher "time" levels (older product) were not surprising, the utility for higher prices was expected to decrease as time elapsed. Therefore, although the direction was negative at the higher level of time, the position of the curve was unexpected. Comments on these results follow the developments on importance, below.

Importance: Complete numerical results are reported in Appendix 4. Table R13 below presents the relative importance scores for the interactions between the diffusion-related variables and the product features:

Table R13
Relative importance scores by group:
a) within "time" interactions
b) within "market" interactions
c) across all interactions

	a) & b) within		c) across	
	early adopters	early majority	early adopters	early majority
time x price	.205	.248	.067	.074
time x warranty	.439	.377	.144	.113
time x capacity	.087	.099	.029	.030
time x ease of use	.225	.202	.074	.060
time x durability	.043	.073	.014	.022
	1.00	1.00		
market x price	.259	.197	.174	.138
market x warranty	.301	.314	.202	.220
market x capacity	.116	.127	.078	.089
market x ease of use	.022	.033	.015	.023
market x durability	.301	.329	.202	.230
	1.00	1.00	1.00	1.00

Table R13 (middle section) reveals that for both "early adopters" and "early majority", the strongest interactions with "time" are those involving "warranty", "price" and "ease of use", with relative importance scores ranging from .20 to .44. When comparing interactions with "time" and those with "market penetration", however, only the (time x ease of use) interaction was, as hypothesized, more important than the corresponding interaction with "market penetration" (Table R13, right section).

The moderating impact of "time" could not be satisfactorily established. The main reason may be found, as suggested earlier,

in the fact that, while time is likely a major decision factor (and an important moderating variable) for innovators, it plays a lesser and decreasing role for later adopters. The composition of the "early adopter" group does not allow for the greater relative importance of "time"'s moderating role for innovators to emerge. The above explanation finds support in the comparison of "early adopters" and "early majority" on the basis of interactions with "time", as revealed by the sum of relative importances for such interactions, which is greater for the former (.328) than for the latter (.299).

Given the apparent relative lack of importance of "time" as a moderating factor, it is difficult to reach any conclusions about the earlier results on the direction of interactions, especially with respect to the decreasing utility of the highest level of "warranty" and of "programming capacity" and conversely, the increasing utility of the highest level of "price", as time elapses. A potential (time x market penetration) interaction effect was not retained as a likely cause because of the directions displayed by the interactions between these features and "market penetration" (Appendix 4).

A possible explanation for the "programming capacity" and "warranty" features would be that respondents, rather than "compensating" for a lack of novelty (older product) by giving more importance to other product characteristics, as hypothesized,

might in fact not be interested in older products altogether, leading to increasingly negative utilities and directions for the above features. However, while the explanation could be retained for "true" innovators, it does not match other conclusions reached for "early adopters" and "early majority".

2. Later adopters [hypothesis H3b)].

Significance: The regression parameter values for "late majority" and "laggards" appear in Table R8, above. The "late majority" group has significant interactions between "market penetration" and all 5 product features, but also between "time" and all such variables. "Laggards" have significant interactions between "market penetration" and 4 features, the exception being with "ease of use", and also between "time" and 4 variables, the exception here being "durability". The lack of significance of (market x ease of use) was unexpected. In both groups (but to a lesser degree for "laggards"), both "time" and "market penetration" appear to have played an important moderating role, with a slight predominance of the latter variable.

Direction: Complete numerical and graphical results based on regression analysis appear in Appendix 4. For the purpose of testing hypothesis H3b), only interactions with "market penetration" were considered. Graphical representations of the interactions with the two continuous variables "price" and "warranty" are presented in Figure R2, and numerical results for

the 3 discrete variables appear in Table R14, below. Conclusions will be drawn in reference to the graphical illustrations of anticipated interaction relationships, appearing in Figure 2 of Chapter III (Theoretical framework), in which the change in direction (arrow) reflects the wording of the hypothesis statements. The same comments about interpreting the results as were made for earlier adopters apply here as well.

Figure R2: Interactions with "market penetration":
X-axis= 3 levels of product feature
Y-axis= utility of product feature
3 curves for 3 levels of market penetration

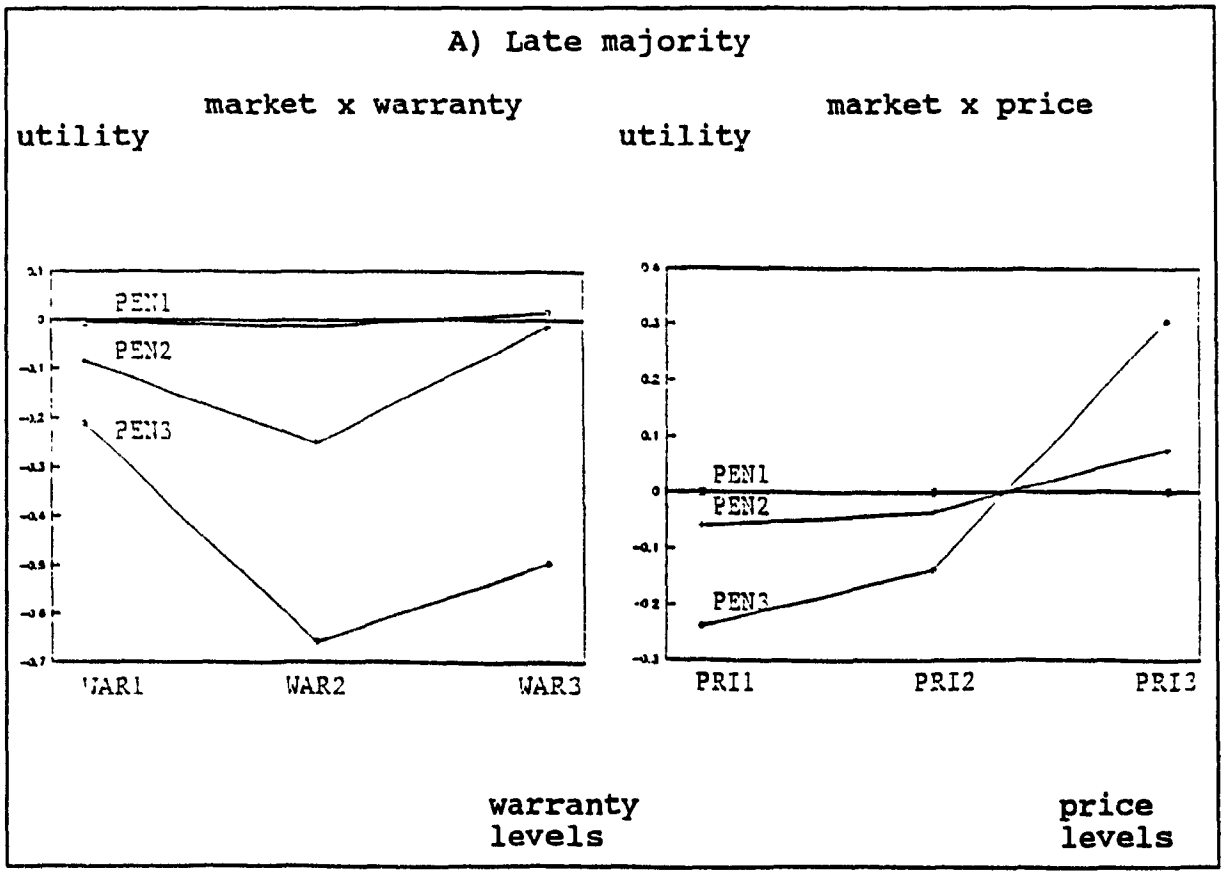


Figure R2 (end)

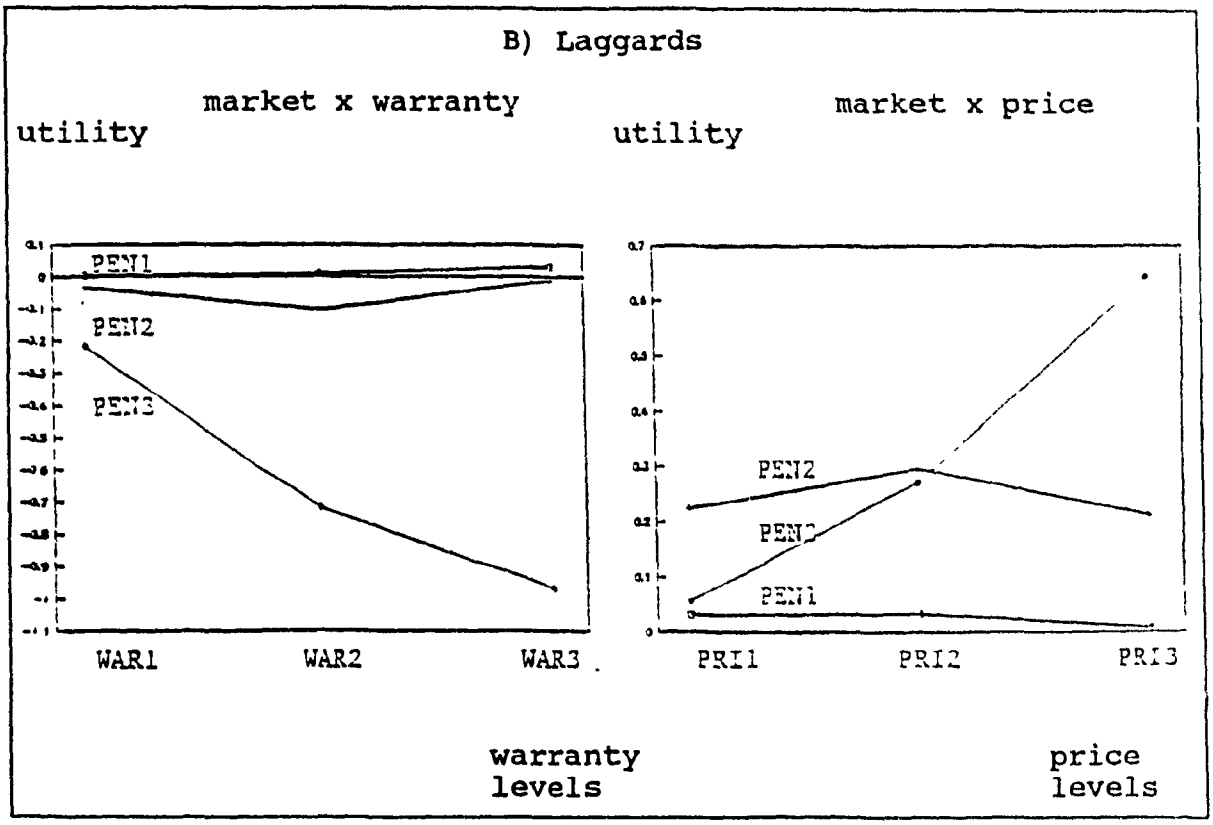


Table R14
Interactions between "market penetration" (PEN1, PEN2, PEN3) and capacity (CAP), ease of use (EAS), durability (DUR)

	Late majority	Laggards
CAP x PEN1	.0135	-.0316
x PEN2	.1800	-.2922
x PEN3	.3601	-.3043
EAS x PEN1	.0204	- -
x PEN2	.1523	- -
x PEN3	.0464	- -
DUR x PEN1	-.0425	-.0526
x PEN2	-.1842	-.1516
x PEN3	.4579	.8863

Mixed results were obtained: The direction was positive rather than negative for (market x programming capacity) in the case of the "late majority" group, but was as hypothesized for "laggards". The direction was generally negative as expected for (market x warranty). In the case of (market x ease) for "late majority" and of (market x durability) for both groups, unanticipated results were obtained: the positive direction for "durability" could be explained by a market penetration "threshold" that respondents would need to reach to consider the product feature's potential advantages (sudden increase in utility under level 3 of market penetration). The apparent kink, positive in the case of the (market x ease of use) interaction, and negative in the case of the (market x durability) interactions, make this explanation generally untenable, however.

Finally, the (market x price) results for the "late majority" group are ideally distributed, with utilities dropping for lower "price" and increasing for higher "price" as "market penetration" increases, resulting in crossed interactions. For "laggards", the results at level 2 of "market penetration" were unexpected at the lower end of "price", but as hypothesized at the higher end.

Importance: Complete numerical results are reported in Appendix 4. Table R15 below presents the relative importance scores for the interactions between the two diffusion-related variables and the product features:

Table R15
Relative importance scores by group:
a) within "time" interactions
b) within "market" interactions
c) across all interactions

	a) & b) within		c) across	
	late majority	laggards	late majority	laggards
time x price	.194	.298	.083	.102
time x warranty	.258	.211	.110	.073
time x capacity	.258	.403	.110	.138
time x ease of use	.188	.088	.080	.030
time x durability	.101	---	.043	---
	1.00	1.00		
market x price	.229	.213	.131	.140
market x warranty	.284	.336	.163	.220
market x capacity	.152	.102	.087	.067
market x ease of use	.064	---	.037	---
market x durability	.271	.349	.155	.229
	1.00	1.00	1.00	1.00

The strongest interactions with "market" are those involving "price", "warranty" and "durability", with scores ranging from .21 to .35. Results here are more consistent with the hypothesized relationships, with (market x price) and (market x warranty) being more important for both groups than similar interactions with "time" and, in the case of "late majority", (market x durability) also having greater importance. Although hypothesis H3b) was not supported for (market x capacity) and (market x ease), the overall greater importance of interactions with "market" was confirmed, with sums reaching .573 and .656 (right section of Table R15) for "late majority" and "laggards", respectively.

Hypotheses H3a) and H3b) were thus only partially supported, with some interesting developments to be noted, such as the evolution of (time x warranty) across all four adopter groups, as illustrated by the complete set of graphs in Appendix 4. While some trends appear more obvious than others, such as (market x price) for the "late majority" group, definite conclusions may not be drawn for the reasons mentioned earlier.

