Purchase Intentions and the Dimensions of Innovation: An Exploratory Model

Susan L. Holak and Donald R. Lehmann

The ultimate success of new product R&D depends as much on customer acceptance as on technological breakthroughs. In this article, Susan Holak and Donald Lehmann focus on customer acceptance by exploring the manner in which the general attributes of Rogers (relative advantage, compatibility, complexity, divisibility and communicability) plus perceived risk combine to form the intention to buy an innovation. Results demonstrate a causal structure among these attributes and lead to various implications for R&D guidelines and product design.

Address correspondence to Susan L. Holak, Graduate School of Management, Rutgers University, 92 New Street, Newark, NJ 07102.

The success of innovative products depends as much on consumer acceptance as on technological factors. Acceptance or adoption of such a product is necessarily influenced by consumers' purchase intentions which, in turn, are determined by certain general attributes (characteristics) of the products.

A substantial amount of literature has examined factors affecting the success of R&D projects, such as environmental elements [9], the product life cycle [20], competitive pressures [14], patents [18], R&D funding [19] and organizational structure [6,15], among others. Considerable effort also has been devoted to predicting the success of new product introductions [3,17]. However, in spite of frequent suggestions to maintain a customer orientation [29], surprisingly little research has appeared that suggests how this customer focus might be incorporated into R&D projects. (Hauser's [10] case study of the narrowband video telephone innovation is the one exception.) This study, therefore, focuses on the impact—direct or indirect—of selected attributes (specifically Rogers' [26] general attributes—relative advantage, compatibility, complexity, divisibility (trialability) and communicability (observability)—plus perceived risk [4,22]) on the planned adoption of consumer durables.

A model is developed to evaluate these impacts, and causal relationships are established among these attributes and consumer intention to purchase innovations. Data for the research were collected from consumer decision makers prior to the purchase of nineteen technologically inten-

Published in: *Journal of Product Innovation Management*

BIOGRAPHICAL SKETCHES

Susan L. Holak is Associate Professor of Marketing at the Graduate School of Management, Rutgers University, Newark, New Jersey. She holds a bachelor's degree from the Wharton School of the University of Pennsylvania, and a master's degree and a Ph.D. in Business from the Graduate School of Business, Columbia University. Dr. Holak's research interests lie in the areas of product innovation management, new product design and consumer response to innovation. Her work has appeared in various journals including *The Journal of Marketing, The Journal of Retailing* and *The Journal of Product Innovation Management*.

Donald R. Lehmann is George E. Warren Professor of Marketing at Columbia University Graduate School of Business. He holds a bachelor's degree from Union College, Schenectedy, New York, and a master's degree and a Ph.D. in Industrial Administration from Purdue University. Dr. Lehmann has published in and serves on the editorial boards of many journals including *Marketing Science, The Journal of Marketing* and *Marketing Letters*. His research interests lie in areas involving choice models and decision making, innovation and research methodology.

sive durable innovations selected for the analysis. Results indicate that complexity has an important indirect impact on intention through its effects on relative advantage, communicability and perceived risk, and that compatibility—and, to a lesser extent, relative advantage and perceived risk—has a direct impact on purchase intention.

Background

New product diffusion research has drawn on studies from several social science disciplines, particularly rural sociology and agricultural economics, for concepts related to product adoption. For example, Rogers [26] suggested five innovation attributes that have become familiar aspects of new product evaluation [11,12,16,23]. These are the constructs that will be used in this study with the addition of a sixth, perceived risk, as suggested by Bauer [4].

Although marketing researchers have used these constructs as explanatory factors to predict purchase intention, little work has been done on how they actually operate to affect intention and adoption. Further, Rogers' [26] dimensions have not been related directly to primary attributes or to actionable product design features [24], so their discriminant validity has not been well established. Prior use of innovation dimensions also presupposed their independence rather than suggesting interrelationships among them. Ostlund [22], however, did indicate that redundancies exist among the constructs, as Rogers and Shoemaker suggested in an earlier study [27]. The present research provides an explanation for Ostlund's results in the form of causal relationships among these evaluative dimensions.

Researchers from many disciplines have explored relationships between innovation attributes and adoption of new items, but much of this research has been subject to criticism. Downs and Mohr [5], for example, suggest that a major flaw in innovation studies has been researchers' failures to make a clear distinction between *primary* and *secondary* attributes[1]; they concede, however, that often this is a difficult task, because primary attributes may be affected by situations or social influences that make them take on some secondary forms. Both Downs and Mohr [5] and Tornatzky and Klein [28] question the existence of a "unitary theory of innovation; Downs and Mohr [5], in particular, caution about generalizing the relationships among innovation attributes and adoption.

Tornatzky and Klein [28] conclude from their meta-analysis of seventy-five studies from various disciplines that although often fraught with conceptual and methodological weaknesses, relationships between certain innovation attributes and adoption show some "consistency in directionality." They suggest studying (1) the operationalization of subjective (secondary) perceptions and (2) the analysis of the interdependence of perceived attributes, noting that only three of the seventy-five studies dealt with attribute interdependence by presenting intercorrelation tables.

Gatignon and Robertson [8,25], in their interdisciplinary summary of innovation research, noted that consumer researchers have paid little attention to innovation attributes and suggested several areas for possible future research. They identified consumer technology innovations as a product classification particularly in need of further study. Our study addresses some of the issues they raised by focusing specifically on technologically intensive consumer durables.

[1] Tornatzky and Klein [28] describe primary attributes as those ". . .inherent to the innovation of technology and invariant across settings and organizations" (such features as size or weight). Secondary attributes are defined by Downs and Mohr [5] as ". . .perceptually-based (or subjective) characteristics."

We begin by describing the attributes used and the proposed model. Next, more specific operationalizations of the attributes are identified and their discriminant validity demonstrated. Relationships among the innovation attributes and the extent to which they are useful for evaluating new products are then discussed. A path model is developed to describe the interdependence among the attributes. Finally, some implications for R&D project direction and marketing are presented.

