NEW PRODUCT MODELING -- A 30 YEAR RETROSPECTIVE AND FUTURE CHALLENGES

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INTRODUCTION

The last 30 years represent an exciting time for marketing science and modeling for new product decision support. The challenges of new product design, forecasting, risk management and launch strategy have spawned a large set of creative and useful models. In this paper I will position in the new product decision process a few selected models from the literature that I believe are representative of the best in the field. Then I will provide a personal retrospective on my own work over this period and reflect on the personal style I have found successful in empirical modeling of new products. I close this paper with a few thoughts on future challenges in the field.

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POSITIONING OF SELECTED WORKS

Figure 1 shows the flow of new product decisions in five stages: opportunity identification, design, pre-market testing, test market, and launch and life cycle management. In each area I select two representative models or analytic frameworks from the literature. This is very difficult because in my book with John Hauser (Design and Marketing of New Products, 1993) we cite more than 100 models and 500 scholarly papers, but I take the author's prerogative to identify my favorites in terms of rigor and relevance. I limit myself to just two methodologies per phase in the development process.

Opportunity Identification: In the opportunity identification stage we are trying to match market needs with technological potential to define an area where innovation is likely to be successful for the firm. Von Hippel's work (1978,1988) on the user active paradigm was an important concept that empirically established the user as a key component in the definition of opportunities in the technical innovation process. In areas where users face problems and can solve these problems at low costs relative to the gains (e.g. electronic laboratory instruments), users often design and build prototypes. They may even then ask a manufacturer to build the product for them. This lead user paradigm suggests that getting close to active

