A model of consumer choice

Frances Marie Magrabi
Iowa State University

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MAGRABI, Frances Marie, 1927-
A MODEL OF CONSUMER CHOICE.

Iowa State University of Science and Technology
Ph.D., 1962
Economics, theory

University Microfilms, Inc., Ann Arbor, Michigan
A MODEL OF CONSUMER CHOICE

by

Frances Marie Magrabi

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Major Subject: Consumption Economics

Approved:

Signature was redacted for privacy.
In Charge of Major Work
Signature was redacted for privacy.
Head of Major Department
Signature was redacted for privacy.
Dean of Graduate College

Iowa State University
Of Science and Technology
Ames, Iowa

1962
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I. PREFACE

To the individual consumer, choice is a recurring problem and one on which much of his welfare depends. His freedom to select from an assortment of goods and services is a potential for obtaining either a maximum or a minimum of comfort, security, and philanthropic giving. Choice has significance in every aspect of the consumer's life and affects his total environment, including other individuals, groups, and social structures. It is no wonder, then, that choice behavior has been studied from many points of view and with a variety of techniques. Some of these types of choice research are discussed in the second chapter.

Research in the area of consumer choice contributes to human welfare in several ways. It extends information about an area of behavior which has far reaching effects in the daily living of consumers, in the degree to which they achieve their long term goals, and in the satisfaction which they enjoy. It enables policy makers in business and government to predict choices in the future and make recommendations with respect to product offerings, characteristics of the nonprice offer, and uses of products.

A consideration of individual choice research makes it apparent that further development is possible, particularly in the study of situational elements which constrain choice
and the characteristics of outcome which the consumer wishes to maximize. The major purpose of this dissertation is to define elements of the choice situation in such a way that multiple constraints and desired characteristics can be measured and an analysis made of their interaction in determining choice. From this foundation, empirical studies may be designed, but this is beyond the scope of the dissertation.

In pursuance of this objective, a terminology of choice is defined and discussed. Three criteria have been applied in the selection and definition of terms: (a) the proposed elements must be capable of being observed and recorded as research data, (b) from the proposed elements it must be possible to formulate hypotheses which have significance for understanding and predicting choice, and (c) statistical techniques of analysis must be applicable.

General considerations in the study of choice are presented in Chapter II where research models are defined as an application of theory to real data and several types of choice research are discussed in that respect. The proposed model is then defined as a special application of theory to choice behavior. The third chapter is devoted to a consideration of characteristics of models and the functions which they serve.

Chapter IV is a discussion of some general characteris-
tics of models and the functions which they serve.

Chapter IV is a discussion of some general characteristics of the choice environment, including the decision maker. Some of these aspects are described in more detail in the next three chapters as elements and relationships of choice, and information, which is the decision maker's perception of his choice situation. Interaction of choice elements is explicated in Chapter VIII, together with conclusions concerning characteristics of chosen alternatives. The final chapter is a discussion of practical considerations relevant to applying the model in research.

A glossary is appended to aid the reader in understanding words which have been given specialized meanings. Many of these terms have been defined and discussed in the body of the thesis, but, in order to avoid repetition and follow a logical organization, words have sometimes been used before they were defined. Use of the glossary should prevent confusion.

This dissertation has been written entirely from the research point of view. Descriptions of the decision maker and his situation should be regarded, not as conclusions about how things really are, but as a way of looking at reality which may be useful in formulating research problems. The proposed model should be examined to see whether it is
intuitively reasonable and logically sound, but its final justification will be its usefulness as a basis for choice research.
II. CONSUMER CHOICE RESEARCH

Choice studies are concerned with behavior in relation to situations which include a set of alternatives from which one must be chosen by the decision maker. If choice behavior is to occur, the set of alternatives must include at least two from which the decision maker is able and willing to choose. Moreover, the decision maker must be aware of at least two such feasible and desirable alternatives and must weigh their relative advantages and disadvantages. Choice studies are not limited to the study of genuine choice behavior, not only because of the practical difficulties of distinguishing it from other behavior but also because information about choice behavior is applicable to many purposes even though the decision maker may have seriously considered only one alternative.

Consumer choice behavior is a selection from among alternatives, with consumption of goods or services being included in or implied by each alternative. Decisions about purchase are included in the definition, as well as decisions about use and disposal of goods.

Choice may be viewed in either a static or a dynamic context. On the one hand one may examine the logic of choice, the elements which enter into a decision and their relatedness, the choices that are made and the persons who
make them, and the results of those choices. This is the static viewpoint. One might, on the other hand, observe how choices are made and how the choice situation and the decision maker change during the choice-making process. This is a dynamic view of choice. Each of these has its particular contribution to make in the solution of social problems and the extension of knowledge.

The kinds of studies designated in this dissertation as consumer choice research are investigations of choice in a static context. Elements are observed and measured without regard to time sequence. Time relationships are observed as static elements. Studies of the dynamic aspects will be termed decision making or decision process research, and will not be discussed.

Before attempting to set up a research model, it seems wise to take an overview of research, its general nature, and its relationship to other kinds of activity and knowledge. In applying research models, data are examined in light of theory, that is, they are compared with a conceptual structure. These data are selected, identified, manipulated, and interpreted in a particular way; they are represented in a model in such a way that theoretic statements may be made about them. Research may be discussed in the contexts of (a) the form of model used, i.e., analytic and synthetic approaches proposed as a bridge between real and theoretic,
methods used, and uses to which conclusions may be put, (b) theories relevant to the research, and (c) the real world from which data are to be drawn.

A. Forms of Research Models

Scientific research is planned and carried out with method and application or use in mind. These vary with the environment, but may nevertheless be categorized in such a way that specifications of a satisfactory model might be based on them.

1. Methods of research

Selection and manipulation of data are planned according to the purposes for which the research is conducted. Interpretations are made and conclusions are stated with respect to one or more particular objectives, for example, to describe, relate, contrast or compare, and predict.

Description is the identification of inclusion relationships, that is, membership in a set. Suppose the research worker has conceptualized a set of elements having distinct subsets. He may wish to categorize data by identifying them with subsets, or he may wish to test the hypothesis that certain data are identified with certain subsets. Descriptive

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research yields information, either in extensive form, as the enumeration of data, or in summaries using frequency distributions, values of the mean, median, or mode, the range or the variance. Description may be the sole purpose of research, or it may be a preliminary to further study.

The research worker may gather data for the purpose of identifying and measuring mapping relationships among elements, and testing the hypothesis that specific relationships are present. These may be cause and effect relations between elements, or simply association. Regression methods might be used to estimate these relationships.

To contrast or compare is to measure deviations from congruence. Real elements and relationships may be contrasted with theoretic ones, or two sets of the real may be contrasted. A predicted measure may be contrasted with an observed measure, or different observations of a single real element or relationship may be contrasted to measure variation or error in measurements. Several elements may be contrasted for the purpose of identifying sets or subsets and, in this way, inclusion relationships may be conceptualized. Similarly, contrast may be helpful in conceptualizing mapping relationships. Factorial experiments are methods of contrasting relationships.

Finally, research may be undertaken for the purpose of prediction, i.e., the assignment of measures to unobserved
relationships. Predictions may be made on the basis of analogy or deduction. Reasoning in the first case proceeds as follows: the observed environment appears to be congruent with the unobserved in specified respects, therefore relationships of interest will be congruent; or, the observed environment is incongruent with the unobserved to a certain degree in some relationships, therefore it will be incongruent to a proportionate degree in other relationships. Reasoning by deduction proceeds by drawing theoretic conclusions and applying them to data fitted into a model. To take a simple example from marginal utility theory, if the price of one good is substantially increased, the consumer whose choices are at equilibrium at one set of prices will move to a new equilibrium set of choices in which quantities purchased of that good are reduced. Applying this conclusion to data fitted to a model of price changes and consumer response, one can predict that increased price will lead to decreased sales. To predict the proportionate or absolute decrease in sales, analogies with previous responses may be made.

These methods may be used singly, or several may be used in one research project. They may correspond to steps in the

---

analysis of data which first involves description, then relationships among categories of data may be measured, and, finally, contrasts may be observed and predictions developed.

Some criteria are proposed in Table 1 for identifying the appropriateness and efficiency of research models with respect to several purposes for which studies may be conducted.

2. Applications of research

The undertaking of research presupposes a problem; the findings are intended to be used, directly or indirectly in the solution of that problem. Three basic uses may be defined as understanding, recommendation, and prediction.

Often the conclusions of research are used for nothing but to understand and comprehend an environment or process. Such research is often intended as preparation for formulating a problem having imperfectly known structure or content.

Conclusions may be used to predict conditions. Prediction as well as understanding is sometimes a preliminary to an ultimate use, which is to recommend courses of action. This is the use to which scientific research should finally contribute, though it may be indirectly and it may happen that this use is not made. Research into consumer behavior is used to make recommendations with respect to production of goods, marketing procedures and conditions, purchase and use
Table 1. Criteria for appropriateness of research models

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Purpose sought^a</th>
</tr>
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<tbody>
<tr>
<td>1. The categories or subsets with which data are to be identified must be exhaustive and exclusive, in the sense that no data are left uncategorized or are identified with more than one category.</td>
<td>D R Ce Cr P</td>
</tr>
<tr>
<td>2. The categories or subsets must be defined in such a way as to correspond with elements of the problem.</td>
<td>D R Ce Cr P</td>
</tr>
<tr>
<td>3. A sufficiently large number of categories or subsets must be conceptualized in the model to provide a satisfactory solution of the problem.</td>
<td>D R Ce Cr P</td>
</tr>
<tr>
<td>4. The cost of categorizing and summarizing data must meet relevant criteria.</td>
<td>D R Ce Cr P</td>
</tr>
<tr>
<td>5. The selection of relationships measured must be such as to provide a satisfactory solution to the problem.</td>
<td>R Cr P</td>
</tr>
<tr>
<td>6. The cost of measuring relationships must satisfy relevant criteria specified in the problem.</td>
<td>R Cr P</td>
</tr>
<tr>
<td>7. The selection of elements to contrast must be such as to provide a satisfactory solution to the problem.</td>
<td>Ce Cr</td>
</tr>
</tbody>
</table>

^a D represents description.  
R represents relation.  
Ce represents contrast between elements.  
Cr represents contrast between relations.  
P represents prediction.
Table 1. (Continued)

<table>
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<tr>
<th>Criteria</th>
<th>Purpose soughta</th>
</tr>
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<tbody>
<tr>
<td>8. The cost of contrasting elements must satisfy relevant criteria specified in the problem.</td>
<td>Ce</td>
</tr>
<tr>
<td>9. The selection of relationships to contrast must be such as to provide a satisfactory solution to the problem.</td>
<td>Cr</td>
</tr>
<tr>
<td>10. The cost of contrasting relationships must satisfy relevant criteria specified in the problem.</td>
<td>Cr</td>
</tr>
<tr>
<td>11. Prediction must achieve a degree of precision and certainty such as to provide a satisfactory solution to the problem.</td>
<td>P</td>
</tr>
<tr>
<td>12. Measure scales must satisfy precision and certainty criteria specified in light of the researcher's definition of an acceptable solution; a statement of measure should include the degree to which these criteria are met.</td>
<td>R Ce Cr P</td>
</tr>
<tr>
<td>13. The cost of meeting precision and certainty criteria must satisfy relevant criteria specified in the problem.</td>
<td>R Ce Cr P</td>
</tr>
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of goods by consumers, and government regulation of the production, marketing, and use of goods. In use the findings of research are a part of the real environment.
B. The Utility Approach

Theories of consumer choice are based on utility theory. An alternative is chosen because it is "better" than all others, i.e., it yields more satisfaction, has greater utility for the consumer. If further explanation of the nature of utility seems useful, it may be argued in a manner such as the following: elements or alternatives have utility because they have certain desirable characteristics, desirable because of their relationship with characteristics of the consumer, i.e., his wants or needs. This shifts the burden of definition to theories of the consumer where, perhaps, the burden properly belongs. In theories of choice the assumption is made that consumers do in some manner impute something called utility to alternatives.

Theories of consumer choice are theories of constrained choice: (a) given a set of elements having a particular preference order and (b) given a set of relationships constraining choice to a subset of those elements, (c) optimum choice is identified by an application of (b) to (a). In the following subsections preference order of alternatives is discussed under utility functions, then price and income constraints are stated. Finally, two ways of relating utility functions and constraints are indicated.
1. **Utility functions**

According to Armstrong,

...the economists' assumption with regard to choice may be expressed as the assumption that for any given individual at a given moment there is a function, which we will call the utility function of the alternatives, any of which could conceivably be presented to the individual, and this function determines an indifference class of alternatives... ¹

The utility function, then, is one capable of ordering a set of alternatives into indifference classes. Armstrong is careful to limit utility functions to specific individuals at specific times. He does not make the assumption that an indifference class determined by a utility function will be the same as that determined if the same set of alternatives were presented to the consumer at another time or were presented to a different consumer. In research models based on utility theory, assumptions about the comparability of utility functions between persons and over time may be needed. If the purpose of the study is to describe a population by observing a sample of persons, and if the conclusions depend on the assumption that each person in the sample chooses in accordance with a utility function, then in some sense those utility functions must be assumed to have applicability not

merely to single individuals at a specific point in time but to a group of persons during a period of time. Similar assumptions must be made if the purpose of research is to relate, predict, or contrast.

Suppose the alternatives to be ordered by the utility function are combinations of consumer goods in different quantities. One may conceptualize the utility function as

\[ U = f(x_1, x_2, \ldots, x_n) \]  

(1)

where \( x_i \) (\( i = 1, 2, \ldots, n \)) are quantities of \( n \) different consumer goods and \( U \) is a quantity which completely orders the set of alternatives. Then for any pair of alternatives, each containing a specific quantity of each consumer good, the utility function determines which alternative is preferred, that is, has the greater utility.

It follows from (1) that for any pair of goods \( x_i \) and \( x_j \), a marginal rate of substitution can be determined which is the quantity of \( x_j \) which could be substituted for the marginal unit of \( x_i \) without changing the value of \( U \). Marginal rate of substitution may be defined in different ways; intuitively, it means that for any good \( x_i \) there must be some quantity of any other good \( x_j \) for which the consumer could be
induced to exchange a unit of \( x_1 \). But while marginal rate of substitution is derived as a concept from the utility function, it can be measured without measuring utility.

2. **Constraints**

   If there were no constraints on the \( x_i \), then \( U \) would presumably be unlimited and there would be no possibility of optimum choice, since no matter what combination of the \( x_i \) were identified, there would always exist other combinations yielding higher utility. The only utility functions of interest in reference to a model of choice are therefore functions in which the \( x_i \) are constrained in some way, that is, there must be limits to the measured quantities in which goods are available as alternatives. If the admissible \( x_i \) are goods which may only be obtained by an expenditure of resources, then the utility function is a basis for the choice problem.

   Suppose only a single constraint is effective, the price and income one. This might be written as

   \[
   Y \geq \sum_{i=1}^{n} p_ix_i
   \]  

   where \( Y \) is money income, appropriately defined, and \( p_i \) is the

money cost to the consumer of units of the ith good. Then (2) constrains choice to a set of alternatives, each of which is a combination of goods which costs no more than the consumer's money income.

Suppose that the use of goods requires the expenditure of several resources in addition to money, for example, time and space. Perhaps the goods may not even be purchased without expenditure of time and space. Then there may be collections of goods which are feasible choices with respect to their money cost, but which may not be chosen because of time or space limitations. Unless these constraints are stated as part of the model, they must be taken as an assumption.

3. Maximization of utility

If \( U = f(x_1) \) orders alternatives by preference, and the only constraint is the price-income one, then

\[
V = v \left[ f(x_1), Y, p_1 x_1 \right]
\]

identifies the alternative having the maximum utility for the consumer from the feasible set.

The preferred feasible alternative might also be identified using marginal rate of substitution. If \( n = 2 \), then the alternative having the maximum utility is the one in which \( x_1 \) and \( x_2 \) are present in quantities such that the marginal rate of substitution of \( x_1 \) for \( x_2 \) equals the ratio of
their prices, and the sum of their money costs equals income.¹

Individual demand for a commodity is the quantity of that good which a given consumer will purchase at a particular price and income level. Aggregate demand is the quantity which a group of consumers will purchase at a particular price level and distribution of income and is a sum of individual demand curves.

Demand may be measured in reality by collecting data on the consumer's actual behavior, or it may be constructed theoretically, given appropriate measures of marginal rates of substitution at a range of prices and incomes. The individual demand curve indicates a collection of alternatives, each having the highest utility of any in the feasible set, for given measures of $p_1$ with $p_j$ and $Y$ remaining fixed or for given $Y$ with $p_1$ and $p_j$ fixed.

4. Relationships presupposed by utility functions

While the utility function, appropriately defined, is satisfactory as a theoretic framework for choice and demand analysis, for some purposes it may be useful to examine other relationships in the decision situation, relationships which may be said to underlie the utility function. In the first

¹Hicks, Value and capital, p. 20.
place, there may be constraints, other than the price and income one, which limit the field of choice. If they are effective at all, it may be well to examine their relationship to the utility function. Second, the statement that collections of goods have utility for the consumer may sometimes be less useful than an analysis of incidence of goods in different situations. Further, suppose that the availability of time and space not only affects feasibility of alternatives, but also is a determinant of $U$, that is, the amount of utility yielded by a given alternative depends not merely on quantities of goods but on time and space expenditure as well. Then for each different allocation of time and space there must be a different utility function; any particular $U = f(x_i)$ must assume some allocation of time and space.

Utility may be dependent on factors other than quantities of goods, time, and space. Utility may vary according to kinds and quantities of goods already owned, personal characteristics of the consumer, his family and other associates, the community in which he lives, and perhaps other environmental characteristics. If these factors are not enumerated in the utility function, then particular environmental conditions must be assumed for any given utility function.

A utility function comprehending all factors affecting
utility can be described.\textsuperscript{1} If the purpose of research is descriptive and analytic, complete enumeration may be useful. However, as a basis for demand functions, all factors other than quantity of goods, prices, and income might be included in those differences among consumers which make generalization of utility functions invalid. Or, if the purpose is to construct a decision model, the enumeration might be limited to factors from whose variations the decision maker can effectively choose.

For some purposes it may be useful to look at relationships which underlie preferences for goods. At one level of generalization, preference can be described as a hierarchy of wants, with preferences for goods derived from their capability of fulfilling wants. At a more detailed level, preference may be conceptualized in relation to planes of living, each of which is an environmental pattern encompassing all the activities of the consumer. Preference is an ordering of the set of all those planes of living from which a decision maker might conceivably choose. Preferences among goods and quantities of goods would be a reflection of preference for the planes of living of which they form a part.

\textsuperscript{1}For example, see Joseph Gartner. An application of economic models to consumer marketing programs. Unpublished Ph. D. Thesis. Ames, Iowa, Library, Iowa State University of Science and Technology. 1961.
If the larger quantity of a good were part of a more highly preferred plane of living, it would be preferred over the smaller quantity.

These preference relationships, derived from a hierarchy of wants or planes of living, are antecedent to any utility function which describes utility as a function of quantities of goods or of other environmental factors. For some specific purposes, these antecedent relationships, rather than the utility function itself, may be more usefully studied.