Perceived Attributes Having an Impact on Innovation Adoption

Product diffusion literature suggests that the following five perceived product attributes have an impact on the rate of innovation adoption: (1) relative advantage, (2) compatibility, (3) complexity, (4) divisibility (trialability) and (5) communicability [7,23,24,26]. Bauer [4] proposed a sixth dimension, perceived risk, later used by Ostlund [23].

Several studies suggest that perceived innovation attributes dominate psychological and/or demographic variables with respect to adoption behavior [11,12,16,22,23]. Although all of these studies incorporate Rogers and Bauer's innovation attributes, the relative importance rankings of the six variables differ across studies.

Ostlund [23] indicated that compatibility and relative advantage predominate as purchase predictors for low-ticket food products. Relative advantage and perceived risk ratings received highest importance weights in the case of oven cooking bags. Compatibility and complexity attribute perceptions ranked highest in relative importance in discriminating between adopters and nonadopters of a solar energy system [16]. Holak [11,12] found compatibility, relative advantage and perceived risk ratings to have a consistently significant impact on reported purchase intention for several durable and nondurable product innovation categories. Overall then, results from these studies suggest that compatibility and relative advantage are the most important predictors of innovation adoption.

Ostlund [22] focused on six hypothetical low-ticket innovations. He obtained ratings for each on Rogers and Bauer's six attributes, then factor analyzed responses for each product. He found substantial redundancy among the evaluative variables. The pattern of redundancy, however, differed across all products, so Ostlund contended that in spite of redundancies, the number of attributes could not be reduced. Still, given the redundancies among perceived innovation attributes in Ostlund [22] and the unequal importance of certain attributes evident in Ostlund [23], LaBay and Kinnear [16] and Holak [11,12], it seems prudent to examine the interrelationships among these variables.

Model Development

This study investigates innovation acceptance in terms of purchase intention. Although intention does not always lead to subsequent purchase, it is significantly related and is the best measure available in cross-sectional studies for products in the early stages of their life cycles [21]. Purchase intention is assumed to depend on the six perceived product attributes offered by Rogers [26] and Bauer [4].

The six perceived product attributes used are as follows.

Relative advantage refers to the degree to which an innovative product is perceived to be superior to those that preceded it [22,26].

Compatibilty relates to the degree to which an innovation is consistent with adopters' behavior patterns, life-styles and values. Some familiarity contributes to adopters' senses of security with new items. This may be determined to some extent by culture as well as by products that have previously been accepted.

Complexity relates to the degree to which an innovation is perceived to be relatively difficult to understand and use. It is generally held that innovation adoption occurs more readily among products and ideas that appear less complex.

Divisibility relates to the degree to which an innovation may be tried on a limited basis or without vast initial commitment. It is thought that consumers are more apt to adopt a product they perceive to be relatively more divisible than other offerings.

Communicability is thought to relate to the rate of diffusion and adoption. If product results or benefits are perceived easily and expressed readily, information about the item will be dissemi-

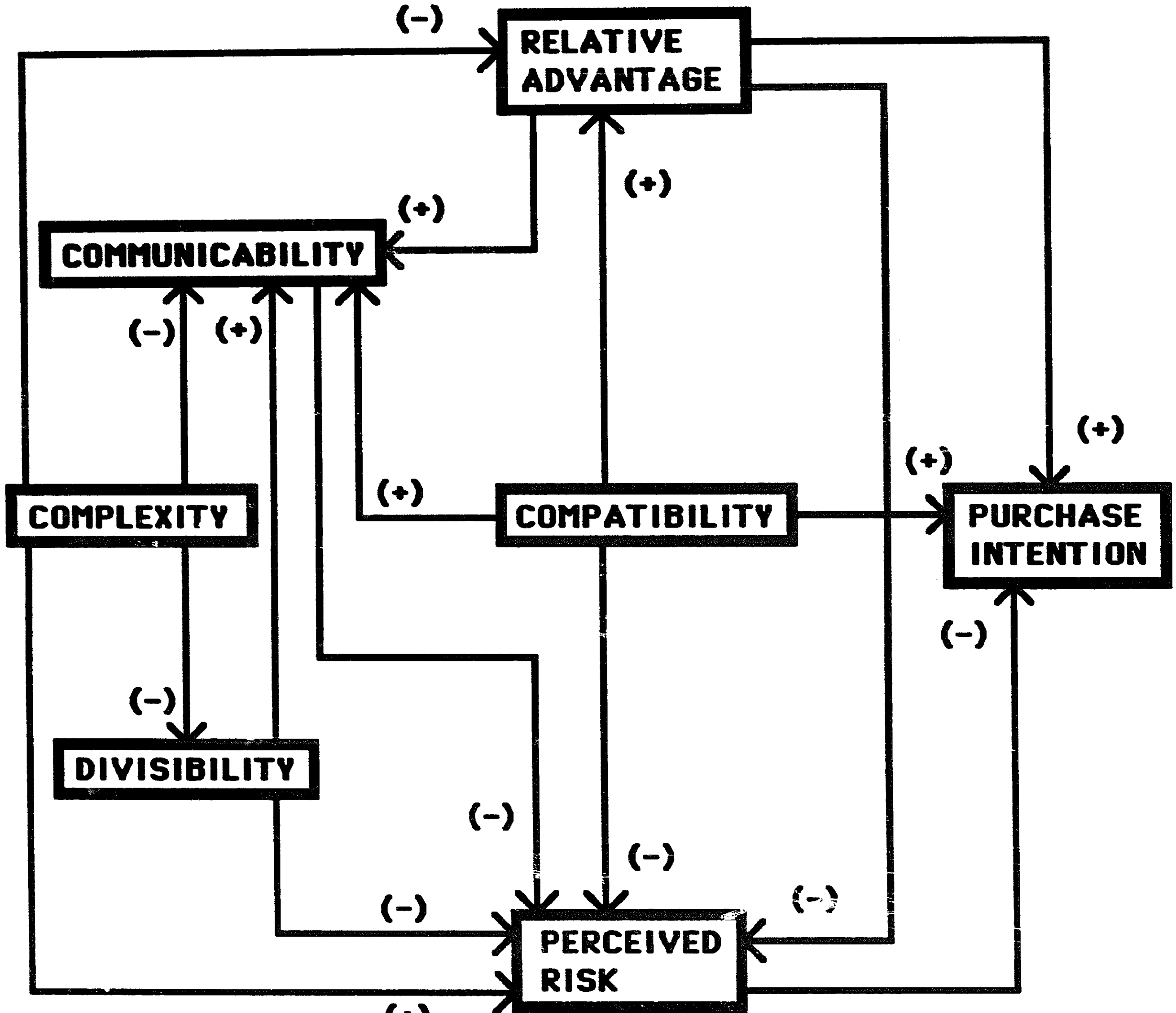

Figure 1. Path model of new product evaluation

nated across a population more quickly than it would about items having low communicability.