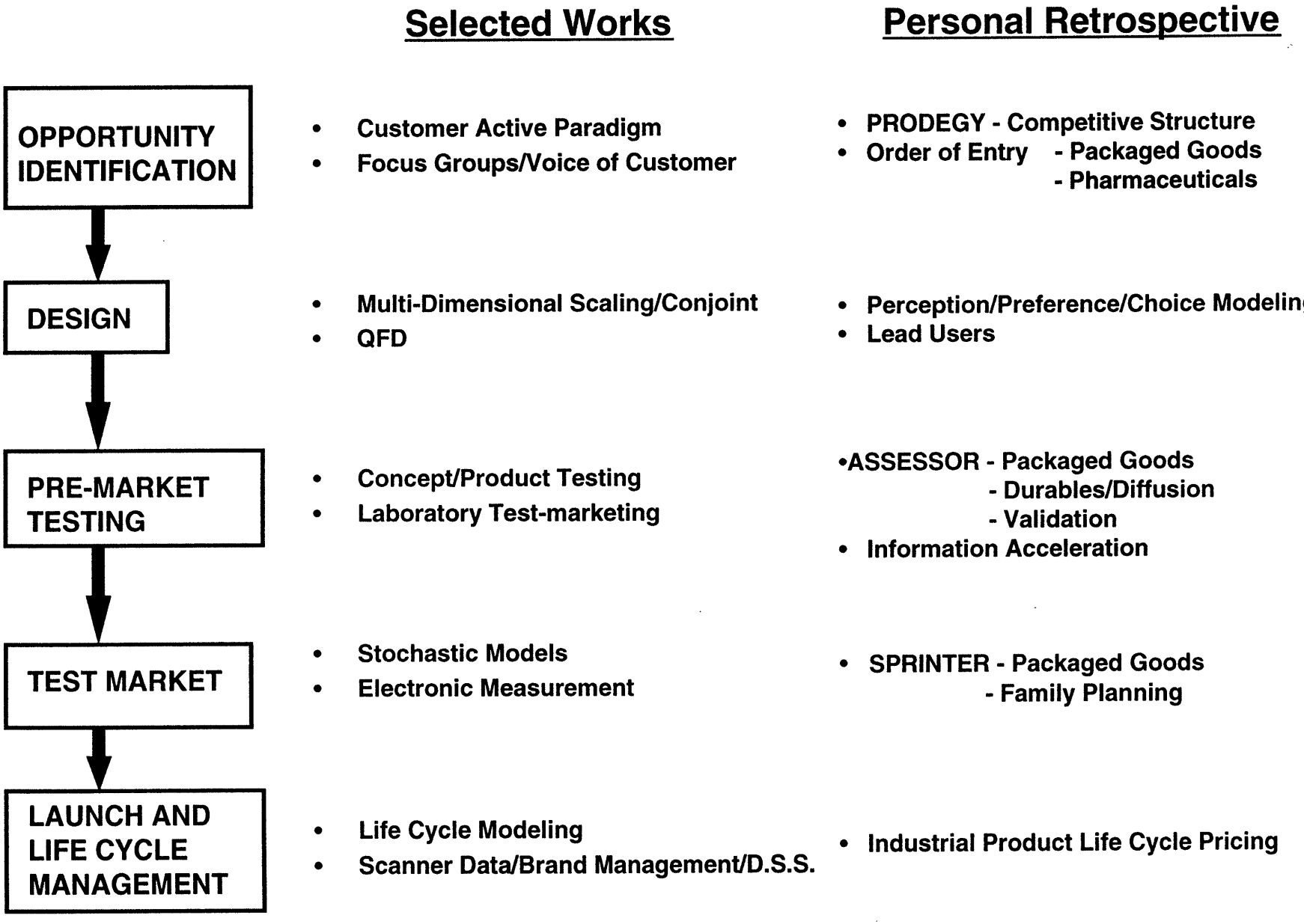

Figure 1. New Product Process, Selected Works and Retrospective

customers may lower R&D costs, shorten the time to market, lower risk, and produce a better fit to customer needs.

Marketers have long used focus groups to learn about consumers, but the formalization of this need acquisition process by Voice of the Customer techniques (Griffin and Hauser,1993) represented a major step forward in capturing customer input. This technique begins with need phrases obtained in one-on-one qualitative interviews (100 to 300 phrases may be generated) or focus groups. It ends with a hierarchical description of the needs of users in a particular market opportunity area. These become critical inputs to the design process.

Design: Next we physically and psychologically design the product or service. Multidimensional scaling techniques pioneered in marketing by Paul Green (1970 with Carmone, 1972 with Rao) have become a major design product positioning tool. Hundreds of articles have been written outlining revised techniques for measurement and estimation and their impact, but all follow Green's original mapping concept (a few perceptual dimensions on which products are arrayed and compared to customer preferences). This was followed by an equally important set of conjoint techniques (Green and Wind, 1973, and Green and Srinivasan, 1978) which allowed specific product

attributes to be linked to customer preferences. Again hundreds of articles have been written on this technique and its elaboration in discrete choice (see Urban and Hauser 1993 for a list of references and Green 1990 for a review). Perceptual mapping and conjoint analysis together have become one of the most commonly used and useful marketing science methods developed for the analysis of new products.

QFD (quality function deployment) represents an important integration of the engineering design process with marketing inputs (Hauser and Clausing 1988). Here the detailed physical properties (e.g. energy required to close a car door measured in foot pounds) are linked to customer need attributes and perceptions (e.g. energy to "easy to close from the outside" and on to "easy entry and exit"). Design team judgments as well as conjoint and perceptual mapping outputs can help determine the linkages. Even if only team judgments are utilized, the linkage of customer input to the engineering design process can create vastly improved products.

Pre-Market Testing: Given a design concept or product, the next task is to forecast potential. Concept and product test models of the 1960's were refined (e.g. Claycamp and Liddy, 1969; Silk and Kalwani, 1982)) to tie evaluations to trial and repeat purchasing

behavior. Measurement and models were extended three directions in the 1970s: home delivery and stochastic models (Charlton, Ehrenberg, and Pymont, 1972), attitude change (Burger, 1972), and laboratory measurement (Yankelovich, Skelly, and White, 1970). These extensions lead to a powerful class of "laboratory test market" or pretest market models for packaged goods that have achieved wide scale use and positive impact (e.g. LITMUS by Blackburn and Clancy, 1980, and largely unpublished proprietary models: BASES by Burke Market Research, ESP by NPD Inc., DESIGNER by Novaction, SENSOR by Research International are examples) .

Test Marketing: One of the earliest areas for new product modeling was test marketing of packaged goods. Stochastic models of repeat purchasing and loyalty were applied successfully to new branded items by Parfitt and Collins (1968) and were elaborated by many authors (e.g. Eskin 1973; see Massy, Montgomery, and Morrison, 1969 for review). With the advent of scanner data in test markets (BEHAVIORSCAN by IRI in 1980), the measurement quality and ability to experiment with market response increased dramatically. These electronic test markets not only collected scanner data but could control advertising exposure at individual homes so experimental designs could be more powerful. At the same time the

growing utilization of pretest models and the tendency of firms to concentrate on product line extensions led to fewer test markets and applications of these models. Test market models remain an important tool in cases where the risk/return trade-off suggests market testing before launch (e.g. telecommunication services and major new packaged goods).

