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The Relevance of Behavioral and Social Models to the Study of Consumer Energy Decision Making and Behaviors

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MASTER



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THE RELEVANCE OF
SOCIAL AND BEHAVIORAL MODELS
TO THE STUDY OF CONSUMER
ENERGY DECISION MAKING AND
BEHAVIOR

BARBARA A. BURNS

NOVEMBER 1980

PREPARED UNDER TASK NO. 5328.30 AND 5637.20

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PREFACE

This report was written as part of the planning for a larger Solar Energy Research Institute (SERI) task, the National Study of the Residential Solar Consumer. This planning effort consisted of literature reviews (such as this one) and exploratory fieldwork. The knowledge gained was used to develop hypotheses, the research plan, and items for the survey. Empirical components of the National Study are a national probability sample of homeowners, and a national mail survey of solar energy users. The overall goal of the National Study is to develop a base of behavioral and social knowledge that will help formulate policies to promote the commercialization of solar energy. The effort documented in this report enables the National Study and other work at SERI to build on and contribute to relevant behavioral and social science models of individual behavior and decision making.


Earlier drafts of this report were reviewed by SERI staff and people at other research institutes. These individuals included Barbara Farhar-Pilgrim, Charles T. Unseld, David Roessner, Avraham Shama, Rebecca Vories, Craig Piernot, Robert Gruber (University of Denver), and Francesco Nicosia (University of California, Berkeley). Their comments have greatly improved the substance and relevance of the report.



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SUMMARY

OBJECTIVE

The purpose of this report is to review the social and behavioral science models and techniques for their possible use in understanding and predicting consumer energy decision making and behaviors. A number of models and techniques have been developed. They address different aspects of the decision process, use different theoretical bases and approaches, and have been aimed at different audiences.

DISCUSSION

Three major areas of discussion were selected: (1) models of adaptation to social change, (2) decision making and choice, and (3) diffusion of innovation. Within these three areas, the contributions of psychologists, sociologists, economists, marketing researchers, and others were reviewed. Reviews of the literature have been published for some of these areas, such as the consumer economics literature (Lancaster 1976); the information processing aspect of decision making (Wilkie 1974); and the diffusion of innovation literature (Roessner et al. 1979; Brown 1978; Brown 1977). In other areas, such as psychological models, the literature is more diffuse.

We first identified five primary components of the models and compared the ways that these components are treated by various disciplines. The components are: (1) situational characteristics, (2) product characteristics, (3) individual characteristics, (4) social influences, and (5) the interaction or decision rules. Such components are defined broadly in this report (as in the existing models), since the choice and operational definition of specific variables in any given study depends on the particular event or product, the purpose of the study, and the possible designs for the study—e.g., can a real-time or longitudinal study be done in the particular case or will only a cross-sectional study be possible?

CONCLUSIONS AND RECOMMENDATIONS

The explicit use of behavioral and social science models in energy decision-making and behavior studies has been limited. This does not imply that knowledge from the behavioral and social sciences was not used in developing existing studies or in analyzing their results. Examples are given of a small number of energy studies which applied and tested existing models in studying the adoption of energy conservation behaviors and technologies, and solar technology. Ongoing SERI research efforts should expand the application of behavioral and social knowledge and models, and will contribute to developing a model of energy decision making and behavior.

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SECTION 1.0

INTRODUCTION

Consumers are faced with an increasing number of decisions about energy matters because of changes in energy supply and costs and the availability of new energy technologies and systems.* Since the oil embargo in 1973, the Federal Government has developed information programs and financial incentives to encourage citizens to modify their energy use patterns. The current energy situation, characterized by uncertain gasoline and oil supplies and by increased prices, is pressing policy makers to find ways to balance energy supply and demand. To influence changes in energy use patterns most effectively, government and other organizations need to understand the factors that influence consumer decision making and behaviors regarding energy use. Such information is important for the development of the technology itself, development of delivery and maintenance systems, integration of new systems and institutions with established institutions (e.g., regulatory agencies and utilities), and development of marketing strategies.

The U.S. Department of Energy (DOE) and SERI have current and future research plans to identify and measure the factors that influence consumer decision making and behavior as the energy situation changes. SERI's particular concern is understanding the adoption of solar energy technologies and energy-conserving behaviors. Three kinds of decisions are being studied: the decision to make some response to changes in the energy situation; the decision to consider solar energy rather than or in addition to some other modification in the energy system or energy behaviors; and the decision to use a particular solar energy system or product. Presently, SERI is concerned primarily with the first two types of decisions. Work at SERI may address general questions related to the third decision (e.g., the relative importance of cost and reliability), but it is expected that private industry and marketing organizations will conduct most of the research on specific product design and performance characteristics, as they do with other new products.

Numerous studies exist about how people adapt to economic, technological, and environmental changes and how and why they purchase products and services. However, there are three major problems in using the findings from these studies in the development of energy policies and programs. First, these studies are scattered among the social and behavioral sciences—especially economics, social psychology, sociology, psychology, and marketing. Each of these disciplines has addressed the questions of decision making, consumer choice, and adaptation to change with different terminologies, assumptions, and models. They have also addressed different aspects of the research areas.

Second, many of the existing studies of adaptation, decision making, and consumer choice were not designed and conducted in such a way that they applied or contributed to the further development of behavioral and social models. This is not only a problem for energy-related consumer research, but for consumer behavior research in general. Jacob Jacoby, a former president of the Association for Consumer Research, sees few models and theories used in much of the existing consumer behavior research. He states:

*In this report, consumer refers to the individual rather than the organizational decision maker.

Despite the availability of consumer behavior theories and models, the impetus and rationale underlying most consumer behavior research seems to rest on little more than the availability of easy-to-use measuring instruments, the existence of more or less willing subject populations, the convenience of the computer, and/or the almost toy-like nature of sophisticated quantitative techniques. Little reliance is placed on theory, either to suggest which variables and aspects of consumer behavior are of greatest importance and in need of research or as a foundation around which to organize and integrate findings. . . . By neglecting theory, the researcher increases the likelihood of failure to understand his own data and/or be able to meaningfully interpret and integrate his findings with findings obtained by others (Jacoby 1978, p. 88).

Third, the extent to which behavioral and social models have been used to study energy behaviors and decision making varies across fields, but has been quite limited for all of them. Time pressures on policy-relevant research, the interdisciplinary nature of energy-related research, and the predominance of physical scientists in energy research projects serve to reduce the use of explicit behavioral and social science models. The use of such models has been most apparent in the promotion of energy-conserving products and behaviors, where such principles as feedback (psychology) have been applied (Seligman, Darley, and Becker 1976).

One area in which this lack of application of behavioral and social knowledge has been noted is energy-related market penetration models (Schiffel et al. 1978). A recent workshop, which reviewed such models for possible application to solar energy, identified "an inadequate basis in behavioral theory for some of the relationships in the models" as a primary limitation of all of the market penetration models (Schiffel et al. 1978, p. 2). During the workshop, it was argued that such models would have difficulty incorporating behavioral variables and relationships for two reasons: inadequate models of the technology adoption process grounded in behavioral theory, and insufficient data and market research on the decision-making process (including data on purchases where available and on perceptions and attitudes of potential purchasers).

This report uses behavioral and social science models to help plan research on solar energy adoption and use. It is also hoped that this review of the literature will be of use to other energy researchers.

SECTION 2.0

PURPOSE AND SCOPE

The primary purpose of this report is to review behavioral and social science models and studies that could contribute to planning a national study of solar energy users. A second purpose is to facilitate and encourage the use of these social and behavioral models by providing a clear, concise, comparative review of them and a discussion of their relevance to the study of consumer energy decision making and behavior. Of particular interest are decision processes and behaviors related to consumer handling of changes in the energy situation and adopting conservation practices and renewable energy systems (e.g., solar energy, wind). The paper summarizes relevant models from the various disciplines in terms of their assumptions and scope, compares the treatment of concepts and variables across the models, discusses methodologies and measurement techniques, and reviews the extent to which the models have been applied in studies of energy decision making and behaviors. Models and hypotheses are not tested, nor are any specific data presented or analyzed.*

This review is directed to two audiences. The first is the community of social scientists planning or conducting research on energy issues. This report will assist them in developing hypotheses, research plans, and data analysis plans. It also encourages the researchers to build on, challenge, or test existing models, thereby adding to the base of behavioral and social science understanding. The second audience comprises users of the knowledge gained from research—policy analysts and program managers in government, industry, research organizations, and public interest groups. The report has value to them as a context within which they can assess the contribution of individual research projects or of research programs to the description, understanding, and prediction of the consumer's decision making and behavior regarding energy.

This review of the literature in each area is not exhaustive. It relies on integrative analyses within the disciplines, where available. A comprehensive analysis of the literature on each model discussed would be redundant to many existing efforts and might reduce the usefulness of this review to those without a behavioral and social science background. Readers who would like additional information in a particular area are referred to the literature.

The remainder of the report is divided into three parts. Section 3.0 summarizes the overall theories and models in the behavioral and social sciences that address adaptation, decision making, and choice. Section 4.0 compares the treatment of various components across the models; i.e., comparing how sociologists, economists, and psychologists define and include variables such as social influences, individual characteristics, and product or stimulus characteristics. Section 5.0 discusses the extent to which and the ways in which these models have been or could be applied to the study of solar energy markets.

*A model, in the sense used in this paper, is "a simplified, organized, and meaningful representation of an actual system or process." A model may be verbal, schematic (e.g., a flow chart), or mathematical (Nicosia and Wind, 1977; p. 29).

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SECTION 3.0

A REVIEW OF SOCIAL AND BEHAVIORAL MODELS

Three major types of models from the behavioral and social sciences are particularly relevant to the study of energy decision making and behaviors. They deal with adaptation to change, decision making and choice, and the adoption and diffusion of innovations. The adaptation models have been developed in the disciplines of sociology, social psychology, and psychology. Theories and models of choice and decision making have been developed in the disciplines of economics, psychology, and marketing. Theories of the diffusion of innovation were first developed in communications, sociology, and geography; a number of other disciplines later applied the model.

These three types of models describe different problem areas in energy behavior and decision processes. Policy makers are asking people to adapt to changes in the energy situation by reducing their demands on conventional energy systems and resources by either using less energy or adopting alternative energy sources. Models of adaptation to change study the interaction of the individual and the changed situation as a set of decision processes. As a subset of the adaptation model, the decision-making and choice models address the process involved in single decisions. The diffusion of innovations model concerns products or ideas that are technological or social innovations (e.g., solar products) and the rate at which they come into common usage.

In many cases, overlaps among the models will be apparent. Synthesizing these models into a comprehensive, testable model of energy decision making and behavior needs to be done, but this is beyond the scope of this paper. It is hoped that future SERI efforts will address this problem.

3.1 INDIVIDUAL ADAPTATION TO SOCIAL AND ENVIRONMENTAL CHANGE

The problem of individual adaptation to conditions of environmental or external change has been studied by personality, environmental, and social psychologists. Social-psychological research on individual adaptation to change has addressed a wide variety of social issues, including adaptation to desegregated environments (Campbell and Yarrow 1958, pp. 29-46; Campbell and Yarrow 1958, pp. 3-7); transitional stages in adult life (Lowenthal 1971, pp. 2, 79-95); turbulent social environments (Emery and Trist 1973); and the rate of social change (Lauer 1974, pp. 510-16).