Perceived risk as introduced by Bauer [4] and interpreted by Ostlund [23] is related to ". . .the degree to which product performance and/or psychosocial risks are attributed to a product." The psychosocial risks introduced refer to purchasers' concerns about other people's opinions of using the item.

Theory presented in the adoption literature [26] and results from previous research were used to develop the model for this study. The model, however, is essentially original, since specific links among these six attributes have not been widely discussed before. Figure 1 depicts the model and shows postulated interrelationships among perceived attributes[2]; some dimensions have direct and others have indirect impacts on innovation adoption.

The model was specified in three basic steps. Based on background evidence discussed earlier, it was first hypothesized that compatibility, relative advantage and perceived risk have direct im-

[2] Figure 1 depicts the final version of the model. The original model was modified to include a positive relationship between divisibility and communicability (see discussion in "Analysis and Results").

pacts on intention. The second step in the development of the model was to specify (also based on background literature) the manner in which the three remaining constructs (complexity, divisibility and communicability) affect purchase intention indirectly. Finally, factor analytic results from Ostlund [22] were used to corroborate the existence of paths.

Hypothesized Relationships

Relationships among the six innovation attributes are first discussed in terms of their impacts on purchase intent, then on each other. Compatibility and relative advantage are hypothesized to have direct and positive effects on intention, while perceived risk is expected to have a direct but negative impact on intention.

Compatibility. Perceived compatibility is hypothesized to drive much of the innovation evaluative process by its direct effect on purchase intention as well as its effects on other attributes. This assertion is intuitively appealing given that humans are, in general, resistant to change (i.e., risk averse in gains) according to Kahneman and Tversky [13]. Compatibility is also expected to have impacts on relative advantage, communicability and risk.

Perceived compatibility is anticipated to have a positive impact on relative advantage. Intuitively, if an item is judged to be in keeping with one's past experience, values and life-style, one probably would be familiar with previous items and thus more capable of judging the present innovation in terms of its superiority over prior offerings. If an innovation were perceived to be incompatible with one's life-style, chances are that some advantages of the item would not be recognized. Ostlund [22] supports a positive relationship.

Compatibility's impact on communicability is expected to be positive. Here again, familiarity or perceived compatibility of an item should positively affect one's ability to recognize and communicate to others the operation and advantages of the new item.

Finally, compatibility is hypothesized to have a negative impact on perceived risk. If an item were felt to be compatible with one's life-style, the perceived risks, especially psychosocial risks associated with product operation, would be mitigated.

Relative advantage. In addition to its direct and positive effect on intention, relative advantage is hypothesized to have an indirect impact on intention through its negative effect on perceived risk. If substantial advantages are associated with a new item, perceived purchase risk may be lessened as potential adopters overlook its shortcomings. This link is also supported by Ostlund [22].

A positive relationship is hypothesized to exist between relative advantage and communicability. Obviously, the more advantageous an innovation is deemed to be, the more evident and communicable are its benefits, ceteris paribus.

Complexity. The complexity variable is hypothesized to affect intention and ultimately adoption through all the other five product dimensions except compatibility. The relationships between complexity and both divisibility and communicability are hypothesized to be negative. These contentions are supported in Ostlund [22] by the relatively high factor loadings (with appropriate signs) of each of these variables on the same factor for several products. If an innovation is viewed as complex, it probably would not be perceived as being easy to try or as having operations and/or advantages easily recognized and explained to others.

Complexity also is hypothesized to affect intention indirectly through perceived risk. The relationship between complexity and risk is expected to be positive. Thus, the more complex an item is perceived to be, the greater the risk associated with its usage. This is also supported by both variables loading on the same factor with the same sign for several products [22].

The relationship between complexity and perceived relative advantage is anticipated to be negative. Intuitively, if an item is perceived to be complicated to understand and use, its relative advantage would not be discernible.

Divisibility and communicability. Both divisibility and communicability are expected to have impacts on perceived risk. It is anticipated that divisibility affects perceived risk in a negative manner. If one is able to try an innovation with little time and/or monetary investment, perceived risk is then reduced. Ostlund [22] supports a negative relationship.

A negative impact of communicability on perceived risk is also hypothesized. If the benefits, advantages and operations of a product are not readily apparent or recognized and communicable to others, it is likely that using that item might be perceived to be risky. Ostlund [22] also supports a negative relationship in this case.

Methodology

Research was conducted in two stages. First, a pilot study was done to ensure that respondents could understand the six constructs selected for use in the main analysis. Then, data for the main analysis were elicited through a questionnaire-type data collection instrument.

Pilot Study

A small sample (twenty-six individuals) was given a list of sixty-eight specific features obtained from prior literature (e.g., ease of operation) and asked to relate them to the six general attributes according to the appropriateness of the operationalization as a means for judging an innovation on the basis of each attribute. To illustrate, if a respondent felt that the feature labeled "number of unique features" were an appropriate basis on which to judge both an innovation's relative advantage and complexity, this could be indicated on the survey. Appendix A contains a percentage summary of the twenty-six respondents' expressed links between specific, often tangible design features and the more abstract dimensions. For example, all twenty-six individuals (100%) indicated that "savings of time in use" is a feature which they felt operationalizes relative advantage. Subjects found the task meaningful. Discussions after the survey indicated the respondents understood the constructs.