I. Deriving purchase probabilities

1. Choice of best alternative.

For the purpose of deriving purchase probabilities, the main-effects model was retained, because of the deterioration in predictive validity that resulted when adding the interaction terms, as indicated earlier. Individual purchase probabilities were derived along the 7-step Logit-based time-related choice process described in Chapter IV (Methodology). The following cumulative penetration levels (Table R16) and diffusion results (Table R17) were obtained:

Table R16
Cumulative penetration levels
used in the diffusion analysis
(percents)

period	1	2	3	4	5	6	7	8	9	10
initial levels	3.0	6.4	14.4	25.6	40.0	54.4	65.6	73.6	78.4	80.0
after 7 iterations (convergence)	4.8	9.7	14.7	19.9	25.3	30.9	36.7	42.8	49.1	55.6

Table R17
Purchase probabilities and diffusion data

periods	1	2	3	4	5	6	7	8	9	10
(1) # of preferred profile	23	23	15	15	15	15	15	15	15	15
(2) average purchase probability of profile	.048	.049	.050	.052	.054	.056	.058	.061	.063	.065
(3) number of buyers	15	15	15	16	17	17	18	19	19	20
(4) cumulative number of buyers	15	30	45	61	78	95	113	132	151	171

Table R17 above reveals that the "preferred alternative" at time (t), that for which the aggregate purchase probability is highest at that time, starts with profile 23 for 2 periods (1 year) and then shifts to profile 15 for the remainder of the time frame, indicating the appropriateness of a decrease in price and in length of warranty. The diffusion pattern reveals a fairly constant inflow of consumers, reaching a market penetration of more than 55% (171/307) after 10 periods (5 years). This is less than the upper-bound of 80% that was set for the time range, which is not surprising given an anticipated longer life cycle for this kind of product than the length of time that was considered in the present study.[19] The number of buyers per period appears to continue to

[19]The reason why 5 years rather than a longer period (10 years for example) were chosen as the time frame, was given earlier. Refer to Chapter IV (Methodology).

increase slightly near the end of the time frame, reflecting the increasing returns to scale of a diffusion curve that has not yet levelled off.

2. Comparing alternatives: Different market shares.

A comparison of all 24 product alternatives on the basis of time-related market penetration incrementals, as reflected in the average purchase probabilities, is provided in Appendix 5A. It appears, for example, that although one's choice of retaining alternative 23 throughout the 10 periods rather than switching to alternative 15 (lower price, shorter warranty) after period 2, would only result in a .40% decrease in market share, retaining any other alternative would mean significantly greater losses. For instance, choosing one of the other best alternatives (profile 24, for example) and keeping it unchanged through time, would result in a decrease of 2.1% overtime.

3. Determining the proportion of buyers belonging to each adopter group.

At every time period, once respondents were "selected" as adopters on the basis of their probability (Logit) scores for the retained "best" alternative (in a proportion of total sample (307) equal to the chosen alternative's average purchase probability), they were divided into their respective adopter groups and their scores were summed to provide group measures: the group frequency, the proportion of buyers each group represents at each time period

(column percentage), and the allocation through time of purchasers from each group (row percentage), are illustrated in Table R18:

Table R18
Classification of adopters through time*
frequency
row percentage
column percentage
marginal change over (t-1)

period (t)	1	2	3	4	5	6	7	8	9	10	Total row
Early adopters:											
freq.	2.25	2.29	2.50	2.54	2.58	2.61	2.62	2.63	2.64	2.64	25.30
row %	.089	.090	.099	.100	.102	.103	.103	.104	.104	.104	
col %	.152	.153	.162	.158	.155	.151	.146	.141	.137	.132	
%change	--	.011	.100	.010	.016	.012	.004	.004	.004	.000	
Early majority:											
freq.	5.10	5.15	5.22	5.37	5.53	5.69	5.85	6.01	6.16	6.32	56.40
row %	.090	.091	.092	.095	.098	.101	.104	.107	.109	.112	
col %	.345	.343	.339	.335	.332	.328	.325	.323	.319	.317	
%change	--	.010	.014	.029	.030	.029	.028	.027	.025	.026	
Late majority:											
freq.	5.26	5.35	5.36	5.60	5.87	6.15	6.44	6.72	7.00	7.28	61.03
row %	.086	.088	.088	.092	.096	.101	.106	.110	.115	.119	
col %	.355	.357	.348	.349	.352	.355	.358	.361	.363	.365	
%change	--	.017	.002	.045	.048	.048	.047	.043	.042	.040	
Laggards:											
freq.	2.15	2.21	2.36	2.52	2.69	2.88	3.07	3.27	3.49	3.72	28.36
row %	.076	.078	.084	.089	.095	.102	.108	.115	.123	.131	
col %	.145	.147	.153	.157	.161	.166	.171	.175	.181	.186	
%change	--	.028	.068	.068	.067	.071	.066	.065	.067	.066	
Total column	14.8	15.0	15.4	16.0	16.7	17.3	18.0	18.6	19.3	20.0	

* sums of percentages may be < or > 1.00 due to rounding

The column totals were discussed earlier. The row totals indicate that 51.6% of "early adopters", 54.2% of "early majority", 58.1% of "late majority" and 57.9% of "laggards" have purchased

after 10 periods. The combining of Rogers'(1962) innovators and early adopters into a single category prevents us from breaking down the row total of 25.30. The percentage of "early adopters" was expected to be somewhat larger, and in any case larger than that for "laggards" given the apparent stage of the product life cycle. The overall large buyer proportions (>.50) come as no surprise considering the basis on which the respondent sample was selected.[20]

The row percentages follow the same general increasing trend for all groups, with the following characteristics: The increases level-off after period 5 for "early adopters" and also, to a lesser degree, for "early majority". They level-off later (after period 6) for "late majority" and more towards the end for "laggards". Such a relationship among group trends was anticipated, given each group's propensity to concentrate purchases on different parts of the time spectrum. Somewhat unexpected is the early purchasing activity of "laggards", although, as anticipated, their greatest marginal surge is found later in time (period 6), while other groups' greatest marginal increases are found earlier, at period 4 for "early majority" and "late majority" and at period 3 for "early adopters".

While column percentages reveal some early purchasing activity

[20]All respondents in our sample (307) had a marked self-stated interest in scanners and considered possible the eventual purchase of a scanner.

of later adopter groups (especially "late majority"), they also clearly illustrate their increasing contribution as time elapses, while conversely the share of earlier adopter groups decreases. Although the comparison of group percentages at specific time periods does not entirely support the anticipated relationship between adopter groups (for example, when comparing "early majority" with "late majority"), the trends clearly indicate the growing importance of later adopters as time elapses. For instance, when looking at the group frequencies per period in terms of the percentage they represent of their respective group size (49, 104, 105, and 49), it appears that the proportion of buyers/group size remains around 5% through time for "early adopters", but increases from 5% to 6% for "early majority", from 5% to 7% for "late majority" and from 4% to 8% for "laggards".

Although the trend for early adopters was somewhat surprising, it may have resulted, here again, from the composition of that group (small proportional representation of innovators) and from the apparently limited coverage of the product's life cycle. Given the concomitant early purchasing activity of some later adopters, an explanation may also be found in the sample's composition. Indeed, as mentioned earlier, it appears from self-stated VCR ownership data that a majority of respondents may be more typically later adopters, perhaps resulting in a weaker discrimination between the time-related purchasing patterns of adopter groups, indicating a possible bias in the results.

Finally, the Logit-based model derives purchase probabilities directly from estimated conjoint utilities, without accounting for measurement errors, the impact of which would be felt through the equation's multiplicator. Such errors may have contributed to a confounding effect, leading to a greater overlapping of adopter groups through time than would otherwise have been the case.

4. Procedure validation using Bass'(1969) growth model.

In order to probe further the usefulness and adequacy of the approach used above for deriving purchase probabilities, a partial validation was undertaken by way of Bass' (1969) model. Predicted values of sales for each time period (measured as a proportion of the untapped market) were derived from the six successive calibrations of the Bass model, as described in Chapter IV (Methodology). They appear along with the "initial" values derived from the probability procedure, in Table R19 below:

Table R19
"Initial" and predicted
market penetration levels
for the last 6 time periods

time period	initial: probability model	predicted: Bass model
5	.0674	.0649
6	.0750	.0717
7	.0839	.0794
8	.0964	.0884
9	.1101	.0998
10	.1277	.1129

The sample correlation coefficient was derived and was found to be r = .998. Regression-related statistical tests were not retained due to the sequential approach that was used to derive each period's predicted value (6 successive calibrations). The correlation result is particularly strong and suggests that the probability procedure was successful in generating a distribution of sales that is quite similar to that which would be derived using Bass' procedure. A slight but constant increase in the error term occurs as time elapses, however, indicating that the procedure would gain in being refined to correct for an apparent inherent compounding effect.

CHAPTER VI

RESEARCH CONTRIBUTIONS, LIMITATIONS AND PROPOSED EXTENSIONS

A. Findings and research contributions

This research makes a number of theoretical, managerial and methodological contributions, which are presented below.

1. Theoretical contributions.

From the point of view of theory, the above findings contribute to a better understanding of the linkages that may exist between adopter categories and consumer preferences: The extent to which earlier and later adopters were different in terms of their preference and choice patterns was investigated. It was shown that earlier and later adopters display different preferences (as indicated by the product features' relative importances), with the "compatibility" variable being relatively more important in the case of earlier adopters, while the "risk" factors and, to a lesser degree, the "complexity" factor appeared to be relatively more important in the case of later adopters, as was hypothesized.

A difference between earlier and later adopters also emerged in the case of "price", although opposite the hypothesized direction: With earlier adopters (especially "early adopters") giving greater relative importance to "price" than later adopters, lower prices being preferred in all cases, the perception respondents had of that factor appeared to be more complex than first anticipated.

Because earlier adopters are less risk-averse than their later counterparts, it was argued that the underlying prevailing dimension which determined early adopters' importance scores for price was not that of "risk" linked to a higher price, but perhaps rather that of "relative advantage" linked to a lower price, as revealed by Holak & Lehmann (1990). In this respect, the second hypothesis about the greater importance of "compatibility" and "relative advantage" factors for earlier adopters finds additional support.

Although in the case of high-involvement, relatively expensive new high-tech goods, innovators have been found to be relatively insensitive to price, this cannot be said of Rogers'(1962) "early adopters", which are likely to account for more than 80% of the "early adopter" group, thus having a determinant impact on that group's revealed importances. A possible complementary explanation may lie in the choice of price levels: While pretests were conducted to establish the appropriateness of the retained levels, such pretests did not involve adopter groups, preventing any perception differences from emerging: Higher prices may have been perceived by early adopters to be exaggeratingly high, thus resulting in a strong importance score for that variable.

A second contribution is made by uncovering the importance of a product's market status (newness, market penetration) in determining individual preferences. Earlier results reveal the

particular importance of "market penetration", not only for "late majority" and "laggards", but also marginally for the "early majority" group.[21] No such conclusion could be drawn regarding "time of introduction", however. Given the wide time frame that was used (3 months to 5 years), the lack of importance of "time" was unexpected, especially for "early adopters". As mentioned earlier, that group's composition may have prevented "true" innovators' higher importance scores from emerging, which would otherwise be expected given their inherent nature of "newness seekers".

The analysis also reveals to some extent the moderating effect that one's knowledge (or perception) of a product's newness and popularity may have on one's evaluation of that product. The results here remain uncertain due to the deterioration in predictive validity resulting from the incorporation of the reduced interaction models on which group measurements were based. However, some general trends emerge that confirm the diffusion-related variables' impact: While "time" has not emerged as an important factor per se, it appears significant in its interaction with most of the product features under consideration, especially in the case of earlier adopters. "Market penetration" also emerges as a significant interactor, with the exception of the "complexity"

[21]The categorization of respondents into adopter groups having been conducted on the basis of rankings, it cannot be said to predetermine these findings, derived from a comparison of predictive validity scores between the "full" and "reduced" main-effects model.

factor (ease of use) for "laggards".

With respect to earlier adopters, it appears that as time elapses, the utility of less desirable features related to "risk" (warranty and durability) and to "complexity" (ease of use) tends to decrease, supporting the hypothesis that the newer the product, the less sensitive an earlier adopter will be to other features due to the attractiveness of newness itself. This could not be shown, however, for the more desirable "compatibility" factor (programming capacity), the utility of which was expected to increase as time elapsed.

With respect to later adopters, the conclusions to be drawn are somewhat less obvious, with partial support being provided for the hypothesis that as market penetration increases, reassurance is provided, contributing to decreasing one's sensitivity to other factors. Some of the mixed results obtained may be due to the presence of a market penetration (or interpersonal communication) "threshold" below which one's sensitivity to some product features remains very low, because of a typically non-compensatory approach to evaluating a product offering. Beyond that threshold (somewhere between our first 2 levels of 3% and 40%), the anticipated pattern may emerge, as in the case of the complexity factor (ease of use).

Overall, respondents' evaluations of product descriptions were shown to be dependent upon the particular diffusion "context" or

"situation" to which they were linked, as revealed by the main effect as well as by the interaction effects involving "time" and "market penetration", with a predominance of the latter.

2. Managerial contributions.

From the manager's point of view, one of the greatest problems with new product development is the fact that, prior to market-testing the product, many uncertainties remain regarding product features to be retained. Most studies of consumer preferences do not discriminate between earlier and later adopters when eliciting potential consumers' preferences for given product features. The manager has no way of knowing if the generally most promising product alternative retained is in fact appealing to early adopters, upon whom the diffusion of the product depends, and how long after its introduction potential buyers are most likely to purchase.

Management is also usually unaware of the extent to which later adopters are different from earlier adopters regarding preference patterns. The adaptation of a product to market evolution usually takes place as a reactive process rather than being proactively planned, which may put a company at a competitive disadvantage in fast moving markets such as that for technological goods. In this respect, the contribution of this research is to provide the manager with: 1) a means to elicit more meaningful preference data that reveal existing differences between earlier and later

adopters, and 2) a means to derive the best product description, with an indication of the nature and timing of desirable product modifications to be introduced along the product life cycle to reflect changing preference patterns of potential buyers.

Respondents' evaluations of situation-specific product descriptions, where the "situation" refers to the product's market status (age and success), provided a basis for categorizing individuals into adopter groups and, from there, for deriving group-specific preference patterns. Further developments were required to determine which product alternative was to be marketed, when and for how long.