Lewin defined three stages of personal change which could be precipitated by a technological or social change: unfreezing, moving, and refreezing. Unfreezing is the process involved in overcoming resistance to change; moving or changing is the process of adopting new patterns of belief or action; and refreezing is the integrating and stabilizing of new patterns (Kelman and Warwick 1973, p. 23). Lewin encouraged researchers to pursue the theoretical analysis and experimental study of change in group life. He felt that the study of attempted or actual change in social conditions would facilitate insights into social processes.

Kelman and Warwick (1973) outline three issues for social-psychological research: the processes, contents, and phasing of social change. The study of change processes includes the conditions that facilitate social change of different types, sources of resistance to social change, and methods of overcoming resistance. The contents of social

change include both the planned and the spontaneous outcomes of change efforts. The phasing of social change refers to changes in one area positively or negatively affecting change in other areas.

Across these issues, Kelman and Warwick identify an important contribution that social psychology could make: the specification of individual psychological dispositions (and their antecedents) that facilitate or impede individual adaptation to social change. These dispositions should be taken as possibly necessary but not sufficient conditions for adaptation to occur. Categories of dispositions described are general personality characteristics; cognitive, motivational, and interpersonal orientations; and sense of personal efficacy. Cognitive orientations refers to the "way(s) in which an individual perceives and stores information and uses it in forming concepts, reasoning, solving problems, and making decisions." An important facet is the individual's time perspective—"the ability to relate one's present condition to long-range goals, . . . (and) a positive but not unduly optimistic evaluation of the future." Motivational orientations refer both to motivational dispositions (the stored expectations of reactions associated with a given class of events) and aroused motives (the dispositions that seek expression in any given situation). Interpersonal orientations includes interpersonal trust and attitudes concerning authority. Personal efficacy refers to perceived and actual competence, especially regarding control or mastery over one's environment and fate (Kelman and Warwick 1973, pp. 41-52).

A number of behavioral models have been developed that are useful in analyzing adaptation to changes in the social environment. The most well known is the social stress model, developed from physiological stress research, social stress studies (Mechanic 1962; Lazarus 1966; Lazarus 1970), and clinical and social-psychological studies of critical life events (Holmes and Rahe 1967, pp. 213-18; Lowenthal and Chiriboga 1973). A second, more recent model is the construction model, developed in environmental psychology. These two models are discussed in the following sections. Other behavioral models of adaptation are not as well developed or have not been applied to social situations.

3.1.1 Social Stress Approach

The concept of stress originates in the physical sciences, where the phenomenon is defined generally as "a force which is exerted on some system in such fashion as to deform, alter or damage the structure of that system, while the resulting deformation is described as 'strain' " (Korchin 1965, p. 247). In psychology, no such agreement on the formal definition exists. The term has been used to refer to the quality of a situation, the initial response of the individual to a given situation, a state of the individual resulting from the interaction of a situation and the individual's efforts to cope, and the reactions of an individual to the failure to cope with a specific situation. Indik, Seashore, and Slesinger (1964) propose a clear definition which closely parallels the model of stress in the physical sciences.

We conceive of stress as a relationship between a system (either personal or social) and its environment such that adaptive demands placed on the system exceed its normal homeostatic capacities and therefore produce a force toward continuing or permanent change in the system itself. Strain refers to the forces generated within the system in response to stress. (p. 26)

Early stress research by psychologists focused on the physiological response(s) of individuals to extreme and highly traumatic events (e.g., severe medical surgery or illness, experimentally-induced electric shock). Research outside of the laboratory addressed the stress situations of war, military training, concentration camps, and imprisonment.

Defining stress as extreme trauma or duress did not encourage the study of stimuli which are stressful to some individuals but not to others, and stimuli which are stressful but neither dramatic nor especially unusual. Researchers have now extended the general stress theory to include such stimuli, and are expanding the interest in adaptation to include behavioral and attitudinal adaptation as well as physiological (Mechanic 1962; Janis 1965; Korchin 1965; Orne 1965; Scott 1970; Lazarus 1970; Lowenthal and Chiriboga 1973).

The range of research interests has expanded to include stimuli such as the aging process and environmental conditions (e.g., pollution, noise). One assessment of future national and international problem areas identifies the effects of stress on individuals and society as an important issue for future study (Mitchell 1977). Although the energy situation has often been referred to as stressful, the explicit application of the social stress model to energy questions has been limited. The applications have focused primarily on the Western mining activities and the resulting "boom town" phenomenon (Freudenberg 1976; Cortese 1979).

Two versions of the social stress model have developed: the life-change model and the cognitive model. The models differ in the variables and relationships of primary interest, and therefore in the research methods used. Either model could be applied to a variety of energy-related problems.

The life-change model is based on (1) the technique of relating life-change events (e.g., marriage, death of a spouse, loss of job) to the onset of illness, developed by Adolf Mayer in the 1930s as a diagnostic tool, and (2) the philosophy that a wide range of events would produce a general type of reaction in individuals, based on Selye's General Adaptation Syndrome (1956). Recent reviews of the life-change model include Dohrenwend and Dohrenwend (1974) and Rabkin and Streuning (1976).

The life-change model identifies events that may occur in an individual's life and determines their relative level of stress based on the demand for adaptation. The focus is on responses common to many individuals, with little analysis devoted to the reasons for individual variation in adaptation. In contrast, the cognitive model is concerned with the processes by which the person perceives and evaluates the stress stimulus and selects a response.

The cognitive model focuses on the mediating variables and processes between the stress event or stimulus and the individual's response. Variables which have been considered include personality characteristics, the background of the individual, prior experience with similar stimuli, situational characteristics, and the social environment. Mediating processes which have been included in the cognitive model are the appraisal of the stimulus and the appraisal of alternative coping strategies. While the outcome of an individual's exposure to a stress-producing stimulus is of concern to the cognitive theorist or researcher, the primary concern is identifying the variables that explain why individuals respond differently to the same stimulus and why they respond differently to a range of stimuli.

The earlier distinction between the cognitive and the life-change models is becoming blurred as the life-change researchers increasingly include situational, individual, and social mediators between life events and the onset of illness or other outcome measures (Dohrenwend and Dohrenwend 1974; Rabkin and Struening 1976).

In the past, the research setting has also been a major difference between the life-change and cognitive approaches to the study of stress. The life-change researchers primarily used field research (both surveys and case studies); the cognitive researchers used laboratory experiments. This difference also is becoming smaller, however, as cognitive researchers are now testing their laboratory results in "real life" stress situations.

Stress and individual adaptation can be studied at three levels of analysis: sociological, psychological, and physiological. Sociological analysis focuses on social system principles and on social arrangements and groups rather than individuals. Stress (or what is often called strain by the sociologist) involves tension in or disorganization of such groups or social systems. Analysis of stress at the psychological level involves such factors as needs, beliefs, appraisal of stimuli, and coping responses. Physiological (or tissue level) analysis involves the study of individual characteristics, such as hormonal levels, heart rate, and blood pressure.

Most research has addressed relationships within a single level (e.g., the effect of electric shock on physiological characteristics) or across two levels (e.g., the effect of job loss on self-esteem). Rarely has a study covered all three levels (e.g., the effect of an urban renewal project on social relationships, psychological, and physiological characteristics of the displaced individuals).*

Two interpretations of the cognitive model are shown in Figs. 3-1 and 3-2. The first shows examples of the variables and processes that affect the way in which individuals react to environmental change. Figure 3-2 represents a model developed by Mann and Neff (1961) which describes ways that individuals perceive and respond to change. Regarding their model, Mann and Neff state:

An individual's reaction to a change appears to be related directly to the clarity of his perception of the meaning of the change and his evaluation of the effect that the change will have on him as an individual with certain aspirations and expectations. (p. 68)

Other researchers echo Mann and Neff's concern for the study of the perception of change. Thurlow (1971) and Henley and Davis (1967) found that perceptions of change situations were more relevant to adaptation measures than were the actual physical conditions. McLean and Taylor (1958) found that social and psychological stressors are highly individual factors, because situations are perceived very differently by persons with various personal characteristics. Dohrenwend and Dohrenwend (1974) suggest three levels of conformity in perception: idiosyncratic perceptions by individuals; perceptions shared by members of culturally homogeneous groups; and universally shared perceptions.

*An exception is the work by Pearlin which investigates the relationships between social status, marital stress, and emotional stress (Pearlin 1975, pp. 344-57).

| Inputs | Mediating Variables | Mediating Processes | | Outcomes |
|---|--------------------------------|---|--|---|
| <u>Environmental/ Social</u> | <u>Environmental</u> | <u>Primary Appraisal</u> | <u>Coping Processes</u> | <u>Environmental and Social</u> |
| Widespread catastrophic event (natural disasters, wars, etc.) | Causation of event, etc. | Irrelevant Benign-positive Stressful (challenge, harm or loss, threat) | Direct action-change or master stimulus Changing individual's sensitivity Inhibition of action | Modification of situation Social structure/relationships |
| <u>Psychological</u> | <u>Personality</u> | <u>Secondary Appraisal</u> | | <u>Personality</u> |
| Life change events (divorce, surgery, loss of job, etc.) | Self-esteem, etc. | Assessment of coping resources and options | | Internal stability Task performance/functioning Social functioning Mental performance, perception-memory-thought |
| Daily hassles-continuing conditions | <u>Physiological</u> | | | <u>Physiological</u> |
| <u>Physiological</u> | Constitutional predispositions | | | Somatic health/disease Levels of hormones/body chemicals |
| Shock, trauma, etc. | | | | |

Figure 3-1. A General Stress Model

Source: Burns 1977. (Based on the research writings of R. S. Lazarus, J. B. Cohen, and R. Launier.)

| STAGES OF PROCESS: | 1. A Major Change is Proposed | | 2. The Individual's Perception of the Change | | 3. The Individual Initiates Search | 4. The Individual's Evaluation of the Impact of the Change on Him/Her | 5. The Individual's Response to the Change | |
|--------------------|-------------------------------|--|--|--------------------------------|------------------------------------|--|--|--|
| | I. | Hi | Lo | Lo | Hi | | | |
| | | Ambiguity of meaning of change | | Trust in change initiators | | Self-Destructive Threatening Negative uncertainty Does not know Positive uncertainty Self-enhancing | Oppose Resist Tolerate Accept Support Embrace | |
| II. | Dimensions | | Control of environment & change | | Intensity of search behavior | | | |
| | | Lo | Hi | Hi | Lo | | | |
| | | As affected by: | | | | | | |
| III. | a. | Extent of information about change | | | | | | |
| | | Zero | | | | | High | |
| | | A little information | | Some information | | Quite a bit of information | Full information | |
| | b. | Extent of psychological participation in the change | | | | | | |
| | | Zero | | | | | High | |
| | | A little influence | | Some influence | | Quite a bit of influence | A great deal of influence | |
| | c. | Other factors such as the individual's acceptance of organization folklore and his past experience with change | | | | | | |
| | | Zero | | | | | High | |
| | | A little acceptance and experience | | Some acceptance and experience | | Quite a bit of acceptance and experience | A great deal of acceptance and experience | |

Figure 3-2. A Model for Understanding an Individual's Response to Change

Source: Mann and Neff 1961, p. 69.