Cluster analysis applied to the same data resulted in a six-cluster solution of features commensurate with Rogers and Bauer's original constructs. The cluster analysis substantiates the use of specific product features to operationalize the six innovation dimensions in a product design setting.

Main Analysis

Product selection. Data for the main analysis were collected on nineteen actual consumer durable innovations, all but one of which were being marketed nationally during the data collection phase. These items were selected based on four criteria. First, they had to be items to which one realistically could be expected to be exposed through the media. Second, a time factor entered into product selection. For the most part, only items introduced to the public no earlier than one year prior to the late-1982 data collection period were used.

The third criterion was that the innovations included were to fall within the following categories: (1) kitchen appliance innovations or (2) entertainment or amusement items such as cameras and various electronic products. These product categories were used because they had enjoyed considerable new product introduction during the eighteen-month period from mid-1981 until data collection in late 1982. In addition, the categories themselves appeared in the results of a factor analysis performed in a related pilot study.

Finally, a fourth criterion for product selection necessitated that items be fairly homogeneous across manufacturers or product lines in terms of features because no particular manufacturer name or specific model identification was given in the questionnaire. As a result, the items selected can be described without brand name, yet bring to mind the same item for response. A detailed list of the items provided in the questionnaire is found in Table 1.

Measures. The data collection instrument provided the sample with brief product descriptions and elicited single-item ratings for (1) prior knowledge, (2) product ratings on each of Rogers and Bauer's judgmental dimensions (subjects rated all the products on one dimension at a time), (3) intention to purchase in the next two years and (4) prior purchase history. Six-point scales were used, except for a five-point scale employed to measure purchase intent.

Product descriptions included neutral information about major characteristics of the item without reference to specific manufacturers to avoid biasing the responses. Information was kept brief as suggested by Armstrong and Overton [1]. The questionnaire was reviewed by two professional editors to ensure neutrality of product descriptions.

Respondents. For convenience, approximately one third of the total sample of 130 was drawn from the student population at Columbia University. The remaining group of respondents

Table 1. Innovations Used as Subject Matter

Product	Trade name	Manufacturer	Introduction date	Suggested Price
3D camera		Nimsio	April 1982	$ 230.00
Disc camera		Kodak	February 1982	75.00
Sun camera	640 model	Polaroid	May 1981	50.00
Electronic camera		Sony	Expected late 1983	650.00
Slide copier		Vivitar	June 1982	159.00
Wide projection television	Nova Beam model 2	Kloss Video	June 1979	3,300.00
Video component TV		Sony	January 1982	2,175.00
Pocket-size TV	Watchman	Sony	August 1982	350.00
Portable stereo cassette player	Walkman	Sony	November 1979	150.00
Video disc player		RCA	February 1981	400,00
VCR	SL5000	Sony	April 1975	600.00
Electronic musical instrument	VL5, VLTone	Casio	September 1980	100.00
Touch control dishwasher		Whirlpool	October 1981	550.00
Sentinel refrigerator		Whirlpool	March 1981	1,600.00
Cardread microwave oven	Brainwave	Toshiba	January 1980	640.00
Electronic triple timer		Westbend	September 1981	35.00
Electronic typewriter	Model 221	Olivetti	April 1980	350.00
Cordless telephone		Uniden	April 1980	100.00
Portable personal computer		Osborne	May 1981	1,600.00

(also a convenience sample) was composed of a heterogeneous group of nonstudents from the communities of Columbia University and the Georgia Institute of Technology. Fifty-eight percent of the sample was male and median incomes were between $30,000 and $40,000.

Analysis and Results

In this section we modify and estimate the model depicted in Figure 1. Estimated parameters are used to verify the model's structure and existence of links in two verification steps. In addition, the path model's generalizability is assessed by investigating separate product categories.

Correlations among the six selected attributes plus purchase intention are shown in Table 2 and indicate that the model generally is supported. Note the relatively high correlation of both relative advantage and compatibility with purchase intention. In addition, the relatively small, negative correlation of complexity with purchase intent is of interest given the final results.

Next, partial correlations were calculated to verify the choice of compatibility, relative advantage and risk as the only direct causes of intention and to ascertain if the model should be modified in any way.

Model Modification

First-order partial correlations between each product attribute an intention are as follows:

	Partial correlations	Significance
Relative advantage	0.2410	$P < .001$
Compatibility	0.3951	$P < .001$
Complexity	0.0204	ns
Divisibility	0.0066	ns
Communicability	0.0254	ns
Perceived risk	−0.1053	$P < .001$

Table 2. Correlations

	Relative advantage	Compatibility	Complexity	Divisibility	Communicability	Perceived risk	Purchase intention
Relative advantage	1.000						
Compatibility	0.529	1.000					
Complexity	0.074	−0.002	1.000				
Divisibility	0.066	0.039	−0.050	1.000			
Communicability	0.175	0.190	−0.342	0.126	1.000		
Perceived risk	−0.077	−0.088	0.375	−0.119	−0.253	1.000	
Purchase intention	0.467	0.556	−0.010	0.036	0.161	−0.150	1.000

These results support the decision to include only relative advantage, compatibility and perceived risk as direct causes of intention. Further inspection of the correlations (Table 2) suggests a positive relationship also exists between divisibility and communicability. Perceiving an innovation to be divisible and, therefore, more accessible, would enhance the attention paid to its observable advantages. Consequently, the original model was augmented to include this link (Figure 1).

Model Estimation

The model of new product evaluation that appears in Figure 1 was estimated using the attribute ratings of the nineteen technologically intensive durable innovations listed in Table 1. Data were pooled across products and respondents. To avoid any effect attributable to product familiarity from use, data from those few respondents in the sample of 130 who indicated ownership of each of the nineteen products under consideration were eliminated from the study.