C. Content of Consumer Choice Research

Some subject areas in which there has been choice research are commodity demand, measurement of utility, goals and values, and related factors. These areas might also be described as answering the questions: What is chosen? What value does it yield? Why was it chosen? and What additional factors constrain or otherwise influence choice? There are also studies of individual and group choice making procedures. These latter will not be discussed, since the present purpose has to do with static analysis of individual choice situations. The first four types of research mentioned above will be described just sufficiently to identify some research areas closely related to the approach proposed in this dissertation.
1. **Demand for commodities**

In a mass production economy where the bespoke article of consumption tends to be the exception rather than the rule, studies of demand provide needed information. Commodities are produced without any commitment from buyers; if these goods are then purchased by the potential consumer, well and good, if not the results are social waste and business losses. Losses suffered by individual firms may be of concern to only a small number of people, but they may also have indirect effects in other industries as well. If, for example, the automobile makers fail to anticipate consumers' tastes in tail fins and are unable to sell their products, the rubber and steel industries may suffer loss of profits. Social waste is less easy to measure; yet unproductive use of resources, both human and nonhuman, has unfortunate results in human welfare which are observable.

Some of the same general statements may be made concerning demand for services. Skills may need to be acquired well in advance of demand for them, equipment may need to be purchased, and at the very least a residence must be maintained by the potential employee in the geographic area where continued demand for his services is anticipated.

It is of private and social importance both to individual consumers and to business firms, to measure and predict demand for consumer goods. At one level, the purpose of
research may be limited to the description of demand. This may be expressed in total quantities of goods purchased by consumers, total quantities purchased at each price at which the goods are offered, average quantity purchased per consumer, or in some other summary form. Such descriptions may be helpful as a means of understanding the environment, but they may also be used as a basis for prediction or recommendation. For example, suppose a producer is willing to assume that the factors causing a particular good to be purchased in a particular total quantity will not change within the next ten years. Then, if he knows the current demand, he can predict demand for the entire ten-year period. If he assumes that all factors other than price will be unchanged, and if he has a description of demand at several price levels, then he can predict demand at any of these prices.

Evidently descriptive research makes a minimum use of theory. However, the research elements are identified with theoretic ones, and price is recognized implicitly as a constraining factor.

If the purpose of demand research is to measure relationships between several factors, then their simultaneous variation must be observed and measured. For example, the relationship of demand with price and income may be measured
using regression methods. The resulting measures of relationships may be used in projection, as in forecasts of demand. Or contrasts may be made, for example, between projected and actual measures as when forecasted demand is compared with actual measures of demand, or between several actual measures as when the price elasticity of bread is compared with that of meat. Models having these purposes may be drawn directly from utility theory, with utility assumed to have the form indicated in the preceding section and price and income as the only constraint. From this the demand relationships may be derived.

2. **Utility measurement**

Prediction of demand as a function of constraining factors gives useful results and avoids the problem of measuring utility; yet in some research problems one would like to bring in the utility function in a more direct fashion. For example, suppose one wants to formulate a rule of choice among alternatives which have no effective constraints, such as two goods having identical prices. In such a case choice is made on the basis of "payoff" or utility yield.

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Models for such purposes may require the measurement of utility. While this area is not well developed, some studies pertinent to the purpose have been made. For example, Davidson and Suppes report an experimental measure of utility based on expressed preferences among outcomes having different probabilities of occurring.¹

3. **Consumer goals and values**

Another approach to consumer choice is to investigate characteristics of the consumer which cause alternatives to have utility for him. These characteristics are his goals and values and environmental characteristics which cause or are associated with goals and values. Goals are the outcomes which the consumer wishes to have realized; values are elements in a set of goals defined at a higher level of abstraction.

The usefulness of such research is apparent: if utility is a function of goals and values, and if goals and values can be measured independently of choice, then choices may be predicted or actual choices evaluated without measuring either utility or relationships between choice and constraints. The directness of such an approach has an

intuitive appeal and avoids, moreover, some errors and inadequacies inherent in demand analysis and utility measurement.

Techniques used in goals and values research include description and contrast. Goals and values are difficult to define with operational precision; however, since description is a necessary first step to other forms of analysis, much of the research in this area has been descriptive. However, where the descriptive data are assumed to be adequate, they may be used for predicting choice or for contrasting actual choice with that indicated on the basis of goals and values.\(^1\)

Goals and values research predicates that utility is primarily a function of goal fulfillment rather than of the alternative chosen. In this it differs from demand analysis.

4. **Factors related to choice**

Some environmental factors, for example, population traits, seem to be related to choice although they are neither utility producing, constraining, nor the goals of

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\(^1\)As examples of this kind of research see the following:
choice. As an example, consider kind and level of education, previous experiences, kind and neighborhood of residence. These factors may well be related to some choices and worth study.

These studies vary in structure and might have their theoretical basis in several of the social sciences. However, studies might be based on special forms of the utility function; for example, consider

\[ U_r = f(x_1) \]

where \( U_r \) is utility derived from reading and \( x_1 \) are cultural factors such as years of formal education. This is quite different from the utility function mentioned in earlier sections which states that the utility experienced is a function of choice. The special form states that the utility of choices is a function of certain cultural factors. The first form is concerned with the causes of choice, the special form with the causes of utility.

These studies might be used for predictions based either on simple description or on projections of measured relationships. More often, perhaps, they are used to enlarge the understanding of individual and social behavior.\(^1\)

\(^1\)Albert Lauterbach. Man, motives, and money. 2nd ed. Ithaca, N. Y., Cornell University Press. 1959. p. 239.
D. A Situational Approach

The model to be proposed in this dissertation can now be classified by structure, relationship to theory, and content. It will be seen to resemble models for demand research, though having some points in common with other models. Basically, the proposed model defines alternatives as bundles of characteristics, rather than of commodities; its purpose may be that of identifying a function of the characteristics which best discriminates between chosen and rejected alternatives.

1. Form

Like studies of demand, the ultimate purpose of the proposed model is projective. The elements are to be described, relationships among them measured, and projections of these relationships made. But like studies of goals and values and of other factors related to choice, description of elements is difficult and essential. Indeed, the elements measured and related in the proposed model may be the same as some of those used in goals and values research or studies of social factors related to choice.

A primary use of the proposed model is to extend and improve the research worker's comprehension of choice as it relates to the consumer and his situation. It is intended to answer the question, "Why were particular alternatives
chosen?" It may also be used to predict choice or recommend policies with respect to control of situational elements. In other words, it may predict what will be chosen under changed circumstances or how the circumstances may be changed to encourage the acceptance of particular choices.

2. Relationship to theory

Basically, in the proposed model, choice depends on the constrained utility function

\[ U = f(x_i) \]

with each \( x_i \) constrained within certain limits. The \( x_i \) of this function are characteristics of alternatives rather than quantities of goods. They might include characteristics such as money cost, time requirements, color, flavor, and the like.

3. Content

The content of the proposed model includes the entire choice situation, although in a practical situation only those elements might be included which can be conveniently and precisely measured and which significantly affect choice. Among these might be money, price, and quantity of certain commodities, variables relating to goals and values, and cultural factors.
E. Similarities of Choice Models

There is a communality of all the models mentioned above which goes beyond their relationship with the common focus, choice behavior. Some of these similarities are in their common philosophic assumptions, some in their similar approach to research. Without attempting a complete list or extensive discussion, some likenesses are suggested below which may help relate choice models to broader fields of knowledge.

In all these models of choice, freedom of will is assumed. The decision maker is influenced by his choice situation, but choice is not predetermined. If it were, there would be little interest in studying choice behavior since presumably it would be beyond anyone's power to influence.

Another similarity is that these models all assume an interrelatedness of environmental elements. In choice analysis quantities of commodities interact with each other and with price and income. Cultural elements influence goals and values and are influenced in turn. A basic meaning of the utility function is that, where several factors influence choice, they do so as an interacting unit.

These models also take similar views of choice makers with regard to their individuality, assuming that choice makers are structurally alike with individualities in scale. This, again, is inherent in the utility function.
Interpersonal comparisons of utility are not possible because the utility scales of individuals differ, not because they do not experience utility derived from the same sources. Again, choice makers are assumed to choose with respect to common sets of values, although the scale on which they measure the relative importance of these goals and values in particular choice situations is not assumed to be identical for all.

And, finally, each of these models takes a limited view of choice. A global model taking account of all aspects of choice is, perhaps, not impossible, but apparently it is deemed more expedient to base research on a model which encompasses only a part of the situation. In this way, specific questions about choice may be answered more efficiently than by using more comprehensive models, and at the same time information is provided which may contribute to analysis of the entire situation.
III. MODELS

A model is a device to bridge the gap between theory and real world. There may be many kinds of models, serving many purposes, but in their function as bridges they have common characteristics.

A. Definition

A model may be defined as an abstraction from a type of real situation. Concepts representing selected elements from the real situation are fitted into a system derived from theory.

The point of interest in a model is the relationships among elements; therefore, elements should be identified in such a way as to exhibit those relationships most clearly. In a real situation it is usually difficult to perceive relationships unless one has a preconception of what they will be, partly because of the brief period of time during which the event occurs, partly because of the presence of elements and relationships extraneous to those ones of interest.

There are difficulties both in going from a real situation to a model and in going from a model to a real situation. In the first case the difficulty is that of constructing, from one's impressions drawn from the real situation a coherent structure which will help one to understand certain aspects of the real situation. In the second case the
difficulty is in identifying elements of the model with one's impressions of the real situation in such a way that one may meaningfully describe the real situation in terms of the model. If, as may often be the case, one tries almost simultaneously to construct a model from sense impressions and apply it to the real situation, both difficulties are involved.

The observer who wishes to understand relationships which govern the internal logic of the situation must sort out those elements and relationships which make a coherent structure. He is like one who tries to put together a structure with pieces from an assortment such as an Erector set which can be used to make different structures. Sometimes his structure is incomplete because he has too few pieces; sometimes he has too many pieces and must select those which make the structure he has in mind. His perception may be incomplete because of his inability to comprehend the entire situation in the brief space of time during which he may view it, or because he is unable to sort out the parts which belong to the model in which he is interested. He may have an inaccurate and incoherent model because parts from several models have been fitted together incorrectly.

Suppose the observer is watching a machine cutting grass and trying to understand the mechanical principles which enable the machine to cut grass. Difficulty arises because
the machine is moving and there is no time to observe each part carefully, because he cannot see all parts of the machine at once and perhaps cannot ever see some parts. Further, the machine may include parts whose movements are random or at least irrelevant to the cutting operation. The observer must identify elements from his confused impressions of lines, colors, shapes, and volumes and examine these elements for indications of relationships among them. If these elements unambiguously exhibit relations relevant to cutting, the observer can be satisfied with his perception of elements; if not he must reexamine his impressions and compose them into a different set of elements. The question is not whether elements are identified in the real situation; rather the question is which set of elements exhibit relationships with least ambiguity.

To give an example in economic research, suppose the observer is interested in money income and expenditures as related by transactions in the retail market. It may be easy to distinguish one individual person from another, but are individual persons the elements which will exhibit unambiguously income-expenditure relationships? Usually not, since one individual may spend only a small portion of the income he receives, another may receive only a small part of the income he spends, and many other individuals may have a considerable effect on income-expenditure relationships without ever receiving or spending any money at all. Family income and
expenditures may be more clearly related; therefore, it may be convenient to treat the family as an element in the income-expenditure situation, even though the family unit is more difficult to define than the single individual.

To continue with the example, suppose that the observer wishes to identify an Engel-type relationship between income and food expenditures. Should one element be expenditures in grocery stores? Will this element exhibit the relationship unambiguously, or will the income-food relationship be confused with relationships between income and expenditures for cleaning supplies, toiletries, and hardware? It is true, this is largely a difficulty in the operational definition of elements. On a more basic level, suppose the object of observation is to distinguish relationships between income and expenditures for necessities as opposed to luxuries. In this case, should expenditures for food be treated as a single element, or subdivided as food for parties, for company meals, for snacks, for family meals? Should beverages be included? Should items such as coffee filters, which are consumed in one using, be classified with expenditures on coffee? Questions such as these arise both in constructing and applying models and must be resolved if the models are to be coherent.
B. Scientific and Personal Models

A model for scientific analysis and prediction should meet more exacting requirements than models constructed and remembered to meet casual requirements of everyday living. Scientific models are included in the corpus of the various sciences; they are tools for the orderly enlargement and verification of knowledge. Personal models are part of the mental equipment of individuals and are transmitted from one person to another with little regard for exactness of duplication.

A model expresses regularities. A scientific model expresses measurable regularities. Irregular or nonmeasurable factors (nonmeasurable because difficult or incapable of measurement) must be omitted from scientific models. It is impossible to take many measurements simultaneously; therefore a model can take into account individually only a few factors, though sometimes many factors may be recognized in a single measurement as, for example, probability measures. Because individuals require less precision of measurement in applying personal models than scientific ones, it is possible for personal models to include many more factors. This sometimes may result in more accurate prediction from personal than scientific models, though the imprecision of measurement causes predictive performance from personal models to be erratic.
For example, suppose the economist is interested in the behavior of persons receiving windfall payments of $100 each. According to the scientific model which the economist wishes to test, consumers as an aggregate will spend a proportion \( k \) out of windfall income and save a proportion \( (1 - k) \).\(^1\)

Suppose one of the windfall payments goes to the economist's next door neighbor. From his personal knowledge of his neighbor, the economist may predict correctly that this man will spend a proportion \( q \) of his windfall income. Or perhaps the economist, while accepting the aggregate model \( C = kY_w \), i.e., consumption equals a proportion \( k \) of windfall income, may predict that behavior with respect to windfall income coming at a particular time or to a particular group of consumers will not conform to the model, due to special circumstances of which he is aware but which are not included in the model. Again the economist's personal model might be a better predictor than the scientific one.

In many situations the advantages of scientific models outweigh the added cost of taking precise measurements and the disadvantage that the personal model may sometimes be a better predictor. One advantage of the scientific model may be that its predictive performance, in repeated applications

to a variety of situations, may be better than that of the personal model. Moreover, the scientific model may be applied without loss of predictive precision to situations about which so little is known that the personal model might be a poor predictor. Also, the formulation and application of personal models usually involve a certain amount of "flare" or intuition; the scientific model may be used with success by any trained technician. But perhaps the most important advantage of the scientific model over the personal is that it gives a standard performance; therefore, the error of prediction may be estimated.

Whether the advantages of the scientific model outweigh the disadvantages in application to any specific situation is a matter for judgment in each individual case. Often no known scientific model is applicable to a situation and so personal models must be used. Many personal models are inexact replicas of scientific ones, and may be applied in situations in which the scientific model is too costly or seems likely to be a poor predictor.

The distinctions between scientific and personal models may be discussed under three headings, consistency, transmissibility, and manner of application to real situations. There may be other distinctions, but these three will illustrate important points of difference.
1. **Consistency**

Consistency is the congruity of parts, that is, corresponding relationships must be the same and no contradictions may exist. Consistency in a model is desirable for two reasons: (a) a belief that no inconsistency is possible in the real world, and (b) the difficulty of knowing which of a set of mutually inconsistent models or relationships applies in a real situation.

Models may be consistent internally and externally. If a model is internally consistent, necessary conclusions drawn from any part of the model must not contradict necessary conclusions drawn from any other part or from the whole model. As a simple example, consider a model which states that savings is a function of interest rate and consumption is a function of income. If savings is defined as income minus consumption expenditures, then the model is internally inconsistent, since if consumption changes in response to a change in income, then savings must change regardless of the interest rate. A model is externally consistent if no necessary conclusion drawn from the model or any part of the model contradicts necessary conclusions drawn from other models held to be true.

Consistency, both internal and external, is a desirable property for a model to have. A minimum requirement for a scientific model is that it be internally consistent. This
is difficult to attain; it takes time and careful thought to explore critically all the implications of any statement. Perfect external consistency is probably humanly impossible of attainment, but nevertheless limited external consistency is the aim of any science; consistency, that is, limited to the models accepted as a part of that science.

Personal models frequently are inconsistent, both internally and externally. Individuals allow inconsistencies in their sets of personal models because of the trouble or impossibility of correcting inconsistencies where the disadvantage may be small compared with the difficulty of attaining consistency, and because of the ease of handling inconsistencies in real situations. The latter is true because in applications of personal models individuals take many factors into consideration which could not be admitted in the application of scientific models.

2. Transmissibility

The criterion of transmissibility refers to the precision with which a model is stated. If a model is stated precisely, it can be transmitted with reasonable care from one person to another and from one time to another without alteration of meaning. Precision of definition and measurement is a distinguishing characteristic of scientific models. By precision is meant exact reproducibility. All terms in a
scientific model should be unambiguously defined so that all persons reasonably familiar with the language in which the model is stated understand the terms in the model to refer to the same objects in the real world and can reproduce exactly measurements of those objects. In scientific application, exact reproducibility is more important than exact correspondence to real situations.

Individuals usually do not trouble themselves to transmit their personal models exactly or to measure elements precisely.

3. Manner of application to real situations

The third criterion distinguishing scientific from personal models has to do with application to real situations. In scientific models this is governed by rules which are a part of the model itself or which are generally accepted within the science as governing the application of models. The application of personal models are governed by no rules save those which the individual considers it reasonable or expedient to follow in any particular situation.

One type of rule with respect to application of scientific models is the prescription of a set of conditions to be met in order for the model to predict the outcome of any particular situation. These may also be called the assumptions of the model. As an example, consider the _ceteris_
paribus assumption governing application of the economic model describing supply and demand, or assumptions about market structure included in the same model.¹

Another type of rule governing the application of scientific models is that which prescribes manner of identifying and measuring elements in the real situation. Still another type governs the interpretation of evidence gathered by observation and measurement. This includes rules regarding the interpretation of observed inconsistencies, the degree of confirmation required for belief in conclusions reached through application of the model, or manner of arriving at and expressing predictions or generalizations about the observed situation.

C. Formulation of Problems

An important application of models to real situations is in the formulation of problems. Although the solution to a problem may be sought in data from the real world, the statement of the problem is necessarily drawn from a model since it is itself an abstraction. The model used in the statement of the problem may be a personal one or, in scientific research especially, a scientific one.

The extensive statement of a problem and solution must

¹Boulding, op. cit., pp. 63-79.
include an indication of admissible factors (elements and relationships), specification of what constitutes an acceptable solution, and the decision rule for arriving at a solution. Of the many factors present in a decision situation, only a few can be admitted into the statement of the problem. This is because a problem containing many factors is difficult to manage, and also because many factors in the situation are extraneous to the desired solution, that is, they either have no effect on the solution, or their inclusion would cause an unacceptable conclusion to be reached. Therefore the statement of the problem must indicate admissible factors, either by itemizing admissible elements or by specifying criteria for admission. Closely allied to this is the necessity for describing the solution which will be acceptable. To give a simple example from mathematics, suppose the problem is

\[ E(X^2) = ? \]

and admissible factors are

\[ Y = f(X), \ 0 \leq X \leq 1. \]

The acceptable solution is defined by

\[
\int_0^1 X f(X) \, dX \quad \text{where} \quad \int f(X) \, dX = 1.
\]

The decision rule describes the manipulations to be performed
in order to reach the specified solution.

Rules for obtaining a solution may not be unique; in any particular problem there may be several decision rules which will give acceptable solutions. Nor are these solutions necessarily identical. For example, consider the payoff matrix for a two-person zero sum game. The admissible factors are summed up in the matrix; the solution which is acceptable is that choice yielding the highest payoff under given assumptions about the opponent's choice. Several decision rules have been proposed for identifying this alternative, the maximin rule, pessimism-optimism index, and the minimum regret rule, for example.\(^1\) These rules do not necessarily give identical solutions, though they are all rules for obtaining solutions.