Indeed, although innovators tend to purchase earliest and laggards tend to purchase latest, there remains a possibility for a purchase's timing to be "atypical", with later adopters buying at earlier periods and vice versa. Furthermore, although later adopters may prefer a certain product alternative, the moderating effect of diffusion-related variables affects the probability of purchasing such an alternative through time. A manager will want to account for these time-related probability changes, as well as for the possibility for any individual to purchase an alternative other than "first choice". This is particularly desirable and appropriate in the context of a new product introduction, when no competing alternative (other than substitute products) is available on the market: A "less than most desirable" alternative is still

likely to be purchased, and a manager may benefit from an estimation of how well such products would behave through time (market penetration).

The Logit-based stochastic model was developed with these considerations in mind. It derives each respondent's purchase probability for each alternative at each time period and selects for each period that alternative with the highest average purchase probability across all respondents. Results indicate that in fact, a number of "buyers" in early periods belong to later adopter groups, and vice versa.

Although the forecasting of sales at the early stage of concept-testing cannot be expected to yield very reliable results, it nevertheless gives a sense of direction that a company's production as well as marketing departments can benefit from. Knowing more about the timespan and spread of preferences, even accounting for their inherent lack of stability, provides market planners with a valuable insight on the market of tomorrow.

3. Methodological contributions.

This research makes two methodological contributions. The first one consists in introducing a time dimension to conjoint measurement. The introduction of situational variables in conjoint analysis is not new. Interactions between product features and situational variables have also been reported and integrated in the

model. What is new, however, is the introduction of a time dimension, via diffusion-related "situational" variables.

This research factors-in the time dimension in two ways: First, by using conjoint partial utilities for "time" and "market penetration" to determine adopter categories, and second, by examining the interaction between product features and these two variables, thus deriving time-dependent utilities. Such an approach to identifying adopter categories and to evaluating the importance of time-related factors in determining preferences is appealing by its simplicity and practical applicability.

A second contribution was made in using the multinomial Logit choice model through time: In the present case, probabilities are not derived across different product alternatives, but rather across different combinations of time/market penetration, for the same product alternative. The Logit approach to deriving probabilities was appealing because of its extensive use in the analysis of consumer preferences. Although the applicability of Logit choice models was shown in the past to be somewhat limited due to these models' underlying assumption of Independence of Irrelevant Alternatives (IIA), such a limitation is not believed to apply here given the particular way in which the model is used.

B. Limitations and proposed extensions

A number of limitations are to be mentioned:

- **Sample**: The sample that was used is a convenience sample. It was chosen carefully among evening students, most of whom work full-time, to avoid the usual biases related to student samples. While usual disturbances due to age and income were likely eliminated, education remains a potential source of bias, although not in an obvious manner (a significant link to degree of innovativeness could not be established).

- **Product**: We chose a programming device for VCR's. It had a number of advantages: it was unknown to all but very few respondents, relatively easy to describe in one page, likely to trigger widespread interest given the large number of households with VCR's, easy to relate to given the frequency with which a VCR user operates the equipment, and it was part of high-tech (consumer electronics) durable goods, a category in which innovations occur constantly. However, it is essentially an accessory product, one which is usually purchased with a VCR. It was described as an independent product, adaptable to different VCR brands, but may have been perceived differently. No prototype was available to allow trial or contact. Our results may be product-specific.

- **Purchase context**: A realistic context was proposed by suggesting to respondents that they had returned from a long trip, which explained why they had not heard about the product before. This

is not the usually prevailing situation in real life, however, and in the case of older (time of introduction) and already popular (market penetration) "new" products, the short 1-page description of the product is a weak proxy for weeks of exposure to advertising, discussions with owners, in-store trial, reading of technical material, etc...

- **Conjoint analysis:** The use of conjoint analysis required a balanced design that would be small enough to allow each respondent to evaluate all profiles. By providing a rest period mid-way through the evaluation task, it was possible to increase the number of profiles to be evaluated beyond what is usually recommended. Nevertheless, a potentially interesting relationship (the "time x market penetration" interaction) was left out to allow for the testing of all hypothesis-related variable effects.

The use of hybrid-conjoint analysis would have alleviated the problem by requiring each respondent to evaluate only a portion of the profiles, thus allowing for a more complex and larger experimental design to be used. However, the use of such a technique also requires the clustering of respondents in a manner that would likely not espouse our adopter categorization. In addition, to categorize adopters on the basis of revealed utilities as was done here, it was necessary to have estimators as unbiased as possible, requiring each respondent to evaluate all profiles of the "balanced" design.

- **Experimental design:** The "balanced" design is not quite so: One level of "market penetration" had to be modified in 4 of the 36 profiles to avoid subjecting respondents to unrealistic combinations. The impact appears to be limited, however.

- **Categorization in adopter groups:** The categorization of respondents, based on continuous criteria derived from utility scores for "time" and "market penetration", was made to approximate Rogers'(1962) distribution. However, category size is known to vary, depending on the kind of product, population characteristics, etc... Misclassifications may have resulted.

- **Probability model:** The fraction multiplicator used in the model to keep the overall probability of purchasing an alternative overtime < 1, consists of an estimated utility derived by using conjoint analysis. It does not account for possible measurement errors, which may have contributed to a confounding effect in the revealed purchase behavior of the different adopters through time.

The model is otherwise appropriate for a situation where no competition exists (early after introduction). Should competition develop, or should we want to consider substitute products, the model becomes inadequate because it does not make purchase probabilities dependent upon other alternatives. The Logit process applied through time would then need to be extended to account for

other alternatives, resulting in the development of a more complex composite model, even if retaining a first-choice deterministic approach when dealing with product alternatives.

In light of the above, the following extensions are being considered:

1- The study could be replicated using other products in the category of consumer electronics, in an attempt to establish generalizability.

2- The sampling method could be revised: A stratified sampling of potential buyers could be used.

3- A form of hybrid-conjoint analysis, where respondents would be clustered according to self-stated (rather than revealed) preferences for "time" and "market penetration", along the same criteria as before, could be attempted. Each respondent being subjected to a limited number of profile evaluations, additional interactions could then be retained for analysis, including (time x penetration).

4- A more sophisticated experiment could be developed, where subgroups of respondents would be provided with different amounts of advertising and written comments from previous "purchasers" to simulate different diffusion environments. Respondents would then

be required to evaluate only profile descriptions consistent with the material provided.

5- Composite design forms could be investigated in an attempt to avoid unbalancing the design to eliminate unrealistic combinations. This would likely result in a larger design frame, however, and might have to be viewed in conjunction with the use of a hybrid form of conjoint analysis, in which the full-profile approach would not be retained.

6- The categorization of adopters could be refined to account for group size variability. One approach based on Bass'(1969) growth model was recently suggested by Mahajan, Muller & Srivastava (1990), who derive **a priori** sizes for the four major adopter groups, based on the anticipated time of adoption peak and inflection points on the adoption curve. These are in turn derived from estimates of potential market size, number of adoptions in the first time period and a sum of the coefficients of innovation and imitation. Such estimates are provided through managerial judgment or by analogy. In that respect, an approach suggested by Lawrence and Lawton (1981) was reported to provide good results. The proportions of individuals to be included in each adopter category are then determined from the above, as provided for in Appendix 5B.

Using such a procedure to refine the categorization process was made impossible in the present research because the product of

interest was originally developed and is currently being marketed as a dependent product, one which can only be sold in conjunction with its manufacturer's (Panasonic) own VCR. Therefore, it cannot be purchased separately and has no life of its own.[22] This situation is likely to change in the near future, however, as other manufacturers are said to be considering the development of adaptable scanner programming devices (Newsweek, Oct.1990).

7- The probability model could be improved upon and made more rigorous by refining the adjustment factor (multiplicator) to account for measurement errors. These could be estimated from individual predictive validity test results.

The purchase probabilities could be viewed in the context of competition: Sensitivity analysis could be applied to elicit choices among a limited number of realistic alternatives at each time period, possibly combining a deterministic choice process for alternatives with the stochastic choice process through time.

[22]This did not represent a problem in the context of our study, given that the scanner was described, in the questionnaire, as being a product adaptable to different makes of VCRs, as mentioned earlier.

Appendix 1

Detailed procedures/results of the pretests

Part A: Focus group - Product attributes identified as being important

A. Important to more than 50% of respondents:

* Robustness (unbreakable): especially important when children.
* Availability/price of bar-coded TV guide.
* Brand name / brand image.
* Capability to change TV channels (as a remote control).
* Flexibility in use: beam not too narrow-focused.
* Cordless.
* Compatibility with one's own VCR.
* Price.
* Warranty.
* Easiness with which scanner can read bar codes.
* Availability of service centers.
* Appearance (color, size, shape, weight).
* Knowledgeable salespeople.
* Manufacturer reputation.

B. Less important:

* Capability to program VCR while viewing: no interruption.
* Battery check (light).
* Possibility to view on screen information contained in bar code.
* Possibility to find beginning/end of recorded show on tape.
* Where is it sold.
* Non-hazardous (children's eyes, pacemaker...).
* Memory: scan several bar codes before programming + recall.
* Accuracy check (beep).
* In-store demonstration.

Part B: First pretest - Description of the scanner and questionnaire

Optical scanners are being used more and more everywhere. Their existence is particularly noticeable at the cash counters of supermarkets and big discount stores. The scanner recognizes the items being purchased by reading the bar codes that are printed on their packages, and transmits the information to the cash register.

Using the same technology, a hand-held scanner, the SCAN-05, has been designed by Videoprom for the programming of its NV-200 VCR. A picture of the SCAN-05 scanner is shown on the next page.

The SCAN-05 scanner allows you to easily program your VCR. Just direct the beam of the scanner to read the bar codes of the TV program you wish to record. All the information (day and time of TV show, length of recording, etc...) will be picked up at once and can then be sent to the VCR by directing the beam in that direction. Videoprom is currently negotiating with a publisher to make available a bar-coded TV guide.

A number of the device's features are still under study and before making any final decision, the company wishes to have a better understanding of the potential consumers' buying behavior.

PLEASE ANSWER THE FOLLOWING QUESTIONS AS CAREFULLY AS POSSIBLE BY CHECKING THE APPROPRIATE BOX.

1. How familiar are you with VCR's ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

2. How familiar are you with scanners as described above ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

3. Are you interested in VCR's ?

Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

4. Are you interested in scanners ?

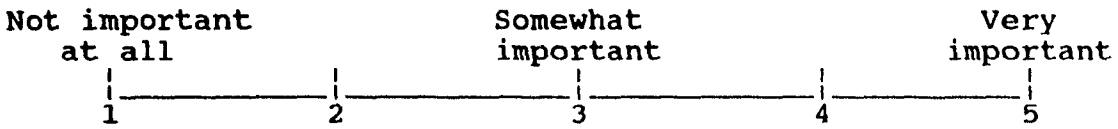
Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

5. Do you have a VCR at home ?

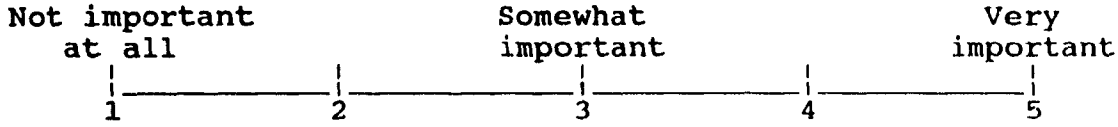
yes [ ] no [ ]

Suppose now that you are in a store considering the purchase of a scanner such as the one described above. INDICATE HOW IMPORTANT EACH OF THE FOLLOWING FACTORS WOULD BE IN MAKING YOUR PURCHASE DECISION (CIRCLE THE APPROPRIATE NUMBER).

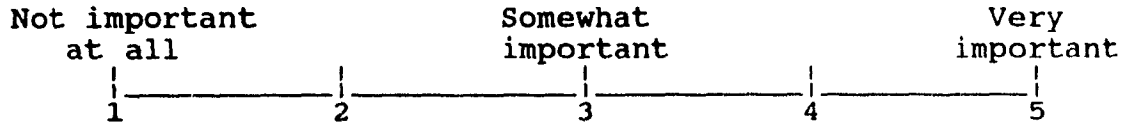
1. Physical appearance of the scanner (pencil-shaped, pistol grip, device integrated in remote control, linked to VCR with cord or not, ...)



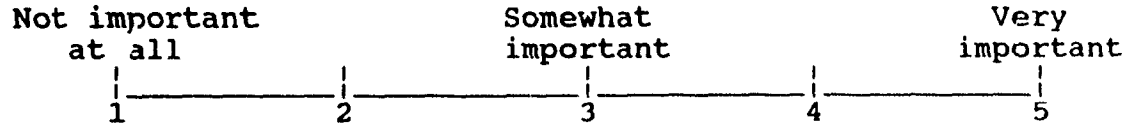
2. Ease of handling (must or must not be held upright, moved slowly or quickly, kept in contact with printed surface, ...)



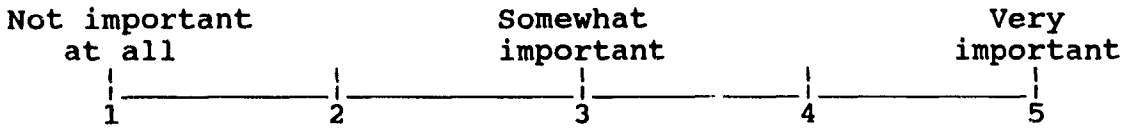
3. Capability to read poorly printed codes (may or may not be able to read light, faded print)



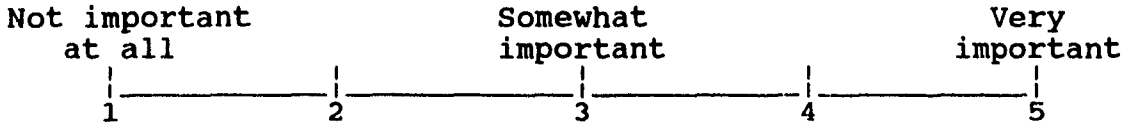
4. Compatibility with VCR's other than the NV-200 and with other appliances (cooking instructions for microwave and conventional ovens, temperature changes for thermostats, humidifiers, recording on radio-cassettes, programming of micro-computers)



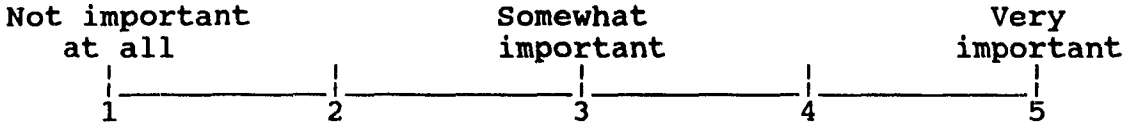
5. Price



6. Warranty



7. Manufacturer's reputation



WHAT OTHER FACTORS WOULD YOU WANT TO CONSIDER AND HOW IMPORTANT WOULD THEY BE? (indicate the appropriate score, as above, in the corresponding box)

8. ..... [ ]

9. ..... [ ]

10. ..... [ ]

11. ..... [ ]

12. ..... [ ]

HOW WOULD YOU CLASSIFY THE SCANNER DESCRIBED ABOVE? (check one box only)

1. A truly new product that can satisfy needs that are not currently met ..... [ ]

2. A product only marginally different from currently available remote control programming devices ..... [ ]

3. A gadget that does not present any functional advantage over what is already available on the market ..... [ ]

IF YOU HAD A VCR AND ASSUMING THE PRICE WAS RIGHT, WOULD YOU CONSIDER PURCHASING SUCH A DEVICE ?

yes [ ] no [ ]

Thank you for your participation.