Given the recursive nature of the model, Ordinary Least Squares (OLS) estimation was used. Residuals from the various relationships in the model proved to be independent because the highest pairwise correlation value is equal to 0.12; most values were well under 0.05. Results from the model estimation appear in the column labeled "All products" in Table 3.

Overall, the results support the hypothesized relationships except for the impact of complexity on perceived relative advantage. This result was predicted to be negative because it was hypothesized that the more complex an innovation is perceived to be, the lower would be the perceived relative advantage due to convenience, time savings in operation, etc. Results indicate a significant positive effect of complexity on relative advantage. This result is understandable when one considers the public's behavior toward the types of entertainment and electronics-based products included in the sample set. Given the heightened interest in technologically intensive products with seemingly intricate control panels, electronic readouts, etc., it appears that consumers actually are attracted by the more complex capabilities they associate with more advanced stereos, cameras, etc., as compared with less sophisticated models. It may be that consumers who may not know how to operate the latest video equipment or electronic camera, let alone be sure for what purpose they would need the item's features, would rather purchase the updated design in the event that they grow to need or want said capabilities in the future.

In terms of new product assessment, the model indicates that the evaluation process is indeed driven by the perceived compatibility of the item. This dimension has the greatest direct effect on reported purchase intention in terms of magnitude (Beta = .42) as well as an indirect effect through other variables, particularly relative advantage (.52). Compatibility is also negatively related to perceived risk (−0.05), as expected.

Relative advantage has the second strongest relation to intention (Beta = .24). The fact that compatibility has a stronger impact on intention than relative advantage emphasizes the importance of "user-friendly" products. Relative ad-

Table 3. OLS Regression Results

Dependent variable (multiple R for total sample)	Independent variables	All products Beta	All products P-level	Entertainment products Beta	Entertainment products P-level	Kitchen products Beta	Kitchen products P-level
Purchase intention	Risk	−.09	.0001	−.10	.0001	−.05	n.s.
R = .60	Relative advantage	.24	.0001	.22	.0001	.32	.0001
p < .0001	Compatibility	.42	.0001	.43	.0001	.32	.0001
		$\bar{R}^2$ = .36		$\bar{R}^2$ = .36		$\bar{R}^2$ = .31	
Perceived risk	Relative advantage	−.05	.05	−.07	.01	−.01	n.s.
R = .41	Compatibility	−.05	.05	−.03	n.s.	−.03	n.s.
p < .0001	Complexity	.34	.0001	.35	.0001	.31	.0001
	Divisibility	−.06	.05	−.06	.01	−.14	.001
	Communicability	−.11	.0001	−.10	.0001	−.14	.01
		$\bar{R}^2$ = .17		$\bar{R}^2$ = .17		$\bar{R}^2$ = .16	
Communicability	Relative advantage	.13	.0001	.14	.0001	.03	n.s.
R = .41	Compatibility	.12	.0001	.09	.0001	.19	.0001
p < .0001	Complexity	−.34	.0001	−.37	.0001	−.28	.0001
	Divisibility	.09	.0001	.07	.001	.15	.001
		$\bar{R}^2$ = .17		$\bar{R}^2$ = .19		$\bar{R}^2$ = .14	
Relative advantage	Complexity	.06	.01	.06	.01	.09	.05
R = .52	Compatibility	.52	.0001	.52	.0001	.53	.0001
p < .0001							
		$\bar{R}^2$ = .27		$\bar{R}^2$ = .27		$\bar{R}^2$ = .29	
Divisibility	Complexity	−.05	.05	−.08	.001	−.005	n.s.
R = .05							
p < .05		$\bar{R}^2$ = .003		$\bar{R}^2$ = .01		$\bar{R}^2$ = .00	

vantage, like compatibility, is positively related to communicability (.13) and negatively related to perceived risk (−.05).

Perceived risk has the smallest of the three direct impacts on intention (Beta = −.09, negative as expected). This may be due in part to the fact that intention rather than actual choice is the dependent variable because people may suppress negative impacts until a decision is made. Risk is most strongly influenced by complexity (.34). Thus, for consumer durables, perceived risk rises noticeably with complexity and is only somewhat mitigated by communicability (−.11), divisibility (−.06), relative advantage (−.05) and compatibility (−.05).

As expected, communicability is significantly and negatively affected by complexity (Beta = −.34) and significantly and positively influenced by relative advantage (.13), compatibility (.12) and divisibility (.09). By contrast, divisibility is relatively independent, being only weakly and negatively (−.05) affected by complexity.

The two most striking results are the strong impact of compatibility on intention and the role of complexity in forming other attribute ratings. Apparently, ceteris paribus, incompatibility is a more powerful deterrent to adoption than relative advantage is a motivator. Also apparently, the complexity of an item has substantial direct impact on its perceived risk (+), communicability (−) and relative advantage (+). Its net effect on intention is fairly subtle, as evidenced by the weak direct relationship in Table 2, because complexity can increase intention through its positive impact on relative advantage while simultaneously decreasing intention through its positive impact on perceived risk.

Model Verification

According to Asher [2], two methods are available to verify a recursive path model. The first is to estimate a model with all possible paths included and then to check for insignificance of paths omitted in the hypothesized model; the more detailed second procedure requires that all possible paths be multiplied and summed to total a calculated Pearson correlation that can be compared with direct correlations. Both methods were used here.

To illustrate the first verification method, consider the implied ordering of the six secondary constructs as follows: compatibility and complexity simultaneously initiate the process, followed by divisibility, relative advantage, communicability, perceived risk and, finally, purchase intention. When all possible paths were included in this model such that each construct was determined by those preceding it in the order implied, those links not originally hypothesized were found to be insignificant, thus verifying Figure 1.

The more complicated verification method required that the calculated correlations between each product attribute and intention implied by the model be close to the corresponding measured correlation. To illustrate the calculation process, the predicted correlation of relative advantage with intention is delineated in Appendix B. Predicted and actual correlation results for each of the six attributes with intention appear in the columns designated for the total sample in Table 4. Comparisons of the correlations predicted by the model with actual correlations indicate close correspondence between the two sets.