3.1.2 Construction Model

Dissatisfied with the ability of the traditional adaptation and stress models to explain human behavior in changing environments, Franck, Unseld, and Wentworth (1974) drew upon the work of environmental psychologists to develop the construction model. The traditional adaptation models conceptualize the adaptation process as basically appraising and responding to a changed situation or stimulus. In contrast, the construction model deals with the active, conscious action of individuals who are modifying a situation or stimuli. The original study by Franck et al. (1974) addressed the move of an individual to a new town and the subsequent actions involved in learning about the environment and building new relationships within the community.

The seven major characteristics of this approach are that it: (1) considers the individual and the environment as transacting elements in a single system; (2) views life and adaptation as an active process; (3) interprets individual-environment transactions in a holistic manner; (4) provides a means of characterizing person-environment transactions; (5) incorporates the psychological dimension of the individual's experience; (6) provides a descriptive rather than an evaluative analysis; and (7) considers individual differences in perceiving, evaluating, and transacting with the environment.

The primary value of the construction model is that it can deal with a range of stimuli, both positive and negative, and that it permits analysis of how individuals differ in the creative construction of an environment.

3.2 DECISION MAKING AND CHOICE

The second group of theories or models covered in this paper are those dealing with decision making and choice. Basic research has been done in psychology, economics, marketing, and mathematics. Most of the discussion here addresses the applications of these models to consumer issues.

The history of behavioral and social research about consumer decision making is reviewed in two articles by Nicosia (1969) and Glock and Nicosia (1963). Two broad research traditions are defined—the prescriptive and the explanatory traditions. The prescriptive approach employs a straight stimulus-response model with no attention to decision processes. Except for early work by behavioral psychologists and the "black-box" theories of the economists, this approach has not drawn much from the social sciences.* In contrast, the social sciences have played a significant role in the explanatory tradition. In this tradition, consumers are seen as reacting to a network of stimuli which interact over time. The aim is to develop an understanding of the processes involved.

Stages of the decision process are defined by a number of researchers, including Brim et al. (1962) and Engel et al. (1973). These stages are: (1) identifying or recognizing the problem; (2) determining information already available (e.g., in memory); (3) obtaining additional necessary information; (4) defining possible solutions or actions; (5) evaluating such solutions; (6) selecting a strategy for performance; (7) actual performance of an action or actions, and (8) subsequent learning and revision based on the outcomes (p. 9).

*An example of the stimulus-response or "black-box" model in energy would be the simple statement that a rise in gasoline prices will result in lowered consumption, with no attempt to measure why or how this result occurs.

Not all decisions involve these same phases. For example, new information may not be necessary for a decision frequently made (e.g., where to buy gas on the way to work). However, the phases are defined broadly enough to apply to the analysis of any type of decision.*

Brim et al. (1962) use the terms "decision processes" and "problem solving" interchangeably. They feel that the two bodies of research differ in focus or emphasis rather than in the types of theoretical issues that are addressed.

Brim et al. classify decisions by two general types of characteristics: the formal or abstract characteristics and the substantive characteristics. Examples of formal characteristics include the probability that certain outcomes will result from a decision, competitive or cooperative conditions surrounding the decision, the type of costs involved, the repetitive versus one-time nature of the decision, revocable versus irrevocable consequences, the number of decision alternatives, and the number of types of outcomes from the decision. Substantive characteristics describe the subject or problem involved in the decision. In most cases the substantive descriptions are based on the social role in which the decision is made (e.g., parent, employee, spouse) (Brim et al. 1962).

3.2.1 Economic Models**

Both macroeconomics and microeconomics have contributed to research and theory on consumer choice and behavior. Microeconomics addressed buyer choice in early studies of agricultural products, and more recently in manufactured and brand-name products. In recent years, macroeconomics has produced a large amount of empirical research on aggregate buyer behavior, specifically on the relationship, at the national level, between income and consumption. This macroeconomic research is useful in predicting aggregate consumer reactions to policy or market changes, but it does not contribute to our understanding of how consumers purchase particular products, nor does it contribute to a theory of individual choice.

One of the foundations of classical economic models of consumer choice and behavior is the concept of utility. Broadly defined, utility is "the pleasure, satisfaction, and need fulfillment that we get from the consumption of material goods and services" (Dolan 1977, p. 78). The questions of whether and how utility can be measured and whether consumers actually try to maximize their utility have concerned economists for years.

Economic theories of choice have addressed three basic types of choice situations—those including certainty, risk, and uncertainty. In conditions of certainty, the decision maker has complete and accurate knowledge of the outcome for each alternative. In conditions of risk, the decision maker knows the probability distribution of the possible consequences for the alternatives. In conditions of uncertainty, the individual cannot assign objective probabilities to the possible consequences (Green and Wind 1973, p. 11). In choice situations involving uncertainty, risk, or intertemporal comparisons, utility is still

*Further discussion of these phases and research relevant to this approach is found in Brim et al. (1962) and Engel, Kollat, and Blackwell (1973).

**This discussion is based on reviews of economic models and their use in consumer research by Lancaster (1976) and Howard (1963). An additional overview of economic models of consumer behavior can be found in Ward and Robertson (1973).

used. In conditions of certainty, utility has been replaced in most cases with the broader, more fundamental concept of preference. Consumers are assumed to choose from available alternatives those which they prefer. Thus, the theory of choice is concerned with the nature of consumer preferences and the constraints on available alternatives.*

Studies of choice under conditions of certainty provided the early base for economic research on behavior. This work relied on the ordinalist theory of choice, which assumes that consumer preferences can be ranked but not measured. Howard considers the ordinalist theory to be basic to understanding consumer behavior and marketing issues for four reasons: it provides the bulk of formal theory in economics and management science; it is widely taught in business schools; it provides a base for a theory of choice under risk conditions; and it sets a context for other social and behavioral disciplines in the empirical study of consumer behavior (Howard 1963, p. 76). The basic element in ordinalist theory is the principle of diminishing marginal utility; i.e., "the utility of each additional unit that is purchased is less than the utility of the preceding unit" (p. 76). Using the standard economic assumption of fixed income, the principle operates for two reasons: the consumer tends to become satiated with the product, and at some point he or she must give up more of alternative products (opportunity costs). A number of significant assumptions are made in the ordinalist theory. These are that (1) the consumers' tastes or preferences do not change; (2) preferences are transitive (if orange is preferred to blue, and blue to green, then orange is preferred to green); (3) the product does not change; (4) products are perfectly divisible; (5) the buyer is a "perfect choosing instrument," in that he/she has no threshold of perception and discrimination; and (6) individual demands can be summed to obtain a market demand (implying that individual preferences are independent of each other, and that buyers are homogeneous or the distribution of their preferences does not change) (Howard 1963).

Choice in risky situations is studied within "modern utility theory," based on the work by von Neumann and Morgenstern. This theory is based on the ordinalist theory of choice, but differs in that it specifically considers imperfect knowledge on the part of the buyer. Howard feels that there has been sufficient empirical work to begin testing the predictive capability of the theory. The basic element in modern utility theory is that "the utilities and subjective probabilities assigned by a subject to a set of risky alternatives can be measured simultaneously and independently" (Howard 1963, p. 80).**

Choices in conditions of uncertainty require a person to decide on a specific alternative before he/she knows what the probable outcomes will be. In such a case, the ability to assess possible influences and impacts on oneself assumes a sophisticated consumer. Howard states that there is a large body of literature on choice under uncertainty, but that ". . . in its current state of development it probably throws little light upon how a buyer does behave in contrast to how he should behave" (Howard 1963, p. 76).

A type of choice particularly relevant in the energy area is that which includes consideration of the future, or intertemporal choice. Examples of current concerns in this area

*Three major assumptions are made by economists: consumers have complete knowledge of their wants and of the means to satisfy these wants; preferences are independent of the environment at the time the choice is made; and preferences are unlimited, nonsatiable, and consistent (Engel, Kollat, and Blackwell 1973, p. 25).

**Howard gives an example of how this measurement can be accomplished, and cautions that it is not measurement in the sense that traditional economists sought to measure utilities (Howard 1963, p. 81).

are life-cycle costing for energy-using appliances, expectations of future energy prices and sources, and savings behavior in inflationary periods. Models in this area involve complex ideas, such as discounting future earnings and life-cycle costing. Lancaster (1976) questions whether consumers can be expected to handle complex intertemporal choices, since their analysis by economists requires highly sophisticated formulas and techniques. Research on life-cycle costing and its use by consumers is discussed in Section 5.0.

Lancaster describes three major contexts for consumer theory: the predictive, Walrasian, and welfare economics contexts. The predictive context is concerned with how individuals or groups of consumers "will behave under closely specified circumstances where behavior in some initial state is taken as given" (Lancaster 1976, p. 12). The only concern is to predict behavior (e.g., how does demand change in response to price changes?) and as such requires only a "black-box" theory of the consumer. The Walrasian context deals with the economy as a whole, and asks broad questions, such as whether perfect competition will "work." This context requires a consumer choice theory that contains universal elements and leads to broad generalizations (p. 12). The welfare economics context requires a consumer theory that is more than descriptive of behavior. The welfare economist "requires that consumer choice be purposive, so that a link can be established between choice and such concepts as 'welfare,' 'utility,' 'preferred,' or even just 'better off' " (p. 12).

Rationality is a basic assumption in economic theory, and may be used in situations involving choice between certain outcomes or choice under uncertainty. In choices between certain outcomes, a particular choice may be "rational" for one person but not for another, implying a relationship between the person and the choice. Rationality also implies consistency, such that "(a) identical choices will be made under identical circumstances (by the same individual); and (b) if x_1 is chosen when x_2 is available, then x_2 will only be chosen when x_1 is not available" (Lancaster 1976, p. 13). In situations of uncertainty, rationality refers to calculating the relationship of outcomes to immediate alternatives or choices.

3.2.2 Psychological Models

In the 1920s James Watson and other psychologists developed the behavioral tradition in psychological research. This work, which included learning theory, influenced marketing and advertising research. Because these subject areas were developed in the laboratory, their application to real-life experiences was difficult, particularly in regard to controlling appropriate variables.

In the 1930s, two additional events occurred that would affect consumer research. The first was progress in opinion polling techniques which led to current survey research methods. The second was the immigration into the United States of a number of European psychologists with clinical and social training.*

These developments in psychology and social psychology began to influence consumer behavior research in the 1950s. Two schools of thought were established. The first, by Katona, emphasized the relationships between economic variables (especially income and prices) and the intention to purchase. The other, by Lazarsfeld, emphasized studies of information channels, both mass media and face-to-face or interpersonal channels.

*This review of early work in psychology is based on articles by Nicosia (1969) and Glock and Nicosia (1963).

Lazarsfeld's was the first attempt to develop a comprehensive paradigm of consumer action. This paradigm defined the act of consumer choice as involving "... an interplay among three broad sets of variables: predispositions, influences, and product attributes" (Glock and Nicosia 1963, p. 23). His work shows the relevance of sociology to the study of consumer behavior, particularly the significance of social variables in consumer decision making. Studies by Lazarsfeld's group between 1944 and 1957 at Columbia University's Bureau of Applied Social Research showed that the individual's social milieu and the values and norms it supports significantly affect a wide range of consumer behaviors. One part of the social influence was given particular attention: the opinion leader, who was seen to serve both as an information channel and as a source of social pressure toward a particular choice.