In some cases no decision rule may be known which gives a solution identified as acceptable. It may be possible, however, to redefine the problem in such a way that a decision rule can be formulated.

Since consumer choice is based on preference, choice problems must take account of both preference and physical relationships. Analysis may proceed in one of two ways: (a) preference relationships may be transformed into physical

ones in the statement of the problem, and the rules for solution given in physical terms; or (b) physical relationships may be transformed into preference ones, and the manipulations be expressed in preference terms. Consider the following simple model: with respect to houses, satisfaction varies directly with amount of floor space. Problem: choose the house yielding the most satisfaction per dollar. Solution: house having the highest ratio of measured floor space to purchase price. In the solution all preference relationships have been transformed into a single relationship between two physical characteristics.

This type of model is not always so simple. For example, indifference curve analysis is a transformation of preferences for bundles of goods into a form in which choice can be made on the basis of physical characteristics alone. Bundles of goods are arranged in order of physical quantity; the indifference curve identifies each set of bundles indifferently preferred; this is the statement of the problem. The solution is given in terms of physical quantities of goods and their money cost.

In contrast with indifference curve analysis, marginal utility analysis states the problem by transforming physical units of goods into preference units and then expressing the solution in terms of operations on the preference units. Physical units, i.e., dollars' worth of goods, are transformed
into quantities of utility, then the solution is that bundle of goods which has the characteristic that marginal quantities of utility are equal.

Indifference curve analysis has seemed an improvement over marginal utility analysis because it has seemed to involve less dependence on preference relations and consequently less need for manipulating intangibles.
IV. THE ENVIRONMENT OF CHOICE

Choice takes place in an environment in which the decision maker, his attitudes, aptitudes and predispositions for action have a key position. Also included are the decision maker's surroundings, both tangible and intangible, animate and inanimate. The purpose of this chapter is to examine environment in a general way as a preliminary to the analysis of choice.

A. The Decision Maker

The individual person exists as part of an environment in which he is in continuing contact with sense data, i.e., impressions of his own bodily processes as well as of objects external to his body. He may be regarded as organizing his sense data, ordering them by preference, forming and conforming to patterns. All of this is involved in perception and is the basis for overt behavior, that is, acts that can be observed. Just as perceptions are structured sense

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1The decision maker might not be a single person, but a family or other group deciding something together. This makes no difference with respect to theory of choice, which is confined in this analysis to the logic of applying preference as a criterion for choosing among alternatives. Hereafter the decision maker will be spoken of as a single person; no account will be taken of possible interaction among individuals in reaching a decision.
data, activities are structures of overt acts performed by
the decision maker.

In the present study, the behavior of interest is con-
sumption and the perceptions and activities related to it.
Choice is the selection from among several forms of consump-
tion and related acts. For example, the activity of food
consumption may be defined as including purchase, storage
and preparation of food as well as food service, eating, and
the cleaning and storage of utensils. As defined here, con-
sumption excludes choices in which the implications of using
up are not significant.

1. **Perceiver**

The individual learns to sense clusters of data which he
reacts to as wholes. Once the cluster is organized, he may
no longer perceive the entire array, but only one or two of
the most salient data, which then serve as cues for behavior.
Other data are sensed, particularly when the individual is in
a situation with some elements of novelty, but some part of
the mind constantly seeks to identify learned behavioral cues.

2. **Pattern maker**

As sense data are structured, corresponding patterns of
behavior are learned. These are activity sequences, each
oriented toward some cluster of sense data and intended to
obtain desired outcomes. The effectiveness of activities in
obtaining these objectives depends on (a) skill in perceiving as cues the appropriate data from the environment, (b) skill in recognizing suitable means, including tools, for obtaining the desired outcome, (c) ability to control such tools for present and anticipated use, (d) possession of a repertoire of effective behaviors, and (e) skill in selecting effective behaviors.

Selection of effective behaviors to obtain desired outcomes is the heart of choice theory. The decision maker must perceive the desired outcome and alternatives within his control which will effect that outcome. His problem is to select an alternative which will achieve the desired outcome to the highest attainable degree or with the greatest likelihood of success.

Choice is possible because sense data can be perceived as patterns. The decision maker learns to anticipate portions of the pattern and control it, for example, by anticipating hunger and providing food to satisfy it. He may also select among variations of a pattern and act in such a way that the desired variant is likely to be realized. Since the actions he perceives as possible may be ineffective or the pattern unpredictable in his information state, he is seldom certain of attaining his objective.
3. **Ordering agent**

The decision maker does not merely perceive his situation; he perceives himself in relation to his situation and orders elements according to his preferences. Order is a structure superimposed on perceptions, with the ordering of particular elements partly dependent on their position in the pattern. For example, the acquisition of savings may be perceived as an essential part of a pattern leading to some outcome having a high preference order; savings, then, would also tend to be valued highly.

Value standards are the basis for preference. These are ideal relationships or benchmarks which the decision maker contrasts with perceived relations in order to identify his preferences with real elements.

Preference ordering of elements is dependent on three factors: real environmental relationships, perception, and value standards. The decision maker senses data, perceives in them cues which indicate a pattern which he recognizes, and orders according to his preference the alternative outcomes associated with that pattern.

**B. Activity Patterns**

A part of the environment of choice are the activity patterns in which choices are realized. It is in this relationship that consumption is evaluated by the decision
maker. An activity pattern is a set of activities having in common their relationship to a single decision maker and also some other relationship such as contiguity in time or space, identity of objectives, or similarities in the actions performed. At intervals in the pattern there occur points at which variations might be effected. Decisions are made at these points, either in advance or as they become necessary.

To the observer activity patterns provide a means for classifying decision makers; for example, as tennis players or as blue collar workers. This classification has two advantages; (a) it is relatively easy to observe certain evidences of activity patterns; and (b) in their mediate position between the decision maker and consumption, activity patterns provide an indirect means of observing and measuring preferences. For example, suppose the observer was interested in consumer decisions to purchase automobiles. One classification of decision makers might be by occupation, since automobiles are used more extensively in some occupations than others and are valued accordingly.

Activity patterns have the following characteristics which make them a suitable basis for classifying consumers: regularity, duration and change, location in time and space, and differing levels of elaboration. These will be discussed in the following sections.
1. **Regularity, duration, and change**

Classification is based on similarities and differences. The degree of regularity in an activity pattern is one basis for comparison. Regularity refers to similarities in intervals at which an element recurs in the pattern, frequency with which two or more elements are associated as they recur, and proportion of such regular recurrences and associations in the total pattern. For example, one consumer may use a toothbrush at regular intervals and always with the same brand of tooth paste; a second consumer may brush at less regular intervals and vary his brand of toothpaste.

Another basis for comparing activities is in their duration. Some acts, as for example the tooth brushing one, may recur during most of the decision maker's lifetime. Other acts may recur over a short time and then be abandoned, as, for example, attending public dances.

The degree of change to which an activity is liable is a third basis for comparison. For example, during any single period of time, patterns of food consumption usually do not change greatly, while during the same period patterns in recreational activity may undergo substantial change. A consumer is less likely to change from three meals a day to one than to change from three movies a week to one.

Regularity, duration, and degree of change of activity patterns have certain implications in choice analysis. They
affect the frequency of decisions and the kinds of decisions which are made. They also may create a predisposition on the part of the decision maker to choose certain kinds of alternatives.

2. **Location in time and space**

   Another aspect of activity patterns worth examining is their location in time and space. Some regularities in patterns are contiguities of elements in time or space.

   Activities may be subsidiary to other activities in the sense that one always precedes or follows the other in time. Other activities tend to be separated in time. Such considerations affect the way the decision maker defines alternatives; for example, two alternatives may be identified as one because of their time relationship.

   The decision maker may allocate much of his effort and resources to procuring the use of appropriate activity space at convenient times and in making commodities and services available. Parks and picnic areas, public streets, and private homes, all are examples of space provided and equipped to facilitate particular kinds of activities.

   Regularity in activity patterns may be partly explained by the considerable organization necessary to bring into conjunction, at appropriate time periods and in appropriate spaces, the persons and physical objects for carrying out
activities. A regular routine conserves resources which would otherwise be consumed in the process of making decisions. Consumers may prefer to adapt their activities to established patterns rather than create new ones.

3. **Elaboration of activities**

Choice takes place within the setting of an activity pattern which partially fixes the conditions for choice making and provides a terminology by which the chosen alternative may be compactly described. What has gone on before in the pattern decides the alternative ways the pattern can be continued, expanded, terminated, or changed. These alternatives may be described in their relationship to the pattern. Therefore, a knowledge of the pattern is pertinent to the analysis of individual choice behavior. It is a partial summary of the physical environment of choice.

Suppose consumption is associated with a small number of basic activities such as eating, ensuring health and sanitation, recreation, rest and sleep. The activities may be carried on at what might be termed a minimum level or may be expanded and elaborated to any degree, for example, by

1. increasing the proportion of time given to that activity;

2. increasing the regularity of its performance, or the priority it is given over other activities;

3. elaborating the materials used in the activity by
increasing the proportion having specialized functions, refining their design, or establishing exclusive rights to materials;

4. increasing the number, specialized function, and refinement of the separate acts included in the activity;

5. establishing and elaborating rituals;

6. including within the activity action units having a purpose subsidiary to the main purpose of the activity;

7. increasing the number of persons participating in the activity; the specialization of their roles, and the degree to which their performance follows a pre-established pattern; and

8. attaching to the activity specialized symbols, language, literature.

Using this approach, variations of activities could be classified or ranked on a continuum according to their level of elaboration. Consumers might be categorized according to elaboration of activities. Also alternatives might be defined as different forms or levels of elaboration.

C. Planes of Living

An alternative method of summarizing the choice environment is in terms of planes of living, a method which has the advantage that the consumer's activities are summarized as an interacting whole rather than as several distinct parts. The plane of living may be defined as the pattern of all
activities carried on by a decision maker. It is a complete
description of the choice environment. Moreover, variations
of planes may be ordered, either by their physical charac-
teristics or by preference.

1. **Physical measurement of planes**

   Suppose it were possible to describe in quantitative
terms the degree to which any activity is expanded and elab-
orated; then the whole activity of a consuming unit could be
described and quantified as plane of living. This would in-
clude all activities engaged in by the consuming unit, al-
though the ones of particular interest here are consuming
activities and their concomitants. A complete description
of plane of living would identify all the separate acts in
each activity, the persons and material objects associated
with each, and time and space allotments.

   There would be very large numbers of possible planes of
living so described, probably at least as many as there are
consuming units. If, however, as may be hypothesized, planes
of living tend to be similar and to be expanded in similar
ways within a culture, it is reasonable to categorize them,
either into groups or along a continuum. Descriptions could
then be simplified to a bare indication of group membership
or position on the continuum. This might be indicated by the
mention of one or more salient characteristics of the plane,
as, for example, residence or club membership.

2. Preferences for planes

The practice of indicating an entire plane of living with a brief descriptive term facilitates communication, but it has two additional effects of some importance. It enables an individual to identify his own plane of living with some group or position on the continuum and to define planes of living he would like to attain. It may also give an exaggerated importance to certain features due to a general recognition of them as characteristic of certain planes of living.

To elaborate, the ability to treat a plane of living as a unit, even though by a mere verbal trick, makes it possible for individuals to develop and express preferences for entire planes. Preferences may be due to presence of preferred characteristics, or, on the other hand, characteristics may be preferred because they are contained in preferred planes.

Verbal description of planes of living as units indicates and intensifies the interrelatedness of the characteristics of a plane of living. These may be interrelated because the time and space each activity occupies must be scheduled in competition with requirements of other activities and because material appurtenances are generally in short supply and can be obtained only by allocating resources among competing uses. Another reason may be the psychological
conviction that, since certain characteristics are treated as a unit verbally, they must necessarily appear together in real life.

The characteristics chosen to serve as indicators of plane of living for the purpose of communication are usually the most conspicuous features or sometimes the most integral. For example, wall-to-wall carpeting or country club membership are convenient tags because these things are highly visible. Conspicuous might also mean most satisfactory or unsatisfactory, for example, planes of living classified by presence or absence of running water or by the amount of paid household help. Some characteristics serve to indicate plane of living because they are an integral part of many activities, for example, income or type of residence.

One's preferences with respect to planes of living are intimately associated with the satisfactions yielded by different planes. Satisfaction stems from the fulfillment of expectations, completion of plans, execution of decisions, from a consciousness of respect and envy on the part of others, from reduction of physical discomfort, and from aesthetic appreciations. Probably satisfactions are associated with activity units rather than with the plane of living as a whole. However, an entire plane of living may be accepted and desired because of certain highly desirable and integral parts. For this reason, certain characteristics of
a plane of living may be highly valued even though the satisfaction derived from them is slight, while characteristics satisfactory in themselves may receive a low valuation because of disagreeable concomitants.

Plane of living is a concept which summarizes a complex array of real elements. The shorthand techniques which enable discussion of planes of living as integrated wholes also affect decisions by further integrating the components of planes and by affecting valuation of components.

As shorthand designations such as country club membership are incomplete descriptions, they may frequently be misleading. However, human behavior is based on imprecise designations and effects of this should be taken into consideration in a theory of behavior. The task is complicated by the fact that human beings are generally well aware that their language is imprecise and make corrections for this. The corrections themselves are not always consistent or well advised. In the case of plane of living, shorthand designations, corrected or not, influence valuation and therefore choice.
D. Decision and Choice

In professional literature a distinction is seldom made between decision and choice. Siegel\(^1\) uses "model of choice" to describe a construct combining utility as a basis for choice with psychological factors which affect the decision process, but in the same context he also speaks of decision making. Davidson and Suppes\(^2\) use the term "decision making" to describe their model, while Luce\(^3\) speaks of choice. Moore and Anderson\(^4\) use the term problem solving in the same sense as decision. There seems to be no consensus on a distinction between the theory of choice and the theory of decision. Thus, each author bears responsibility for defining and justifying the terms he does use.

1. **Definitions**

A distinction between decision and choice is feasible with respect to their scope and dynamic aspects. In the


\(^2\)Davidson and Suppes. *op. cit.*


chapters which follow, decision will be taken to mean an entire process, including identification of objectives and alternatives, gathering and evaluating information, and selecting a single alternative. Choice is only one step in the decision process, that of selecting one alternative from a set of two or more alternatives. Action follows, but is not included in, choice. Decision is a dynamic concept, choice is static. Every step in the decision process is somehow related to choice; therefore, the analysis of choice yields a static picture of decision viewed at the moment of choice.

Choice might be viewed simply as behavior, without normative implications. In contrast, studies dealing with the logic of choice seek to identify the characteristics of the optimum, that is, the alternative which the decision maker really wants or ought to choose. Having defined optimum choice, these studies may proceed either to compare the characteristics of the optimum choice with those of the actual choice, or to identify and measure the characteristics of the actual choice defined arbitrarily as the optimum.

2. Elements and relationships in choice

The logical nature of choice has been explained in many ways, but these models necessarily cover two facets of the choice situation. First, the elements in each alternative possesses certain causal or associational relationships with the physical outcome of choice, and second, each alternative
possesses causal or associational relationships with the psychological or sociological outcome. To illustrate this, suppose a family is choosing a home from among several houses on the market. Each house possesses physical characteristics, that is, each has particular outside dimensions, number and shape of rooms, kind and quality of materials, location with respect to other residences, schools, shopping areas, the breadwinner's job. Each house has its own terms of sale, including amounts and timing of money payments. These characteristics bring into being physical relationships, such as the amount of money to be spent for housing in relation to total income and to other expenditures, contiguity to other persons resident in the neighborhood, lines of travel to business establishments, school, and friends. These physical relationships produce different physical outcomes, depending on which house is chosen. If one house is purchased, the family may follow one pattern of time and money use, have one set of friends, engage in one set of activities; if another is chosen, these may be quite different. But physical relations alone are not a sufficient basis for choice; there must in addition be preference relationships.

"Physical" has, perhaps, been used in a peculiar sense. By it is meant that which can be observed or inferred directly from evidence other than introspection. Preference refers to emotional content. Physical relationships may or may not
be directly measurable. Preference can only be measured by introspection or by indirection, that is, by measuring physical factors closely associated with preference. Where it seems necessary to take preference into account it is important to select with care the physical relations assumed to exhibit the effects of preference. The first requisite is that these physical relations be unambiguously defined, both in themselves and as carriers of preference relationships. The second is that they be conveniently and exactly measurable. The third requisite is that these physical relations be good predictors in a model where they are included as measures of preference.

Physical relationships are relatively easy to define, while preference relationships may be extremely difficult to identify and manipulate in a model. To give an example, chemists and physicists have taken considerable trouble to remove psychological content from their disciplines. Their success in building a body of knowledge has been due in large part to their accomplishment of the statement of problems and solutions in physical terms. But scientists concerned with conscious human behavior cannot purge their data of psychological intent without sometimes distorting the significance of physical relationships. The best they can do is define problems in such a way that observable physical relations embody definable preference relationships. As an example,
consider mathematical learning theory, in which experiments are set up in such a way that overt behavior gives information by inference about learning relationships.\(^1\)

3. **Statement of the choice problem**

Choice might be approached from several points of view; the one chosen for this dissertation is analytic. This means that each alternative presented to the decision maker may be resolved into elements or characteristics which can be measured both in physical units and in terms of preference, and that some function of these elements measured in physical units is capable of discriminating between those alternatives which the decision maker is likely to reject and those which he will accept if feasible. The discriminate function is presumed to reflect in some manner the decision maker's preferences with respect to elements of alternatives and the decision rule which he applies.

The present study was undertaken to construct a model of choice such that discriminate functions which are good predictors may be fitted from data, and inferences drawn concerning preferences and decision rules.

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V. ELEMENTS OF CHOICE

One way to analyze choice is in terms of elements and relationships among them. An element is described by the inclusion relationship; it is an entity belonging to a class having certain specified properties. To be part of the choice situation, an element must be present in or bear some relation to each alternative, directly or indirectly. To have an effect on choice, the degree in which an element is present in or related to alternatives must vary.

The same situation can be defined using alternative sets of elements. For example, in an area survey one might take as elements houses, blocks, groups of blocks, or entire cities. Expenditures could be divided into elements by consumption categories as food, clothing, housing; by type of store where expenditures were made as grocery, hardware, department store; by manner of payment as cash, credit, or barter; by the person benefiting by the expenditure; by durability of goods purchased; or by other criteria which could be devised.

Clearly, the real situation is not affected by the choice of elements used to describe it, but the ease of analysis and even the decision maker's choice among alternatives may be. This is because different sets of relationships become apparent depending on the classification used to identify elements. These relationships do not cease to exist when
the situation is described in elements which do not exhibit them. They are an integral part of the alternatives, ready to work out their physical effects when an alternative is acted upon.

A set of elements may cover the entire decision situation or only part of it. An analysis of a decision might include several sets of elements, each completely covering the situation. For example, the family planning its expenditures might classify them by consumption categories, by manner of payment, by person benefited and by person making the expenditure.

Measurements of all kinds might be elements as, for example, number, weight, space, volume, direction, intensity of color or of sound, location in time, quantity of time, probability of occurrence, shape, color. Relations which are not measured in cardinal units might be elements as well, for example, tonal quality, artistry, emotional content. A manifestation, that is, something which either is or is not present, might be an element.