Launch and Life Cycle Management: Life cycle modeling is very useful in updating and projecting the diffusion of innovation of a new product as launch data is acquired. In cases where a good analogy exists for a new product they have been used to make forecasts before the launch. These models were pioneered in marketing by Bass (1969) and elaborated by over one hundred publications by various authors (see Mahajan, Muller, and Bass, 1995, for a recent review). In their extended forms they are useful to track the launch and adjust marketing variables that affect the life cycle. Particularly noteworthy are the recent extensions to generations of technological life cycles (Norton and Bass 1992) which estimate parameters from early generations of the product and use them in forecasting successor new product life cycles.

In managing the mature phase, the most significant development has been market response analysis and decision

support especially based on market data. Little's BRANDAID (1975) represents an early multi-variate decision support model. The integration of scanner data (e.g. Guadagni and Little, 1983, Little, 1992) to this class of models makes them very powerful.

PERSONAL RETROSPECTIVE AND RESEARCH STYLE

It is clear that marketing science has made many valuable contributions to the field of new product development over the last 30 years. On this occasion of the Converse Awards I thought it appropriate to take a retrospective look at my efforts to contribute to this field and reflect on the personal research style I have found effective.

RETROSPECTIVE

Figure 1 also shows some of my work at each stage in the development process. It began at the launch and test market phases, moved to the earlier stage of pre-market testing, and went on to the even earlier phases of design and opportunity identification. This prompted my friend and colleague, Al Silk, to say "Urban's research has been going backwards for many years". I will give a stream of consciousness description of my work and then try to identify the critical aspects of my research approach.

Early Work: My new product research began at the University of Wisconsin when I wrote a MBA thesis on "Product Planning in the Aerospace Industry" in 1964. I worked with several firms (e.g. General Motors and 3M Aerospace divisions) to describe their new product processes and generalized a multi-stage decision sequence from this industry. My Ph.D. thesis at Northwestern was a modeling effort aimed at understanding the interdependency between new and existing products. It drew on a then new modeling approach called "Monte Carlo Simulation" and insight gained from the industrial chemical product line substitution and complementary effects that Union Carbide faced in launching and pricing a new chemical product (Urban 1968). This thesis work plus a text that provided a state-of-the-art road map to management science in marketing in the late 1960s (Montgomery and Urban, 1969) set the stage for 25 years of research.

Test Marketing: In the late 1960s major new theoretical approaches were being developed in the field of stochastic models. Growing out of a contact with a summer session student working from the Noxell Corporation, I learned that forecasting national sales levels based on test market results, planning the best marketing mix for launch, and

tracking test market and launch for diagnosis and control were important problems that were not being adequately addressed. This led to a sponsored research project at MIT and the development of a macro flow model methodology that combined elements of stochastic models, response functions, and empirical data in a managerial tool called "SPRINTER" for managing the new product test market and launch (Urban, 1970). This methodology was elaborated in a macro flow model applied to family planning with Planned Parenthood in Atlanta (Urban 1974).

Pre-Market Testing: In 1972 Cal Hodock, then market research director at Gillette, called me with an invitation that I join him for lunch. Since I usually bought lunch for him as I tried to garner MIT sponsored research funds from Gillette, I was suspicious. At lunch he said he needed a modeling and measurement system that would forecast the sales of a new product in test market based on the pretest market availability of the product, packaging, and advertising. He wanted the research to cost (on an on going basis) less than $25,000 and the forecast to be delivered three months after the project start. I told him it was impossible based on the complexities I had observed in test market tracking and forecasting. He persisted and persuaded me and Al Silk to look into this area by

giving us $40,000 in sponsored research funds at MIT. This need input and emerging LOGIT modeling at MIT by Dan McFadden (1970) led to a convergent pre-market forecasting approach based on measured changes in preference and laboratory simulated trial and repeat purchasing. This led to the ASSESSOR model for forecasting the sales of new packaged goods (Urban and Silk, 1978) and over time its validation (Urban and Katz, 1983).