Katona's paradigm also postulates three broad sets of variables: enabling conditions, precipitating circumstances, and attitudes. Enabling conditions are factors that bound the individual consumer's purchasing ability, such as income and access to credit. Precipitating circumstances either produce a problem solvable by a consumer decision or trigger the resolution of an existing problem. Attitudes serve as filters for the other two sets of variables before they affect choice. Social factors are assumed to be included in the formation of the attitudes.

A separate area of consumer research stems from clinical psychology. This area, motivation research, believes that consumer behavior must be understood through the cognitive structure—needs, drives, and motives. Environmental variables are included as basic determinants of motivation and cognition.

Another area of consumer research, marketing personality research, is based on trait-factor theory. Traits are inherited or acquired characteristics that make up an individual's personality. They are common to many individuals, but differ in absolute amounts. They are relatively stable and are not affected by short-term environmental changes. It is assumed that traits can be inferred by measuring behavioral indicators (Engel et al. 1973).

Three types of basic "input" factors are considered in all of these psychological models of choice and decision making: individual predispositions existing prior to the choice situation, situational factors influencing the individual at the time of the choice, and the attributes of the choice product or alternatives. Predispositions include those that are latent and those that become activated or salient in a particular choice situation.

Two types of output from the choice situation are considered by psychologists: (1) behavioral responses, such as purchase of an item, selection of information, or providing information to others; and (2) internal responses, such as changes in beliefs, attitudes, or knowledge, that may affect future choice behavior (Hansen 1976).

Research and modeling efforts may focus on exposure, choice, or deliberation situations. Exposure situations are those in which information from the environment leads to internal responses (e.g., changes in beliefs and attitudes). Choice situations involve a behavioral response as a result of some mixture of predispositions and situational factors. Deliberation situations are those in which the situational factors act only as a background for the cognitive activity resulting in changed predispositions (the focus is on the processes by which the predispositions change) (Hansen 1976).

In most studies, the consumer choice process has been studied over a fairly short span of time (e.g., one choice situation). However, the models allow for studying the longer-term dynamic process that involves learning by the consumer.

Green and Wind (1973) state that modeling consumer decision processes requires understanding how trade-offs between product attributes are made and how multi-attribute products and services are evaluated. They say that, because it is difficult to study the trade-off process, most research focuses on defining the number of stages in the decision process, describing the final decision, or studying specific issues, such as perceived risk.

A major contribution by psychologists to the study of consumer choice is the development of multi-attribute or multi-dimensional attitude theories. The basic formula of multi-attribute attitude theories is:*

$$A_i = \sum_{j=1}^n a_{ij} b_j ,$$

where A_i is the overall evaluation of the alternative (i), a_{ij} represents the various outcomes (j) of choosing an alternative (i), and b_j is the subjective importance of an outcome (j).

Hansen cites the original formulations of the theory in the 1950s and 1960s by Peak, Rosenberg, and Fishbein, and a number of more recent reviews of the area. He concludes that, "In general, it is established that these multi-dimensional attitude models are good predictors of overall evaluation or attitude, whereas their ability to predict behavior is more varied" (p. 50). The Fishbein and Rosenberg versions of the model are conceptually similar, but are slightly different in emphasis and have used different scales. The Fishbein version emphasizes the evaluative aspect (b_j) of the attributes and the strength of the belief (a_{ij}) that the alternative has the attribute. The Rosenberg version defines the variables slightly differently as the importance of the attribute (b_j) and the extent to which the alternative is seen to possess the attribute (a_{ij}) (p. 50).

Other attitude models that have been used to a more limited extent are those concerning balance, consonance, congruence, consistency, and attribution. Unlike the Fishbein and Rosenberg models, which address the relationship between predispositions and behavior, these other models concern the relationships among various beliefs and attitudes. The use of attribution theory is fairly new, and concerns "how beliefs about other people may influence the perception of behavior" (Hansen 1976, p. 51). Recent uses of attribution theory to explain consumer behavior include work by Mizenski (1978) and Calder and Burnkrant (1977).

Other approaches that Hansen reviews include (1) the attribute adequacy models that recognize that an alternative may have too much of an attribute as well as not enough and that compare a perceived ideal amount of the attribute with perceptions of how much the alternative has; (2) image-congruence studies where consumers form images about themselves and then select products with matching images; and (3) evidence by Ostland that "consumers' perceptions of innovations may be useful in identifying innovators" (Ostland 1976).

*Consumer researchers disagree on the proper use of a_{ij} and b_j . This format will be retained throughout the report.

3.2.3 Comprehensive Choice Models

A number of comprehensive models have been developed to explain consumer choice and decision-making processes. Three of the best known are those by Nicosia (1966; Jacoby 1978); Engel, Kollat, and Blackwell (1973 and 1978); and Howard and Sheth (1969).^{*} Much of the base for these models is found in the work, discussed earlier, of some economists and psychologists, but the models warrant a separate discussion because of their attempt to be comprehensive.

Comprehensive consumer choice and decision-making models were developed for products familiar to consumers and to explore such topics as brand loyalty rather than to address the purchase and use of major consumer product innovations. The models, however, form the educational and practicing bases for most of the consumer and marketing research fields. They also provide a detailed model for the study of behavioral processes such as information selection and processing.

Nicosia's model is specifically aimed at product innovation and consumer consideration of innovations. He bases his model on a view of consumer decision making as a funneling process. This means that ". . . the experience of a problem triggers search activities that gradually narrow the area of possible solutions until a 'final' solution is found—the purchase of a specific brand, in a certain quantity, at certain conditions" (Nicosia 1966, p. 121). The model is composed of four components or phases in the decision process: from the message source to the consumer's attitude; internal and external search for and evaluation of information and alternatives; the act of purchase; and feedback from the act of purchase.

The two best developed consumer choice and decision-making models are those by Howard and by Engel, Blackwell, and Kollat (both described in Engel, Blackwell, and Kollat 1978). Both models have been reduced to a series of testable equations, although only the Howard model has been tested empirically. The results of these tests are discouraging, however. They do not consistently support the relationships in the model, and the amount of variance explained is small. Engel et al. (1978) state that, given the problems of conceptualization and measurement, it is unlikely that either model can be empirically verified.

The buyer behavior theory developed by Howard and Sheth (1969) focuses on brand choice and change within a product class rather than on major product innovation. Four sets of variables are included in the theory: input variables, output variables, hypothetical constructs, and exogenous variables. Input variables include information about product attributes (gained either directly from the product or through advertising), and information from the social environment regarding a purchase decision. Output variables are physical or verbal measures of changes in attitudes or awareness, purchase expectations, or actual purchase behavior. Hypothetical constructs are based in behavioral science, particularly psychology. They are concerned with learning and with perception. Exogenous variables (e.g., situational factors) are expected to influence buyer behavior, but are not themselves explained by the theory. In most cases, they are assumed stable for the analysis.

^{*}Readers interested in a detailed discussion of these models should consult the original sources.

The model of consumer behavior developed by Engel, Kollat, and Blackwell (1973 and 1978) specifically addresses the "... many processes [that] intervene or mediate between exposure to a stimulus and final outcomes of behavior" (Engel, Kollat, and Blackwell 1973, p. 49). Components of this model are the individual's psychological makeup or central control unit, information processing, environmental constraints, and the decision process. The psychological components of interest to the model are information and experience (including memory), evaluative criteria (used to compare products and brands), and attitudes. Each of these is affected by the individual's personality. These components and the personality constitute the central control unit (CCU). The CCU is believed to shape individual behavior in two ways—by controlling and interpreting the information received, and by directing consumer actions.

3.2.4 Information Processing Models

Information processing models address a subset of the issues covered in the comprehensive buyer or consumer behavior models. Yet, there is a separate research tradition and a feeling expressed by some that information processing models should not be folded into the more comprehensive consumer behavior models (Wilkie 1974).^{*} Information processing is also addressed in other types of models and theories, including problem solving and exploratory behavior.

The body of consumer research dealing with information processing has its roots in cognitive psychology, economics, communications, and computer sciences. It should not be confused with formal information theory, although the two bodies of knowledge are related. Formal information theory and economics define "information" very precisely, as that which either increases or decreases uncertainty. The consumer information processing literature tends to use broad, descriptive definitions. Information includes any stimulus which is or could be perceived by a consumer about any aspect of a consumer purchase decision or experience (actual or vicarious). The stimulus can be newly received (as in advertising) or part of the cognitive store of information (Wilkie 1974, p. 23).

The models of information processing consist of two major components: the characteristics of information and the processing activities. Characteristics of information include dimensions or attributes on which a product may be evaluated (e.g., length, color) and the rating or value on these dimensions (e.g., four meters, blue). Information processing is defined by Wilkie to be those "serial mental activities which occur systematically and which involve different sections of the conceptual and sensory systems" (Wilkie 1974, p. 24). Specific processing activities include search, input or receipt, actual processing (evaluation and integration), and output. Characteristics of information and the processing activities are studied within a research framework that includes the task environment and stimulus, individual consumer differences, the initial state (before processing), the process measures, and the end state.

Research questions concern the use of information in evaluating and selecting a product or alternative. Do people process the information by brand or by attribute? What determines the set of products or brands considered by the buyer (some variables identified are awareness of product, prior experiences, brand-name reliance, and available information)? Do attributes reflect consumer perceptions of the product, or do they

^{*}A detailed review of consumer information processing research and its application to public policy issues is found in Wilkie (1974).

reflect objectively measurable product characteristics? How many attributes does a consumer typically use in judging or selecting a product or brand?

Research on consumer information processing has used two approaches. An input-output design commonly is used in marketing, advertising, and communications studies to address the issue of effectiveness. The process design is less developed and has been used mostly for basic research on processing.

The input-output approach measures the end state (or the decision reached) and infers what processes are operating. Thus, it does not measure consumer information processing directly, but it can be used to study the effects of the processing. One area in which this approach has been particularly useful is studying the effect of "information overload" on the quality of the decision (Jacoby 1977). Consumers are assumed to have a cognitive capacity constraint which limits their ability to process additional information for use by short-term memory. If this capacity is "overloaded" with information, the decision-making process is believed to become less accurate and effective (Jacoby 1977).

Direct monitoring research is a type of input-output research expanded to study the processing stage. It is based in cognitive psychology, particularly in theories of cognitive consistency. The major applications have been in advertising and communications research. The research looks at the consumer's exposure to persuasive messages and at the components during the exposure in order to better understand the process. Much of the measurement, however, is post-process in order not to bias the process itself. Some measurement techniques have been developed to directly address the process. Examples include encouraging the subjects to describe the ways they process messages and using eye movement to determine the selection of information.

Decision net research addresses the processing of information more thoroughly than do the other approaches. Its focus, in fact, is on the rules used by the consumer during a decision or choice. Very small samples (sometimes just single consumers) are studied in realistic or real-choice environments (e.g., supermarkets). A typical example of the decision net approach involves the experimenter following a subject through a store with a tape recorder, asking the subject to think out loud and report everything he/she is thinking during the decision about a particular product. From this data the researcher develops a model of what information was processed and how the choice was made. This technique can be very useful for in-depth exploratory studies of decision making, but the effort required for data collection and the problem in data coding and analysis make the approach infeasible for larger studies of consumer information processing.