A relationship is an association of several elements. Relations may be treated as elements in one part of the analysis and as relations in another. An element might be a single thing or several things in conjunction. For example, weight might be an element and volume another; the relationship between weight and volume might be a part of the
analysis. But volume is itself the relationship of other measures, for example, length, width, and height, which might also be taken as elements in the analysis.

The following are proposed as significant elements of the decision situation: objectives, alternatives, and characteristics. Each of these is an entire set of elements; together they describe the decision maker's perception of the decision situation. The problem and its solution can be expressed in those terms.

A. Objectives

Objectives are goals or purposes which the decision maker wishes to have accomplished by his choice. Alternatives are defined in relation to objectives held by the decision maker.

Objectives may be defined narrowly or broadly; that is, one's objective might be to obtain a mower for cutting grass, to keep one's lawn beautiful, to keep up the value of one's property, to maintain one's status in the neighborhood, or all of these things defined in some comprehensive statement.

1. Definition of objectives

The complete statement of an objective would include an indication of sensory outcome and level of elaboration of some activity pattern. The sensory outcome might be the satisfaction of hunger, the preservation or enhancement of a
feeling of security, the satisfaction of a desire for companionship, or the desire to relieve pain. Categories may differ; there is no need here to make a definitive or comprehensive list.

Activity patterns may be described by the persons and material objects involved and space and time requirements; therefore, objectives might be defined in the same way.

Persons involved are those whose needs will be gratified or frustrated by the fulfillment of the objective as well as those whose existence or actions facilitate or hinder the fulfillment. For example, suppose the decision maker is considering the purchase of a lawn mower. He thinks of himself, as the person who will use the lawn mower, and of his preferences for efficiency and convenience in the grass cutting operation of a lawn mower, its propulsion requirements, storage and upkeep requirements. He considers the preferences of himself and his family for a trimmed lawn. He considers his neighbors, both with respect to keeping the lawn in such condition that it will not detract from the appearance of the neighborhood and with respect to their needs and rights to quiet on a Sunday morning when he may want to cut his grass. He may also consider his neighbors with a view to keeping abreast of them in possession of gadgetry. He considers the persons with whom he will deal in purchasing and maintaining the lawn mowers from among which he is
choosing. These persons may differ with respect to their reliability, their willingness to oblige, their skill, their pleasantness. He may consider others who will share the use of the lawn mower.

Objectives are defined with respect to material objects and space. The decision maker above considers lawn mowers in relation to the size of his lawn, its contours, the shrubs, trees and other plants on it, and also sidewalks, walls, lawn furniture, and other objects on the lawn. He considers the variety of grass and other growth on the lawn, other equipment he has for lawn care, and storage space.

These material objects are related to the objective either as they are part of it, as they enable the decision maker to obtain other material objects which are part of the objective, or as they facilitate or hinder actions which contribute to the objective. Objects may be possessed by the decision maker or not; they may or may not be within his control, and the control may be complete or partial. Considerations such as these affect the relation of material objects to the objective.

Finally, objectives are defined with respect to time. Some period of time is defined as appropriate for fulfillment of the objective; fulfillment at another time is irrelevant or may even be undesirable. Some objectives might be appropriately fulfilled at any time, others not.
Like the objective, the activities associated with the
alternatives considered by the decision maker are dated.
Their dating depends on the time period considered appro­
priate for the fulfillment of the objective; however, the
activities need not take place in the same period during
which the objective is fulfilled. Suppose the decision maker
decides to write a letter inviting a friend to visit him. He
must decide on a time to write the letter, and he may specify
in his letter the time appropriate for the friend's visit,
but he might also indicate that any future time would be
appropriate, so that the fulfillment of the objective, that
is, the visit, might occur any time.

Objectives are defined not only with respect to point of
time for their fulfillment but also period of time during
which fulfillment is to endure, and regularity of occurrence
of fulfillment, if this is to come at different points of
time. Location in time may be defined by time measures
alone, or in relation to other objectives or extraneous
events, for example, ones which permit the objective to be
fulfilled.

Objectives differ with respect to the clarity and pre­
cision with which elements are defined. The decision maker
may have one objective so clearly in mind that he can say
exactly with which of his psychological needs it is identi­
fied, what persons, material objects and spaces will be
involved, and what time periods will be allocated for the accomplishment of the objective. But other objectives held by the decision maker may be defined imprecisely in any or all of these respects. An objective need not be defined precisely to be the motivation of choice; indeed, it may not be possible to define any objective with perfect precision. But the precision with which the objective is defined may affect the decision maker's choice, and so must be taken into consideration in the analysis of choice.

Objectives differ also with respect to the precision with which fulfillment is defined. After the chosen alternative is acted upon, the decision maker evaluates its success in accomplishing his objective. This evaluation may take the form of a list of precisely defined conditions to be met, with success the realization of all these conditions, or evaluation may be a vague introspection into the decision maker's emotional state with success defined imprecisely or not at all. Successful fulfillment may be defined before the decision is made or not until some later time. It may be identified with emotions, condition of material objects and space, persons, or time; or it may be defined in all these terms.

Success with respect to time may have to do with (a) the point in time when the objective is realized, either measured in time units or in relation to other events; (b) the period
of time during which fulfillment endures; (c) promptness; or (d) regularity. Successful fulfillment with respect to persons may be defined as their having completed certain actions or their indicating certain emotional states.

A distinction may be made between conceptual and operational precision of objectives. An objective is conceptually precise if the decision maker has clearly in mind, as discussed above, the state or condition he would like to see obtain. The desired condition will be defined in general terms, however, with many details left to chance or later consideration. An objective is operationally precise if it is defined in such a way that it can serve as a guide for action.

For example, suppose the objective is to serve a company meal. This objective might be amplified to gain conceptual precision by further specifying that the meal is to be served to a small congenial group of friends, that it must be inexpensive and easy to prepare, that the table service must be attractive and convenient, and that the food itself must be tasty and have a variety of textures, colors, temperatures and forms. Stated in this way, the objective serves as a guide for decisions about the meal. Once these decisions have been made, the objective can be redefined in operationally precise terms: list of guests, menu, serving dishes, times to begin preparation of foods. An objective
is made conceptually precise to serve as a basis for decision. It is made operationally precise to serve as a basis for action.

Decisions are often made in stages. Beginning with a general objective, such as that of entertaining friends, decisions are made which redefine the objective in operationally meaningful terms, such as a menu, guest list, plan of work. The objectives finally arrived at in this narrowing process are expressed in terms of objects, time, and manipulations.

Another respect in which objectives differ is in the overtness with which they are acknowledged. This is related to but not identical with precision. Some objectives are overtly acknowledged by the decision maker, both to others and to himself; other objectives which are held by the decision maker and which serve as the basis for decision may be only partially acknowledged or even denied. Objectives are expressed in preference orderings, however, whether the objectives are overtly or covertly held. If preference orderings are truly and honestly reported, they give a basis for reconstructing objectives.

2. Relationships among objectives

Objectives are interrelated, not only in level of definition as discussed above, but also in intensity and in
complementarity and substitution relationships.

Intensity is exhibited in the decision maker's preferences among objectives. If it were possible to include all objectives in a set of mutually exclusive elements, then the decision maker should be able to order these objectives according to how strongly he desires their fulfillment in the current time period. The condition of mutual exclusiveness is a necessary one, however. If the objectives are not so stated, that is, if all objectives are not on the same level with respect to operational precision, then the intensity of the decision maker's feelings about one objective may enter into his ordering of other objectives. For example, suppose the set to be ordered contains the objectives of entertaining friends graciously and serving an appetizing meal. Since the second objective may be a part of the first at a different level of operational precision, the decision maker cannot reasonably distinguish between them to the extent that he wants one more than another. Suppose the set is enlarged to include a third objective, participating in the conversation in such a way that all the guests are comfortable and interested. This is on the same level as the second objective, serving an appetizing meal; therefore it would be feasible to order these two by intensity.

Intensity must also be expressed for a definite time period because objectives are identified with particular
times, but also because the lapse of time may bring changes in the situation or in the decision maker. For example, suppose two objectives, eating lunch or attending a movie, are to be ordered by intensity. Obviously their order of intensity might be reversed from 12:30 p.m. to 7:30 p.m. because these objectives are defined for particular times of day. Or consider two possible objectives, getting a good education and having a full social life. Intensity order might be reversed from age twenty to age thirty because of environmental changes.

Other changes may occur due to changes in taste. It may be hypothesized that this takes place rarely while changes due to shifts in the decision situation occur more frequently. Changes in intensity due to time identification of objectives are almost automatic, since these objectives may lose in intensity when the appropriate time for their fulfillment has passed.

Intensity is affected by time and also regulates the scheduling of time. It may be expressed in willingness to postpone the fulfillment of the objective, in the frequency of fulfillment of the objective, in the length of the time period during which fulfillment is to endure, or in position in time with respect to other objectives.

Intensity as expressed in the placement of objectives in time shows itself in several scheduling tendencies.
Objectives held most intensely tend to be those chosen for immediate fulfillment. Children are good examples; they are unwilling to postpone their pleasures, even for the sake of increasing their satisfaction. Many adults, indeed, all adults, exhibit the tendency in some degree. A second scheduling tendency is to schedule objectives held most intensely for fulfillment during times when they are least likely to be interrupted by chance events. A third tendency is to schedule intensely held objectives for time periods in which the decision maker expects himself to be in a favorable physical or psychological condition for fulfillment. In any given situation these tendencies may conflict and be exhibited in some compromise which reflects their relative strength.

Intensity of objectives is also exhibited in the willingness of the decision maker to allocate resources which he controls to their fulfillment. This facet of decision has been so thoroughly explored in the literature of consumption theory\(^1\) that there seems little reason for discussing the point here except for the reminder that by resources is meant all those persons, material objects, time or space, capable of being directed toward the fulfillment of alternative

objectives and within the control of the decision maker.

A second type of interrelationship of objectives is in substitution, complementarity,\(^1\) and competition. These relationships may refer to occupancy of time. If this is the case, complementary objectives might be those whose fulfillment is enhanced in some respect when their fulfillment coincides, while competitive objectives might be those whose fulfillment could not occupy the same time period or whose fulfillment would be detracted from in some manner if their fulfillment coincides. Objectives at different levels of operational definition, for example, entertaining friends and serving an attractive meal, may be complementary. An example of objectives at the same level of operational definition which are complementary with respect to time might be worship and aesthetic appreciation; the person attending a worship service in aesthetically pleasing surroundings may gain a higher level of fulfillment of one or both objectives because fulfillment coincides.

The time relationship between objectives complementary in time need not be one of coincidence. Fulfillment of objectives might be enhanced by placement in adjacent time periods, or even in periods considerably removed from one another. This might mean that the relationship between two

\(^1\)As defined in Hicks. Value and capital. p. 44.
objectives might be complementary when a lapse of time was allowed between fulfillment of one and the other, and competitive when the time periods for fulfillment were adjacent or coincident. Objectives competitive with respect to time may be illustrated by getting an education and having a full social life. Students often schedule these for coincident time periods, for example, library dates, but the objectives are to a degree competitive in that the student probably cannot do as much either of studying or of socializing as he would like. Competition or complementarity may have their effects either in performance of actions necessary to attain objectives or in appreciation of attainment.

Objectives may be related by complementarity and competition with respect to persons; moreover, persons may be complements or substitutes with respect to objectives. This was not true of objectives with respect to time, since time is presumably uniform. If the fulfillment of two objectives is in some way enhanced when they involve the same set of persons, then they may be said to be complements with respect to those persons; if fulfillment of an objective is enhanced in some way if two persons are involved in the fulfillment, then the persons might be said to be complementary with respect to the objective. For example, entertainment and study might be complementary with respect to persons, provided the time scheduling allowed for both, since
entertainment might refresh the mind for study and study might enhance appreciation of entertainment by contrast. In the converse relationship, entertainment may be more pleasant if shared by several persons.

Substitution is not the precise opposite of complementarity, nor are substitution and competition exactly the same. Two factors are substitutes if the inclusion of one renders the inclusion of the other less necessary; they are competitive if the inclusion of one renders the inclusion of the other less possible or desirable. Substitute objectives might be travel and education; note, however, that these are substitutes with respect to some higher level objective. This characteristic of substitute objectives need not be true of complementary or competitive objectives.

Complementarity and substitution of resources with respect to given objectives exhibit their effects in like relationships among objectives, that is, affect the level of attainment of an objective at a given expenditure of resources. The relationships among objectives then influence the level of attainment chosen for each objective.

B. Alternatives

Alternatives are defined with respect to objectives. Assuming an objective is precisely defined by the decision maker, he must then consider alternative actions open to him and, following a chain of reasoning, anticipate the outcome
associated with each action.

1. **Definition**

An alternative is one of a set of incongruous elements, each capable of fulfilling a common objective in some degree. Each alternative is a structure including an activity of the decision maker which he might conceivably choose to perform, related persons and material objects, and time and space relationships.

A distinction can be made between set of alternatives and decision situation. Besides the alternatives, the decision situation may include elements which enter equally into all alternatives or which have no effect on objective attainment. Since the decision situation can be global without being troublesome, all limitations on it need not be delineated. The decision maker usually does not examine the decision situation extensively. In the choice context, his interest is confined to the manner in which elements in the decision situation may affect his attainment of objectives through choice among alternatives.

Alternatives can be identified as actions of the decision maker which involve other persons and material objects and occupy time and space. If the alternative is taken to mean the entire set of actions, persons, and material objects involved in producing the outcome, then the action of the
decision maker may be a trivial part of the alternative, perhaps nothing more than a gesture indicating his choice. By a reasonable definition, an alternative would include both an action and its outcome, since the decision maker considers both in deciding among alternatives.

2. **Identification of alternatives within the decision situation**

In real situations there may be ambiguity in defining limits for a single alternative. Obviously it cannot include all actions of the decision maker within a specified period. It is not always necessary that the decision maker identify the alternative with a specific time period. Nor is it reasonable to define an alternative as including an indefinite range of persons and objects, or even of all persons and objects which will affect attainment of objective. A more reasonable limitation on range of actions, persons, and objects included in an alternative would be those directly influenced by the decision maker's choice of actions. Many other things may influence attainment of the decision maker's objectives, but if they are not influenced by his actions, then he cannot be said to choose them since they would occur or not occur, whatever his choice. However, these things are part of the decision situation and may have considerable influence on his choice of alternatives, since they may influence the effectiveness of his actions in attaining his...
objectives.

That alternatives are defined with respect to objectives limits the scope of alternatives, but it is hardly possible for a decision maker to confine himself to a single objective unless it is expressed in such general terms that it is useless as a guide for action. Although the decision maker may have as a primary goal the attainment of some single objective, he cannot ignore the effects which his alternative actions will have on the attainment of other objectives. The decision situation is defined with respect to the entire set of objectives even though the primary objective defines those actions of the decision maker which form the nucleus of separate alternatives. That is, each alternative must include some action of the decision maker which affects his attainment of the primary objective, but the alternative may include many other actions which do not affect this objective, actions oriented toward subordinate objectives.

The effects of choosing an alternative are not considered beyond the period specified for attainment of objectives, but since some of the decision maker's objectives endure for his lifetime or beyond, the time barrier becomes meaningless. This is true even if attainment of the primary objective is specified precisely for a brief, immediate period. The decision maker may not examine the effects of his actions beyond some point in the immediate future; the stronger his
time preference the shorter will be the time he considers. Moreover, the decision maker may consider the future to be so uncertain that he believes it impossible to predict the effects of his actions beyond some particular point of time.

C. Characteristics

Alternatives may be classified according to characteristics. A characteristic is any feature or trait which describes the alternative. A person or object might be a characteristic, as may some feature of the person or object such as size, shape, or action. The fact that what is regarded as a single characteristic in one context might be a whole bundle of characteristics in another is not important in the present discussion.

1. Variation

Classification implies that each characteristic must be present in each alternative to some degree. The degree to which it is present may be zero, that is, that characteristic may not appear, but this is a basis for classification also.

Usefulness of characteristics in classification depends on their regularity, that is, in their appearance as recognizable variants not only in all alternatives in that decision situation, but also in several decision situations. The more familiar the characteristic is to the decision maker in all its variants, the more easily and precisely can he
classify alternatives through it. Also, the more of recognizable and effective variants a characteristic has, the more finely can alternatives be classified.

2. **Effectiveness of variants**

By effective variant is meant one which effects a variation in outcome. Not all variations influence outcome. For example, suppose the decision maker must choose whether to buy Brand X or Brand Y, both of which cost the same, weigh the same, are packaged the same, and in fact are the same product with brand name as the only varying characteristic. Unless the decision maker has a perceptable mental reaction to one or the other brand names, the characteristic of being X or Y can be said to have an ineffective variation. In fact, in the absence of a mental reaction, brand name must always be an ineffective variation except as it is an indication of the presence of effective variations such as quality and price.

A variation might be rendered ineffective by the action of the decision maker, by forces beyond his control, or by some accompanying characteristic. For example, even if Brand X and Brand Y were different in quality, this variation would have no effect if the chosen good were destroyed before it could be used. Or suppose the prices were identical but the package of Brand X contained a greater quantity by weight of
the product than did Brand Y. This is a variation of one characteristic, price per unit of weight. But suppose Brand X is less efficient in attaining outcome, so that in fact the outcome produced by one package of X exactly equals that from one package of Y. Then the variation in weight is ineffective, at least in the ratio supposed. The effective characteristic is price per unit of realized outcome.

The skill of the decision maker lies partially in his ability to identify characteristics having effective variations. He is not really interested in any other characteristics, though he may be aware of them. Moreover, he is not interested in characteristics whose effect on outcome is identical regardless of alternative chosen.

Characteristics, then, might be classified as those having differential effects on outcome, those having equal effects on outcome, and those having no effect on outcome. Further, the manner in which characteristics affect outcome might be termed direct or indirect. Characteristics having a direct effect on outcome are those which enter into the outcome or which affect characteristics of the outcome. Consider the color and style of a refrigerator. If appearance of the refrigerator is part of the outcome, then these characteristics are not only part of alternative refrigerators considered for purchase, but are also part of the outcome. Suppose that the time required to care for the refrigerator
is considered to be part of the outcome of purchase. Then automatic defrosting features directly affect a characteristic of the outcome.

Characteristics having indirect effects on outcome are those which affect other characteristics of the alternative causing their effect on outcome to be different than they would otherwise have been. Consider the characteristic of weight in a piece of lawn furniture. This has an effect on outcome, though the effect is different depending on whether or not the furniture also has wheels. Thus, a single characteristic may enter directly into the outcome, affect other characteristics of the outcome, and affect other characteristics of the alternatives. The effects which a characteristic may have on other characteristics are to alter the degree of the outcome characteristic by transforming it into another variant of the same characteristic or to change the relationship between outcome characteristics.

A characteristic may have no effect on the outcome of a choice, but may affect characteristics of other decision situations, either by altering the effectiveness of characteristics in producing an acceptable outcome or by limiting the range of effective choice. For example, suppose the immediate decision is among alternative sets of living room furniture. The color of the chosen set will alter the effectiveness of the choice of wall paint. Price is a
characteristic whose chief effect is to limit the range of effective choice in other decision situations.

3. **Identification and measurement**

Regularities in characteristics enable the decision maker to identify them and their effects. One type of regularity identifies a trait as a variant of a single characteristic on the basis of measurable relationships among the variants of the characteristics. A simple example is in the characteristic of weight. With the aid of standard measuring units the decision maker can indicate the relationship among alternatives with respect to this characteristic.