Part C: First pretest - Importance weights for selected attributes

(5-point scale)
(percentage of respondents)

	Phys.	Ease	Capab.	Compat.	Price	Warr.	Manuf.
not at all							
1	5	0	0	3	0	0	0
2	18	0	0	3	0	0	0
3	29	26	8	29	29	8	16
4	32	48	55	34	32	45	47
5	16	26	37	31	39	47	37
very							

Other self-stated features listed as important:

- availability of coded program [coded 4,4,4,5,5,5]
- price of coded program [coded 5,5,5]
- cordless [coded 3,5]
- durability/unbreakable [coded 4,4,4,5,5,5,5,5]
- kind of batteries needed [coded 3,4]
- availability of after-sales service [coded 4,4,4,5,5,5,5]
- quality [coded 5,5]
- everyone can use (easy) [coded 5,5]
- availability in stores [coded 4]
- can change TV channels [coded 3]
- clear instructions provided [coded 5]
- what characters it can read [coded 5]
- helpful salespeople [coded 4]
- obsolescence [coded 3]
- brand name [coded 3]
- country of origin [coded 3].

Part D: Attribute elimination process

The attributes identified as important by the focus group and respondents (first pretest) were eliminated as follows:

- some of the items had been specified during the focus group session as of secondary importance, and were therefore left aside:
  * battery check;
  * additional information storage capacity;

- some were discarded as representing isolated preoccupations that were not picked up by the focus group and did not appear appropriate, or because they were desired characteristics of the VCR rather than of the scanner itself:
  * affects quality of picture;
  * obsolescence (technology advance);
  * can program without interrupting viewing of VCR;
  * can locate beginning/end of a recording on tape;

- some were already part of the description provided or would eventually be incorporated in it as they were perceived essential to the sellability of the product (standard features):
  * availability/price of bar-coded TV guide (to be specified);
  * brand name/image (SCAN-05);
  * type of characters the scanner can read (bar codes only);
  * clear instructions (to be specified);
  * kind of battery (to be specified);
  * cordless (to be specified);
  * non-hazardous (to be specified);
  * accuracy check (to be specified);

- Some were set aside for belonging to a category of characteristics which goes beyond the product itself. These would eventually be interesting variables to investigate:
  * accessibility of service centers;
  * knowledgeable/expert salespeople in stores;
  * availability of the product (retail outlets);
  * country of origin/manufacturer reputation;
  * in-store/home demonstration of the product;

- The remainder were retained for further analysis.

Part E: First pretest - Individual characteristics (38 respondents)

Percent of respondents

	Familiar with VCR	Familiar with scanner
not	3	32
somewhat	18	47
quite	37	16
very	42	5

	Interest in VCR	Interest in scanner
not	3	11
somewhat	21	50
quite	39	26
very	37	13

	Have a VCR	Would consider buying a scanner
yes	89	68
no	11	32

	Consider the scanner as:
truly new product	[illegible]
marginally new	[illegible]
gadget	[illegible]

Part F: Second pretest - Description of the scanner and questionnaire

Optical scanners are being used more and more everywhere. Their existence is particularly noticeable at the cash counters of supermarkets and big discount stores. The scanner recognizes the items being purchased by reading the bar codes that are printed on their packages, and transmits the information to the cash register.

Using the same technology, a hand-held scanner, the SCAN-05, has been designed by Videoprom for the programming of its NV-200 VCR. A picture of the SCAN-05 is shown on the next page.

The SCAN-05 allows you to easily program your VCR. Just direct the beam of the scanner to read the bar codes of the TV program you wish to record. All the information (day and time of TV show, length of recording, etc...) will be picked up at once and can then be sent to the VCR by directing the beam in that direction.

The SCAN-05 is a non-hazardous, cordless device which uses ordinary batteries. It beeps to indicate it has picked up the bar-coded information. Clear and illustrated instructions are provided and an affordable bar-coded TV guide is expected to be on the market shortly.

A number of the device's features are still under study and before making any final decision, the company wishes to have a better understanding of the potential consumers' buying behavior.

PLEASE ANSWER THE FOLLOWING QUESTIONS AS CAREFULLY AS POSSIBLE BY CHECKING THE APPROPRIATE BOX.

1. How familiar are you with VCR's ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

2. How familiar were you with scanners before reading the above description ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

3. Are you interested in VCR's ?

Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

4. Are you interested in scanners ?

Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

5. Do you have a VCR at home ?

yes [ ] no [ ]

Suppose now that you are in a store considering the purchase of a scanner such as the one described above.

INDICATE HOW IMPORTANT EACH OF THE FOLLOWING FACTORS WOULD BE IN MAKING YOUR PURCHASE DECISION (circle the appropriate number)

1. Physical appearance of the scanner (pencil-shaped, pistol grip, plastic or metal, black or other color, light or not so light, small or not so small)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

2. Ease of handling (must or must not be held upright, moved slowly or quickly, kept in contact with printed bar codes, aimed precisely at beam receptor in VCR, ...)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

3. Reading and programming capability (may or may not be able to read light, faded print, can or cannot be used to select TV channels)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

4. Compatibility with other VCR's and with other home appliances (cooking instructions for microwave and conventional ovens, temperature changes for thermostats, humidifiers, recording on radio-cassettes, programming of micro-computers)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

5. Price

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

6. Warranty

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

7. Durability (breakability, resistance to blows)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

8. Memory capacity (can or cannot scan several bar codes before beaming the information, can or cannot recall programmed information to check entries)

Not at all important		Somewhat important		Quite important		Very important
1	2	3	4	5	6	7

WHAT OTHER FACTORS WOULD YOU WANT TO CONSIDER BEFORE MAKING A PURCHASE DECISION AND HOW IMPORTANT WOULD THEY BE ? (indicate the appropriate score, as above, in the corresponding box)

9. ..... [ ]

10. ..... [ ]

11. ..... [ ]

12. ..... [ ]

USING THE SAME ITEMS AS ABOVE, DIVIDE 100 POINTS AMONG THEM SO THAT THE DIVISION REFLECTS HOW IMPORTANT EACH ITEM IS TO YOU IN MAKING YOUR PURCHASE DECISION:

(make sure the total adds up to 100):

Physical appearance ..... [ ]

Ease of handling ..... [ ]

Reading and programming capability ..... [ ]

Compatibility with other VCR's and appliances .... [ ]

Price ..... [ ]

Warranty ..... [ ]

Durability ..... [ ]

Memory capacity ..... [ ]

TOTAL = 100 pts

HOW WOULD YOU CLASSIFY THE SCANNER DESCRIBED ABOVE ? (check one box only):

1. A truly new product that can satisfy needs that are not currently met ..... [ ]

2. A product only marginally different from currently available remote control programming devices ..... [ ]

3. A gadget that does not present any functional advantage over what is already available on the market ..... [ ]

IF YOU HAD A VCR AND ASSUMING THE PRICE WAS RIGHT, WOULD YOU CONSIDER PURCHASING SUCH A DEVICE ?

yes [ ] no [ ]

NOW, CONSIDER THE FOLLOWING LIST OF HOME ELECTRONICS. HOW LONG DO YOU THINK THEY HAVE BEEN ON THE NORTH AMERICAN MARKET?

(Please give us your general impression by checking the appropriate box)

	6 mths	1 yr	2-3 yrs	4-6 yrs	7-10 yrs	11-15 yrs	over 15 yrs	don't know
microwave oven	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
compact disc	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
VCR	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
home personal computer	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
camcorder (sound camera)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

IN HOW MANY HOUSEHOLDS IN NORTH AMERICA DO YOU THINK WE CAN FIND SUCH PRODUCTS TODAY?

(Please give us your general impression by checking the appropriate box)

	under 5%	10%	25%	40%	60%	80%	near 100%	don't know
microwave oven	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
compact disc	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
VCR	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
home personal computer	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
camcorder (sound camera)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

GENERAL INFORMATION:

SEX: male [ ] female [ ]

AGE: less than 25 [ ] 25 - 34 [ ] 35 and more [ ]

HOUSEHOLD INCOME:

less than $ 25,000 [ ]

$ 25,000 - $ 49,000 [ ]

$ 50,000 - $ 74,000 [ ]

$ 75,000 and more [ ]

don't know [ ]

IN YOUR CASE, HOUSEHOLD MEANS:

yourself/spouse/child [ ] your parents or other family [ ] other [ ]

Your participation is greatly appreciated. Thank you!

Part G: Second pretest - Importance weights for selected attributes

A. 7-point scale.

percentage of respondents

	phys	ease	read	compat	price	warr	durab	memor
not at all								
1	0	0	0	10	0	0	0	0
2	5	3	0	7	0	5	0	5
3	29	12	0	19	3	2	5	17
4	22	7	10	32	5	5	5	15
5	27	3[illegible]	37	15	34	37	24	44
6	10	22	29	12	34	29	39	17
7	7	24	24	5	24	22	27	2
very								
mean	4.3	5.3	5.7	3.9	5.7	5.5	5.8	4.6
std.dev.	1.3	1.4	1.0	1.6	1.0	1.2	1.1	1.2

B. Constant-sum scale.

not at all								
0	2	0	2	7	0	0	2	7
1-5	41	27	19	44	0	17	7	32
6-10	29	32	29	27	12	37	34	37
11-15	12	19	10	10	15	22	27	17
16-20	7	12	32	10	17	10	19	5
21-30	7	5	7	0	29	15	10	0
31-40	0	2	0	2	12	0	0	2
41-50	0	2	0	0	7	0	0	0
> 50	0	0	0	0	5	0	0	0
very								
mean	8.9	12.1	11.9	8.0	25.1	12.5	12.9	8.5
std.dev.	6.1	8.4	7.2	6.8	13.2	7.3	6.2	6.0
spread	0-25	1-41	0-30	0-33	9-60	2-30	0-30	0-32

Part G (end): Correlation between 7-point scale and constant-sum scale (C) ratings

	corr. coeff.	compared to corr. with other variables
phys * Cphys	.68	signif. better
ease * Cease	.46	signif. better
read * Cread	.44	signif. better
compat * Ccompat	.46	signif. better
price * Cprice	.44	better but price * warr = .42
warr * Cwarr	.53	signif. better
durab * Cdurab	.50	better but durab * Cwarr = .40
memor * Cmemor	.24	not better: memor * durab = .30

Other features listed as important:

- reads code properly each time [coded 7]
- after-sales service [coded 4,6,7]
- TV guide available [coded 5,5,5,6]
- obsolescence [coded 5]
- power consumption [coded 3]
- brand name [coded 6]
- compatibility with own VCR [coded 6,7]
- price of coded TV guide [coded 3]
- practicality [coded 5,6]
- distance capacity [coded 4]
- check for reading accuracy [coded 3]
- child-proof [coded 6]
- life expectancy [coded 4]
- how many batteries needed [coded 3]
- waterproof [coded 2]
- size [coded 4].

Part H: Second pretest - Individual characteristics (41 respondents)

	Percent of respondents	
	Familiar with VCR	Familiar with scanner
not	0	22
somewhat	15	51
quite	44	17
very	41	10
	Interest in VCR	Interest in scanner
not	0	12
somewhat	27	61
quite	61	17
very	12	10
	Have a VCR	Would consider buying a scanner
yes	88	51
no	12	49
	Consider the scanner as:	
truly new product	27	
marginally new	54	
gadget	19	

Appendix 1 (cont')

Part I: Real market data

	Year of market introduction (Que & North Am.)	Number (millions) and percentage of households (1989)			
		Quebec	Canada	U.S.A.	North Am.
Microwave	1980	1.50 60%	6.00 63%	68.25 75%	74.25 74%
Compact disc	1983	0.24 9.5%	1.10 11.6%	11.83 13%	12.93 13%
VCR	1975	1.36 54%	5.58 59%	54.60 60%	60.20 60%
Home PC	1977	0.25 10%	1.20 12.6%	16.38 18%	17.58 17%
Camcorder	1983	0.07 3%	0.25 2.7%	2.60 3%	2.85 3%
	Total households (1989)	2.50	9.50	91.00	100.50

Part J: Respondents' perceptions of time of introduction and of market penetration for five home electronics products (Percent of respondents)

1. Time of introduction

	6mths	1yr	2-3yrs	4-6yrs	7-10yrs	11-15yrs	>15yrs
North Am. mkt.							
microwave	0	0	0	24	**43**	24	5
comp. disc	0	5	14	**48**	33	0	0
VCR	0	0	0	9	48	**33**	10
home PC	0	0	0	10	24	**43**	24
camcorder	0	0	0	**33**	38	10	5
Quebec mkt.							
microwave	0	0	0	15	**40**	40	5
comp. disc.	0	0	15	**70**	15	0	0
VCR	0	0	0	0	50	**35**	15
home PC	0	0	0	5	45	**35**	10
camcorder	0	0	10	**45**	30	0	5

2. Market penetration

	<5%	10%	25%	40%	60%	80%	100%
North Am. mkt.							
microwave	0	5	5	5	**45**	**30**	5
comp. disc	5	**25**	40	15	10	0	0
VCR	0	0	5	10	**50**	20	10
home PC	0	**35**	**15**	20	15	10	0
camcorder	**20**	35	25	5	0	0	0
Quebec mkt.							
microwave	0	0	9	29	**38**	24	0
comp. disc.	0	**19**	67	9	5	0	0
VCR	0	0	19	19	**24**	33	5
home PC	0	**43**	14	24	14	5	0
camcorder	**33**	33	14	0	0	5	0

* The missing percentages went to the "don't know" category.
* The percentages in bold correspond to reality. Two categories are in bold when reality falls in between.
* Tests of differences in proportions were conducted between Quebec and North America for "time". None were significant at .05.