Design: As the seminal work on perceptual mapping was appearing there seemed to be a natural fit to new product design. The notion of a "core benefit proposition" could be represented in the positioning and in a model called PERCEPTOR, I made a very early attempt to link positioning to new product sales potential and extended this model for marketing of the MIT HMO (Urban 1975 and Hauser and Urban, 1977). I continued research on product design in an effort to integrate Von Hippel's lead user notions with market research methods (Urban and Von Hippel, 1988) and apply it to industrial product (i.e. CAD/CAM systems for electronic printed circuit boards at Computer Graphics Inc.) innovation and diffusion from lead users to other customers.

Opportunity Identification: Over this period of the 1980s I became convinced that not only did we need to effectively forecast and design products, but we also needed good strategic opportunity identification. The first project was on market definition. This returned to my original interest in product lines and interdependency as we tried to define a hierarchical market structure that created segments of products that competed with each other in their group, but showed little customer switching between segments. This system was called PRODEGY and addressed PRODuct stratEGY by examining the coverage and duplication of a product line (Urban, Johnson, and Hauser 1984). The second project grew out of the empirical experience gained from applications of ASSESSOR. I noted that second brands in a market rarely got the same share as successful first entrants even if they had a parity positioning and spent the same amount on advertising and promotion -- contrary to the predictions of perceptual mapping models. This led to a statistical cross sectional analysis of the effects order of entry on market share (Urban, Carter, Gaskin, and Mucha, 1986). This order of entry effect was confirmed in a time series cross sectional analysis of test market scanner data (Kalyanaram and Urban, 1992) and ethical pharmaceuticals (Berndt et al, 1995). This work was contemporaneous with the PIMS data analysis and led to interesting

insights as the results were integrated (Kalyanaram, Robinson, and Urban, 1994, 1995).

Recent Work: In parallel with the work on opportunity investigation I was pursuing the application of pretest market forecasting to consumer durables. This grew out of discussions with a student of mine (John Dables) who worked at General Motors. He indicated the risk in developing a new auto was greater than in packaged goods because the investment was larger (hundreds of millions of dollars) and no test marketing existed. So why not apply the methodology to consumer durables? This discussion led to a five year Buick sponsored research project at MIT and resulted in a "durable ASSESSOR" model and applications to premarket auto forecasting based on an early production line version of the auto (Roberts and Urban, 1988, and Urban, Hauser, and Roberts, 1990). Good forecasting results were achieved, but top managers at G.M. commented that this forecasting was too late because once the car existed in initial production line versions, the launch commitment was virtually assured; the costs were sunk and on a marginal basis it was almost always profitable to go forward. This was forcefully brought home to me when we predicted in 1986 that the new downsized Buick Riviera sales would be half of the old level rather

than the hoped for doubling of sales, but Buick introduced the car anyway. We were glad to have an opportunity for validation (actually sales dropped to .4 of the old level), but we were too late in the process to stop the program.

In the late 1980s Hyper Card was developed at Apple and MIT's Media Lab had invented the basic elements of surrogate travel. In 1990 we began an effort to use interactive multimedia to create a virtual auto market of the future before the new car was built. We put the customer in the future environment with full information and ability to control the search and measured responses to predict future sales before the production commitment was made. The first application was to electric vehicles at G.M. (Urban, Weinberg, and Hauser, January 1996) and, based on application and validation experience (Urban et.al. 1996), the potential of this model and measurement methodology was encouraging for forecasting really new products where the capital risks are large.

RESEARCH STYLE

That brings us to the current time and although I did not comment on all my research, this above set allows the abstraction of the critical elements of the research approach that has worked for me.

Managers Need Input and Implementation: I have always worked closely with actual managers and real decisions. My style is rather inductive and I have been impressed with the knowledge and insight that managers have gained in facing tough decisions. It seems particularly natural in marketing where we think of "customer needs" that we define our customers for analytic modeling as managers and involve them early in the design of our decision support products. Implementation must be considered from the start of the project and to beyond its academic completion if we are to keep our research relevant and improve the practice of management. Equally important, this orientation to managers can generate funds that provide research assistants, computers, software, and large data bases (I have benefited from over one million dollars of industry support over the years at MIT). I also have found that consulting practice after publication often is useful in assuring that the models are used and that evolutionary model extensions are made to create a positive benefit-cost ratio for managers.