A second type of regularity is that between the characteristic and outcome. If the variants of some characteristic of alternatives have a fixed effect on the variants of some characteristic of the outcome, or on other characteristics of alternatives or of decision situations, this characteristic furnishes a reliable basis for classifying alternatives. Price is an example of a reliable characteristic with respect to its limiting effect on alternatives in other decisions. Given a limited money income, a higher price paid for the chosen alternative in one decision always means that the decision maker has less money to spend in the choice among alternatives in other situations.

A characteristic may be irregular in its effect on
outcome either because there is no real cause and effect relationship between its variants in the alternative and in the outcome, or because the effect of the characteristic is influenced by other characteristics. An example of the first type of irregularity is the price and the performance of a good. Higher price is often but not always associated with better performance. The relationship between price and performance may be said to be one of association, rather than of cause and effect. An example of the second type of irregularity is the relationship between the quality of the raw ingredients of a meal and the palatability of that meal. Both quality of the raw ingredients and cooking methods affect palatability.

If many interacting characteristics affect the outcome, it is difficult for the decision maker to predict the effects of variation in a single characteristic. It may be possible to gain knowledge leading to better prediction of effects by experimentation in which only one characteristic at a time is allowed to vary and the effects on outcome are noted. If there are several characteristics which alter both the outcome and the effectiveness of each other, and if the range of the variation of each of these characteristics is wide,

the problem of prediction may be unmanageably complex, even though experimentation is feasible. In this case it might be possible to reclassify the characteristics in such a way that there is a minimum of interaction among the characteristics of the alternatives and a maximum of regularity with respect to effects on outcome.

One difficulty when describing an alternative by characteristics is that, if the purpose is to classify alternatives by characteristics, any characteristics identified in one alternative must have an identifiable variant in each of the other alternatives. Shape is an example of a characteristic having a composite measure which presents this difficulty if shape is broken down into a cluster of characteristics. A single measure of length which could be recognized as a characteristic of one alternative may have no counterpart in another characteristic, but shape might be a characteristic of both.

Measurement of characteristics and their effects frequently is subjective rather than objective. In some cases objective measures such as weight, speed, or money cost may be conveniently applied; in other cases no objective measures have been devised, as, for example, for aesthetic quality. Some characteristics require several measures for a complete description of the variation. It should always be possible to classify an alternative by characteristics in such a way
that variants of each characteristic could be measured in only one way. Shape, for example, could be broken into a cluster of related characteristics which could be measured in length, angle, curvature. However, there may be several objections to this: (a) it may increase interaction among characteristics of the alternative and reduce the regularity of their effects on outcome, (b) it may increase the difficulty of distinguishing one characteristic from another because of the need for introducing criteria to delimit them, and (c) by increasing the number of effective characteristics the task of decision may be made more difficult. For convenience, then, the decision maker may substitute a subjective measure for an objective one, or may define characteristics in such a way that their effectiveness is most apparent, while the interaction among them is at a minimum, even though these characteristics have no single measure. Where there is no single measure, the decision maker might use an approximate classification of the variants according to only one or two of the possible measures of the characteristic, or use a single subjective measure such as palatability, aesthetic appeal, or ease of operation.

The use of subjective rather than objective measures by the decision maker complicates research having to do with decisions because of the difficulty of reproducing these measures and describing them, but it makes no difference in
the theory of choice. The necessary condition of any measure is that it enable the measurer to classify elements into subsets. This condition is fulfilled by subjective measures as well as objective ones. If some sort of measure can be applied to a characteristic, then the alternatives can be classified by that characteristic.

The subsets into which a subjective measure divides variants may not be as small as they would be had an objective been applied. This may be because the decision maker cannot perceive minute differences, or because he indicates as having an identical measure all those variants whose effect on outcome is, in the decision maker's estimation, identical. The first reason for a coarser subdivision, that of lack of ability to perceive minute differences, is called the threshold effect. The second reason involves expediency in coming to a decision.
VI. RELATIONSHIPS WITHIN THE CHOICE SITUATION

Choice is made on the basis of relationships among elements, that is, objectives, alternatives, and characteristics, in the choice situation. As a preliminary to analyzing influences on choice, it is worth while to examine the structure and content of relationships in order to gain further insight into the nature of the choice situation.

A. Structure

Three relationship structures may be distinguished among those effective in choice; these are inclusion, measure, and mapping. Inclusion relates elements within a set to its boundaries, measure relates elements within a set to each other, and mapping relates elements of different sets.

1. Inclusion

The relationship of inclusion is exemplified by equal to, greater or less than, indifferent or preferred to, east of, five miles from, as they refer to bounds of set; for example, if A is greater than B it belongs to the set of elements of which B is a lower bound or criterion for admissibility. A set is bounded by elements; inclusion or exclusion is determined by relationship to those elements. In the statement, "the chosen alternative was preferred to all other feasible alternatives," several sets are implied: the set of alternatives, the subset of feasible alternatives bounded by
feasibility criteria, and the subset of the one chosen alternative which is bounded by the other elements in the feasible set.

2. Measure

Measure relationships represent inclusion as it applies to partitioning of elements within a set. It relates pairs of elements; for example, A greater than B or preferred to B. The set of A greater than B is of no immediate interest; only the particular A and B. The distinction between inclusion and measure is in emphasis only; inclusion stresses the relation between elements and bounds of a set, while measure stresses the relation between two elements within a set.

3. Mapping

The mapping relationship associates members of different sets. For example, there is the relationship between quantity of a commodity and its price. Or one might say that an alternative has three characteristics, price, outcome, and time required for realizing outcome. This is the same as saying that to name the alternative is to specify mapping relationships with prices, times and outcomes.

A mapping relationship might be regular or irregular. If the price of commodity is fifty cents per pound, the mapping is regular, but if the price is between twenty-five and fifty cents, depending on unspecified factors, either mapping
is not regular or regularities are not specified.

B. Content

Content of relationships may be categorized as physical, preference, time, and space. Every relationship has structure and content; moreover, two elements may be related by all four types of content.

1. Physical relationships

By physical relationships are meant those which can be perceived and measured comparably, not only by the decision maker but also by other persons. Evidence for these relationships is direct and tangible. Though the measurements given for physical relationships may differ from one person to another, or from one decision situation to another, the differences are due to error or intention rather than variation in measuring scale.

Having identified a characteristic and its variants, the next step is to examine the physical relationships among variants. These physical relationships must exist, for they are the basis for identifying a trait as a variant of a characteristic. Consider the characteristic, money price. The variants of this are different quantities of money, measured in cardinal units, i.e., dollars. The physical relationship among any two prices may be of ordinal form, that is, greater than, equal to, or less than, or of cardinal form, that is,
five dollars greater or less than.

These are relationships of inclusion. The two traits $p_1$ and $p_2$ are identified first as being variants of the characteristic money price, i.e., elements included in the set $P$ called money price. Then the statement that $p_2$ is greater than $p_1$ means that $p_2$ is included in that subset of $P$ containing all $p$'s greater than $p_1$. Inclusion in the set $P$, money price, is defined in terms of certain specifications, as, loosely, $p_1$ is a variant of the characteristic, money price, if it is a sum of money and if possession of a good is to be obtained only by the surrender of $p_1$. The specifications for membership in the set of all $p$'s greater than $p_1$ might be described in some similar manner. The variants $p_1$ and $p_2$ are related both by their common inclusion in $P$ and by a measure relationship between them.

Besides relationships of inclusion, physical relationships among elements include mapping relationships, that is, each element of an alternative (variant of a characteristic) is mapped onto the outcome. An element may have a mapping relationship with one or more elements of the outcome and/or of alternatives. For example, choice of upholstery fabric (a characteristic of alternatives) is related to the appearance of the chair, ease of care, and the length of its wear life (characteristics of the outcome). It is also related to the money cost of the chair (a characteristic of the
alternative) and to the aesthetic quality of the room (the outcome of several decisions).

Suppose that the characteristics of an alternative are defined in such a way that each variant of a characteristic is the focus of two types of relationships: it is related to each other variant of the characteristic by inclusion and measure, and also to one or more other characteristics by mapping. For example, suppose a chair is to be covered with either nylon or cotton upholstery fabric; the nylon fabric may be expected to last five years, the cotton two. The two fabrics are related to each other by their inclusion in the set of upholstery fabrics and are also related by mapping to the set of time periods during which upholstery fabrics last. Both relationships are pertinent to choice.

2. Preference relationships

Preference relationships are based on physical ones, but are different in that any specific measure is valid only for the person making it. Preference applies to variants of a characteristic, that is, one variant is preferred to another by the decision maker, but the bases for preference among variants are relationships among characteristics. The decision maker's preferences are really among variants of the characteristics of outcome, but he has derived preferences for the characteristics of alternatives mapped onto characteristics of outcome. This means, for example, that the
decision maker has no direct preference for paying a smaller price for a good; his preference is for some characteristic of the outcome, e.g., additional goods and services, which can be obtained with money released by the smaller price. Characteristics such as color, which enter directly into outcome, may take their preference order as characteristics of the alternative directly from their preference order as characteristics of outcome.

Measurement by the decision maker of his preference relationships may be very complex, since a characteristic may be mapped onto several other characteristics. The manner in which mapping relationships help to order preferences within an alternative cannot be explored here.

Preference relationships must also exist among characteristics in order for the decision maker to choose among them. An example is preference between two meals, one tasting good, the other looking attractive. Unless the decision maker can order taste and attractiveness by preference, he cannot decide between the two meals.

As an ordering relationship preference may be transitive; that is, if A is preferred to B and B is preferred to C, then A is preferred to C. Also, A not preferred to B and B not preferred to A does not necessarily imply that A is equal to B; it may indicate that the decision maker is indifferent between A and B although they are not equal.
If the threshold effect is allowed, then indifference is not necessarily transitive. Suppose one characteristic variant is preferred to another only if the first is physically related to the second (e.g., greater than) by \( n \) or more units. If \( A \) is greater than \( B \) by less than \( n \) units and if \( B \) is greater than \( C \) by less than \( n \) units but \( A \) is greater than \( C \) by \( n \) or more units, then \( A \) is not preferred to \( B \) because the difference between them is small and \( B \) is not preferred to \( C \) for the same reason but \( A \) is preferred to \( C \) because the difference between them is large enough to be perceptible.

If the threshold effect is not allowed, that is, if the decision maker is assumed to perceive infinitely small gradations of difference, then transitivity extends to the indifference relationship.

3. **Time**

Time relationships are a special kind of physical relation. When one speaks of a point in time one always means a duration because time is a flow. A point in time has the same physical unreality as a point in space. The possible relationships between two periods of time are that they coincide, that some portions of them coincide, or that no portions of them coincide. For portions of time which do not coincide, the terms earlier than or later than may be applied to indicate the position of one period of time with respect
to another.

There are two time relations, duration and position. Two time periods may be compared with each other directly in these respects; that is, one may be said to endure longer than the other, or to begin earlier or later than the other. Or the two time periods may be compared to each other by relating them with a third indication of time, for example, one may be said to begin Tuesday while the other began Wednesday.

Time relationships have meaning only with respect to other relationships, that is, the statement that one characteristic is earlier or coincident with another is meaningless. A meaningful statement would be to the effect that the duration of characteristic A's inclusion in set 0 coincides with the duration of characteristic B's inclusion in the same set or a different one. Or one might say that the duration of the mapping relationship between A and B has some relationship to the duration of an event D.

Preference relationships are based on time relationships as well as other physical ones. This is exemplified in the time preference exhibited for attainment of outcomes. If the decision maker's preferences were not influenced by time relationships, he would be indifferent to identical outcomes occurring now or in the future, provided that they were equally likely to occur.

Inclusion relationships may be based on time
relationships, for example, a set may be defined as all those elements existing during some period of time. This leads to the conclusion that certain so-called functional relationships are really inclusion relationships based on time relationships. The appearance of one characteristic may be taken as an indication of another, not so easily observed, characteristic because they are known to occur together in time, but in fact the time relationship may be the only direct relationship between them; their functional (mapping) relationships may be with additional characteristics. If the time relationship between two characteristics is regular, it may be a good basis for prediction. It is also a good indication that other physical or preference relationships exist between the two characteristics, either directly, or indirectly through a third characteristic.

4. **Space**

Space resembles time in that it is a form of physical relationship, but it might also refer to preference. Just as duration and position describe time relationships, extent and contiguity describe relationships of space. Extent refers to the area or volume measure of characteristics. Contiguity refers to position of one element or characteristic relative to another.

An importance of spatial relationships is in the limita-
tions which they place on the effectiveness of characteristics with respect to outcome. This can be exemplified in many ways: by scheduling problems, differences in the ease of manipulation of elements, or by preference ordering of spatial characteristics of outcome.
VII. INFORMATION

Information is not an element of alternatives, but a relationship between decision situation and decision maker. Extent and certainty of the decision maker's information affects his evaluation of alternatives and limits his choice. The decision rule which he uses may take information into account. Therefore, choice research must take the decision maker's information into account, either as an assumption or as part of the investigation. Some implications of information states with respect to choice are discussed below.

A. Definition

Information is the set of facts or data perceived by the decision maker as a description of relationships and elements in the real world. It is an awareness of physical, time, and space relationships and is the basis for preference.

Information might be classified as public and individualized. Public information is that which might be useful to anyone, for example, information about prices, average lifetime of durable goods, majority opinion concerning the merits of goods, or the results of standardized tests. Individualized information describes the decision maker's situation. For example, the price of a good is public information but the relation between that price and the amount of money in the decision maker's bank account is individualized. Average
lifetime of a good for all consumers is public information but expected or realized lifetime of the same good under the conditions of use peculiar to the decision maker is individualized.

Public information is gathered and disseminated more or less widely among consumers by public or private agencies. Retail stores publish information about their wares through advertisements, displays, labels, and word of mouth communications by their paid representatives. Other business firms use the same methods though it may be to different audiences. Governmental and private education agencies conduct research and publish findings and other information in bulletins, magazines, and word of mouth communications. Even information obtained in casual conversation with friends might be termed semipublic. All information is useful to the consumer to the degree that he is able to perceive it as part of his own situation. By this interpretation it becomes individualized information. Research agencies often perform the interpretation in the reverse direction; that is, they gather individualized data and interpret it so as to transform it into public information. For example, consumer characteristics such as disposable income are aggregated to produce public information.

The information discussed above may or may not have been true information conforming to reality; the decision maker
usually has a good deal of misinformation which he may treat as if it were true information. Often he cannot distinguish between true information and misinformation, either because the situation does not allow him to observe relations directly or because measuring techniques are inadequate for obtaining correct information. In addition to errors such as those which cannot be remedied easily, the decision maker often uses misinformation because it has not seemed worth while to correct or improve the information he has. The disadvantage of holding incorrect information may be slight, while the cost of checking to see whether information is correct and then obtaining correct information may be great.

An additional source of error in information is due to bias in observing and interpreting data. Suppose reality is regarded as a network of relationships. Then there may well be a set of key relationships which encompass the whole of reality. A knowledge of these relationships would enable one to understand any situation with little difficulty, since it would only be necessary to identify these key relationships in the situation and follow out their implications. No contradiction can exist in reality, so that any information consonant with these key relationships would almost certainly be correct.

A correct master set would be without contradiction, either within itself or with any outside data. Suppose that
the decision maker has in his mind such a master set of relationships or, more likely, fragments of several sets. Some part of the set is incorrect; there are inconsistencies and contradictions within the set, but it serves, nevertheless, to guide his perception of data. Observing, not the whole situation, but cues which his master set teaches him to look for, the decision maker compares these with his master set and, adopting the interpretation which seems to embody the least contradiction between cues and master set, he "observes" certain relationships in the situation. If his master set is not entirely correct, then some of these relationships are probably incorrect, no matter how carefully or extensively he examines cues.

B. States of Completeness

Of the elements and relationships in a real situation, only part may be mapped on the decision maker's information set. Three possibilities may be distinguished, global, complete and partial mapping of information.

1. **Global information**

Global information encompasses all relationships within and among all elements in the alternatives and the decision situation in general, no matter how these elements are defined. It is impossible for human beings to have global information, first because one has insufficient time to become
aware of all relationships, and second because many relationships are too minute or too confused to be detected by observation, either directly or by using instruments.

2. **Complete information**

Complete information represents all the knowledge of relationships possible to the decision maker, provided he is a keen and careful observer and has at his command all existing instruments for the detection and measurement of relations.

Unless measurements can be made infinitely precise, information cannot be said to be global. Because infinite precision is impossible to attain and also carries little or no advantage over somewhat less precision in its use as the basis for decision making, completeness is defined as the more attainable state. But the degree of precision marking the difference between global and complete, if it is not to be infinite, must be defined operationally, that is, in practice some degree of precision will be sufficient for completeness.

Some relations cannot be known without altering the relations themselves. For example, if the situation includes the actions of other persons, then to ask them in advance what their behavior will be in this or that event is often an alteration in the situation sufficient to change their
behavior from what it would otherwise have been. Some relations cannot be known without altering other relations. In decisions regarding food one cannot know about palatability without tasting, but in so doing one alters other relations, for example, the shape and quantity of food, one's own appetite, the money cost of choosing. In cases such as this, complete information is defined to include a knowledge of relations, even though they can be measured only after the event.

3. Partial information

The third and most likely information state is that of partial information. In this case the decision maker is aware of only some of the relations in the situation. He might know all the inclusion relationships among certain elements, but not be aware of all mapping relationships. For example, he might know the exact money cost of each alternative, but not know how this was related to quality or to the cost of future wants.

C. States of Certainty

The terms certainty, uncertainty, and risk refer to degree of confirmation or state of belief. If a relationship is consistent with other relationships in the information set and inconsistent with none, it is completely confirmed; if it is consistent with some relationships and inconsistent only
with incompletely confirmed relationships, it may be regarded as partially confirmed.

1. **Certainty**

A relationship which is known with certainty is completely confirmed. Such knowledge might be part of either complete or partial information.

Confirmation of a relationship may be by direct measurement of the elements involved, or it may be by measurement of other elements with a known relationship to the ones to be confirmed. Often only the indirect confirmation can be obtained. Whether or not indirect confirmation alone can be allowed to prove certainty must depend on convention or the judgment of the decision maker.

2. **Uncertainty**

A relationship which is known with uncertainty is unconfirmed or may not be known at all or only within a range. That is, the decision maker might know that the true relationship falls within the range of all possible variations of that relationship, or perhaps within a subset of that set, but that subset is so large that the decision maker is not able to use the relationship to classify alternatives into subsets. Uncertainty may not seriously disadvantage the decision maker. He may be able to classify alternatives satisfactorily by other relationships.
In distinguishing between certainty and uncertainty the decision maker may be guided by conventions, by criteria which he sets up, or by his intuition and state of optimism. For example, suppose a stranger informs the decision maker that he is John Doe and asks him to cash a check. Is this information, that the stranger is John Doe, certain or uncertain? It is unconfirmed; however, it is also uncontradicted. Will the decision maker accept the information because of the stranger's honest face, his own good spirits, and his past experience of honesty in strangers? Will he accept the information as certain only when he has seen the man's driver's license, when disinterested persons have testified to the man's identity, when he knows the result of an expert's comparison of the man's fingerprints with prints recorded as belonging to John Doe, or will he continue to regard the information as uncertain even with all this confirmation? If certainty is to be recognized as a real state, some degree of confirmation must be specified as a criterion distinguishing certainty from uncertainty.