Generalizability

To demonstrate the generalizability of this model, the analysis and subsequent verification procedures were rerun, splitting the data into kitchen and entertainment product groups. Tests for the differences between groups reveal that the two types of products are statistically significantly different at the 5% level for four of the five equations reported in Table 3. While the results are quite consistent directionally and in terms of general magnitude, some differences are observable in Tables 3 and 4.

Except for the insignificant parameter estimate associated with compatibility in the perceived risk equation, the entertainment results closely parallel those from the total sample. This is not surprising because fifteen of the total nineteen products are entertainment items.

The kitchen product category results were generated using data from four appliances; therefore, the number of observations was smaller. It is not surprising then that five parameter estimates fail to be significant for this category. Despite these insignificant estimates, parameter values for the kitchen product category have signs and magnitudes similar to those generated from the total sample. The two verification methods performed using the total sample also were applied to the kitchen and entertainment categories. When the model was estimated with all possible paths included in the implied ordering of constructs, results for the entertainment product category were identical to those from the total sample. Except for an insignificant parameter value for compatibility in the risk equation when a significant result was anticipated, all findings supported the model in Figure 1.

In the case of kitchen appliances when the model was estimated with all possible paths, one major difference was noted: specifically, the positive parameter linking complexity to intention is significant at the .01-level rather than insignifi-

Table 4. Verification of Path Model Results

Attribute	Pearson correlation of attribute with purchase intention			Calculated path relationship		
	Total	Entertainment	Kitchen	Total	Entertainment	Kitchen
Relative advantage	.467	.455	.495	.465	.455	.488
Compatibility	.556	.558	.487	.556	.557	.494
Complexity	−.010	−.046	.113	−.020	−.026	.009
Divisibility	.036	.037	.055	.008	.009	.009
Communicability	.161	.158	.145	.139	.135	.115
Perceived risk	−.150	−.160	−.086	−.152	−.160	−.087

cant, as anticipated. Considering the total number of relationships estimated, this difference may be due to chance. The only other differences involved two parameters that failed to be significant as expected. This may be because of the smaller number of observations associated with the kitchen product category estimations.

Results from the second verification method appear in Table 4. As with the total sample results, calculated correlations for relative advantage, compatibilty and risk are almost identical to the actual Pearson correlation values for both product categories. Values for communicability are very close when compared. As with the total sample, there is more of a difference between calculated and actual values for the divisibility construct. Following from the first verification procedure, the calculated and actual correlation values for the complexity construct are reasonably close for the entertainment product category but differ more substantially for kitchen items.

In general, our separate results for entertainment and kitchen products support those from the total sample with the possible exception that complexity may have a different impact on intention depending on the product category. In any case, the parameter associated with complexity is positive, a result that contradicts the adoption literature.

Summary

The model of new product evaluation sheds light on several aspects of the consumer's judgmental process, especially with respect to technologically intensive durable products. Prior research studies have incorporated the perceived attributes [16, 23] but have treated them as independent and direct predictors of a purchase intention measure. The factor redundancy that appeared in Ostlund's [22] study of six low-ticket items may be explained by relationships among the attributes themselves.

The directionality of each parameter value is consistent with intuition and prior literature except for the positive effect of the complexity variable on an innovation's perceived relative advantage. As suggested earlier, for technologically intensive durables such as those that dominate this study, more "complex" designs in terms of buttons, movable parts, etc., may imply greater capabilities of an item to consumers, which result in heightened advantage ratings.

The relatively large, direct, positive impact of the compatibility variable on reported purchase intention indicates that the predominant concern of individuals is maintaining a life-style. One might conclude from this that consumers are more concerned with a new item's compatibility with their living patterns and self-images than they are with more specific information about its operating features or benefits related to perceived relative advantage. Hence, it may be more cost effective to direct R&D dollars toward making a product compatible (user friendly) rather than to making it more technically advanced.

Implications and Conclusions

Several managerial implications stem from this research in terms of the appropriateness of product promotional messages or design features. In keeping with the marketing concept (i.e., developing products to meet consumers' wants and needs), care should be taken to focus on customer benefits in addition to more technologically driven product aspects. Design features might be selected to allow a product to be used compatibly with others already owned by an individual (e.g., space-saving appliances) or simultaneously when the individual is occupied with another activity (e.g., the cordless telephone). When faced with product design decisions constrained by limited resources, managers might consider selecting features that enhance perceived compatibility (see Appendix A). In addition, the perceived relative advantage of an innovation also might be enhanced by offering the most advanced features and operations possible as indicated by the positive impact of complexity on relative advantage. Finally, when introducing a discontinuous innovation, efforts to make the product appear to be continuous (i.e., compatible) should speed its initial adoption. Clearly, however, these implications require further investigation using larger samples, different products and multiple-item scales to substantiate their generalizability further.

In addition to further substantiating some of the findings presented here, future research might explore the operationalizations of Rogers and

Bauer's perceptual dimensions beyond the design features noted in Appendix A. Also, a second research stream suggested involves the unexpected positive role that perceived complexity plays in the evaluation model. Consumer judgments of their future needs and uses of innovations replete with advanced capabilities might be the focus of such research. How are expectations formed regarding unfamiliar advanced products? What role does uncertainty about product capabilities as well as future personal needs play in the consumer's evaluative process? Further insights into these issues would serve to aid managers in making crucial new product development decisions in addition to facilitating the R&D-marketing interface.

The authors wish to express their appreciation to Ms. Ann Phillips for her editorial suggestions and to two anonymous reviewers for their valuable comments on earlier drafts of this work.