Part K: Respondents' perceptions of time of introduction and market penetration (Tests on proportions)

A. Time of introduction
Comparing Quebec/North American proportions correctly classified

	critical value (at .05)	Ho: pQ = pNA
Microwave	.253	cannot reject
Compact disc	.252	cannot reject
VCR	.243	cannot reject
Home PC	.250	cannot reject
Camcorder	.250	cannot reject

B. Market penetration
Comparing true percentages with percentage category chosen by greatest number of respondents*

	derived Z		Ho: p < or > ptrue (at .05)	
	North Am.	Que.	North Am.	Que.
Microwave	-1.42	same %	cannot rej.	- -
Compact disc	1.60	2.18	cannot rej.	rej.
VCR	same %	2.28	- -	rej.
Home PC	-0.083	same %	cannot rej.	- -
Camcorder	1.84	1.79	rej.	rej.

* For example, 45% of "North American" respondents chose a 60% market penetration level for microwaves. Real penetration level is 74%. We tested H0: .60 > .74

Part L: Third pretest - Description of the scanner and questionnaire

First version (word-of-mouth):

Optical scanners are being used more and more everywhere. Their existence is particularly noticeable at the cash counters of supermarkets and big discount stores. The scanner recognizes the items being purchased by reading the bar codes that are printed on their packages, and transmits the information to the casn register.

Using the same technology, a hand-held scanner, the SCAN-05, has been designed by Videoprom for the programming of its NV-200 VCR. A picture of the SCAN-05 is shown on the next page.

The SCAN-05 allows you to easily program your VCR. Just direct the beam of the scanner to read the bar codes of the TV program you wish to record. All the information (day and time of TV show, length of recording, etc...) will be picked up at once and can then be sent to the VCR by directing the beam in that direction.

The SCAN-05 is a non-hazardous, cordless device which uses ordinary batteries. It beeps to indicate it has picked up the bar-coded information and has a battery check incorporated. It cannot make errors when picking up information. It allows you to recall the programmed information by displaying it on your TV screen. Clear and illustrated instructions are provided with the scanner, and at least one newspaper has agreed to publish a weekly bar-coded TV guide. Affordable bar-coded guides will also be sold at newsstands. The scanner is adaptable to most VCR's currently on the market. After-sales service will be provided nearby retail outlets to accomodate the buyer.

A number of the device's features are still under study and before making any final decision, the company wishes to have a better understanding of potential consumers' buying behavior.

Consider the product characteristics below. They will be used in scanner descriptions that will appear in the following pages.

1. How long the scanner has been ON THE MARKET: 6 months
   2 years
   5 years

2. How much you have HEARD about the scanner: nothing
   a little
   a lot

3. How much it COSTS: $ 50.00
   $ 100.00
   $ 150.00

4. What WARRANTY is attached to it: 3 months
   1 year
   3 years

5. Its capacity to also SELECT TV CHANNELS: .can
   .cannot

6. How EASY it is to use: .very easy
   .some care required in movement and aim

7. How DURABLE it is: .resistant to normal wear and tear
   .added durability: child-proof

IMAGINE NOW THAT YOU ARE CONSIDERING BUYING A SCANNER. LOOK AT EACH OF THE FOLLOWING DESCRIPTIONS AND INDICATE HOW MUCH YOU WOULD LIKE TO PURCHASE EACH ALTERNATIVE.

You may tear off this page if you find it convenient for reference purposes.

HOW MUCH WOULD YOU LIKE TO PURCHASE EACH ALTERNATIVE ?
Circle the appropriate point on the scale, where:

not at all — somewhat — very much

0 5 10

(01)
Has been on the market for 6 months
You have heard nothing about it
It sells for $ 50.00
It has a 3 month warranty
It cannot select TV channels
Some care is needed in handling
It is resistant to normal wear and tear

0 5 10

(02)
Has been on the market for 2 years
You have heard a little about it
It sells for $ 150.00
It has a 1 year warranty
It cannot select TV channels
Some care is needed in handling
It has added durability: child-proof

0 5 10

(03)
Has been on the market for 5 years
You have heard a lot about it
It sells for $ 50.00
It has a 1 year warranty
It can also select TV channels
It is very easy to use
It has added durability: child-proof

0 5 10

(04)
Has been on the market for 2 years
You have heard nothing about it
It sells for $ 50.00
It has a 1 year warranty
It can also select TV channels
Some care is needed in handling
It is resistant to normal wear and tear

0 5 10

(etc...)

WORD-OF-MOUTH AND MARKET PENETRATION.

You are aware of the fact that as more people buy a new product (camcorders, for example), the more you are likely to hear about this product through word-of-mouth, from friends, colleagues, etc.. Or, in reverse, the more you hear people talk about a product, the greater the number of consumers who are likely to have tried it.

Imagine for a moment that what you hear about a product through conversations with other people is generally in favor of that product.

CONSIDER THE FOLLOWING LEVELS OF WORD-OF-MOUTH FEEDBACK. WHAT DO THEY SUGGEST TO YOU IN TERMS OF MARKET PENETRATION (i.e., the % of market that already have bought the product, such as a VCR) ?

INDICATE THE RANGE OF MARKET PENETRATION LEVELS THAT ARE LIKELY TO CORRESPOND TO THE STATEMENTS ON THE LEFT.
(Refer to the scale on the right to answer the question.
All scale percentages need not be included in the ranges).

	ESTIMATED RANGE OF MARKET PENETRATION	MARKET PENETRATION LEVELS
In the past few months,		- 0%
(1) You have not heard about the product from anyone	from % to %	- 10% - 20%
(2) You have heard about the product once or twice	from % to %	- 30% - 40%
(3) You have heard about the product a few times	from % to %	- 50% - 60%
(4) You have heard about the product a number of times	from % to %	- 70% - 80%
(5) You have heard about the product a great deal	from % to %	- 90% - 100%

Your participation is greatly appreciated. Many thanks !

Second version (market penetration):

Optical scanners are being used more and more everywhere. Their existence is particularly noticeable at the cash counters of supermarkets and big discount stores. The scanner recognizes the items being purchased by reading the bar codes that are printed on their packages, and transmits the information to the cash register.

Using the same technology, a hand-held scanner, the SCAN-05, has been designed by Videoprom for the programming of its NV-200 VCR. A picture of the SCAN-05 is shown on the next page.

The SCAN-05 allows you to easily program your VCR. Just direct the beam of the scanner to read the bar codes of the TV program you wish to record. All the information (day and time of TV show, length of recording, etc...) will be picked up at once and can then be sent to the VCR by directing the beam in that direction.

The SCAN-05 is a non-hazardous, cordless device which uses ordinary batteries. It beeps to indicate it has picked up the bar-coded information and has a battery check incorporated. It cannot make errors when picking up information. It allows you to recall the programmed information by displaying it on your TV screen. Clear and illustrated instructions are provided with the scanner, and at least one newspaper has agreed to publish a weekly bar-coded TV guide. Affordable bar-coded guides will also be sold at newsstands. The scanner is adaptable to most VCR's currently on the market. After-sales service will be provided nearby retail outlets to accomodate the buyer.

A number of the device's features are still under study and before making any final decision, the company wishes to have a better understanding of potential consumers' buying behavior.

Consider the product characteristics below. They will be used in scanner descriptions that will appear in the following pages.

1. How long the scanner has been ON THE MARKET: 6 months
   2 years
   5 years

2. What percentage of the potential market for such a product has PURCHASED the scanner: under 10%
   20-40%
   over 60%

3. How much it COSTS: $ 50.00
   $ 100.00
   $ 150.00

4. What WARRANTY is attached to it: 3 months
   1 year
   3 years

5. Its capacity to also SELECT TV CHANNELS: .can
   .cannot

6. How EASY it is to use: .very easy
   .some care required in movement and aim

7. How DURABLE it is: .resistant to normal wear and tear
   .added durability: child-proof

IMAGINE NOW THAT YOU ARE CONSIDERING BUYING A SCANNER. LOOK AT EACH OF THE FOLLOWING DESCRIPTIONS AND INDICATE HOW MUCH YOU WOULD LIKE TO PURCHASE EACH ALTERNATIVE.

You may tear off this page if you find it convenient for reference purposes.

HOW MUCH WOULD YOU LIKE TO PURCHASE EACH ALTERNATIVE ?
Circle the appropriate point on the scale, where:

not at all somewhat very much

0 5 10

(01)
Has been on the market for 6 months
Purchased by less than 10% of market
It sells for $ 50.00
It has a 3 month warranty
It cannot select TV channels
Some care is needed in handling
It is resistant to normal wear and tea

0 5 10

(02)
Has been on the market for 2 years
Purchased by 20-40% of market
It sells for $ 150.00
It has a 1 year warranty
It cannot select TV channels
Some care is needed in handling
It has added durability: child-proof

0 5 10

(03)
Has been on the market for 5 years
Purchased by over 60% of market
It sells for $ 50.00
It has a 1 year warranty
It can also select TV channels
It is very easy to use
It has added durability: child-proof

0 5 10

(04)
Has been on the market for 2 years
Purchased by less than 10% of market
It sells for $ 50.00
It has a 1 year warranty
It can also select TV channels
Some care is needed in handling
It is resistant to normal wear and tear

0 5 10

(etc...)

MARKET PENETRATION AND WORD-OF-MOUTH.

You are aware of the fact that as more people buy a new product (camcorders, for example), the more you are likely to hear about this product through word-of-mouth, from friends, colleagues, etc.. Or, in reverse, the more you hear people talk about a product, the greater the number of consumers who are likely to have tried it.

Imagine for a moment that what you hear about a product through conversations with other people is generally in favor of that product.

CONSIDER THE FOLLOWING LEVELS OF MARKET PENETRATION (i.e., the % of market that have already bought the product, such as a VCR). WHAT DO THEY SUGGEST TO YOU IN TERMS OF THE WORD-OF-MOUTH FEEDBACK YOU ARE LIKELY TO HAVE HAD ABOUT THE PRODUCT?

INDICATE THE FEEDBACK LEVEL THAT BEST CORRESPONDS TO EACH MARKET PENETRATION LEVEL ON THE LEFT.
(Refer to the table on the right to answer the question. The same feedback level will appear several times).

MARKET PENETRATION	CORRESPONDING FEEDBACK LEVEL
0 %	[ ]
10 %	[ ]
20 %	[ ]
30 %	[ ]
40 %	[ ]
50 %	[ ]
60 %	[ ]
70 %	[ ]
80 %	[ ]
90 %	[ ]
100 %	[ ]

FEEDBACK LEVELS

(1) You have not heard about the product from anyone

(2) You have heard about the product once or twice

(3) You have heard about the product a few times

(4) You have heard about the product a number of times

(5) You have heard about the product a great deal

Your participation is greatly appreciated. Many thanks !

Part M: Perceived links between market penetration levels and word-of-mouth levels

Group 1

Market penetration levels	Word-of-mouth (percent of respondents)				
	heard nothing	heard once or twice	heard a few times	heard number of times	heard a lot
0%	100	--	--	--	--
10%	56	44	--	--	--
20%	--	67	33	--	--
30%	--	33	56	11	--
40%	--	11	44	44	--
50%	--	--	22	78	--
60%	--	--	--	78	22
70%	--	--	--	44	56
80%	--	--	--	--	100
90%	--	--	--	--	100
100%	--	--	--	--	100

Percentages were rounded and may not add up to 100.

Group 2

word-of-mouth categories	market penetration levels (word-of-mouth category with which closest association was found)										
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.nothing	x	x								-	-
2.once/twice		x	x							-	-
3.few times			x	x						-	-
4.number of times					x	x				-	-
5.a lot							x	x	x	-	-

10% and 20% were equally associated with two categories.
90% and 100% were never mentioned.

Part N: t-tests of the differences between means - Evaluations of "market penetration" profiles vs. "word-of-mouth" profiles (under assumption of equal prob.)

profiles	prob.	profiles	prob.
1	.65	23*	.02
2	.62	24	.22
3	.58	25	.34
4	.93	26	.40
5	.82	27	.87
6	.42	28	.38
7	.54	29	.43
8	.48	30	.94
9	.18	31	.38
10	.98	32*	.06
11	.73	33	.45
12	.35	34	.12
13	.92	35	.43
14	.57	36	.70
15*	.08	37	.94
16	1.00	38	.61
17	.99	39	.39
18	.13	40	1.00
19	.59	41	.28
20	.31	42	.27
21	.40	43	.75
22	.62	44	.51

Part P: Pearson correlation coefficients (actual vs predicted preference scores for 8 holdout profiles using the full model)

Total sample: r= .411

"Market penetration" group: r= .495

By individual: r= .665
r= .667
r= .740
r= .218
r= .688
r= .482
r= .818
r= .685
r= .547
r= .484
r= .753

"Word-of-mouth" group: r= .331

By individual: r= .258
r= .285
r= .666
r= .859
r= .582
r= .697
r= .329
r= .140
r= .337
r= .546
r= .584
r= .752

Appendix 2

Final questionnaire

Optical scanners are being used more and more everywhere. Their existence is particularly noticeable at the cash counters of supermarkets and big discount stores. The scanner recognizes the items being purchased by reading the bar codes that are printed on their packages, and transmits the information to the cash register.

Using the same technology, a hand-held scanner, the SCAN-05, has been designed by Videoprom, a reputable video manufacturer, for tne programming of its NV-200 VCR. A picture of the SCAN-05 is shown on the next page.