3. **Risk**

Risk differs from both certainty and uncertainty. Suppose the decision maker has partial confirmation for the belief that the true relation falls within some subset of possible relations. This is not uncertainty, though it might be
transformed into that condition by enlarging the subset to include all possible relations. But, though the decision maker does not have certain information, he is better off than under uncertainty, because the subset within which he expects the relationship to fall is sufficiently small that it may be used in ordering alternatives. Suppose he enlarges the subset within which he expects the true element to fall. If he has chosen likely elements to add to the set, then he should consider it even more likely that the true relation would be contained in the enlarged set.

If he were able to assign some sort of numerical value to these likelihoods, say that in fifty cases out of a hundred the relationship would be included in the first set and in seventy cases out of a hundred it would be in the enlarged set, and if he progressively enlarged his subset, beginning with a very small one and continuing until all possible relations had been included, then the numerical values which he assigned to each subset would form a probability distribution. Even though persons cannot always assign numerical values to their estimates of likelihood, the concept of risk may sometimes be valid without precise measures.

D. Cost of Information

To obtain information the decision maker may incur costs, defined as alteration in characteristics of the
decision situation. Suppose the decision maker, sensing the need for decision, acts to gain information on which to base his choice. He may obtain what he considers sufficient information in a few minutes' time or for months he may devote a large portion of his time, energy, and other resources to gathering and confirming information. Whether the time required is short or long, it causes a delay during which the decision maker cannot make a choice and act upon it. This delay may be of little importance or in some situations may seriously limit his field of choice as the passage of time makes some alternatives unobtainable. Some characteristics of the alternatives may change over time. Because resources are used to obtain information, these cannot be used to actuate the choice. Public information may be given to the decision maker free of money cost or at a price, but at least a small amount of time and energy is required to comprehend the information. More often the decision maker must actively seek information in order to choose satisfying outcomes.
VIII. A MODEL OF CHOICE

In the preceding chapters the elements and relationships of choice have been discussed; they are now to be fitted together into an integrated description of choice which can be used in designing research and interpreting data.

The model will be discussed first under the simplifying assumption that the decision maker has complete information; then some modifications appropriate to the partial and uncertain information case will be mentioned.

A. Choice Under Conditions of Complete Information

1. Assumptions

Several conditions are to be assumed. First, as has been noted, the decision maker has complete information. Moreover, he is certain and has no need to make allowances for probabilities of less than one. He is able to evaluate information without cost, and therefore excludes nothing from consideration.

Second, the alternatives are already identified by the decision maker, which implies that his objectives must also have been defined. Since he has complete information, the precise physical measure of all characteristics of the alternatives are also known to him. From knowledge of his environment, the decision maker is able both to order
characteristics by preference and to identify the limits of feasibility.

Preference order, as expressed by the decision maker, is assumed to have some regular relationship with physical order. However, this relation may differ for different characteristics. And, finally, the model is based on the assumption that choice can be identified by a rule based on the decision maker's preference.

2. The set of alternatives

Suppose that the choice situation is defined as follows: A set of alternatives is open to the decision maker, who must choose some element in this set and cannot choose outside of the set. Each alternative is defined as a single element in the set. The set of alternatives is identified with respect to the accomplishment of some objective or set of objectives and contains every alternative capable of fulfilling the objective in some degree. If the objective is modified or changed in any way, then the entire choice situation is altered, in the identification not only of the set of alternatives but also of the relationships among those alternatives. A small variation in an alternative would convert it to a new alternative.
3. Characteristics

Each alternative is a bundle of characteristics which, taken together, completely describe the alternative; for example, one characteristic might be money cost, another might be the quantity of time consumed in carrying out the actions included in the alternative. Each alternative might have a large number of characteristics. Now suppose the decision maker surveys the entire set of alternatives and, for each alternative, notes a single characteristic, money cost. This characteristic might vary from one alternative to another. Variations in money cost could be aggregated to form a set of characteristic variations. Similarly the time consumed in each alternative might be measured and the variations identified as a second set of characteristic variations.

Each characteristic of an alternative would be a member of a set of characteristic variations. Each characteristic of an alternative would be related to the other characteristics of the alternative through their common association with that alternative, but each characteristic would also be related to a characteristic of each of the other alternatives also, as being a variant or level of a common characteristic.

4. Sets of characteristic variants

The variants of a single characteristic, for example, money cost, comprise its characteristic set. If each
alternative has \( n \) different characteristics, then there are \( n \)
characteristic sets. Any single characteristic set has a
characteristic variant for each alternative. Characteristic
set might be defined as a universal set containing all pos-
sible variations of that characteristic. In that case, the
characteristic set for any set of alternatives would be a
subset of the universal set. The alternatives might be said
to have a mapping relationship with the characteristic set,
and the process of obtaining information about alternatives
would be a mapping operation from the universal set.

5. **Relationships among characteristic variants**

Any single element or variant of a characteristic set is
physically related to any other element of the same set. The
physical relationship completely orders the set; that is, for
any pair of characteristic variants contained in the set, the
first must be greater than, equal to, or less than the second
with respect to that physical relationship.

The physical measure of one characteristic need not be
the same as the physical measure of other characteristics of
the alternative. For example, if one characteristic is money
cost, another is time requirement, and a third is color, the
first characteristic might be measured in dollars, the second
in minutes, and the third in a compound measure containing
hue, value, and intensity.
The decision maker considers and compares characteristic variants rather than alternatives as a whole. Suppose he considers the characteristic of money cost: he considers the money cost of each alternative and forms a preference ordering of these money costs. This preference ordering completely orders the characteristic set and is regularly related with physical ordering; that is, if the elements of the characteristic set were arranged according to their physical measure, they would exhibit some regularity of arrangement viewed by their preference relationship.

Three of the possible relationships between physical ordering and preference orderings are illustrated below:

Every point on the line ab represents an element of a single characteristic set measured in physical units on the horizontal axis and preference units on the vertical axis. For purposes of representation, cardinal measures are assumed. In
A any variant which is physically greater than another is also preferred to it, in B any variant which is physically less than another is preferred to it, and in C any variant of less than a certain physical measure is preferred to variants physically less than it, but variants greater than that physical measure are preferred to variants which are physically greater than themselves.

Relationship A might represent a characteristic involved in ease of care of a durable good; the easier the care, the more preferred would be the alternative. B might show the relationship between preference for money cost and the physical measure. An example of the relationship illustrated in C might be the size of a piece of furniture; up to a point the decision maker might prefer the larger television screen, but beyond that size the disadvantages of finding space for a larger piece might make him prefer a smaller one.

6. Preference ordering of unimportant characteristics

One aspect of the decision situation which may seem to complicate choice but which need not is the large number of characteristics which an alternative might have. Many of these might be of little practical importance in the decision, or, in other words, be ineffective in the outcome. Preference ordering of the characteristic variants makes this relatively easy to handle. Those deemed by the decision
maker to be of little or no importance are given identical
preference ratings, that is, the preference relation among
the elements in such a characteristic set is one of indiffer­
ence. If all variants of that characteristic are equally
preferred, the set has no effect on choice and can be ig­
nored. Thus, while in theory all possible characteristics
enter into the decision, the number which actually affect
choice may be small. If evaluation of characteristics cannot
be accomplished without cost, an initial choice might be to
rate all but a few selected characteristics as indifferently
preferred.

7. Partial ordering of alternatives by characteristic
variants

If each of the characteristic sets mapped onto the set
of alternatives is completely ordered by a preference rela­
tionship, then the set of alternatives is partially ordered
by those preference relationships. With respect to any al­
ternative in the set, this means that three subsets of al­
ternatives can be defined. One subset contains all those al­
ternatives which are equally or more preferred in all their
characteristics to the specified alternative; a second sub­
set contains all those alternatives to which the specified
alternative is equally or more preferred in all characteris­
tics; and the third subset contains all those alternatives
which are contained in neither the first nor the second
subset. These three subsets completely exhaust the set of alternatives. Note that the specified alternative is a member of the first subset and also of the second. This is one partition which may be made on the basis of preference orderings alone. Similar partitions may be made on the basis of physical orderings.

Suppose that the set of alternatives is partitioned in several ways as described above. For example, it might be partitioned into three subsets by a selected alternative on the basis of preference, then partitioned by physical order and the additional partitions superimposed on the first; then one or more of the subsets might be partitioned by a selected element within each subset. Proceeding in this way the set of alternatives might be partitioned as minutely as desired.

Instead of partitioning the set of alternatives by selecting single alternatives within the set, the partitioning might be done by selecting a single variant of a characteristic. For example, suppose the decision maker selected some specific money cost. Then the set of alternatives could be partitioned into two subsets, that containing all alternatives costing no more than the specified money cost and that containing all alternatives costing more than that cost. Again, by successively selecting variants, either from a single characteristic or from different characteristics, and partitioning on the basis of the selected variants, the set
of alternatives could be partitioned as minutely as desired.

Once the alternative or characteristic variant is selected, the partition remains only to be recognized. It is the basis for selecting the alternative or variant which is a matter for choice. The decision maker must do two things: (a) specify the alternatives or variants to be used as criteria and (b) specify the order in which criteria are to be used in partitioning the set. Order in partitioning may or may not make a difference but, in cases where it does, order must be specified.

8. Feasible subsets

Suppose that the decision maker has limited resources, for example, time or money. Then one variant of the characteristic money cost might be identified as the extreme limit of the amount that he was able to spend on any of the alternatives. This variant would act as a criterion to partition the set of alternatives into two subsets, one feasible with respect to money cost and the other not feasible. Suppose that on time expenditure there was also a limit which could be identified and would partition the set of alternatives. Taken together (in this case order of applying criteria would be irrelevant), these two characteristics would partition the set into four subsets: (a) those alternatives feasible with respect to both time and money, (b) those feasible with
respect to money but not time, (c) those feasible with re-
spect to time but not money, and (d) those feasible in
neither respect. If no more than one of subsets (c), (d),
and (b) were empty, then both time and money might be termed
constraining characteristics, that is, both characteristics
exclude some alternatives from the feasible set.

In the foregoing example, feasibility was defined with
respect to physical order. It might be defined with respect
to preference ordering as well. For example, suppose some
variants of a characteristic, perhaps hues of a color, fla-
vors, or shapes, were unacceptable with respect to prefer-
ence. If these variants were really unacceptable in the
sense that they would never be chosen, they also would bound
the feasible set. The feasible set contains all alternatives
which the decision maker need consider, since his choice must
be made from that set.

9. Preferred subsets

The feasible set is likely to be much smaller than the
entire set of alternatives, but it may be possible to narrow
still further the set to be considered. Any selected alter-
native might partition the set to which it belongs into two
subsets: (a) the subset containing all those alternatives
which are equally or less well preferred in all characteris-
tics to the selected alternative, and (b) the remaining
alternatives. Suppose an alternative is selected in such a way as to make subset (a) as large as possible. Then choice may be limited to (b), which might be called the preferred set, since any member of (b) must be equally or more preferred to any member of (a).

Some ambiguity arises from the fact that there might be some alternatives in (a) which were equally preferred in all characteristics to some alternative in (b). There is no reason why these alternatives might not be chosen even though they were members of (a); on the other hand, if the two alternatives were really indifferently preferred, there is no reason why they should be. The confusion is easily eliminated by adding a further condition, that alternatives in (a) must be less well preferred in at least one characteristic to any alternative in the preferred set.

If the choice is made under conditions of complete information and on the basis of preference orderings, it must belong to the preferred set. But to distinguish a single preferred alternative some decision rule must be applied since in many cases the preferred set will contain more than one element.

10. Decision rules

One simple type of decision rule would be to choose an alternative from the preferred set which has the highest
preference rank on some specified characteristic, disregarding preferences for any other characteristic. The decision concerning the particular characteristic on which to base choice might be made at some previous time for an entire set of decisions or might be made as a preliminary choice to apply only to the situation in question. If a person always chose the alternative costing the least money, he could be presumed to follow this rule. But suppose two alternatives were equal in this characteristic and cost less money than any other alternative. An additional specification would be needed to identify a unique choice. This might take the form of choosing the more preferred alternative according to a second characteristic, or the lexicographic principle of choice.¹

The lexicographic principle might take on many specific forms. For example, the chosen alternative might be identified on the basis of preference ordering of a single characteristic but be chosen from a subset of the preferred set. This subset would be identified by additional constraints on specified characteristics. Or the preferred set of alternatives might be narrowed by applying successively higher constraints on characteristics arranged in some order, perhaps

the order reflecting the decision maker's preference for characteristics.

A second type of decision rule would involve the random selection of an alternative from the set of alternatives or from some subset of alternatives. This rule should not be overlooked; it may be that random selection does take place in some instances.

A third general type of rule is based on interrelationships among characteristic orderings, either preference or physical. If the interrelationship can be expressed as a mathematical function, then the element may be chosen by maximizing this function. A simple (but important) decision situation in which this type of rule is used is the case of the producer who wishes to maximize profit. In his case the characteristics in which he is interested, i.e., inputs and output, are all measured by a common preference unit, dollars, and profit is a function of the dollar value of the characteristics. Maximization may be over the entire set of alternatives or over some subset defined by relevant criteria.

11. Interpretation of partitions

The usefulness for research of the preference ordering of characteristics lies in the fact that, if the preference orderings of each of the characteristic sets is known or can
be reconstructed from indirect evidence (regular relationships between physical orderings and preference orderings can be used for this), then any selected alternative partitions the set of alternatives into a number of subsets of known properties. Suppose the data included preference orderings and the identification of the alternative which was actually chosen. Then the following subsets could be distinguished:

(1) The set of all those alternatives preferred or indifferent in all their characteristics to all the characteristics of the chosen alternative.

(2) The set containing all those alternatives to all of whose characteristics the characteristics of the chosen alternative are preferred or indifferent.

These subsets may be understood more easily from examples and further interpretation. In the case in which subset (1) is not empty, i.e., the case in which it contains one or more alternatives other than the chosen alternative, the chosen alternative either is not the most preferred alternative or the decision maker employed some criterion other than the presumed preferences in making his choice. This would indicate that his decision situation ought to be examined further.

Subset (2) is the rejected subset, but it may include some members of the preferred subset. If so, choice must have been based on a decision rule.
Subset (3) is the subset containing all those alternatives preferred to the chosen one with respect to a characteristic C and no alternatives preferred with respect to characteristic M. Suppose further that, when new alternatives are introduced into the situation, they are chosen if and only if they are preferred to the original choice with respect to either C or M and are less preferred in neither. Then one of these characteristics may be termed the constraining characteristic and the other the maximized characteristic. If C is the constraining characteristic, subset (3) is the feasible set.

The only distinction between the constraining and the maximized characteristics is in the capabilities and intentions of the decision maker: he does not choose less preferred variants of the constraining characteristic because he is unable to do so; he would prefer to choose more preferred variants of the maximized characteristic but is unable to do so because they are linked with less preferred constraining variants.

But under certain circumstances the constraining and maximized characteristic and the feasible set can be identified if only one of them is known. Suppose that the alternatives and the preference order of their characteristics were known to the researcher and that in these alternatives all possible permutations of characteristic variants were
present. Then from a knowledge of the chosen alternative and one of the following, constrained or maximized characteristic or feasible set, the other two could be deduced. The chosen alternative always contains (a) the variant of the constraining characteristic which bounds the feasible set and (b) the most preferred variant of the maximized characteristic within the feasible set.

The above is true especially if there is only one maximized and one constrained characteristic. If there are several of each, they may be more difficult to identify.

To summarize, research could furnish information as to the identity of constraining characteristics, that is, those characteristics for which the variant of the characteristic attached to the chosen alternative is usually the boundary of feasibility. Money cost is usually assumed to be the constraining characteristic, and it often may be so, but it would be well to have more evidence on this point. It may be that, in some classes of consumer decisions, characteristics other than money constrain choice. If certain characteristics were known or assumed to be the constraining characteristics, then data on actual choice would furnish evidence concerning the location of the bounds of feasibility fixed by decision makers.

An alternative question for research might be the identity of characteristics to be maximized. Suppose the chosen
alternative had attached to it one or more characteristics which were not at the bounds of feasibility on those characteristics but were at the bounds of the feasible set; then these must be characteristics which the decision maker maximized by his choice. For example, if money was the constraining characteristic, then the set of all conceivable alternatives could be partitioned into those feasible with respect to money and those not feasible. If, within the set feasible with respect to money, the decision maker chose the alternative most preferred on some other characteristic, for example, palatability, then that other characteristic must be the one he wishes to maximize. The boundary variant of the constraining characteristic is the variant least preferred in the feasible set; the chosen variant of the maximized characteristic is the one most preferred in the feasible set.

Another point on which it should be possible to gain evidence is the relation between the physical variation of any particular characteristic and the preference ordering of these variations. It has been hypothesized that this is a regular relationship, but there are several possible forms for this regularity. If characteristics can be identified in such a way that they pertain to many products having the same general use, then the relationship between physical variation of and preference for characteristics may be a
better guide for predicting choice, recommending products to consumers, or creating new products than information about demand for or satisfaction with each product considered as a whole. The information might also be more economical to obtain and might be valid for a longer time and for a wider range of products.

A fourth point of investigation has to do with the improvement of choice. If the set of alternatives equally or more preferred in all characteristics to the chosen alternative is not empty, then the decision maker could choose an equally good or better alternative from that set. This could be the basis of recommendations to the decision maker. If the purpose of the investigation were to indicate ways in which the choices of the decision maker could be improved by altering the characteristics of the alternatives available to him or by altering the bounds of the feasible set, then a knowledge of those bounds and of the sets rejected by the decision maker in order to maximize a single characteristic would be helpful.

Or suppose that the bounds of feasibility were altered, for example, by windfall income or emergency drains on time or money. A knowledge of the bounds of feasibility and of preference orderings would assist in predicting choice in the new situation. This might be a fifth area to examine.

Finally, data on consumer's actual choices and their
preference orderings would furnish evidence as to the decision rules which they actually follow. This would be of considerable interest, since it might permit a general theory of choice behavior to be formulated on the basis of empirical evidence.

12. **Relationship between characteristics and objectives**

The theoretical basis of preference ordering needs further comment. To recapitulate, the decision situation is defined with respect to the decision maker and his objectives. His immediate objective determines a set of alternatives. Those actually considered, the feasible set, are defined with respect to the immediate objective, to the entire set of objectives held by the decision maker, and to the decision situation. Specifically, the set considered to be feasible includes only the alternatives which will (a) achieve for the immediate objective the minimum level of attainment acceptable to the decision maker, and (b) permit a specified level of attainment for each of the other objectives. Both (a) and (b) are defined within a specific decision situation.

The set of all characteristics may be divided into four subsets on the basis of their relationship with the immediate objective and the set of all objectives. Characteristic set A includes all those characteristics whose variation affects only the attainment of the immediate objective; characteristic
set B includes all those whose variation affects only the attainment of one or more objectives other than the immediate objective; characteristic set C includes all those characteristics whose variation affects attainment of the immediate objective as well as of one or more other objectives; and characteristic set D includes all those whose variation affects the attainment of no objective held by the decision maker.

The effects of objectives on preference ranking of characteristic variations may be seen from this classification. Characteristics in group A take their preference rank directly from the levels of the immediate objective to which they are attached. Characteristics in groups B and C take their preference rank from all the objectives to which they contribute as well as from the immediate objective. These objectives must be weighted in some way according to the intensity with which the decision maker desires their fulfillment. Characteristics in group D cannot affect decision; their variants are indifferently preferred.