3.2.5 Sociological Models

Sociology can play two major roles in the study of consumer behavior and decision making. The first is to define the ways in which social influence and social variables affect other nonsociological variables, such as the cognitive processes and the available alternatives. The second is to identify sociological variables which more directly affect consumer behavior and decision making, such as the influence of reference groups and opinion leaders.

A series of articles by researchers at the University of California, Berkeley, has reviewed the concepts and research findings in sociology and social psychology and discussed ways in which they could contribute to the understanding of consumer behavior and aggregate consumption behavior (Nicosia 1969; Glock and Nicosia 1963; Glock and Nicosia 1964; Nicosia and Mayer 1976). Three particularly relevant areas are

identified. The first deals with communication and information channels—especially the two-step flow of communications and the role of opinion leaders. The second is the role of reference groups. The third is the influence on consumer behavior of particular roles that the individual fills, such as that of the newly married couple, the new parent, or the career professional.

To date, most of the sociological research on consumers has paralleled that of the social psychologists in focusing on how social factors influence the behavior of individual consumers. Another area in which sociology has a particular role to play is the study of aggregate consumption behavior. Until recently, most work in this area was done by macroeconomists, drawing on sociological theories and principles where necessary. Two articles, by Glock and Nicosia (1964) and Nicosia and Mayer (1976) have, however, provided the basis for developing a "sociology of consumption." Central concepts in the study of consumption are the content and effects on consumption of cultural values, the role of social institutions, and the nature of consumption activities. Increased understanding of a society's consumption would not only provide a valuable social indicator, but would also contribute to the debate on policy issues, such as government provision of information (Nicosia and Mayer 1976).

3.3 ADOPTION AND DIFFUSION OF INNOVATIONS

Many of the models and approaches used by consumer researchers were developed to handle products familiar to the consumer and choices among brands rather than decisions about product innovations. Yet, solar energy systems are a major consumer product innovation as were automobiles, computers, and television and, as such, have particular attributes that need to be considered.

The purchase and use of such consumer innovations have usually been studied using the diffusion of innovations model rather than the comprehensive consumer choice models.

The diffusion of an innovation refers to the process by which a new idea or product spreads among individuals and/or organizations in a social system. Originating in geography, the diffusion model has spread to and drawn from other disciplines, such as sociology, political science, urban studies, economics, marketing, and communications. In recent years, diffusion theory has made a significant contribution to the theories and study of consumer behavior (Engel, Kollat, and Blackwell 1973; Ward and Robertson 1973; Glock and Nicosia 1964; Leonard-Barton 1978; Howard and Ostland 1973).*

The diffusion model has been used to study specific products purchased or used by individuals, the adoption of new processes by firms and industries, and the spread of political and social ideas in a society. In the consumer product area, diffusion models have, in most cases, been used to study generic products rather than brands.

*More detailed discussions of the diffusion of innovations model can be found in two recent SERI reports (Burns, Mason, and Armington 1979; Roessner et al. 1979). Extensive discussions of the diffusion model's relevance to the study of consumer decision making and behavior are found in the books by Engel, Kollat, and Blackwell (1973); Howard and Ostland (1973); and Engel et al. (1978). This model is being used by SERI's National Study of the Residential Solar Consumer.

Three types of products innovations have been defined—continuous (minor changes in the product), dynamically continuous (substantial changes, but in the same product class), and discontinuous (entirely new product classes). Diffusion models were designed for the latter, but are often applied to the first two incorrectly by marketing and consumer researchers.

The literature on the diffusion of innovations was reviewed by Rogers in 1962, and updated by Rogers and Shoemaker in 1971. Their central theme is the importance of communication in the entire social change process. Rogers and Shoemaker describe diffusion as the process by which information about new ideas or products is communicated to the members of a social system; social changes may result from the adoption or rejection of the idea or product.*

Rogers and Shoemaker surveyed the literature in anthropology, sociology, rural sociology, education, medical sociology, communications, marketing, economics, psychology, geography, and other disciplines with smaller amounts of diffusion literature. They identified eight main topics in diffusion research: rate of adoption in a social system, comparative rate of adoption in different social systems, perceived attributes of innovations, characteristics of innovators, earliness of knowing about innovations, characteristics of opinion leaders, use of communication channels, and consequences of innovation. Rogers and Shoemaker identified the shortcomings of the existing research at that time as (1) the difficulty of taking into account the fact that diffusion occurs over time, with no clear beginning or end; (2) emphasis on the nature of the innovation itself rather than the general process and the theory; (3) the focus on optional decisions by the individual rather than on decisions with a collective or authoritative nature and on individual adopters rather than adoption by communities or organizations; (4) the use of the individual as the unit of analysis rather than the relationships among individuals; (5) the concentration of studies on modern societies (i.e., the United States and Western Europe) rather than on traditional systems; and (6) the reliance on cross-sectional research rather than on longitudinal studies.**

Marketing and consumer researchers have made a useful distinction between the macro view of the diffusion process and the micro view of the adoption of the innovation (Ward and Robertson 1973; Engel et al. 1973; Kotler 1971). Diffusion models describe or predict the spread or rate of adoption of an innovation. These models include four components: the characteristics of the innovation, the communication process concerning the innovation, characteristics of the social system, and the passage of time. A number of modified versions of the model have been developed for application in marketing and consumer research. The best known modification is the market penetration model, which fits a mathematical curve to new product sales in order to predict market penetration

*Adoption, in turn, is defined as the decision to continue use of the innovation, not just the initial purchase.

**The literature collected by Rogers and Shoemaker primarily addresses specific innovations adopted by individuals; chapters of the book are devoted to organizational and collective innovation decisions, however. The adoption perspective has also been applied to adoption of innovations by firms (Mansfield et al. 1971). Instead of focusing on communication channels and messages, the important variables are the proportion of firms already using the innovation, the profitability of using the innovation, and the investment required to install the innovation. Readers interested in organizational adoption of innovation can find useful discussions in a number of sources (Yin 1978; Mansfield et al. 1971; Rosenberg 1972; Rosenberg 1978).

during a given time period, and the epidemic model, in which early adopters are seen as "infecting" others through social interaction (Rogers and Shoemaker 1971; Engel et al. 1978; Kotler 1971).

Adoption models focus on the micro-level, behavioral, and decision processes of the individual consumer or user. There are various formulations of the model, each of which has three basic levels or stages through which the consumer passes—the cognitive level (attention, awareness, or knowledge of the innovation), affective level (developing an interest, liking, or preference for the product and an evaluation or conviction), and action level (the purchase or trial of the innovation and the decision to repurchase or continue use of the innovation). A basic assumption of the models is that as people move through the stages, they are more likely to adopt or purchase the innovation.

The individual decision to adopt or reject the innovation is a function of the individual's perception of the choice situation, the communication available to the individual, the perceived innovation attributes, and the characteristics of the individual considering adoption. Thus, the adoption model focuses on variables that describe consumer decision making about a new product.

Recent analyses of the diffusion literature have provided three different ways of categorizing the research. Kelly and Kranzberg define three categories of diffusion research by the conceptual structure used and the variables receiving primary attention (Kelly and Kranzberg 1975). The geographic or spatial diffusion approach (the traditional approach) focused originally on the pattern of innovation diffusion and related learning processes. More recently, this approach also has incorporated market factors. The economic approach focuses on cost-related factors of innovations, such as profits, cost, and economic advantage in explaining the rate and pattern of diffusion. The social-psychological approach focuses on individual resistance to change and innovation, the nature of comparative advantage, and the influence of social networks.

Yin defines four approaches to the study of the innovation process (1978). Unlike Kelly and Kranzberg, however, only one of Yin's approaches deals with the individual adopter. This approach, the classic diffusion model, is termed the social interaction approach, with focus on social networks and information channels. The research, development, and diffusion approach focuses on the linear development of innovations through the institutions responsible for the phases of the process. Relatively little attention is given to the adoption and use of the innovation. The other two approaches Yin defines deal with the organization rather than the individual as the adopter of innovations. The innovative organizations approach identifies organizational characteristics that lead to adoption of innovations. The organizational change approach considers innovation as one type of change process in organizations.

The third set of categories of diffusion research is found in a paper by Brown (1978). He identifies and discusses four major approaches to diffusion research: the adoption, market and infrastructure, economic history, and development perspectives. The adoption perspective most directly concerns the individual consumer, with the focus on "the process by which adoption of the innovation occurs, (or) the demand side of diffusion." The market and infrastructure perspective addresses "the process by which innovations and the conditions for adoption are made available to potential adopters, (or) the supply side of diffusion." The economic history perspective is concerned with "the preconditions for diffusion whereby the innovation is adapted to the needs and situations of potential adopters." The development perspective deals with "the social and economic consequences of the diffusion of a given innovation and the interrelationship between social and economic change, development, and diffusion" (pp. 4, 5).

Primary concerns in the adoption perspective are the innovativeness of individuals and the factors that influence innovativeness. Work by Hagerstrand in geography* expanded the concept of innovativeness to include social and economic resistance of individuals. According to Hagerstrand, social resistance occurs when adoption of the innovation would be inconsistent with the individual's values. Economic resistance results from practical factors that make adoption difficult or impossible. Levels of social and economic resistance vary as a function of personal and group characteristics, with higher levels of resistance requiring more information for adoption to occur (Brown 1978).

The traditional diffusion approach only touched upon the supply of the innovation being considered for adoption. Yin (1978) addressed this area with his research, development, and diffusion approach. Perhaps the best explanation of the supply side of diffusion, however, is that of Brown (1978 and 1977) who defines the market and infrastructure perspective.

This model of the innovation process comprises three activities: the establishment of diffusion agencies, establishment of the innovation, and adoption of the innovation. This approach focuses on the supply side of diffusion by addressing the characteristics and role of the diffusion agencies. Agencies are categorized by their organizational structure; the extremes are a mononuclear or highly centralized diffusion agency structure and a polynuclear or fragmented structure (Brown 1978). The approach recognizes both the supply and demand sides of diffusion, the creation and use of an infrastructure, and the marketing of the innovation.

In this perspective on diffusion research, the adoption decision is also tied to the presence and characteristics of the infrastructure. Two sets of factors are thought to influence the decision and behavior of the potential adopter: (1) "the potential adopter's need or desire for the innovation and his ability to obtain it," and (2) the "infrastructure that enables or enhances the subsequent use of the innovation and generally is made available through the actions of persons other than the adopter" (Brown 1978; Schiffel et al. 1978). Brown sees the infrastructure factors as important for only some innovations and, in those cases, feels that their absence may constrain diffusion. In the market and infrastructure approach, only a few of the factors controlling innovation diffusion relate to communications and innovativeness, which are cited by other approaches as primary factors in the adoption perspective. This approach also sees diffusion as having a variety of patterns that cannot be explained by a single process, with phenomena proposed by some researchers as empirical regularities of diffusion (such as S-curves) occurring only under certain circumstances.

*A discussion of Hagerstrand's conceptual model of the innovation diffusion process and later modifications of his work can be found in L. A. Brown (1978 and 1977). Hagerstrand's 1953 book has also been translated from the Swedish by A. Pred as Innovation Diffusion as a Spatial Process, University of Chicago Press, 1967.