The SCAN-05 allows you to easily program your VCR. Just direct the beam of the scanner to read the bar codes of the TV program you wish to record. All the information (day and time of TV show, length of recording, etc...) will be picked up at once and can then be sent to the VCR by directing the beam in that direction.

The SCAN-05 is a non-hazardous, cordless device which uses ordinary batteries. It beeps to indicate it has picked up the bar-coded information and has a battery check incorporated. It cannot make errors when picking up information. It allows you to recall the programmed information by displaying it on your TV screen. It can be purchased seperately with a "transmitter" that makes it compatible with other brands of VCR's currently programmable by remote control.

Clear and illustrated instructions are provided with the scanner, and at least one newspaper has agreed to publish a weekly bar-coded TV guide. Inexpensive bar-coded guides will also be sold at newsstands. After-sales service will be provided through regional centers to accomodate the buyer.

A number of the device's features are still under study and before making its final decision, the company wishes to have a better understanding of potential consumers' buying behavior.

Consider the alternative product characteristics below. They are used in scanner descriptions that appear in the following pages.

1. Length of time the scanner has BEEN ON THE MARKET:
   - 3 months
   - 2 years
   - 5 years

2. Percentage of the market that has ALREADY PURCHASED the scanner:
   - 3%
   - 40%
   - 80%

3. PRICE of the scanner:
   - $ 50.00
   - $ 100.00
   - $ 150.00

4. Full-coverage WARRANTY that goes with the scanner:
   - 3 months
   - 1 year
   - 3 years

5. The scanner's capacity to also SELECT TV CHANNELS (as a TV remote control):
   - .cannot
   - .can

6. How EASY TO USE the scanner is:
   - .some care required in movement and aim
   - .very easy to use

7. How DURABLE the scanner is:
   - .fair resistance to normal use
   - .added durability: very robust

You may tear off this page if you find it convenient for reference purposes later on.

IMAGINE YOU HAVE RETURNED FROM A LONG (SEVERAL YEARS) TRIP THREE MONTHS AGO AND HAVE SINCE LEARNED ABOUT THE SCANNER. ASSUMING YOU WERE CONSIDERING PURCHASING A PROGRAMMING DEVICE, INDICATE THE EXTENT TO WHICH YOU WOULD TEND TO BUY EACH SCANNER DESCRIPTION BELOW, IN THE NEAR FUTURE, FROM AMONG ALL PROGRAMMING DEVICES THAT YOU KNOW OF. Circle the appropriate point on the scale.

	certainly not buy	perhaps buy	certainly buy
	0	5	10
	:--:--:--:--:--:--:--:--:--:--:		

(01)
On the market for 3 mths
Bought by 3% of market
Sells for $ 50.00
Has a 3 mth warranty
Cannot select TV channels
Some care needed in handling
Fair resistance to normal use

0 5 10
:--:--:--:--:--:--:--:--:--:--:

(02)
On the market for 2 yrs
Bought by 40% of market
Sells for $ 150.00
Has a 1 year warranty
Cannot select TV channels
Some care needed in handling
Added durability: very robust

0 5 10
:--:--:--:--:--:--:--:--:--:--:

(03)
On the market for 5 yrs
Bought by 80% of market
Sells for $ 50.00
Has a 1 year warranty
Can also select TV channels
Very easy to use
Added durability: very robust

0 5 10
:--:--:--:--:--:--:--:--:--:--:

(04)
On the market for 2 yrs
Bought by 3% of market
Sells for $ 50.00
Has a 1 year warranty
Can also select TV channels
Some care needed in handling
Fair resistance to norml use

0 5 10
:--:--:--:--:--:--:--:--:--:--:

(etc... interrupt after half of the profiles).

We shall come back to product descriptions later. For now, PLEASE ANSWER THE FOLLOWING QUESTIONS AS CAREFULLY AS POSSIBLE BY CHECKING THE APPROPRIATE BOX.

1. How familiar are you with VCR's ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

2. How familiar were you with scanners before starting this questionnaire ?

Not familiar	Somewhat familiar	Quite familiar	Very familiar
[ ]	[ ]	[ ]	[ ]

3. Had you heard about this particular scanner product before ?

yes [ ] no [ ]

4. Are you interested in VCR's ?

Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

5. Are you interested in scanners ?

Not at all	somewhat	quite	very
[ ]	[ ]	[ ]	[ ]

6. Do you have a VCR at home ?

yes [ ] no [ ]

7. If you do, how do you use it ? [CHECK ONE BOX ONLY]

- only for viewing rented or purchased videos [ ]
- mostly for viewing rented or purchased videos [ ]
- only for recording & viewing TV shows [ ]
- mostly for recording and viewing TV shows [ ]
- equally for rented/purchased videos & TV shows [ ]

We now come back to earlier product descriptions. As before,

CONSIDER THE FOLLOWING ALTERNATIVE SCANNER DESCRIPTIONS. INDICATE THE EXTENT TO WHICH **YOU WOULD TEND TO BUY THEM**, IN THE NEAR FUTURE, FROM AMONG ALL PROGRAMMING DEVICES THAT YOU KNOW OF. Circle the appropriate point on the scale.

would certainly not buy	would perhaps buy	would certainly buy
0	5	10

:--:--:--:--:--:--:--:--:--:--:

(next half of the profiles appears here)
as earlier

Now consider seperately the factors used earlier. INDICATE HOW IMPORTANT EACH ONE WOULD BE TO YOU IN MAKING A PURCHASE DECISION (circle the appropriate point on the scale):

	not at all important		very important
1. HOW LONG THE SCANNER HAS BEEN ON THE MARKET:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
2. HOW MANY PEOPLE HAVE ALREADY BOUGHT ONE:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
3. HOW MUCH IT COSTS:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
4. HOW LONG ITS WARRANTY IS:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
5. ITS CAPACITY TO ALSO SELECT TV CHANNELS:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
6. HOW EASY IT IS TO USE:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10
7. HOW DURABLE IT IS:	:--:--:--:--:--:--:--:--:--:--:		
	0	5	10

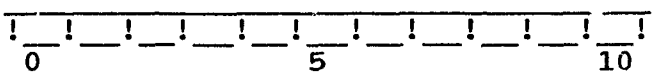
Finally, for each of the factors below, REPRESENT THE ALTERNATIVES ON THE SAME SCALE IN A WAY THAT REFLECTS YOUR PREFERENCE

Think of point 10 as representing your IDEAL. Compared to that, put **EACH** letter a) b) c) in the most appropriate box.

1. How much the scanner costs:

a) $ 50.00
b) $ 100.00
c) $ 150.00

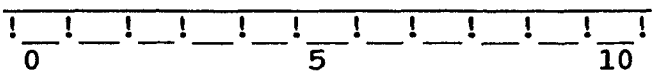
Worst possible — Best possible



2. The kind of warranty it has:

a) 3 months
b) 1 year
c) 3 years

Worst possible — Best possible

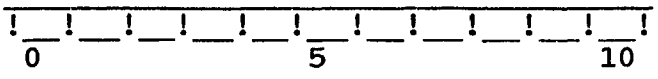


HOW APPEALING are the following characteristics to you? Put BOTH a) and b) in the appropriate box.

3. It's capacity to also select TV channels:

a) cannot
b) can

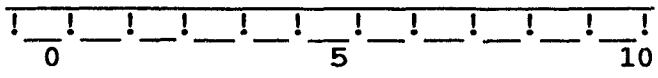
Not at all appealing — Very appealing



4. How easy it is to use:

a) some care required in movement and aim
b) very easy

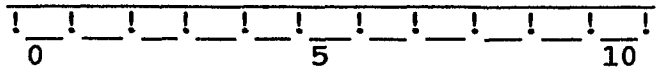
Not at all appealing — Very appealing



5. How durable it is:

a) fair resistance to normal use
b) added durability: very robust

Not at all appealing — Very appealing



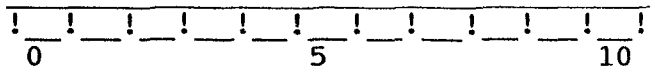
FOR THE FOLLOWING TWO FACTORS, THINK ABOUT WHAT AND HOW YOU **USUALLY TEND TO BUY**, in the product category of consumer electronics.

For example, do you **tend to buy** a product when you believe it has already been bought by a number of consumers? Represent EACH alternative on the same scale.

6. A product you believe has been on the market:

Tend to buy least — Tend to buy most

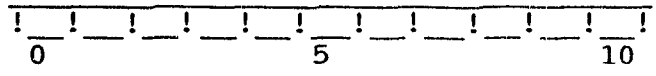
a) 3 months
b) 2 years
c) 5 years



7. A product you believe has been purchased by:

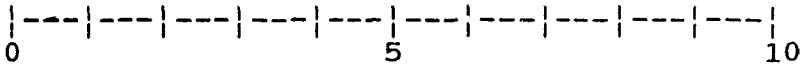
Tend to buy least — Tend to buy most

a) 3% of market
b) 40% of market
c) 80% of market



Assuming you were considering the purchase of a programming device for your VCR, how likely would you purchase a scanner rather than another kind (usual remote control) ?

Certainly not a scanner — perhaps a scanner — Certainly a scanner



GENERAL INFORMATION:

Your mother tongue is: [ ] French [ ] English [ ] Other

Are you a full-time student? [ ] yes [ ] no

Your household income is: [ ] under $25,000 [ ] 25,000-40,000
[ ] 41,000-59,000 [ ] $60,000 or more

How old are you? [ ] under 25 [ ] 25-35 [ ] over 35

What is your sex? [ ] male [ ] female

Your participation is greatly appreciated. Thank you!

Appendix 3

Preliminary analyses of the sample data

Part A: Comparison of language groups - Anova and t-test results F-value (prob>F) - Group means (group sizes)*

	F-value (prob>F)	French (F)	English (E)	Other (O)
		Means (group sizes)		
(1) Years of VCR ownership	4.17 (.02)	4.33 (15)	4.61 (49)	6.69 (13)
(2) Familiarity with VCR's	3.44 (.03)	6.91 (56)	7.80 (151)	7.21 (42)
(3) Familiarity with scanners	2.87 (.06)	4.28 (56)	3.51 (151)	4.67 (42)
(4) Interest in VCR's	1.60 (.20)	6.50 (56)	7.15 (151)	7.05 (42)
(5) Interest in scanners	1.20 (.30)	4.80 (56)	5.21 (151)	5.59 (42)
(6) Likelihood of buying scanner	2.70 (.07)	5.69 (55)	5.73 (152)	6.52 (42)

* (smaller sizes due to missing values)

T-test results for (1) and (2)

	groups	t	prob>t
(1) Years of VCR ownership	F vs E	-0.39	.69
	F vs O	-2.23	.03
	E vs O	-2.79	.01
(2) Familiarity with VCR's	F vs E	-2.23	.03
	F vs O	-0.59	.56
	E vs O	1.54	.12

Part A (end): Comparison of language groups - Anova results for profile evaluations* - F-value (prob>F)

Pr1	1.52	Pr12	0.43	Pr23	0.31	Pr38	0.82
	(.22)		(.65)		(.73)		(.44)
Pr2	1.73	Pr13	0.05	Pr24	0.84	Pr39	2.29
	(.18)		(.95)		(.43)		(.10)
Pr3	2.64	Pr14	0.98	Pr25	0.97	Pr40	1.57
	(.07)		(.38)		(.38)		(.21)
Pr4	0.04	Pr15	1.18	Pr26	1.95	Pr41	1.68
	(.96)		(.31)		(.14)		(.19)
Pr5	0.76	Pr16	1.62	Pr27	0.56	Pr42	0.77
	(.47)		(.20)		(.57)		(.46)
Pr6	0.56	Pr17	1.71	Pr28	0.08	Pr43	0.69
	(.57)		(.18)		(.92)		(.50)
Pr7	0.77	Pr18	1.47	Pr33	0.18	Pr44	1.70
	(.46)		(.23)		(.83)		(.18)
Pr8	0.86	Pr19	0.05	Pr34	0.95	Pr45	1.62
	(.42)		(.95)		(.39)		(.20)
Pr9	0.15	Pr20	0.01	Pr35	0.71	Pr46	1.46
	(.86)		(.99)		(.49)		(.23)
Pr10	0.51	Pr21	0.52	Pr36	2.03	Pr47	0.26
	(.60)		(.60)		(.13)		(.77)
Pr11	0.15	Pr22	0.13	Pr37	1.29	Pr48	0.01
	(.86)		(.88)		(.28)		(.99)

* The 4 duplicate profiles (Pr29 - Pr32) were not subjected to the test.

Part B: Other tests conducted on language groups

An analysis of variance (GLM procedure) and t-tests were performed to investigate differences between language groups on the basis of the reliability measure (reliability correlation). No significant difference (at .05) could be detected in any case.

	Reliability correlation means
French	.740
English	.745
Other	.730

A frequency table was set up to investigate possible differences between language groups in terms of their classification into adopter groups. A chi-square test revealed no significant difference between the cells: No language group appeared to be more or less of an earlier/later adopter, and vice versa ($\chi^2 = 4.2$, prob = .65).

For each language category, group means were derived for the out-of-sample validity measure (validity correlation). The table below illustrates these means:

	Validity correlation means
French	.759
English	.731
Other	.681

Group comparisons were conducted by way of an analysis of variance (GLM) which revealed no significant difference (at .05).

Appendix 3 (end)

Part B (end)

The language group means for the curve directions of "time" and "market penetration" and for these variables' importances were compared. The hypothesis of equal means could not be rejected (at .05). Directions and importances of all other variables were also tested. A significant difference (at .05) was found in only one case, that of "durability", with the mean of the "English" group being higher than that of the "Other" group (.171 and .091 respectively). This single difference is less than what we could expect to obtain by chance alone. These results, combined with those obtained from earlier tests, led us to believe we could safely consider that there was no differences in preferences between language groups in our sample.