A second distinction which is often made among characteristics is durability with respect to achievement of the immediate objective. Some characteristics remain essentially unchanged when the alternative to which they are attached is chosen and used to achieve the objective; others undergo material diminution or augmentation. This change
might have to do either with physical or preference order. If with physical order, anticipations of change affect preference orderings on which choice is based.

Suppose that a characteristic belongs to group A, whose variation affects only the immediate objective. In this case durability is immaterial, since increase or decrease has no effect on any other objective. If the time period pertaining to the immediate objective were one day, then the decision maker would not care whether the characteristic lasted beyond that day or not. But suppose on the second day he wished to fulfill an objective identical with the immediate objective, for which the characteristic, if enduring, might be utilized. Since the time period is different, the objective is different, and any characteristics which contribute to both objectives must belong to group C, containing those whose variation affects the immediate objective and one or more other ones. If an objective is duplicated in succeeding time periods, any characteristic which contributes only to the immediate objective must be one which is reduced to nothing in the time period that objective covers.

If a characteristic is unchanged by fulfillment of any objective, then preference for variations of the characteristic are based directly on the level of attainment of the immediate objective to which it contributes. If it does not affect the level of the immediate objective, then the
decision maker is indifferent to it.

If a characteristic is changed by fulfillment of the immediate objective, then preference for variations of the characteristic are based on the level of attainment to which it contributes of all those objectives affected by its variation. These objectives must be weighted in some way by the decision maker's relative preference for each. In a real situation during a single time period, the decision maker must decide among various levels of objectives for that time period and in future ones.

13. Relationships among characteristics, alternatives, and planes

Suppose that the decision maker considers a set of planes of living, of which each element (plane) in the set is a particular level of fulfillment of each possible objective at each successive small period of time, beginning with that immediately following choice and continuing for many periods of time. Suppose that the set of planes is a universal set which includes all conceivable planes or combinations of objective fulfillment. This set will be very large; however, many of these planes will be impossible to attain due to constraints on characteristics. Suppose that these constraints are identified for all time periods; then the universal set of planes can be partitioned into two sets. Of these, one, called the feasible set, contains only those planes which
satisfy all constraints over all time periods, and the other contains only those planes which fail to satisfy a constraint in some time period. The second set may be dismissed from further consideration.

Suppose that the decision maker is able to order all planes in the feasible set according to his preference. In each alternative which he considers, characteristics are present at some physical measure. If the decision maker chooses alternative I, he in effect chooses a subset of planes consisting of those planes in which each of the characteristics is present in the physical measure associated with alternative I. But each characteristic variant associated with I is also included in a larger subset of planes consisting of those planes in which that particular characteristic is present in the measure associated with alternative I but other characteristics may be in any feasible measure. The rank associated with the most preferred plane in the first set of planes is the rank associated with alternative I, but the most preferred plane in the second set gives its preference rank to the single characteristic variant common to all the planes included in it.

Next, consider alternative II. It also is associated with a set of planes, and each of its characteristics variants are associated with a set of planes. Suppose that the characteristic to be examined is that of money cost of al-
ternatives. The money cost of alternative I is associated with a set of planes and the money cost of alternative II is also associated with a set of planes, many of which may also be included in the set belonging to I. But if a single plane associated with the money cost of alternative II is more highly preferred to any plane included in the set associated with the money cost of alternative I, then the money cost of II is preferred to the money cost of I. Similarly if any plane in the set associated with alternative I is more highly preferred than any plane in the set associated with alternative II, then alternative I is preferred.

By considering the set of planes associated with each characteristic variant, complete preference orderings for the variants of any characteristic might be obtained, based on preferences for planes. In the same way, preference orderings for alternatives might be obtained. But suppose that for some reason the decision maker prefers not to examine the set of planes of living in order to obtain preference orderings of characteristics. This approach would, after all, require that he comprehend and evaluate an extremely large quantity of information. To avoid the necessity for gathering and processing all this information, the decision maker might adopt certain conventions with respect to the preference orderings of characteristics. For example, he may observe that a smaller unit price on any one commodity
purchased usually enables him to achieve a more highly preferred plane; therefore he might adopt the convention that he always prefers a lower unit price. Similarly he might adopt conventions about other characteristics. These conventions enable him to specify preference orderings of elements in a characteristic set without defining precisely the planes of which these elements form a part.

But if the decision maker orders the elements of each characteristic set without identifying them with planes, then he has no common preference scale for measuring all characteristics for the purpose of ordering alternatives. Therefore, he must employ a decision rule in order to arrive at a choice, except in the special situation in which one alternative has the highest preference rating in all its characteristics.

To help clarify the foregoing, consider the following decision situations. In each situation, there are $s$ planes to consider and these are ordered by preference and labeled $p_1, p_2, \ldots, p_s$. The decision maker considers three alternatives, each of which has three characteristics. With each level of each alternative there is associated the subset of planes of which it forms a part. For the sake of simplicity, assume that if a characteristic variant is a part of any particular plane, it is also a part of all planes less preferred than that one; therefore the subset of planes with
Table 2. Example of alternatives ordered by preferences among characteristic variants and among planes of living

<table>
<thead>
<tr>
<th>Rank of preferred plane associated with separate characteristic variant</th>
<th>Preference order of alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative</td>
<td>Characteristic</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>a₁</td>
<td>6 1 2</td>
</tr>
<tr>
<td>a₂</td>
<td>2 3 6</td>
</tr>
<tr>
<td>a₃</td>
<td>3 5 5</td>
</tr>
</tbody>
</table>

| II            |               |    |    |    |           |                  |
| a₁           | 5 6 5          |    |    |    | a₃ - 4     | a₃ a₂ a₃ a₃     |
| a₂           | 6 3 3          |    |    |    | a₁ - 6     | a₁ a₂           |
| a₃           | 4 3 1          |    |    |    | a₂ - 6     | a₂ a₁ a₁        |

| III           |               |    |    |    |           |                  |
| a₁           | 2 5 7          |    |    |    | a₃ - 5     | a₃ a₂ a₃        |
| a₂           | 4 3 6          |    |    |    | a₂ - 6     | a₁ a₃ a₂        |
| a₃           | 1 4 5          |    |    |    | a₁ - 7     | a₂ a₁ a₁        |
which that variant is associated can be identified merely by mentioning the most preferred member of the set. The highest plane is also the rank of the characteristic variant associated with it. Table 2 summarizes this.

In I the characteristic elements are randomly associated with subsets of planes. Although alternative 3 is really the one enabling the decision maker to achieve the most highly preferred plans of living (plane 5), this is not evident if each characteristic set is ordered separately. In fact, alternative 3 is second best with respect to characteristics 1 and 3 and third best with respect to characteristic 2. It is only when all three characteristics are taken into consideration and are ordered on the same preference scale that it becomes evident that $a_3$ is the best the decision maker can do. The relative importance of characteristics is implicit in the ordering of the set of planes.

II shows the situation in which $a_3$ is most preferred in all characteristics and can be identified as the most preferred alternative without the use of any decision rule. III shows the situation in which a single characteristic $C_3$ is the constraining one. In this situation the most preferred alternative can be identified by considering only $C_3$. 
B. Choice Under Conditions of Incomplete Information

The assumption of complete information and certainty is highly unrealistic. In a few situations the decision maker may gather and evaluate a large amount of information, so large as to be complete; but in the majority of situations the decision maker is likely to choose on the basis of incomplete and uncertain information. There are two reasons for the decision maker's willingness to act with incomplete information: one is the difficulty of distinguishing correct information from that which is incorrect; the other is the cost, including time, money and effort, of completing information fields. Because of the first reason, complete information is difficult or impossible to obtain, but for simplicity one might put the two reasons together and assume that the difficulties of obtaining information could all be overcome at some cost.

1. Assumptions

The first assumption about the uncertainty situation is that all the elements and relations discussed in the certainty situation do, in reality, exist in the uncertainty situation as well. This is equivalent to assuming that relations are not changed in the process of gaining completeness, they are merely comprehended. Devices used to obtain information, such as laboratory tests or opinion survey, are assumed to do
no more than make apparent information which existed already and would have become apparent had events followed a natural course.

The complete mapping of all elements and relationships in the decision situation, including relations within and among alternatives, may be called for the purposes of the present model the real field of choice. The decision maker does not make his decision from this real field, though his choice is an element of that real field and subject to all its relationships. The decision maker is able to consider only a portion of the real field, that portion which is mapped onto what might be termed his information field. This is a partial mapping of the elements and relationships of the real field, together with false elements and relationships mapped onto the information field from various incorrect perceptions. Obviously there might be error in either public information, in the transformation of it into individual information, or in both.

A second assumption about the uncertainty situation is that any part of the real field may be mapped onto the information field, but that such an extension or revision of the mapping involves a cost. This is true even if the information is incorrect, though incorrect information may be less costly to obtain. The costs of mapping are changes in the relationships in the real field, especially changes in
the bounds of the feasible set of alternatives.

A third assumption is that all characteristics are known to the decision maker, but not all relationships. For example, he knows that a commodity has a money cost; he may not know what that cost is. He knows that a collection of commodities are capable of fulfilling an objective to some degree, but may not be certain as to the precise degree. He has the basic ingredients for interpreting any situation; what is lacking is measurements.

Finally, the decision maker is assumed to be able to order those planes of consumption with which he is familiar according to his preference. The number of planes mapped on his information field may be very small or very large; their mapping may be nearly complete for a few planes, skimpy for others. It is reasonable to suppose that the mapping will be most complete for those planes within a narrow range of his own plane, and least complete for planes having many elements outside this range.

Experience is a source of information about planes of living. It includes printed matter, both fiction and factual reports, pictures, spoken communications, and personal observation. Because of his incomplete mapping of planes, the decision maker cannot know his preference ordering for characteristics with certainty. At best he can do no more than estimate the probability that a characteristic is attached to
a range of planes. He knows that it belongs to certain parts of planes, but unless he knows with certainty the highest plane to which the characteristic belongs, he cannot know his preference with certainty.

2. **Relationships under uncertainty or risk**

Under these assumptions, analysis proceeds in a relatively straightforward way. The decision maker senses a choice to be made with reference to some objective. Decision in uncertainty is carried on as a multi-stage process, in which the early stages are decisions with respect to extending information mapping.

The decision maker may be visualized as attaching to each relationship measure in his information set a probability between and including zero and one. This probability is his estimate of the likelihood that the measure corresponds to reality. The probability might be attached to a point estimate or a confidence interval estimate. If the decision maker is unable to estimate the probability that a measure is correct, that is, if he is in a state of uncertainty about the relation, he has several alternative strategies of evaluating the uncertain relation. One strategy is to postpone the evaluation until some preliminary decisions are acted on and their outcomes are known. This strategy includes decisions to seek information deliberately, but the activity
may also be extended through time in such a way that information gained in performing early stages of the activity can be utilized in decisions about the later stages. The decision maker might decide on the early stages in detail but preserve some freedom to revise decisions about later states as information became available.

A second strategy for handling uncertainty is to ignore the uncertain relationships and make the decision on the basis of other information. A third strategy is to adopt some randomly arrived at or conventional estimate of the relationship. For example, where probabilities are unknown, assume that each alternative is equally likely.

3. Decision rules

The decision rules formulated for the complete information case apply equally to the case of incomplete information but, since the information mapping is expressed in terms of probabilities, the decision maker must apply an additional decision rule concerning probabilities. There are three types of these probability rules which might be applied by the decision maker.

Type I: Maximize the probability that the chosen alternative is the preferred one. In this type are included all rules which maximize expected utility, including those
by LaPlace\textsuperscript{1}, Savage\textsuperscript{2}, and Shackle\textsuperscript{3}.

Type II: Maximize the probability that the chosen alternative belongs to some specified subset of alternatives. This type includes the Wald maximin criterion\textsuperscript{4}, the Savage minimax principle\textsuperscript{5}, Simon's satisficing criterion\textsuperscript{6}, and the Hurwitz pessimism-optimism index rule\textsuperscript{7}.

Type III: Maximize the probability that the chosen alternative is the preferred alternative subject to the condition that there is a specified probability that the chosen alternative belongs to a specified subset of alternatives.

In general, Type II rules have the advantage that the decision maker can specify the subset of alternatives in such a way that when his evaluation is made after choice, he can perceive whether or not the chosen alternative was in fact a


\textsuperscript{4}Savage, op. cit., p. 184.

\textsuperscript{5}Ibid., p. 164.


\textsuperscript{7}Luce and Raiffa, op. cit., p. 282.
member of the specified subset. The simplest example is the two person game in which the payoff matrix is known. A player chooses with certainty that his payoff will be one of a set, but he does not know which one it will be. In a slightly more complex game situation in which he knows not only the payoff sets pertaining to each of his alternatives but also the probability of obtaining each payoff given that the alternative was chosen, the decision maker might decide on a range of acceptable payoffs and choose the alternative in which the probability that the payoff would be included in that range was at a maximum.

If the decision maker uses a Type I rule, he can seldom know with certainty whether or not he did in fact choose the alternative he would have preferred in the complete information situation. If he uses Type III rule, he can know whether the alternative belonged to the specified subset, but usually not whether it was the preferred alternative.

The advantage derived from knowing whether choice was successful, that is, whether the chosen alternative was the preferred alternative or from the preferred set, is that it may enable the decision maker to improve later decisions by enlarging his information field. For this reason, Type II or III rules may be preferable.
4. Application of incomplete information model in research

At this stage of research into consumer choice behavior, decision rules relative to risk are probably of little interest because the body of data to fit models of such refinement is insufficient. It seems more reasonable to label every information bit as certain or uncertain and assume that the decision maker bases choice only on certain information. Subtleties due to allowances for risk would be hard to detect and might add little to the accuracy of the findings.

The decision maker could reasonably be assumed to consider the relationship having the highest probability of being true as a certain one; or, if the probability of being correct was low, to consider the relationship as uncertain. If uncertain, he might ignore it or defer final decision, at least on actions depending on the uncertain relationship. It might be important, therefore, for the researcher to gather evidence for the certainty or uncertainty attached by the decision maker to information, and also to differentiate decisions as to the stages in which they are actually made.
IX. APPLICATIONS OF THE MODEL IN RESEARCH

In the preceding chapters a terminology of choice was defined and some theoretic relationships were examined. In the present chapter some practical considerations will be explored relative to applying the model in research. These considerations will be categorized as content areas to which the model is applicable, data selection, and research objectives to be achieved by the analysis of data.

A. Areas of Applicability

Choices may be viewed from different points of view as well as with differing content. One such point of view is that of the decision maker himself. The consumer is a decision maker; so also are producers and distributors of consumer goods. Members of each of these groups analyze choice with the purpose of understanding and improving the effectiveness of their own choices. A second point of view is that of the producer or distributor in making those choices whose effectiveness in obtaining desired outcomes depends on accurate prediction of the choices of consumers. A third point of view is that of the governmental policy maker, whose job is to mediate between choice makers with conflicting interests. This last point of view involves both the understanding and the accurate prediction of choices.
1. **Purposes of analysis**

Choice behavior may be studied for a variety of purposes which may be classified as follows:

1. to improve ability to identify the optimum choice among alternatives,
2. to improve accuracy of predictions about choices of others,
3. to improve ability to identify optimum choice when this depends on the choices of others.

As an example of the third purpose, consider the policy maker who is interested in promoting economic growth. He must take into consideration probable choices in several sectors of the economy if a particular action policy is put into effect. The policy may affect other choice makers directly in several ways: (a) by altering the constraints on the set of feasible choices, (b) by altering the physical measures of characteristic variants, (c) by altering preferences among variants, and (d) by altering the decision maker's information set. Obviously, the policy may have indirect effects, for if some choices are based on predictions of the choices of others, and if those other choices are affected by the policy, then choices based on predictions of those other choices are affected as well. The consuming sector, the producing sector, the marketing sector, the financial sector, and all other identifiable sectors will each
adapt their choices to the new policy, presumably in accordance with their own interests. The policy maker must estimate the scope and direction of adaptations to direct and indirect effects, predict the choices which will be made, and evaluate the choices with respect to economic growth and perhaps with respect to other criteria.

To continue the example, suppose the policy had to do with regulating the marketing of pork. On the one hand, the policy maker would need to predict the choices which marketers of pork would make with respect to quantities, forms and conditions at which pork would be offered at retail; on the other hand, the policy maker would need to estimate the consumer demand for pork under the changed circumstances. There might be changes in prices, but not necessarily. Demand analysis can be used to predict choices as they respond to changes in income or prices, but neither change might be involved here. Theories of profit optimization are useful in predicting the choices of business firms under changed conditions of cost or demand but, again, neither change might be involved.

The approach suggested in this dissertation would be clumsy to use in studying the response of aggregate demand to price changes in a well established product, but it might be used to study choices to which demand analysis does not apply. An example of this is the case where demand changes
in response to factors other than price or income. Similarly, it should be useful in analyzing the manner in which factors other than money enter into choices made by firms or governmental agencies. The suggested area of application of the model is in the study of individual consumer decisions, either for predictive or normative purposes. Some examples of decisions in this area are given in the next section.

2. **Content of choice**

Decisions to purchase major items of consumption are well worth study because they are likely to exemplify deliberate decision making, because they have a considerable effect on the welfare of consumers, and because decisions in other economic sectors are based on predictions about them. One decision of this type which might be examined is the decision as to whether or not the family should purchase a second automobile and, if they do so, what kind to purchase. In making this decision, the family is likely to survey its needs, interests, abilities and objectives with some care and choose from among alternatives on the basis of the relevant elements in its situation. Many families need a second automobile to help them carry on their chosen activities. If the wife works away from home, she may need separate transportation to her job. If she participates in community activities, she may find that her needs for transportation
conflict with those of her husband. As the children reach their late teens, they also have pressing needs for automobile transportation.

The increase in disposable income for families in the United States has made it possible for many families to buy a second car, and the wide variety of cars on the market has enabled them to choose cars which closely fit their respective needs and resources. These are a few of the reasons why there is much to be learned from a study of the decision to buy a second automobile, both by way of describing and explaining current needs and behavior of families and as a basis for predicting future behavior.

Another pertinent type of decision has to do with maintaining and building up inventories of consumer goods. Many commodities are purchased as replacements of commodities previously used. In this situation, an important part of the total decision has been the decision to discard the older commodity. Discard is used here as a term to designate any new disposition of the commodity, either to a new ownership or to uses other than the original one.

Some commodities, for example, washing machines, are often bought as replacements for possessions which are being transferred to a new ownership or destroyed. Others, such as clothing, are bought either to supplement or to replace garments which the decision maker already owns. In either case,
the decision to discard possessions is significant in determining the behavior of the decision maker and may be more intimately associated with needs and preferences than are decisions to purchase new commodities. The problem of controlling inventories of consumer goods takes on more and more priority in the minds of decision makers. Several causes contribute to this effect; among them cost of storage space, increasing geographic mobility of families, and property insurance rate increases are significant.

Consumers make many decisions regarding the use and maintenance of the goods which they own. One decision of this type is the choice of whether or not to expend resources in order to keep up the appearance and working efficiency of a possession, or to "use up" its value and then replace it. One consumer with whom the writer is acquainted wears an inexpensive watch which she never has cleaned or repaired. Instead she buys a new watch every few years. She feels that this plan has the advantage of variety and is no more costly than buying and maintaining a more expensive watch. In the case of commodities such as electrical appliances for which repairs may be expensive and difficult to obtain, the cost and inconvenience of repairing the old one may be little less than that of replacing it. Or, again, the choice may be between repairing a commodity or using it in a state of disrepair. Elderly persons who own their own homes may decide
to allow deterioration rather than allocate part of their income to maintaining the value of their property. Such choices have implications for the design of products and arrangements for financing their purchase and maintenance.