In 1980 while reporting results of a second PERCEPTOR study at Dow Corporation the group product manager leaned over and said to me, "Tell us something we do not know this time." It was new to me but old stuff to him. Coping with implementation problems gave

me a growing perspective on needs so my follow-on projects could fit the changing managerial decision requirements. Building models and applying them should be considered an organization change process, not an exercise in mathematical gymnastics (Urban, May1974).

Finally, writing a text book like Design and Marketing of New Products (with John Hauser 1980) helps diffusion of knowledge as well as providing a framework for the relevance of my research efforts.

Match Needs to Theory: While interacting with managers it has been important to me to match their needs to the emerging theories and methods so that the ensuing research can advance the state-of-the-art of marketing science as well as affect practice. Whether it is LOGIT modeling, multidimensional scaling, utility theory, or virtual reality, I have tried to find problems that lend themselves to analysis by the most recent management and behavioral science technologies. This is a creative process; one of looking for relevant problems with theoretical content. I have tended to shy away from small epsilon extensions to existing work and favor major problems that have not been extensively studied. A sense of research adventure, entrepreneurship, and intellectual flexibility have served me well in the matching process.

Use the Power of Empirical Data: I have used measurement and empirical data heavily. Whether it be test market, laboratory simulation, survey, market experiments, or virtual reality data, I have found it essential in my new product work to measure customer response. I have also tried diligently to test my model predictions. This is a difficult validation process but a critical one if marketing science is to progress. Often these empirical efforts require innovation in measurement methodology and persistence in obtaining response and validation data, but the research power gained is well worth the effort.

Do Programmatic Research: I am a research planner. I lay out my research activities over one and five year time frames and examine how they fit into accomplishing my overall long term research goal of improving the productivity of new product development and advancing the art of marketing science. This sometimes calls for long term projects -- most of my models have a five year or longer development time frame. This may not maximize the number of publications, but those that do come out the end of the pipeline can be significant. Fortunately MIT has been patient and has tenure criteria that do not depend solely on the amount of publication.

Have Great Co-authors: Co-authors are a great intellectual inspiration and leverage for a wider scope of research. I have had some of the very best collaborators and am indebted to them. I must acknowledge John Hauser (who has written more joint papers with me than anyone) for his rigor, scholarly standards, tightness in writing, and creative input. I have benefited greatly from him and my other professorial co-authors (e.g. Silk, Von Hippel, Robinson, Berndt, Qualls in chronological order of publication). It is important to recognize my student co-authors who probably have gotten less credit than they deserve for their inputs (e.g. Weinberg, Kalyanaram, Hulland, Roberts, Carter, Gaskin, Mucha, Johnson, Katz, and Karash in reverse chronological order). Although I have not co-authored with all the managers who have contributed to my work, special contributions were made by several of them (e.g. Ed Sellars of Noxell, Cal Hodock of Gillette, John Dables of Buick, Tom Hatch of Miles Labs, Sean McNamara GMEV, Vince Barabba of G.M. , and Roberta Chicos of Marketing Technology Interface in chronological order). I have one virtual co-author who although we have only formally worked on only one small publication, has truly been my mentor and research role model -- John Little thank you! I never would have achieved

the apparent productivity without the help of my MIT support team of co-authors and research assistants.

Generalizability: I do not know if this style will work for others, but I offer this experience as a case. I am aware of several other researchers in our field who use some or all of these elements (e.g. Hauser, Laurent, Lilien, Little, Lodish, Silk and Roberts). You may want to experiment with some of the elements, if you do not use them already, and see if they work for you.

FUTURE FOR NEW PRODUCT MODELING

Business strategy is shifting from the re-engineering period of the early 1990s where shareholder wealth increased by downsizing to a phase of growth where premium profits will be earned by innovation. Total quality, strategic focus, customer satisfaction and productivity will remain important, but I predict new product development activity will dramatically increase in the next ten years as revitalization becomes the strategy of choice. This raises a number of challenges for modelers.