Appendix 4

Detailed results of hypothesis tests: Numerical results for directions and importances of interactions

EARLY ADOPTERS

	IMP	REL IMP					AVERAGE INTERACT	IMPORT BY LEVEL
			PRI1	PRI2	PRI3			
			0.00155	0.001615	0.000194	TIM1	0.00112	0.001421
TIMxPRI	0.645794	20.54%	0.099226	0.103358	0.012398	TIM2	0.07166	0.09096
			0.620159	0.645988	0.077485	TIM3	0.447877	0.568503
			WAR1	WAR2	WAR3			
			0.042677	0.12803	0.042668	TIM1	0.071125	0.085382
TIMxWAR	1.380104	43.90%	0.174133	0.52016	0.149495	TIM2	0.281263	0.370665
			-0.28159	-0.85994	-0.44848	TIM3	-0.55	0.578353
			CAP1	CAP2				
			0	-0.04671		TIM1		
TIMxCAP	0.275142	8.75%	0	-0.27514		TIM2		
			0	-0.2655		TIM3		
			EAS1	EAS2				
			0	-0.06988		TIM1		
TIMxEAS	0.707103	22.49%	0	-0.2919		TIM2		
			0	0.415199		TIM3		
			DUR1	DUR2				
			0	0.006783		TIM1		
TIMxDUR	0.135651	4.31%	0	0.05426		TIM2		
			0	0.135651		TIM3		
			PRI1	PRI2	PRI3			
			-0.00407	-0.01322	-0.02745	PEN1	-0.01492	0.023383
PENxPRI	1.66808	25.95%	-0.17424	-0.15271	0.064576	PEN2	-0.08746	0.233814
			-0.60725	-0.25444	1.06023	PEN3	0.06598	1.66808
			WAR1	WAR2	WAR3			
			-0.00035	0.004972	0.065893	PEN1	0.023505	0.066243
PENxWAR	1.937347	30.14%	-0.14344	-0.4152	0.022983	PEN2	-0.17855	0.438183
			-0.58694	-1.87145	-1.80396	PEN3	-1.42078	1.284516
			CAP1	CAP2				
			0	0.027863		PEN1		
PENxCAP	0.743024	11.56%	0	0.371512		PEN2		
			0	0.743024		PEN3		
			EAS1	EAS2				
			0	0.017053		PEN1		
PENxEAS	0.141883	2.21%	0	0.141883		PEN2		
			0	0.098922		PEN3		
			DUR1	DUR2				
			0	-0.06084		PEN1		
PENxDUR	1.938021	30.15%	0	0.02961		PEN2		
			0	1.377181		PEN3		

EARLY MAJORITY

	IMP	REL IMP					AVERAGE INTERACT	IMPORT BY LEVEL
			PRI1	PRI2	PRI3			
			0.30677	0.022998	0.348685	TIM1	0.326151	0.341915
TIMxPRI	0.683398	24.31%	0.119704	0.217932	0.204504	TIM2	0.210707	0.17431
			0.580721	0.690667	0.32984	TIM3	0.553743	0.360927
			WAR1	WAR2	WAR3			
			0.025265	0.372013	-0.31627	TIM1	0.027303	0.38823
TIMxWAR	1.040432	37.75%	0.090221	0.246915	-0.17131	TIM2	0.055277	0.418229
			-0.25387	-0.79352	-0.80478	TIM3	-0.25372	0.227944
			CAP1	CAP2				
			0	-0.03857		TIM1		
TIMxCAP	0.272667	9.39%	0	-0.23509		TIM2		
			0	-0.27267		TIM3		
			EAS1	EAS2				
			0	-0.06732		TIM1		
TIMxEAS	0.556539	20.19%	0	-0.30273		TIM2		
			0	0.255811		TIM3		
			DUR1	DUR2				
			0	0.036814		TIM1		
TIMxDUR	0.202678	7.35%	0	0.202678		TIM2		
			0	0.11311		TIM3		
			PRI1	PRI2	PRI3			
			-0.30275	-0.30345	-0.3171	PEN1	-0.30943	0.317443
PENxPRI	1.270971	19.71%	-0.14438	-0.12411	0.061416	PEN2	-0.36909	0.205994
			-0.52244	-0.27293	0.140521	PEN3	-0.41585	1.277977
			WAR1	WAR2	WAR3			
			0.304068	0.32019	0.366527	PEN1	0.330463	0.38144
PENxWAR	2.026887	31.44%	-0.1148	-0.3312	0.030504	PEN2	-0.1235	0.261701
			-0.61815	-1.96056	-1.78528	PEN3	-1.45466	1.342405
			CAP1	CAP2				
			0	0.015876		PEN1		
PENxCAP	0.816806	12.67%	0	0.306206		PEN2		
			0	0.816806		PEN3		
			EAS1	EAS2				
			0	0.025946		PEN1		
PENxEAS	0.211927	3.29%	0	0.211927		PEN2		
			0	0.134079		PEN3		
			DUR1	DUR2				
			0	-0.09111		PEN1		
PENxDUR	2.121183	32.90%	0	-0.15986		PEN2		
			0	1.961322		PEN3		

LATE MAJORITY

	IMP	REL IMP					AVERAGE	IMPORT
			PRI1	PRI2	PRI3		INTERACT	BY LEVEL
			0.039178	0.06074	0.064686	TIM1	0.054868	0.025508
TIMxPRI	0.342918	19.44%	0.251259	0.36159	0.330993	TIM2	0.314614	0.110331
			0.361722	0.371124	0.328206	TIM3	0.253684	0.342918
			WAR1	WAR2	WAR3			
			0.00816	0.021041	-0.02965	TIM1	-0.00015	0.050693
TIMxWAR	0.455795	25.84%	0.022786	0.047192	-0.21004	TIM2	-0.04669	0.257229
			-0.12514	-0.40118	-0.4086	TIM3	-0.31164	0.283466
			CAP1	CAP2				
			0	-0.06807		TIM1		
TIMxCAP	0.455165	25.80%	0	-0.32471		TIM2		
			0	0.130453		TIM3		
			EAS1	EAS2				
			0	-0.05736		TIM1		
TIMxEAS	0.33236	18.84%	0	-0.28368		TIM2		
			0	0.048685		TIM3		
			DUR1	DUR2				
			0	0.033917		TIM1		
TIMxDUR	0.177677	10.07%	0	0.177677		TIM2		
			0	0.042806		TIM3		
			PRI1	PRI2	PRI3			
			-0.00034	-0.00019	0.000429	PEN1	-3.3E-05	0.000764
PENxPRI	0.543488	22.91%	-0.05964	-0.03422	0.076236	PEN2	-0.00587	0.135872
			-0.23854	-0.1369	0.304944	PEN3	-0.0235	0.543488
			WAR1	WAR2	WAR3			
			-0.00507	-0.01336	0.015403	PEN1	-0.00101	0.022765
PENxWAR	0.674026	28.42%	-0.0353	-0.25074	-0.01253	PEN2	-0.11638	0.238164
			-0.21088	-0.65862	-0.49655	PEN3	-0.45535	0.447736
			CAP1	CAP2				
			0	0.013503		PEN1		
PENxCAP	0.360073	15.18%	0	0.180036		PEN2		
			0	0.360073		PEN3		
			EAS1	EAS2				
			0	0.020388		PEN1		
PENxEAS	0.152355	6.42%	0	0 152355		PEN2		
			0	0.046365		PEN3		
			DUR1	DUR2				
			0	-0.04248		PEN1		
PENxDUR	0.642075	27.07%	0	-0.1842		PEN2		
			0	0.457873		PEN3		

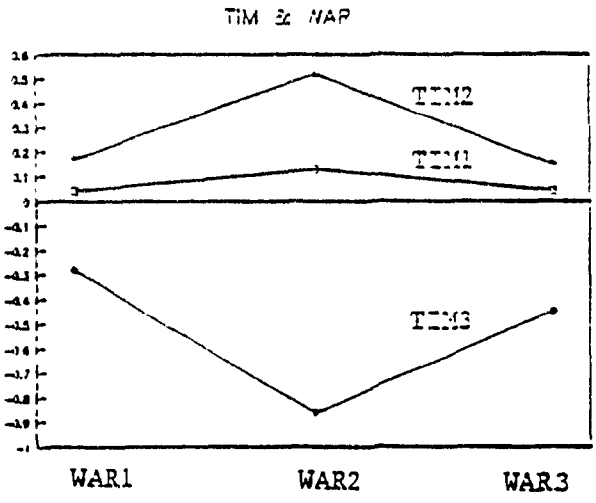
LAGGARDS

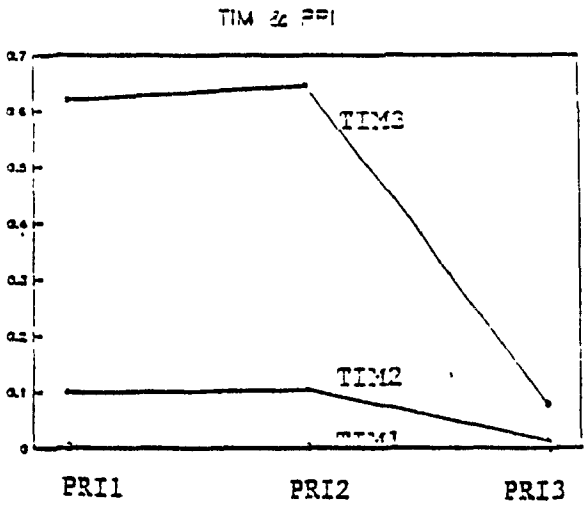
	IMP	REL IMP					AVERAGE	IMPORT
			PRI1	PRI2	PRI3		INTERACT	BY LEVEL
			0.014881	0.029092	0.042633	TIM1	0.028868	0.027752
TIMxPRI	0.465071	29.79%	0.10029	0.157708	0.172256	TIM2	0.143418	0.071966
			0.170341	0.072736	-0.29282	TIM3	-0.01658	0.463157
			WAR1	WAR2	WAR3			
			-0.00058	-0.00596	-0.04682	TIM1	-0.01779	0.346236
TIMxWAR	0.330065	21.14%	-0.01853	-0.07883	-0.27431	TIM2	-0.12389	0.25578
			-0.10566	-0.33065	-0.25606	TIM3	-0.23079	0.224991
			CAP1	CAP2				
			0	0.001572		TIM1		
TIMxCAP	0.628758	40.28%	0	0.100601		TIM2		
			0	0.628758		TIM3		
			EAS1	EAS2				
			0	-0.00686		TIM1		
TIMxEAS	0.13711	8.78%	0	-0.05484		TIM2		
			0	-0.13711		TIM3		
			PRI1	PRI2	PRI3			
			0.030514	0.033286	0.008314	PEN1	0.024038	0.024972
PENxPRI	0.635172	21.33%	0.225182	0.29591	0.212186	PEN2	0.244426	0.083724
			0.357546	0.272042	0.243406	PEN3	0.224033	0.385709
			WAR1	WAR2	WAR3			
			0.002473	0.010101	0.031971	PEN1	0.014048	0.022498
PENxWAR	1.000485	33.60%	-0.03492	-0.10261	-0.01125	PEN2	-0.04959	0.291355
			-0.21664	-0.71826	-0.96851	PEN3	-0.83447	0.751873
			CAP1	CAP2				
			0	-0.03163		PEN1		
PENxCAP	0.304266	10.22%	0	-0.29219		PEN2		
			0	-0.30427		PEN3		
			DUR1	DUR2				
			0	-0.05263		PEN1		
PENxDUR	1.037954	34.86%	0	-0.15161		PEN2		
			0	0.986344		PEN3		

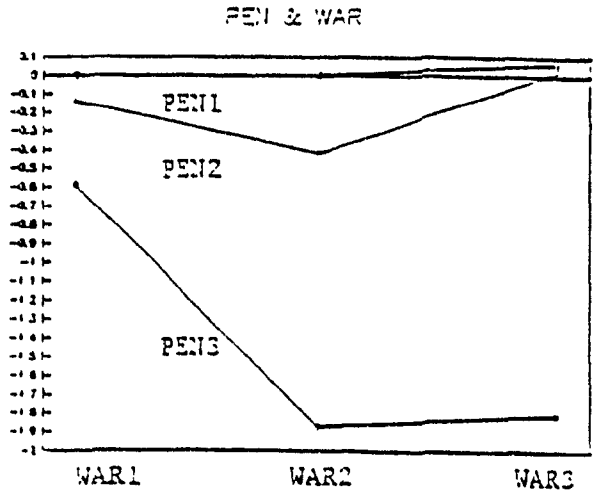
Appendix 4 (cont')

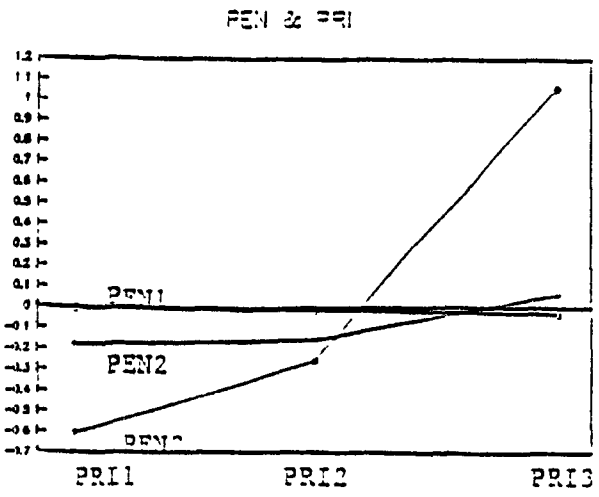
Directions & importances of interactions:
Graphical representations for
(time x warranty), (time x price),
(market penetration x warranty), (market penetration x price)