References

1. Armstrong, J. S. and Overton, T. Brief vs. comprehensive descriptions in measuring intentions to purchase. *Journal of Marketing Research* 8:114–117 (February 1971).
2. Asher, H. B. *Causal modeling*. In: *Sage University Papers Series: Quantitative Applications in the Social Sciences,* Eric M. Uslaner (ed.). Beverly Hills, CA: Sage Publications Inc., 1976.
3. Bass, F. M. A new product growth model for consumer durables. *Management Science* 15:215–227 (January 1969).
4. Bauer, R. A. Consumer behavior as risk taking. In: *Dynamic Marketing for a Changing World,* R. S. Hancock (ed.). Chicago: American Marketing Association, 1960, pp. 389–398.
5. Downs, G. W. and Mohr, L. B. Conceptual issues in the study of innovation. *Administrative Science Quarterly* 21:700–714 (1976).
6. Ettlie, J. E., Bridges, W. P. and O'Keefe, R. D. Organizational strategy and structural differences for radical versus incremental innovation. *Management Science* 30:727–738 (1984).
7. Fliegel, F. C. and Kivlin, J. E. Attributes of innovations as factors in diffusion. *American Journal of Sociology* 72:235–248 (November 1966).
8. Gatignon, H. and Robertson, T. S. A propositional inventory for new diffusion research. *Journal of Consumer Research* 11:849–867 (March 1985).
9. Hambrick, D. C. and MacMillan, I. C. Efficiency of product R&D in business units: the role of strategic context. *Academy of Management Journal* 28:527–547 (September 1985).
10. Hauser, J. R. Consumer research to focus R&D projects. *Journal of Product Innovation Management* 2:78–84, (March 1985).
11. Holak, S. L. An approach for analyzing innovative consumer durables: an intermediate test procedures for suggesting product modification and predicting acceptance. Unpublished doctoral dissertation, Columbia University Graduate School of Business, 1985.
12. Holak, S. L. Determinants of innovative durables adoption: an empirical study with implications for early product screening. *Journal of Product Innovation Management* 5:50–69 (March 1988).
13. Kahneman, D. and Tversky, A. Prospect theory: an analysis of decision under risk. *Econometrica* 47:263–291 (1979).
14. Kamien, M. and Schwartz, N. L. On the degree of rivalry for maximum innovation activity. *Quarterly Journal of Economics* 90:245–260 (1976).
15. Katz, R. and Allen T. Investigating the not invested here (NIH) syndrome: a look at the performance, tenure, and communication patterns of 50 R&D project groups. *R&D Management* 12:7–19 (1982).
16. LaBay, D. G. and Kinnear, T. C. Exploring the consumer decision process in the adoption of solar energy systems. *Journal of Consumer Research* 8:271–278 (December 1981).
17. Mahajan, V. and Muller, E. Innovation diffusion and new product growth models in marketing. *Journal of Marketing* 43:55–68 (Fall 1979).
18. Mansfield, E. Patents and innovation: an empirical study. *Management Science* 32:1973–1982 (February 1986).
19. Mansfield, E. and Switzer, L. Effects of federal support on company financed R&D: the case of energy. *Management Science* 30:562–571 (1981).
20. Moore, W. J. and Tushman, M. L. Managing innovation over the product life cycle. In: *Readings in the Management of Innovation,* M. L. Tushman and W. L. Moore (eds.). Boston: Pitman, 1982.
21. Morrison, D. G. Purchase intentions and purchase behavior. *Journal of Marketing* 4:65–74 (Spring 1979).
22. Ostlund, L. E. Factor analysis applied to predictors of innovative behavior. *Decision Sciences* 4:92–108 (1973).
23. Ostlund, L. E. Perceived innovation attributes as preditors of innovativeness. *Journal of Consumer Research* 1:23–29 (September 1974).
24. Robertson, T. S. *Innovative Behavior and Communication.* New York: Holt, Rinehart, and Winston, 1971.
25. Robertson, T. S. Marketing's potential contribution to consumer behavior research: the case of diffusion theory. *Advances in Consumer Research* 11:484–489 (1984).
26. Rogers, E. M. *Diffusion of Innovations.* New York: The Free Press, 1983.
27. Rogers, E. M. and Shoemaker, F. F. *Communication of Innovations.* New York: The Free Press, 1971.
28. Tornatzky, L. G. and Klein, K. J. Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. *IEEE Transactions on Engineering Management* EM-29:28–45 (1982).
29. Von Hippel, E. The dominant role of users in the scientific instrument innovation process. *Research Policy* 5:212–239 (1976).

Appendix A. Association of Features with General Attributes in Pilot Study

	Relative advantage	Compatibility	Complexity	Divisibility	Communicability	Perceived risk
Availability of service	80.7	15.4	15.4	11.5	15.4	80.8
Believability of claims	50.0	19.2	30.8	19.2	80.8	57.7
Rate of cost recovery	65.4	3.8	3.8	19.2	3.8	65.4
Union vs. nonunion mfg.	15.4	38.5	0.0	0.0	3.8	11.5
Savings of time in use	100.0	50.0	26.9	0.0	23.1	19.2
Number of unique features	69.2	19.2	42.3	3.8	34.6	42.3
Mechanical advantage	73.1	15.4	46.2	3.8	26.9	19.2
Health factors associated with use	50.0	61.5	3.8	0.0	11.5	84.6
Maintenance required	65.4	30.8	57.7	3.8	15.4	65.4
Availability of free samples	19.2	3.8	7.7	88.5	19.2	38.5
Degree of difference from existing items	57.7	19.2	46.2	11.5	34.6	38.5
Skill required for assembly	30.8	30.8	80.8	11.5	11.5	38.5
Regularity of reward from use	88.5	42.3	3.8	0.0	34.6	26.9
Length of operating instructions	19.2	7.7	92.3	11.5	34.6	26.9
Legality of use	26.9	53.5	7.7	7.7	7.7	76.9
Ease of repair	65.4	23.1	57.7	0.0	23.1	53.5
Flexibility	65.4	30.8	34.6	3.8	19.2	19.2
Social acceptability	30.8	65.4	3.8	0.0	42.3	26.9
Availability of trial period	34.6	7.7	11.5	80.8	23.1	50.0
Capacity of operation	69.2	23.1	23.1	0.0	15.4	30.8
"Bugs worked out"	46.2	7.7	26.9	7.7	11.5	76.9
Payback period	53.5	11.5	0.0	19.2	7.7	57.7
Clarity of results from use	46.2	19.2	19.2	0.0	57.7	23.1
Availability of product warranties	53.4	11.5	0.0	7.7	23.1	88.5
Social approval	26.9	69.2	3.8	3.8	23.1	15.4
Efficiency	92.3	26.9	11.5	3.8	11.5	15.4
Initial cost of item	69.2	23.1	3.8	34.6	19.2	53.5
General level of knowledge required for item's use	30.8	19.2	88.5	3.8	42.3	30.8
Minimization of risk	50.0	19.2	3.8	19.2	7.7	76.9
Social reward associated with use	34.6	73.1	0.0	0.0	26.9	19.2
Appreciation potential	61.5	26.9	0.0	3.8	19.2	34.6
Durability	84.6	23.1	7.7	3.8	15.4	53.5
Price/quality relationship	80.8	19.2	7.7	19.2	23.1	42.3
Number of operating instructions	19.2	11.5	88.5	3.8	30.8	11.5
Likelihood of item's discontinuation	23.1	11.5	0.0	3.8	7.7	92.3
Technical complexity	19.2	15.4	92.1	3.8	42.3	19.2
Ease of operation	65.4	34.6	80.8	7.7	34.6	15.4
Social visibility associated with use	30.8	73.1	0.0	3.8	42.1	19.2
Number of movable parts	15.4	3.8	76.9	3.8	7.7	46.2
Amount of after-sales service required	61.5	19.2	38.5	3.8	15.4	61.5
Consequences of product failure	34.6	23.1	19.2	19.2	15.4	88.5