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SECTION 4.0

ANALYSIS OF THE MODEL COMPONENTS

The previous section reviewed the behavioral and social models that are relevant to the study of energy decision making and behavior. Five basic components are included in the models: situational characteristics, product characteristics or attributes, individual consumer or decision-maker characteristics, social factors, and decision rules. This section reviews the theoretical treatment and our level of empirical knowledge for each basic component.

4.1 SITUATIONAL CHARACTERISTICS

The characteristics of the decision-making or choice situation itself are treated more thoroughly by psychologists than by those in other disciplines. For the economist, the situation is included only as reflected in the product, good, or particular issue in question. For the sociologist, the primary situational characteristic is that of social influence, which is described later in this paper as a separate component.

Four major categories of situational variables are included in the psychological models: general and specific physically measurable aspects, and general and specific perceived aspects (Table 4-1). The most important distinction to psychologists and marketing researchers is between actual and perceived aspects.*

Specific physical variables include specific sensory aspects, such as color, shape, tactile sensations, sound, and light. Research has addressed situational variables in advertising and product displays and print versus television information. The general approach in studying specific physical stimuli is to vary the stimulus and observe the effect on behavior and cognition. Hansen feels that the understanding of the effect of variations in specific stimuli is increasing, but that a systematic classification of such stimuli is needed (p. 40).

In contrast to physical stimuli, "Specific perceptual variables are concerned with what is being perceived in the environment. Perceptual psychologists have repeatedly shown that there is no simple one-to-one relationship between the actual stimulation in the environment and what is being perceived" (p. 41). Examples of perceptual variables that have been addressed include credibility and expertise of an information source, and positive and negative advertising appeals.

General stimuli are those factors that are relevant to a wide variety of different situations, such as the amount of stimulation and complexity of the situation. Regardless of the specific stimulus characteristics involved, those general aspects may have particular relationships with individual responses. For example, the amount of environmental stimulation has been shown to have a curvilinear relationship with aroused psychological conflict, such that a high or low amount of stimulation produces little conflict, while intermediate stimulation levels result in greater levels of conflict.

*This discussion of situational variables is based on the recent review by Flemming Hansen (1976).

Table 4-1. SITUATIONAL VARIABLES IN PSYCHOLOGICAL MODELS

| | <u>Specific Aspects</u> | <u>General Aspects</u> |
|------------------------|---|---|
| Actual Stimuli Present | Single, physical stimulus dimensions which can be measured, or variations in the entire stimulus situation. | Total environment or situation (e.g., number of stimuli, complexity, pattern of stimulation). |
| Perceived Stimuli | What is perceived in environment; can be different aspects or levels of an aspect. | Familiarity, perceived conflict, etc. |

General perceptual variables have not been clearly defined in consumer research. In general, Hansen says, ". . . studies dealing with general perceived variables have focused on the extent to which the environment is able to arouse conflict and generate arousal, conflict-solving behavior, cognitive processes, and information search" (p. 45). Examples of such variables which have been addressed by consumer research include uncertainty and risk, perceived importance, ambiguity, and belief instability.

The review by Hansen affirms the need to study how situational factors influence individual choice and how situational variables interact with predispositional variables. However, he points out that future progress in this area depends both on developing a conceptual framework within which to deal with the environmental variables and on developing measures to quantify these variables (p. 45). One study cited by Hansen classified consumer decision situations to explain differences in information search behavior. The four basic factors defined were: (1) perceived importance of the decision; (2) complexity of the decision; (3) extent to which the needed information is objective or subjective; and (4) the availability of the needed information (pp. 45, 46).

Diffusion researchers have studied a number of environmental variables, but they have not been the major focus of the work. Most of the environmental variables studied have been concerned with organizational innovation. The only environmental variables relevant to individual decision making addressed by diffusion researchers are communication channels and networks.

4.2 PRODUCT CHARACTERISTICS

Traditional economists viewed consumer choices as being made among particular goods or products. Problems with this approach led to the development by Kelvin Lancaster of an approach that uses choices or preferences among properties or characteristics of goods (Lancaster 1975). Each good is seen as having several distinct characteristics, and each characteristic can be obtained from a number of goods. This approach has a number of particular advantages. First, it allows for the analysis of new or hypothetical goods in the same framework as existing goods. It also allows a potentially infinite number of goods to be reduced to a finite number of characteristics. And, last, goods can be analyzed with regard to their complementarity or substitutability.

Two particularly important properties of Lancaster's characteristics approach are that: (1) preferences for characteristics are assumed to be more basic and stable than goods preferences, allowing new goods or varieties to fit into established relationships; and (2) there is the "expectation that the minimum number of characteristics necessary to approximate the actual choice situation will be considerably less than the minimum number of varieties of goods that need to be taken into account" (p. 20). The major difficulties with this model are specifying and measuring the relevant characteristics of the good(s).

In most cases, economists treat products as generic products, not allowing for or including consideration of brands. Products are considered to relate to each other in three ways. They may be substitutable (if you take more of one product, you necessarily take less of another), complementary (if you take more of one product, you simultaneously take more of the second), or independent (purchasing more of one product does not affect the purchase of another, except with regard to overall income limits). One reason why economists have not studied brand or product differences specific to particular companies is that such analyses would have to take into account behavior among competitors (Howard 1963, p. 80).

As in the case of situational variables, a major question regarding product attributes is whether they are objectively present or are perceived. Wilkie states that the attributes in information processing models are the objective content or the performance characteristics of the product, while those in attitude models are defined in terms of subjective or perceived dimensions (1974). Diffusion research also considers the attributes of the innovation (product, idea, etc.) to be perceived by the adopter, rather than being objectively determinable, and unchanging from adopter to adopter.

Major attribute categories that have been defined by diffusion researchers include the embodied-disembodied nature of the innovation,* whether it is a product or process innovation, and whether it is a continuous or discontinuous innovation. Based on their analysis of existing research, Rogers and Shoemaker defined the five most important characteristics of innovations, as perceived by the adopters, which influence the rate of adoption: (1) relative advantage in economic and noneconomic terms; (2) compatibility with existing values and past experiences of the receiver; (3) complexity; (4) trialability, or the degree to which the innovation can be tried on a limited basis; and (5) observability, or the visibility of the innovation's results to others (1971). Other attributes of the innovation which have been identified or proposed include initial uncertainty, efficiency, reversability, commitment, impact on personal relationships, financial and social cost, returns on investment, and communicability (Lancaster 1976).

King and Summers (1967) identify two perceived product attributes that can influence the adoption rate for new products. The first is the price-quality relationship; the second is the perceived risk—i. e., the uncertainty about the performance of the product and the consequences of product failure. In an empirical study of consumer attitudes and new product adoption behaviors, King and Summers found that the importance of the second attribute, perceived risk, was much greater for durable than nondurable products.

Research by Ostland on adoption of six consumer innovations tested the importance of perceived product attributes relative to innovator characteristics in predicting consumer behavior (1973). He found that the product attributes (the five from Rogers and Shoemaker plus perceived risk) were better predictors of buying intention than were attitudinal or sociodemographic characteristics of the prospective innovators.

4.3 INDIVIDUAL CONSUMER CHARACTERISTICS

The characteristics of the individual decision maker are treated very differently in different disciplines. Psychology emphasizes individual differences; economists tend to disregard them.

One useful discussion of individual predispositions is that by Hansen. He groups predispositional variables along a continuum from general to specific. Four major categories are defined:

- (1) Personality;
- (2) General attitudes, values, and interest;

*These terms are used by economists to distinguish between innovations that are manifested as a physical product (embodied) or not (disembodied).

- (3) More specific attitudes, beliefs, and images; and
- (4) Choice-specific preferences, intentions, and purchasing probabilities (Hansen 1976, p. 48).

Both specific and general variables are assumed to be valuable, but for different reasons. General variables are expected to be fairly stable across choice situations and, therefore, tell us more about decision-making processes and strategies than specific variables. Specific variables, however, are better predictors of specific choice. The types of variables form a hierarchy, and specific variables are derived from the more general ones.

An important distinction is the one between latent and salient (or activated) predispositions. Hansen assumes "that only salient values, traits, attitudes, preferences, etc., influence behavior in specific situations" (p. 48). However, he also acknowledges that the latent-salient distinction is not always made clear by researchers, even though it may explain some of the problems with behavioral models and large attitude and interest batteries.

Hansen reviews the research on each of the categories of predispositional variables, citing key research and summarizing the overall state of knowledge. In the case of the personality variables, he concludes from available studies that "single and multiple personality dimension measurement instruments have not been successfully applied in studies of consumer behavior" (p. 49). Individual differences are demonstrably important, but it has been difficult to identify particular explanatory variables. A study by Belk (1973) and a review by Kassarian (1971) pointed out that personality variables played only a small part in explaining variations in choice behaviors; Kassarian estimated their contribution at less than 10% of the explained variance. Hansen states that personality measures have been applied more successfully to consumer research when the behaviors being studied are significant (rather than trivial) behaviors, the alternatives involved are significantly different from each other, and specific motivational variables are addressed.

To the extent that consumer behavior involves problem solving or decision making, it might be expected that traits, such as intelligence or aptitudes, would have an influence on behavior. However, Hansen says that research of this type has not been reported except in a few cases of ghetto shopping behavior. Hansen identifies only a small number of studies of such variables. Several standardized test batteries about values have been developed but not applied to consumer behavior. Interest batteries have received only slightly more attention.

More research is claimed to exist on lifestyles or personality profiles, based on consumer activities, interests, and opinions. Hansen states, "Generally, it has been possible to identify categories of consumers, who can be meaningfully described in terms of their attitude, interest, and opinion profiles" (p. 49). However, Hansen cautions that "the explanatory power of these variables alone is quite low in predicting specific consumer behavior" (p. 49).

In general, Hansen feels that personality characteristics and traits "may have more influence on the way in which the consumer responds to stimuli—what and how he perceives—and on the choice principle applied than on what alternative is chosen" (p. 50).

Research on specific attitudes and beliefs has followed two major approaches: (1) establishing relationships between attitudes and beliefs and behavior, and (2) defining relationships among predispositional variables (e.g., belief as a predictor of intentions, consistency among beliefs and attitudes). Only very recent research has considered the relationship among situational factors, predispositional variables, and behavior (p. 52).

Beliefs and attitudes are seen to vary along four dimensions: the kind and content, determined by the objects of the belief or attitude; structure, defined by the precision and the specificity (isolation from or connection to other beliefs and attitudes); strength and importance, or resistance to change and salience; and verifiability. The verifiability dimension helps define the relationship between the individual's beliefs and objective facts; it also helps to differentiate among knowledge, opinions, and faith.

The relationship between attitudes and behaviors has not been firmly established by research, although such a relationship is intuited. If attitudes are accurate predictors of buyer behavior, then marketing researchers should be able to use attitude measures in place of recording overt behaviors. In fact, Howard says, a large amount of marketing literature has been developed by measuring beliefs and attitudes, and then inferring buyer behavior. However, Howard cites a growing skepticism among social-psychologists that an individual's behavior can be predicted from attitudes, in large part because the concept of attitudes is not clearly defined. This may be due, in part, to the focus of social-psychologists on how the attitude was formed and how it can be changed, rather than on its implications for behavior.

Attitudes comprise cognitive, affective, and behavior components. A number of methods of attitude measurement have been developed, including forced choice and multiple choice, physiological responses, overt behavior, summated ratings (Likert scales), scalogram analysis (Guttman scale), rating methods (use of judges), judgment methods (Thurstone), and semantic differential (Osgood).