EARLY ADOPTERS



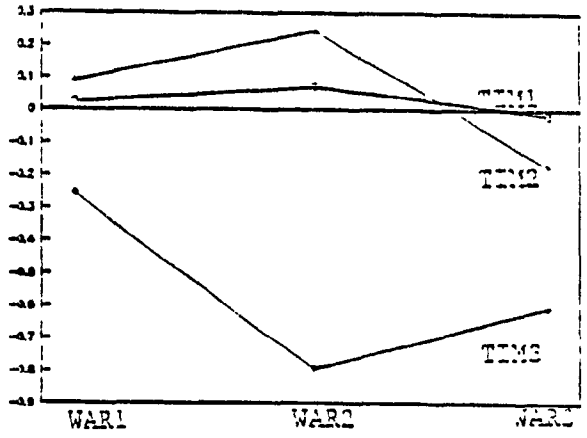




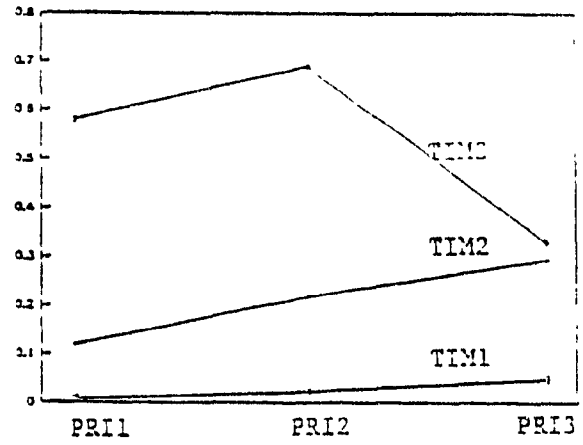


EARLY MAJORITY

TIM & WAR



TIM & PRI



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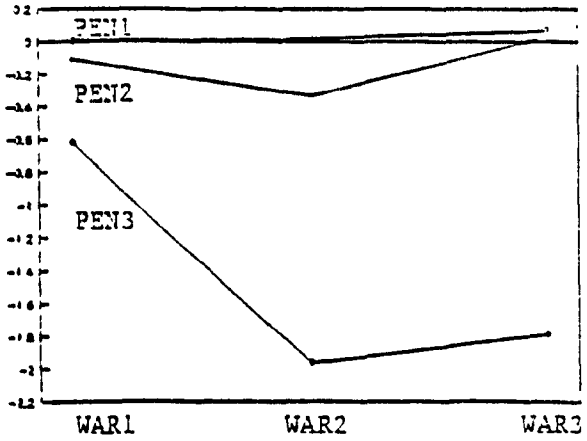

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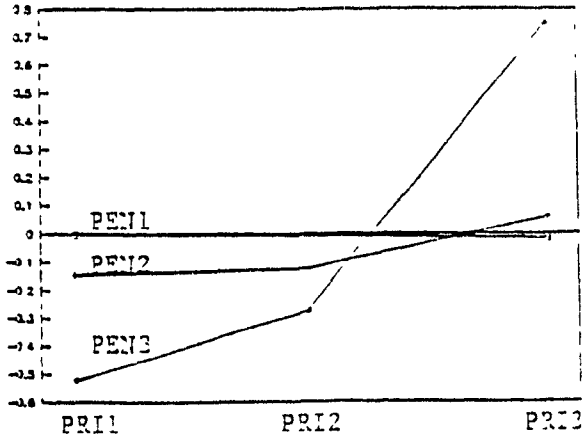
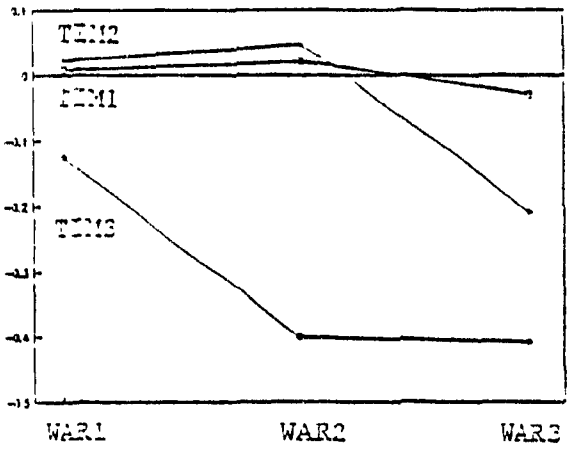


LATE MAJORITY

TIM & WAR



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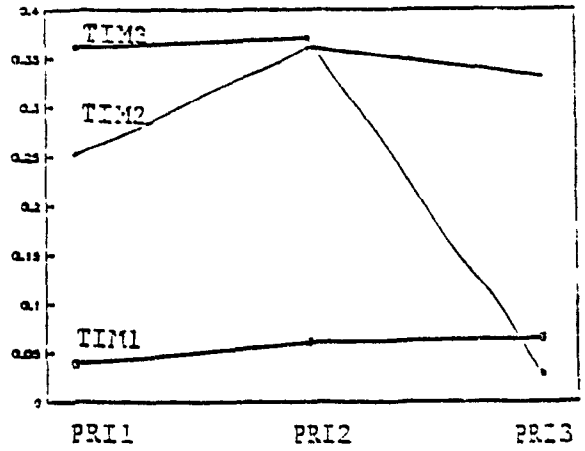

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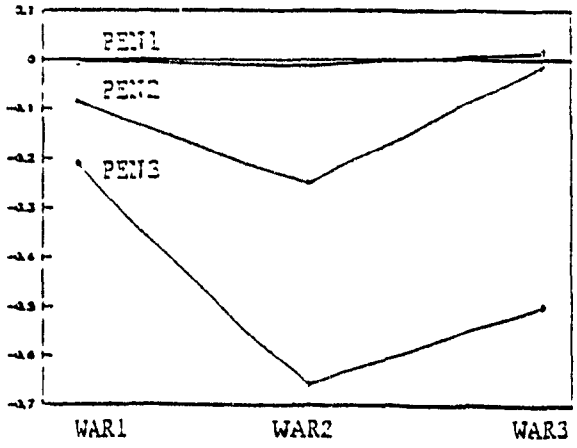

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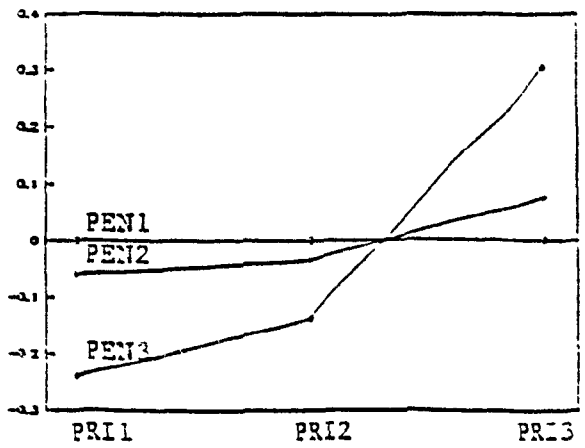
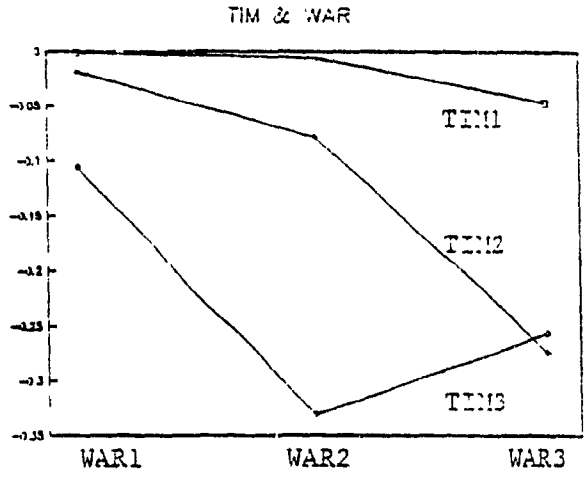
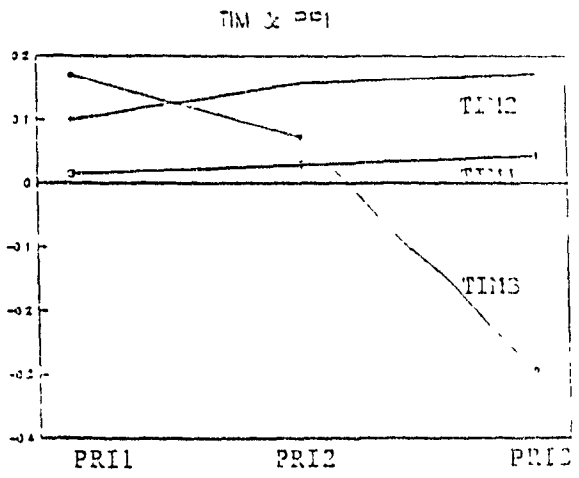
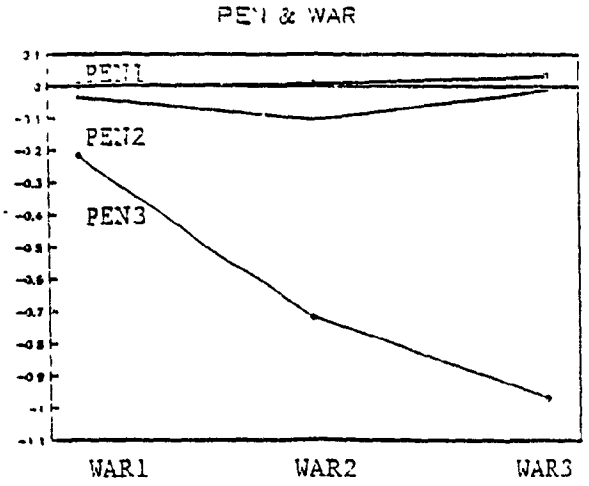


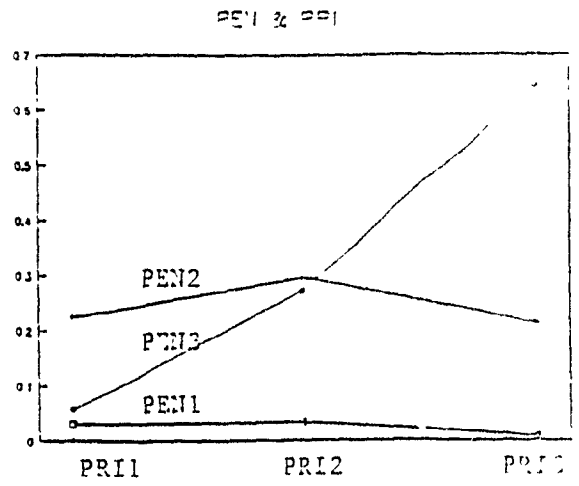
Appendix 4 (end)

LAGGARDS









Appendix 5

Detailed results of the probability model

Part A: Average purchase probability of each alternative at each time period

period profile	1	2	3	4	5	6	7	8	9	10
1	.020	.021	.021	.022	.022	.023	.024	.025	.026	.027
2	.018	.019	.019	.020	.020	.021	.022	.023	.023	.024
3	.019	.020	.020	.021	.021	.022	.023	.024	.025	.026
4	.018	.019	.019	.020	.020	.021	.022	.023	.024	.025
5	.039	.040	.041	.042	.043	.045	.047	.048	.050	.051
6	.039	.039	.040	.041	.043	.044	.046	.047	.049	.050
7	.040	.040	.041	.042	.044	.045	.047	.049	.050	.052
8	.039	.040	.040	.042	.043	.045	.046	.048	.049	.051
9	.026	.027	.028	.029	.030	.032	.033	.034	.036	.037
10	.025	.026	.027	.028	.029	.030	.032	.033	.034	.035
11	.027	.027	.028	.029	.030	.032	.033	.035	.036	.037
12	.026	.026	.027	.028	.030	.031	.032	.034	.035	.036
13	.047	.048	.050	.052	.054	.056	.058	.060	.062	.064
14	.046	.047	.049	.051	053	.055	.057	.059	.061	.063
15	.048	.048	**.050**	**.052**	**.054**	**.056**	**.059**	**.061**	**.063**	**.065**
16	.047	.048	.049	.051	.053	.055	.057	.060	.062	.064
17	.027	.027	.028	.029	.030	.031	.032	.034	.035	.036
18	.026	.026	.027	.028	.029	.030	.031	.033	.034	.035
19	.027	.028	.028	.029	.030	.032	.033	.034	.036	.037
20	.026	.027	.027	.028	.029	.031	.032	.033	.035	.036
21	.048	.048	.050	.051	.053	.055	.057	.060	.062	.064
22	.047	.048	.049	.051	.052	.054	.056	.058	.061	.063
23	**.048**	**.049**	.050	.052	.054	.056	.058	.060	.062	.064
24	.047	.048	.049	.050	.052	.054	.056	.058	.060	.062

* Bold numbers indicate highest average purchase probability before rounding.

Part B: Categorizing adopters using Bass'(1969) model

Following Lawrence & Lawton (1981), three parameters need to be estimated through managerial judgment or by analogy. Given the nature of the product considered here, we choose to contact managers at Panasonic.

Parameters to be evaluated:

1. potential market size **m**;

2. number of adoptions in first time period **S1**;

3. an estimate of the sum of coefficients of imitation and innovation **p+q**.

Given the difficulty for managers to estimate 3., we will use the value suggested by Lawrence & Lawton (1981) as being most frequently encountered in the case of consumer durable goods: .50

Having estimated the above, we can derive:

$q/p = [m(1-e^{-(p+q)})-S1] / S1e^{-(p+q)}$

Time of adoption peak:

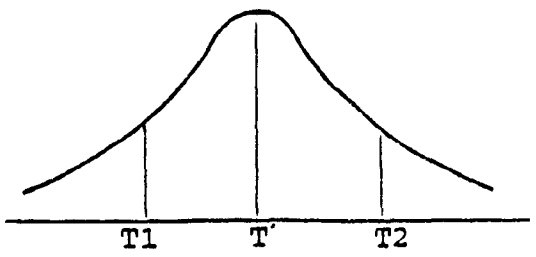
$T^* = -[1/(p+q)]\ln(p/q)$

Points of inflection:

$T1 = -[1/(p+q)]\ln[(2+\sqrt{3})p/q]$

$T2 = -[1/(p+q)]\ln[(1/(2+\sqrt{3}))p/q]$

These in fact divide the adopters into innovators + early adopters, early majority, late majority and laggards:



Part B (end)

To find the proportions of individuals included in each of the adopter categories, we must derive the cumulative proportion of adopters at times T^*, T1 and T2, based on:

Innovators = p

Early adopters = F(T1)-p

Early majority = $F(T^*)-F(T1)$

Late majority = $F(T2)-F(T^*)$

Laggards = 1-F(T2)

where:

$$F(T^*) = (1/2)-(p/2q)$$

$$F(T1) = F(T^*)-(1/\sqrt{T2})[1+(p/q)]$$

$$F(T2) = F(T^*)+(1/\sqrt{T2})[1+(p/q)].$$

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