Appendix A. (*Continued*)

	Relative advantage	Compatibility	Complexity	Divisibility	Communicability	Perceived risk
Fit with customer's existing system	42.3	84.6	15.4	7.7	19.2	19.2
Price of Item	76.9	19.2	0.0	26.9	23.1	50.0
Skill required for installation	38.5	23.1	88.5	15.4	7.7	26.9
Savings of discomfort in use	76.9	50.0	7.7	0.0	19.2	11.5
Manufacturer return policy	42.3	7.7	3.8	30.5	15.4	73.1
Initial capital outlay	53.5	23.1	3.8	53.5	7.7	57.7
Environmental impact	30.8	76.9	0.0	3.8	15.4	38.5
Customer need fulfillment	76.9	76.9	7.7	3.8	34.6	11.5
Level of sophistication for intended audience	23.1	57.7	57.7	0.0	23.1	19.2
Customer sentiments toward manufacturer	38.5	46.2	0.0	3.8	30.8	19.2
Physical appearance of item	73.1	46.2	23.1	3.8	38.5	11.5
Social responsibility associated with use	30.8	76.9	3.8	0.0	19.2	26.9
Customer sentiments toward country of origin	38.5	65.4	0.0	3.8	23.1	15.4
Extent to which item alters buying task	34.5	53.5	11.5	11.5	23.1	23.1
Technical level of item	26.9	19.2	92.3	7.7	30.8	30.8
Relative size of purchase	30.8	15.4	7.7	42.3	7.7	57.7
Potential for approval from family or friends	34.6	69.2	0.0	0.0	30.8	15.4
In keeping with existing customer habits	30.8	84.6	3.8	3.8	23.1	11.5
Extent to which item alters customer process	30.8	50.0	11.5	3.8	19.2	26.9
Ease in justifying purchase to others	38.5	46.2	7.7	15.4	61.5	11.5
In keeping with self-image	23.1	92.3	0.0	0.0	23.1	7.7
Importance of item to customer's operation	69.2	38.5	7.7	15.4	23.1	38.5
Performance of item	84.5	11.5	15.4	3.8	30.8	42.3
Reliability of item	84.6	11.5	11.5	3.8	19.2	69.2
Continuing cost of item	61.5	15.4	0.0	15.4	15.4	53.5
Ease of understanding item's operation	42.3	15.4	76.9	11.5	53.5	19.2
Product quality	96.2	30.2	3.8	3.8	42.3	46.2

Appendix B. Calculation of the Predicted Correlation of Relative Advantage with Purchase Intention

Paths from relative advantage to purchase intention are calculated by multiplying parameters from individual links. Directional arrows may not go forward once having gone backward. All possible paths are then summed to arrive at a final calculated correlation.

1. (Compatibility → Relative advantage) * (Compatibility → Purchase intention)

   0.52 * 0.42 = 0.2184

2. (Compatibility → Relative advantage) * (Compatibility → Perceived risk) * (Perceived Risk → Purchase intention)

   0.52 * −.05 * −.09 = 0.00234

3. (Compatibility → Relative advantage) * (Compatibility → Communicability) * (Communicability → Perceived risk) * (Perceived risk → Purchase intention)

   0.52 * 0.12 * −.11 * −.09 = 0.0006177

4. (Relative advantage → Communicability) * (Communicability → Perceived risk) * (Perceived risk → Purchase intention)

   0.13 * −.11 * −.09 = 0.001287

5. (Complexity → Relative advantage) * (Complexity → Perceived risk) * (Perceived risk → Purchase intention)

   0.06 * 0.34 * −.09 = −0.001836

6. (Complexity → Relative advantage) * (Complexity → Divisibility) * (Divisibility → Perceived risk) * (Perceived risk → Purchase intention)

   0.06 * −.05 * −.06 * −.09 = −0.0000162

7. (Complexity → Relative advantage) * (Complexity → Communicability) * (Communicability → Perceived risk) * (Perceived risk → Purchase intention)

   0.06 * −.34 * −.11 * −.09 = −0.0002019

8. (Relative advantage → Perceived risk) * (Perceived risk → Purchase intention)

   −0.05 * −0.09 = 0.0045

9. (Complexity → Relative advantage) * (Complexity → Divisibility) * (Divisibility → Communicability) * (Communicability → Perceived risk) * (Perceived risk → Purchase intention)

   0.06 * −.05 * .09 * −.11 * −.09 = −0.0000026

10. (Relative advantage → (Purchase intention) = 0.24

    TOTAL 0.465088