Technological Change and Cycle Time : The need to get to market fast will become even more important as rapid technological change and

the intensity of competition increase. Firms will be utilizing more overlap in their process and the rather orderly traditional sequential process will become more ad hoc and iterative. For researchers this means we need models and measurement methods that can be flexible, adapt to re-specifications, and be iteratively updated and recalibrated at low cost. Most models are rather large and elaborate and require 3 to 6 months to apply and cost $100,000 to $300,000 -- including all of mine. We will need agile models that can be applied in 3 to 6 weeks and cost less than $10,000 to $30,000 per iteration. This will be particularly challenging when we realize that markets will become even more saturated and that premium profits will be greatest for really new products where little baseline experience exists and customers have little experience with the technology and its potential benefits.

Engineering-Manufacturing-Marketing Links: Although conjoint analysis and QFD supply initial approaches to linking engineering design to market responses, we need to make another step forward. The recent book by Ulrich and Eppinger (1995) represents the convergence of engineering design and marketing. The detailed engineering design activities need to be integrally linked to markets through micro design/manufacturing specifications. This process is

characterized by many revisions and it is important to always keep the customer response in the forefront as the iterations are made. As services continue their proportionate increase in the world economy we need to link service delivery and design to marketing as well as concentrating on physical products.

Globalization: The world is the market and increasingly firms are considering global products that reach economically and psychologically specified segments rather than geographically defined country market segments. We have methods that have been used in developed countries or applied to one country at a time. How do we assess a global market that is simultaneously existing in 50 countries that span for example China, Poland, France, Canada, Kenya, Chile, and Japan? The languages, cultures, and market research infrastructure may differ as dramatically as the customer responses themselves. This is further complicated by the increasing use of partnerships in the supply chain that create multi-client decision environments for modelers.

World Wide Web and Internet: I believe the worldwide web represents a major new technology for marketing. This paradigm shift will present opportunities and challenges for new product

development. In the future web shopping for both consumer and industrial products and services will become common in our markets. Vast amounts of information are available free at a web site. While banners will be common on web browsers, advertising will be fundamentally altered because once someone has accessed and identified themselves at a web site, return information -- advertising -- can be sent to them free of charge and it can be interactively customized to their needs. We know word-of-mouth is the most important influencer for most products and with the web it will be available for all products and services. Information will flow freely around the globe and communities of customers will exist to exchange word-of-mouth recommendations and experiences. Pricing can be individually set or negotiated if so desired with the web interface. This micro marketing plus mass customization of products could lead to segments of one person. New intermediaries will develop to help customers surf the web and find the best products and prices. Competition will increase and power will flow from manufacturers to intermediary virtual personal purchasing agents or buyers. These new structures will fundamentally alter the way we do marketing.

For new product development the web offers a new way to sell products and collect information. With more information and word-

of-mouth we can expect more rapid diffusion of innovation and lower launch information costs. This may make development more profitable, but at the same time we can expect shorter life cycles and even more sensitivity to the window of opportunity for new technologies.

Product design may become more collaborative with the ability of lead users to identify each other and work together in a leading edge community. Since the web also offers a convenient method to collect information from customers worldwide, I can visualize conducting an Information Acceleration study on the web with a large sample at very low cost and having the capability to update results quickly for design and market changes. The web plus the push for more innovation will mean lower measurement costs and risks for development and will result in more new products to meet customer needs and the corporate mandate for profit growth.

CONCLUDING COMMENTS

The challenges of the future are reflected in my research plans. I am continuing research on Information Acceleration. One component is on how to simulate learning over multiple usage occasions for a really new product in the virtual information acceleration environment. The second component is how to make the

Information Acceleration model agile by measurement over the internet and rapid updating on a worldwide basis. My order-of-entry research is continuing with Professor Ernie Berndt (MIT) and J. & J. Merck in a project on antiulcer drugs (e.g. Tagament, Zantac, Pepcid, and Axid) as they move through the ethical, generic and over the counter markets. It appears that strategies for a drug manufacturer require careful understanding of order-of-entry advantages, market response, and cannibalization in order to be effective.

My most recent research plan for the next five years puts the world wide web as a top priority new research project. John Hauser and I have been doing some thinking about virtual personal buyers and are looking for a leading edge corporation to work with on defining modeling needs.

Based on my 30 years of experience and the future needs for innovation, I feel that new product modeling presents many new challenges and opportunities for academic researchers to combine rigor and relevance. It is a critically important field for success of firms in the 21st century and deserves more of our marketing science modeling attention.

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