Specific predispositional variables (e.g., preferences among specific products) have been studied both as dependent variables and as predictors of behavior. Reviews of the relationships between these variables and behavior are found in Fishbein (1972) and Rapoport and Wallsten (1972). One major observation of these studies has been the inconsistency of choice in both experimental and real-life situations. Also, Hansen notes, there has been no attempt to include situational variables in the attitude-behavior relationships. A number of measures have been used, including simulated choices, rank ordering, scaled preferences, and recall.

Motivation and learning are also important aspects of the individual decision process. The technical sense of motivation is the process which activates behavior but does not determine its direction. The marketing literature, however, includes both activating and directing. Interest of market researchers in the motivation process is based on a "desire to get at the 'real' motives for buying behavior as opposed to the more traditional indirect means of inferring why people buy, from their attitudes or their behavior" (Howard 1963, p. 63). Howard defines three basic questions: Do the needs ascribed to individuals actually exist in the situations? Is there a relationship between needs and purchase behavior? And, do measures of the relationship affect the effectiveness of marketing policies? Examples of motivation or needs that have been studied by marketing researchers are dominance, autonomy, affiliation, and achievement.

Research on the diffusion of innovations has been geared to tying a number of attitudinal demographic and socioeconomic characteristics to innovative behavior. Variables studied

include age, education, social status, dogmatism, attitudes towards risk, social participation, and exposure to interpersonal communication channels. The relationships in most cases, however, are supported by no more than two-thirds of the studies (Roessner et al. 1979). Other characteristics found to be correlated with adoption by at least one study include social mobility, relative income level, occupational status of the husband, literacy, aspirations for one's children, achievement motivation, awareness of outside events, and attitudes toward change. Rothman identified three factors from the literature that are consistently related to innovativeness (but not necessarily to the probability of adopting a particular innovation): level of social participation, a felt need for change, and socioeconomic status (Roessner et al. 1979).

The concept of innovativeness has been particularly appealing to researchers. One of the recent discussions is an article by Midgley and Dowling which reviews the evidence for the innovativeness concept and its relationship to adoption behavior (1978). They concluded that any correlations between the innovativeness concept and behavior were meaningless without a better theoretical explanation of the relationship.

The diffusion framework used by King and Summers (1967) to study the adoption of new consumer products relies heavily on the individual's predispositions and perceptions of new products in general. These attitudes may be based on a number of personal characteristics, including psychological and socioeconomic factors, consumption patterns, and past experience with new products. The predispositions can affect consumer behavior in a number of ways. These include the speed with which the consumer learns that a new product exists, how much information is collected on the new product, and selective attention to and retention of information.

4.4 SOCIAL INFLUENCE

The influence of social factors on consumer decision making and behaviors has been included in a wide variety of social and behavioral models, but it is the special concern of sociologists and social psychologists. Much of the work on social influence has not been done in the context of consumer research, but it is now being applied to those issues. Both Howard (1963) and Glock and Nicosia (1963) review the research relevant to the study of social influence on consumer behavior and indicate ways in which sociology could contribute to the understanding of consumer decision making and behavior. Both reviews acknowledge that sociological research on consumer behavior has been limited in the past, but express the view that sociology could be increasingly important to future research.

The influence of reference groups on consumer behavior has been of particular interest to sociologists. From the literature he reviews, Howard concludes that informal and formal groups are probably significant in influencing buyer decisions, although the evidence is not clear. In fact, he states that "the available empirical research on group influence upon the individual contributes little to an understanding of purchasing" (p. 151)*. Empirical studies have produced two types of evidence, however, that other people are an important influence on the individual's perception of stimuli. In a number of studies (see, e.g., those of Asch), group pressure was shown to influence the individual's verbal description of his or her perception. In other studies where there is an ab-

*This is an example of the need to test sociological principles directly in consumer research.

sence of objective standards or accepted authority, the individual will turn to others for evaluations and information. This latter evidence suggests that persons may seek information and judgments from friends and acquaintances more often when considering the adoption of a new product since there is no authority, tradition, or standard on which to rely.

The influence of the family and family members on consumer decisions is also an important social influence issue. Howard raises three basic questions: "What are the relative influences of each of the various members of the family in purchase decisions? What is the relative influence of the family group versus other kinds of groups upon purchasing behavior? And, what is the influence of the family life cycle on purchasing decisions?" This latter question has been studied for newly marrieds in studies by Nicosia and Ferber.

Howard also reviews the evidence for social class as an influence. He concludes, "That social class significantly makes a difference in buying behavior is generally accepted, but not enough evidence is available to permit a more precise statement" (p. 162).

One important aspect of social influence is the flow of communication and information. Research in this area draws both on the diffusion model and on sociological and social psychological work on opinion leaders.

Social influence has been included in some formal, mathematical consumer models. An example is Fishbein's extended model predicting behavioral intention. Using Delaney's theory of propositional control, Fishbein has extended his model to include a social influence component—beliefs about how others see the action and motivation to comply with how others expect one to behave. In this model, behavioral intention is determined from a linear regression model:

$$BI_i = W_0 \sum_{j=1}^n a_{ij} b_j + W_1 \sum_{k=1}^m NB_k Mc_k ,$$

where BI is the behavioral intention toward the act i , NB_k is the normative belief about referent k 's evaluation of the act in question, Mc_k is the motivation to comply with the referent k , m is the number of referents, and W_0 and W_1 are regression weights (p. 51).

Hansen cites a number of studies that show how including the social influence component improves the predictive ability of the Fishbein model. However, he still cautions that behavioral intentions may not explain behavior well because they do not consider situational influences. One study is cited which held the situation constant, thereby significantly improving the predictive ability of the model.

4.5 INTERACTION OR DECISION RULES

By interaction or decision rules, we mean the explicit or implicit formulas used by the individual to arrive at a decision. The formula indicates what information is to be used and how it is to be combined. These rules have been developed primarily in economics and psychology.

4.5.1 Economic Decision Rules

As described in Section 3.2.1, economists traditionally used the concept of utility as the core of the decision-making process. Utility has now been replaced in many cases by the concept of preferences.* As viewed from the outside, consumers are subject to a budget constraint in terms of money or goods that can be sold at stated prices, the prices of goods are fixed, consumers are presumed to act in accordance with their preferences, and they are assumed to have perfect knowledge regarding their wants and the alternatives available.

Lancaster raises a number of questions concerning the formation and stability of preferences which he says are not addressed in economic theory. "Are preferences innate? Are they entirely due to social conditioning? Can they be influenced by advertising or propaganda? Do individuals know their 'real' preferences, or do they have to learn what these are from experience? How stable are these preferences? Do behavioral changes due to major environmental changes represent a shift in preferences or an adjustment within a grand pattern of preferences?" (p. 27).

Within the preference approach, there are three groups of assumptions. They concern rationality, economic behavior, and good technical or mathematical properties (1976). The rational preference assumptions are those of completeness— xRy (x is preferred to y) or yRx (or both xRy and yRx) for all x and y in the set; reflexivity— xRx for all x ; and transitivity—if xRy and yRz , then xRz .**

Lancaster asserts that convexity is the most important single assumption in the economic theories of consumer choice. (By convexity, the economist means that the indifference curves are convex toward the origin.) Referring to strict convexity, Lancaster says that "if the individual is indifferent between alternatives represented by points x and y , he prefers any weighted average of x and y with positive weights to either one alone. . . . Strict convexity is necessary for the analysis to be performed with calculus methods but is difficult to relate directly to any intuitive view of the consumer's psychology" (p. 17).

Demand theory is based on the assumption of strict convexity of preferences, resulting in a unique best choice in all budget-constrained situations. The general formula is as follows:

$$x_i = f^i(p, M)$$

for each good i , where p is the price vector, M is the money income, and x is the chosen alternative.

One property of the demand function, seen as universal for all individuals, is that if all prices and money income are changed in the same proportions and the availability of

*This discussion of economic decision rules draws on Lancaster (1976).

**Alternatives are preference ordered as words are alphabetized. For example, alternative cars have various components, such as size, color, reliability, gas mileage. The components are ordered by decreasing importance. Thus, the first component ("a") determines the preference unless alternatives are equal, in which case "b" is considered. If "b" is equal, "c" is considered, etc.

goods does not change, the quantities of all goods chosen are unchanged. This implies important restrictions on the relationship between price and income elasticities, the most basic property of traditional demand theory.

It has been argued that the theory should include preferences related to prices as well as quantities. Two examples of this given by Lancaster are the "Veblen" effects—where things are bought because of their high price to show wealth, and Veblen and Scitovsky's arguments that price gives information about the quality of the good (Lancaster 1976).

Substitution effects and income effects are used to explain why a decrease in the price of a product always leads to at least some increase in consumption of the product. Substitution effects concern the extent to which product a substitutes for product b. Income effects occur when product a is a significant part of the budget and the price of a drops, increasing the income available for spending. The analysis is particularly relevant when dealing with products that make up a large part of the individual's total expenditures (Howard 1963, pp. 79, 80).

4.5.2 Psychological Decision Rules

Interaction or decision rules developed by psychologists are based in the cognition process, taking new information from the environment and fitting it into existing structures. Lazarus' definition of cognitive processes, although developed in the study of social stress, is relevant here:

[t]he term "cognitive" does not imply awareness, good reality testing, or adaptiveness. It only implies that thought processes are involved, not the kind or quality of the thought. What is meant is that beliefs, expectations, perceptions, and their motivations underlie how a (threat) stimulus is reacted to. Furthermore, the cognitions involved need not be reportable (1970, p. 162).

These cognitive processes rest in part on perceptions. As such, they are vulnerable to problems of selective perception in the form of attention or exposure to or retention of information. They are also affected by such factors as the individual's attempts to reduce dissonance between new information and beliefs, and between attitudes or beliefs and behaviors.

Howard (1963) comments on a particular aspect of this perception problem: "In predicting behavior, it is necessary to describe an individual's cognitive structure with respect to the stimulus; otherwise the observer cannot know what the individual is experiencing. Most data from public opinion studies are difficult to interpret, partly because this description is not available" (p. 138). This happens less often in other types of field research, where the product being studied is clearly presented.

Two basic types of multi-attribute decision models have been defined by psychologists—compensatory and noncompensatory. In compensatory models, a product's possession or amount of one attribute can make up for the lack of another attribute, and one overall score or utility is given the product. In noncompensatory models, tradeoffs are not allowed between product attributes and no overall score or utility is determined; alternative actions or products are compared on an attribute-by-attribute basis; the scales do not have to be the same for all attributes (Green and Wind 1973; Hansen 1976). Tables 4-2 and 4-3 outline the various compensatory and noncompensatory models.

4.5.3 Attitudes, Intentions, and Behavior

One area in which these interaction or decision rules are particularly important is in understanding the links among attitudes, behavioral intention, and behavior. Howard cites a number of studies on consumer plans and intentions (pp. 84-91). He concludes from the evidence that "there is a positive but not very tight relation between consumer plans and purchasing behavior with respect to durables. It is not quite clear at this point that the evidence provides support for the model that relates consumer anticipations, plans, and fulfillment of the plans" (p. 91). A later review by Hansen supports this conclusion.

In general, purchase intentions are not very successful predictors of actual purchase, according to Hansen. However, he does cite work by Granbois and Summers that has improved this predictive value by "looking at intentions in relation to the entire purchasing process" (1975). In the case of repeat buying or repetitive choice, the brand previously purchased may be a significant predictor of choice. However, the person's experiences with the prior choice must be taken into account. Recent work by Morrison (1979) develops a framework for future research on purchase intentions and behavior.

It would be useful to know if prior experience with a similar product, not necessarily the same brand, is also a significant predictor of choice. In the case of energy-efficient appliances, for example, a satisfactory performance in one case might encourage further such purchases.

Table 4-2. COMPENSATORY MULTI-ATTRIBUTE COMBINATION RULES

| Model | Formula | Explanation |
|--|--|---|
| I. Subjective Expected Utility (SEU) | $A_i = \sum_{j=1}^n [P_{ij}(x_j)U_j(x_j)]$ | The evaluation (A) of an alternative depends on the amount of utility $U(x_j)$ that the individual associates with each aspect of the alternative, multiplied by the probability $P(x_j)$ that the alternative has the attribute. |
| II. Trade-off | $A_i = \sum_{j=1}^n a_{ij}$ | Conjoint measurement used to decompose the total utility of an alternative into its components; partial utilities can be added or multiplied to compute total utility. |
| III. Expectancy Value | | Total evaluation or attitude is related to the beliefs about whether the alternative possesses the attributes and the evaluation associated with those beliefs. |
| A. Linear (Fishbein/Rosenberg) | $A_i = \sum_{j=1}^n a_{ij}b_j$ | |
| B. Logarithmic | $A_i = \sum_{j=1}^n a_{ij} \log b_j$ | |
| C. Exponential | $A_i = \prod_{j=1}^n e^{a_{ij}b_j}$ | |
| D. Multi-attribute/ multi-alternative | $A_i = \sum_{i=1}^m W \sum_j^n a_{ij}b_j$ | |
| IV. Attribute Adequacy | | Emphasis placed on the discrepancy between the ideal amount of a certain attribute and the actual amount that the alternative possesses. |
| A. St. James | $A_i = \sum_{j=1}^n [F(a_{ij} - 1_j)(b_j)]^{-1}$ | |

Table 4-2. COMPENSATORY MULTI-ATTRIBUTE COMBINATION RULES (concluded)

| Model | Formula | Explanation |
|-----------------------|--|---|
| B. Ginter and Bass | $A_i = \left(\sum_{j=1}^n b_j a_{ij} - l_j ^p \right)^{1/p}$ | |
| V. Weight | $A_i = \sum_{j=1}^n W_j a_{ij}$ | Estimate the relative importance of the different beliefs or instrumentalities with the use of regression weights rather than measuring the evaluation associated with the various beliefs directly. |
| VI. Extended Fishbein | $\text{Behavior} = B_i = W_o \left(\sum_{j=1}^n a_{ij} b_j \right) + W_1 \left(\sum_{k=1}^m NB_k Mc_k \right)$ | Behavioral intention is studied as a function of attitude toward the alternative, normative beliefs, and the motivation to comply with the normative beliefs; weights, W_o , and W_1 established by linear regression. |
| VII. Image | | Versions of above models; assumed that the total evaluation of the alternative is a straightforward additive function of the evaluation along the individual dimensions—simple version of the linear form of the expectancy-value model (all b's set equal to one); image congruence model—is the distance between the self-image or the ideal image and the image of the alternative—special unweighted version of the attribute adequacy model. |

Note: In these formulas, A_i = the overall evaluation of the alternative; a_{ij} = the presence of an attribute; b_i = the evaluation of that attribute. Some researchers reverse the use of the symbols; Hansen (the major reference for the tables) uses this style.

Sources: Hansen (1976); Green and Wind (1973); and Engel et al. (1978).

Table 4-3. NONCOMPENSATORY MULTI-ATTRIBUTE COMBINATION RULES

| Model | Formula | Explanation |
|-------------------------------------|---|--|
| I. Dominance | | The alternatives are evaluated on all dimensions; that alternative dominates which is equal to or better than the other alternatives on all dimensions. |
| II. Conjunctive | $A_i = \frac{n}{\pi} \prod_{j=1}^n b_j a_{ij}$ | Alternatives are not ordered, but are rated as "pass" or "fail"; an alternative is preferred only if it is sufficiently good on all attribute dimensions. |
| III. Disjunctive | $A_i = \frac{n}{\pi} \left(\frac{1}{a_j - b_j} \right) a_{ij}$ | Only some of the attributes are considered, and the alternative must be satisfactory on one or more out of several attribute dimensions; may be seen as a unidimensional noncompensatory choice principle. |
| IV. Lexicographic semi-order choice | | Attributes or dimensions are first ranked by importance; alternatives evaluated along most important dimension; those not satisfactory are deleted and comparison continues with next most important dimension; continued until only one acceptable alternative is left. |
| V. Elimination-by-aspects | | Probabilistic version of the lexicographic model; ordering of aspects determined by a probability proportional to the perceived importance of the aspect. |

Sources: Hansen (1976) and Green and Wind (1973).

SECTION 5.0

APPLICATION OF THE MODELS IN ENERGY STUDIES

Over the last few years, the interest and activity levels in research on energy decision making and behavior have increased greatly, particularly in energy conservation and use of alternative energy systems. Two reports have stressed the potential applications of behavioral and social science to energy research, but their focus has been more on institutional and administrative needs and barriers rather than on the models and substance of the research (Wilbanks 1977; Yale University 1979).

We do not as yet have an integrated model of consumer energy decision making with regard to new energy products. Such a model ideally would have the reliability of the diffusion approach and its handling of new product characteristics, and the detailed coverage of factors in the comprehensive consumer choice models.

Most research on consumer decision making in the energy area has not explicitly used either the adoption or the consumer choice models. Much research on energy behavior and purchasing energy products has been conducted by manufacturers of the products, and is proprietary information. For these and other reasons, our understanding of consumer energy decision making is not complete. We do not understand how consumers use information such as the energy efficiency ratings in their purchase decisions. We also do not know how consumers incorporate their judgment about the national future in their purchase decisions (Stern 1979).

To date, no comprehensive studies have been done with the intent of modeling and testing a model of consumer adoption of energy products. Most psychological research on energy conservation has focused on curtailment (changing one's behavior to use less energy) rather than investment in efficiency (buying products that allow the consumer to behave in much the same way, but using less purchased energy).

The U.S. Department of Energy (DOE), its predecessors, and private industry have sponsored a number of studies on consumer energy behaviors, using techniques such as marketing research, national public attitude surveys, special group studies, focus group interviews, and demonstration projects (Vories 1980). Recent reviews by SERI staff have summarized the market research studies on solar energy (Vories 1980) and have organized public attitude surveys on energy issues, including solar energy, within a conceptual framework (Farhar et al. 1979). In both of these reviews, the large majority of the studies cited did not explicitly build on behavioral or social models. Basically, the studies covered demographic characteristics and a limited number of attitudes. In some cases, items on information sources and use are included, and an implicit set of hypotheses concerning the importance and use of information. Because of the lack of explicit models and comparable research questions, the studies are difficult to aggregate or compare. In many cases, the intent was to "take the public's temperature" rather than to understand or explain the attitudes.

A small number of studies have been conducted, to date, on solar energy users. In a review of 15 of these studies of solar energy adopters, or users, only one study employed a social science model explicitly (Unsel and Crews 1979). This study, by Dorothy Leonard-Barton, used models of the adoption and diffusion of innovation in the study of solar adopters in California. Two other related projects currently funded by the California Energy Commission are continuing this work by looking in-depth at the attitudes and decision processes of solar consumers (Vories 1980).

This is not to say that the other studies did not use knowledge from behavioral and social models of and research on consumer decision making and behavior. But, the explicit use of models is not identifiable from the reviews. In most cases, however, these studies are useful in identifying relevant variables and in generating hypotheses that could be tested in later research. In particular, they have identified product attributes, consumer attitudes, and system or infrastructure problems that should be incorporated into future research on the solar energy consumer.*

A limited number of energy studies in recent years have explicitly used the behavioral and social science models of consumer behavior and decision making. These studies are particularly valuable because they collect immediately useful data while contributing to the longer-range understanding of consumer behavior. The work discussed earlier by Leonard-Barton and Rogers is one example of this kind of study. Another example cited earlier is the DOE studies at Princeton of the role of feedback in reinforcing energy conservation. A major result of these studies is the development of an energy monitor for households; it is being tested currently in four U.S. and two Canadian cities (Department of Energy 1979). A third example is the Energy Cost of Ownership (ECO) program, which is aimed at two aspects of consumer decision making. The first aspect involves making consumers aware of an additional attribute—life-cycle costs—which has not been included in most consumers' decision rules. The second involves determining consumer decision-making rules for energy products (U.S. Department of Energy 1979).

The diffusion of innovations approach has also been explicitly applied to the study of solar energy issues to develop the concept of a technology delivery system (TDS). As charted by Ezra (1975) and a report for DOE (1978) the TDS ranges from the research organizations to the end consumers, including such institutions as trade and manufacturers' associations, realtors, labor unions, and taxing authorities. The TDS applies the infrastructure model of diffusion to the solar energy systems and the consumer decision process. Particular questions include which attributes of the innovation are considered, the predispositions of various types of consumers, and perceived barriers to adoption or use of solar energy.

Two current research projects at SERI use behavioral and social science knowledge in studying energy decision making and behaviors. One major research effort is the National Study of the Residential Solar Consumer. The two empirical components of that project—a national probability sample, and a national mail survey of solar users (homeowners)—used this paper and exploratory field work to develop hypotheses and research questions. Results of the national study will include a model of individuals' solar energy system adoption decisions; a definition of the market segments for solar energy systems; an analysis of solar energy systems' effects on lifestyles, values, and attitudes; and an application of the diffusion model to the present adoption patterns for solar energy. A second research project is seeking to improve behavioral science inputs to market penetration models for solar technologies. This project was developed as a result of the market penetration workshop discussed earlier that identified the lack of behavioral knowledge and models as a serious limitation on market penetration modeling ability. Specific areas addressed by the study are residential and commercial buildings.

It is hoped that this report will encourage other SERI projects to use behavioral and social science models in studying consumer energy decision making and behaviors.

*For a discussion of these variables, see the review of public attitude surveys and empirical studies of users of solar energy that were discussed earlier (Farhar et al. 1979; Unsel and Crews 1979).

SECTION 6.0

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| | | 14. | |
| 16. Abstract (Limit: 200 words) This report reviews social and behavioral science models and techniques for their possible use in understanding and predicting consumer energy decision making and behaviors. A number of models and techniques have been developed that address different aspects of the decision process, use different theoretical bases and approaches, and have been aimed at different audiences. Three major areas of discussion were selected: (1) models of adaptation to social change, (2) decision making and choice, and (3) diffusion of innovation. Within these three areas, the contributions of psychologists, sociologists, economists, marketing researchers, and others were reviewed. Five primary components of the models were identified and compared. The components are: (1) situational characteristics, (2) product characteristics, (3) individual characteristics, (4) social influences, and (5) the interaction or decision rules. The explicit use of behavioral and social science models in energy decision-making and behavior studies has been limited. Examples are given of a small number of energy studies which applied and tested existing models in studying the adoption of energy conservation behaviors and technologies, and solar technology. | | | |
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