Another type of decision has to do with obtaining and using resources. For example, should the decision maker improve his abilities to perform certain actions which facilitate consumption? Should he use more of his time and energy in order to get more consumer goods? Should he use his resources to obtain goods which yield no immediate satisfaction but which can be used to obtain other consumer goods? And, on the other hand, how should resources be allocated among alternative ways of obtaining consumer goods? Should the home maker use her time and energy to clean her house, should she hire someone else to clean, or should she use money to obtain devices which will reduce the time and energy necessary to clean her home? The choices which consumers make in response to these questions determine the kinds of products and services which should be offered on the market and the educational and service facilities which are needed, and also the role of the government in promoting consumer welfare by means of regulation of the production, marketing, and use of goods.
3. **Conditions to be met**

If a decision is a real decision, that is, if the decision maker is aware of and chooses among several alternatives, the proposed model applies, regardless of whether the choice stands alone or is one of a chain of choices as it might be in managerial activity. If the choice is a member of a chain or cluster of choices, the researcher must be careful to distinguish the characteristics which belong to one choice situation from those which do not, and the alternatives which the decision maker considers in making one decision from those considered in other decisions.

In research which included an entire cluster or chain of choices, the researcher might analyze each decision separately, or, if the decision maker's information map did not change markedly during the decision period, he might analyze the entire set of decisions as though it were a single decision. If the information map did change from one subsidiary decision to the next, and this affected the number of alternatives considered and the preference ordering of characteristics, it would be more realistic to analyze each subsidiary decision separately.

A cluster or chain of choices may be analyzed as a single choice provided that the set of alternatives is exhaustive and mutually exclusive, that is, the set must be defined in such a way that the decision maker (a) can choose only one
alternative and (b) must choose from that set. If the al-
ternatives are not so defined, then preferences among vari-
ants of characteristics are not comparable because mutual
exclusiveness is not fulfilled, or the calculated probabili-
ties that the different alternatives will be chosen are in-
correct because the set is not exhaustive, or both.

The error of treating as two decisions that which was
made as a single decision is probably not serious. If the
analysis is accurate, the same results should be reached
whether the decision was regarded as single or double, pro-
vided that the conditions of mutual exclusiveness and ex-
haustiveness are satisfied.

The danger of including extraneous elements in the de-
cision situation is that the preference for extraneous ele-
ments will depend on unidentified objectives. If choices of
a random sample of decision makers were examined, one would
expect their preference rating for extraneous elements to be
randomly distributed in the same manner as unimportant char-
acteristics, but this might be not the case. An extraneous
element might be generally ranked low or high, not because it
bore any relation to the objective under investigation, but
because some unstated objectives were held in common by the
decision makers.

The converse error is to fail to include all elements
pertinent to a decision. The only means of checking on this
is to examine the consistency of the model for predicting or explaining actual choices. If interest centers on regularities in the choice behavior of a sample of persons, there is probably less danger that elements influencing their choice will be omitted than if the choice of a single person were examined.

The analysis of choice is less applicable to habitual behavior than to that pertaining to deliberate decisions. Even habitual behavior which is based on some previous decision is not necessarily identical with behavior which the decision maker would have exhibited had he made a new decision. Perceived cues in the situation might be the same as those which he had taught himself to recognize as signals of the original situation, but other elements might be changed in such a way that some other alternative would now be preferred. In analyzing habitual behavior which is based on an earlier decision, the researcher takes the risk that the situation may have changed sufficiently that the chosen behavior is not consonant with the decision maker's preferences.

Habitual behavior is abandoned or modified when conditions change markedly, but there may be a delay in this response. If the purpose of the research worker is to predict future behavior, he may find that his predictions are inaccurate even when conditions have not changed from those
in effect when he obtained his data. This could be due to an adaptation delayed until after he collected his data. If, on the other hand, the researcher wishes to study choices with a view to making normative recommendations, he may find that the decisions he studied were habitual choices which did not accurately reflect decision makers’ real preferences and, therefore, any recommendations based on these choices would be at fault.

B. Selection of Data

Having decided on the type of decision which he will study, the research worker must decide what data he needs in order to analyze choices adequately. In order to do this, he should define or identify the scope of the decision, applicability of the model to the decision, data necessary for analysis, optimum timing of data collection, optimum sources of data. These depend upon the content of the problem in which the researcher is interested and upon purposes of his investigation.

1. Necessary data

Several types of data are pertinent to the analysis of choice:

1. qualifying criteria,
2. physical characteristics of alternatives,
3. preference orderings of characteristic variants,
4. chosen alternative,
5. physical characteristics of the decision situation,
6. constraints.

These types are not necessarily listed in the order in which the data would be sought. Questionnaires or interview schedules should be organized in such a way as to minimize bias and error in the responses.

In order to observe regularities in behavior, some variables must be controlled in order that the effects of other variables may be compared. In general the fewer uncontrolled variables there are in the situation, the more precisely can effects be measured. The sample might be limited to a population of those decision makers choosing a particular alternative, to those confronted with an identical set of alternatives, or to those in decision situations similar in specific respects. The qualifying criteria may be physical characteristics of the alternatives, of the decision situation, or of the chosen alternative.

Physical characteristics of each alternative in the set should be identified and measured. The research worker has three alternative ways by which he may decide on the identity of characteristics: (a) follow some logical scheme, (b) identify characteristics as nearly as possible after the manner in which decision makers identify them, or (c) identify
them in such a manner as to make measurement most convenient, precise, or consistent. Each of these ways has its own advantages and limitations. Perhaps the easiest way to identify all characteristics is to follow a logical plan; however, if the resulting set of characteristics is defined differently from those characteristics as the decision maker defines them, the preference orderings of the decision maker may not be completely applicable. The characteristic as defined by the decision maker may be difficult to identify precisely and to measure consistently. Characteristics should be identified in such a way as to conform with logical criteria and conditions necessary for precise, unambiguous, and consistent measurement and at the same time to preserve the applicability of preference orderings.

Particular preference orderings may be assumed from evidence not included in the study, from responses to questions designed to indicate the decision maker's general preference structure, or from responses to specific and detailed questions about preferences. Preference orderings may also be reconstructed or confirmed through analysis of physical characteristics, actual choice, and constraints. Suppose, for example, that actual choices were noted in situations in which the feasible set was made successively smaller. Then, disregarding those characteristics on which constraints had been changed, some other characteristics of the chosen
alternative should show a consistent trend in variation as the more stringent constraints forced the decision maker to choose less and less preferred variations of those characteristics.

If he wishes to gather data concerning specific decision rules, the research worker must identify the alternative which decision makers actually choose. The chosen alternative may be identified by observation of overt behavior or by simply asking decision makers what they choose, what they expect to choose, or what they would choose in a hypothetical situation. All alternatives included in the analysis should be defined at the same operational level as the chosen alternative. Because the chosen alternative may have already been acted upon or have been considered in great detail with respect to action, it may be easy to specify minutely the operations included in that alternative, while other alternatives can be described only sketchily. Similarly, there may be a chain of subordinate decisions stemming from the original decision and confirming every aspect of carrying out the alternative. Unless this chain of decisions can be identified adequately for each of the original alternatives, it may be better to ignore them or treat them as separate decisions. Including data pertaining to a chain of decisions as part of one alternative without including similar data for all may make the alternatives noncomparable in some characteristics.
Data about physical characteristics of the decision situation and constraints have been listed as separate types, but they are really ways of getting data about the same thing. What the researcher would like to know is the precise identity and measurement of constraints which limit the decision maker's feasible set. Whatever direct evidence he can get he should use. But where constraints are hard to identify or precise measurements of them are lacking, measurements of the physical characteristics of the decision situation may furnish indirect evidence about constraints.

For example, suppose the decision of interest had to do with buying a toaster. The alternatives might differ with respect to money cost. The constraint related to this characteristic would be the amount of uncommitted income in the hands of the decision maker. If this were not known, the total income of the decision maker would be useful in constructing a demand function for toasters.

The research worker may measure some physical characteristics of the decision situation because he believes they are related to constraints which he is unable to identify. For example, he may observe that purchases of consumer durables fluctuate with the business cycle. Without being able to define the nature of the constraint which produces this effect, he may still find it useful to include in his model a measure of general business conditions.
2. **Sources of data**

The model is intended, not as a guide to discovering the actual thought processes a decision maker goes through, but as an aid to identifying factors which are associated with specific choices. However, the decision maker can only be influenced through his information set. If he believes a characteristic enters the situation in zero degree, his decision is made on that basis, regardless of the true measure. In collecting data the research worker must take into consideration the problem of incomplete information on the part of decision makers.

How the researcher resolves the problem of incomplete information depends on his purpose in doing the study. If he wishes to learn the nature of decision rules followed by decision makers, he may base his analysis on the decision maker's description of the situation and his alternatives. These data may be biased or incomplete because the decision maker may be unable or unwilling to put into words every aspect of the decision; therefore, the questions must be selected and framed with care. If the research worker can obtain an approximately correct report, it will not have the fault of exaggerating the extent of correct information on which choice was based.

However, if the purpose of the analysis is to predict future choices, the research worker cannot confine his data
to subjective measures of characteristics as reported by decision makers. He needs a precise and consistent measure as well. For some purposes, such as conventional demand analysis, only the latter measure is needed. Analysis of choice for purposes of prediction could be refined and made more exact by including measures of information in order to estimate the effects on actual choice of different incomplete information mappings.

These are some considerations in designing a study of choice. If the research problem has been defined with sufficient precision, it is relatively easy to distinguish between pertinent and irrelevant data. It is not so easy to decide among several alternative methods of measuring characteristics of the decision situation. The best method is the one which probably will give the most adequate solution. Where the researcher has several purposes or is uncertain which method is best for a particular purpose, he may measure characteristics in several ways. In this case, a comparison of analyses based on alternatives measures could yield useful guides for subsequent research.

3. **Timing of data collection**

Investigations of choice might be either ex post or ex ante, that is, data might be collected either before or after choice. If before, then the assumption must be made that
data collected are applicable to that choice. Several in­fluences might make it inapplicable. Either physical or preference measures of characteristics might change between the time the measurement was taken and the time of choice. The decision maker himself might not be able to assess his own preferences until the moment of choice. Constraints may also be unpredictable, that is, the decision maker might not be able to predict in advance how much time or money he would be able to allocate to any particular choice.

If data are collected after choice is made, then elements may be forgotten or misrepresented. The decision maker might tend to justify his choice by reporting limitations or preferences incorrectly. Because he now has information which he did not possess at the moment of choice, he might explain his choice in other terms than he would have orig­inally. Or, because he is dissatisfied with his choice, he might report preference orderings which do not reflect the influences which determined his choice. If the analysis is based on other evidence that that reported by the decision maker, there is the difficulty of including all influential elements.

C. Objectives of Analysis

After the data are collected, the analysis may proceed along the following lines:
1. Identify those characteristics of alternatives and of the decision situation which are related to the decision, that is, those characteristics whose variation is associated with variations of choice.

2. Identify those characteristics which constrain the set of feasible alternatives and those which the decision maker attempts to maximize in his choice.

3. Estimate the probability of each separate alternative being chosen, given particular sets of characteristic variants. From this an aggregate decision function could be fitted.

4. Compare decision makers' information about characteristics as they report it with objective measurements of the same characteristics. From this the amount of "error" in their choices might be estimated. By error is meant the difference between their actual choice and the choice they might have made had they possessed more correct information. This might be done by comparing their choices with those of better informed decision makers in the sample or with the recommendations of persons who are experts in that field.

5. Examine the relationship between the physical and the preference orderings of particular characteristic variants.

6. Compare the consistency of the choice made during the initial interview with the actual choice made later, and
of the initial and the ex post measurements of characteristic variants as reported by decision makers. An additional check would be on the compatibility of the actual choice with constraints reported during or inferred from the initial interview. In cases where such incompatibilities are found, additional data might be sought to explain why choice was possible.

Study of choice behavior should provide conclusions on several levels:

1. It should yield useful descriptive data concerning the practices of consumers and the situations within which they make a particular type of choice.

2. It should enable the research worker to test specific hypotheses. For example, hypotheses concerning the relationships between preference and physical measures, concerning the characteristics which constrain choice or which the decision maker wishes to maximize, or concerning the effect of incomplete information might be tested.

3. It should provide evidence on which to base hypotheses concerning decision functions, individual or aggregate. These hypotheses should then be perfected and tested in further research, but even as hypotheses they might prove useful as a theoretic explanation of decision making and decision making behavior.
D. A Proposed Application of the Model

An area of choice to which the situational model discussed in the preceding chapters seems particularly well fitted is that concerned with product innovation and design. The outcome of such decisions may have considerable effect on the welfare both of consumers and of makers and distributors of products. On the one hand, the consumer's field of choice is limited to a large extent by the array of goods which are offered on the market. Within constraints imposed by his willingness and ability to expend money (assuming that this is a constraining factor), many combinations of other characteristics may be feasible; however, only a few of these combinations will be produced and marketed. It is to the consumer's interest to have those combinations offered him which most closely resemble his preference pattern for product characteristics and which at the same time satisfy constraints on his field of choice. On the other hand, the makers and distributors of consumer goods base their decisions with respect to product offerings partly on their knowledge of the preference patterns of consumers.

Suppose that some research agency has been given the responsibility of advising a washing machine manufacturer regarding modifications in the design of his product. The manufacturer has identified six characteristics of home washing machines which seem worth study:
1. economy in initial money cost;
2. economy in money cost of operation;
3. dependability of operation;
4. conservation of operator's time and energy;
5. excellence of performance with respect to cleaning and preserving garments; and
6. glamour.

If money price is a constraining factor, then in a study of consumer choices at all prices, the effects of the money constraint will be confounded with the effects of preferences for other characteristics. For example, suppose the agency were to compare demand for washing machine model A, priced at $400 and having a high dependability, with model B, priced at $300 and having less dependability. One cannot know whether the consumers who chose model B did so because their preference for dependability was low or because the higher priced machine was not a feasible choice. For this reason, price elasticity of demand for washing machines might best be left for a separate investigation.

The remaining five characteristics might be studied using the following procedure: Select a price range within which it seems unlikely that money constraints will be effective. Within this price range select several different makes and models of washing machines which, among them, represent the combinations being offered of the five characteristics.
Measure the number of units of each different machine sold during a specified time period. Devise a scale for measuring variation in each characteristic; the scale might be based on composite measures, but it should be constructed in such a way that differing positions on the scale represent corresponding differences on the average consumer's preference scale. Calculate the elasticity of demand with respect to each characteristic.

As outlined, the study would have several limitations. Some constraints might still influence choice and their effects be confounded with the effects of preference orderings. Also, decision makers are likely to have chosen under conditions of incomplete information and for this reason their choices might not exactly correspond to their true preferences. And, finally, projections of demand for products having innovations whose variation exceeded that of the products studied might be doubtful.

However, the investigation would have the advantage that some of the effects of constraining variables would be eliminated. Demand responses to innovations should be more exactly predictable, provided that these innovations could be measured on the scales devised to measure the five characteristics studied. Thus, by taking several product characteristics into consideration, by devising measuring scales which reflect consumer preferences, and by designing the
investigation in such a way as to minimize effects other than of preference, more predictable relationships between choice and variations in design should become apparent.
X. SUMMARY

Consumer choice is a key determinant of welfare. Its outcome affects many individuals and organizations besides those immediately involved. Because of this, research in this area may serve a variety of purposes and include a wide range of content. Its purpose may be to describe, relate, compare, or contrast the elements of choice, and perhaps to make predictions. The content of these studies includes estimation of demand, measurement of utility, and description and analysis of consumer goals and values as well as of other factors related to choice, such as occupation or educational level. All of these studies have a basis in utility theory.

The purpose of this dissertation was to examine the concepts used in analyzing consumer choice and, from them, to construct a model which can be applied in specific studies. Using the proposed approach, the researcher could base his descriptions and predictions of choice behavior and his recommendations for altering the conditions of choice upon a broad and inclusive analysis of situational factors which influence the decision maker. His results would supplement those from research based on other models.

A model is defined in this study as a conceptual structure which enables a researcher to analyze in theoretic terms his data concerning the real world. On order for it to be a
useful and valid instrument in research, the model should be scientific rather than personal by satisfying the following three conditions. The model should be consistent, both within itself and with other scientific models. It should be capable of exact transmission, that is, any competent person should be able to apply the model to identical situations and reach identical conclusions. And, finally, rules specifying valid applications of the model to real situations should be included in the model or accepted generally among scientists.

Using a model, specific problems may be formulated and their solutions identified. Scientific models have several advantages over personal ones with respect to problem solution. They may provide satisfactory solutions in a higher percentage of instances; their use demands less "flair" on the part of the researcher; and, most important, since performances are standardized, their errors can be estimated.

The environment of choice includes the decision maker, his actions, perceptions and conceptualizations, and his real surroundings. As the central figure in his environment, he perceives patterns which enable him to predict the outcomes of his choices. Outcomes might be defined as unrealized portions of pattern. Because the decision maker perceives himself in relation to his situation, he is able to order outcomes according to his preferences.

The interaction of the decision maker and his situation
may be conceptualized as his set of activities. These have certain characteristics such as regularity, duration and change, location in time and space, and level of elaboration which influence the preference order assigned to outcomes by the decision maker. These characteristics result from the interaction of activities in an over-all pattern called the plane of living. This is the universal set of activities belonging to a single decision maker in his lifetime. Situation is a perception of this plane under conditions of complete information and at a moment when a portion of the plane is still indeterminate and unrealized. The ultimate basis for preference among outcomes or characteristics of outcomes is the decision maker's preference ordering of planes of living.

An element is any thing viewed as an entity. Three classes of elements are proposed as components of the choice problem. These are objectives, alternatives, and characteristics. An objective is the decision maker's concept of a desirable outcome. It may be formulated with conceptual or operational precision. An objective must be conceptually precise to serve as a guide for decision, operationally precise to serve as a guide for action. A decision maker is influenced by a number of objectives at any given time. The relationships among those objectives affect his preferences and choice.

Alternatives are the elements among which the decision
maker chooses. They should be identified in such a way that each variation is a separate alternative, otherwise it would not be meaningful to order them according to preference. Each alternative may be viewed as a bundle of characteristics, each with characteristic of an alternative having its counterpart in every other alternative in the set.

Elements within the choice situation may be related by common membership in a set, by being different measures of a common element, or by association with elements in another set. These relationships may be termed inclusion, measure, and mapping. Choice relationships may have physical content by being capable of exact duplication, and preference content by referring to comparisons with value standards, or time or space content. Physical orderings affect feasibility. Time and space relationships affect both feasibility and preference for alternatives.

Although global information describes outcomes which will actually be realized by given choices, the decision maker must often base his choice on less inclusive mappings. If his information is as correct and detailed as comprehensive use of technology and keen observation permits, it might be termed complete information. The more likely case is incomplete information. Completeness refers to the precision with which relationships are known; certainty and uncertainty of information refer to the degree of confirmation for
measurements of relations. Risk is the condition in which the decision maker can order different sets of relationship measures by the likelihood that they contain the real measure.

Since the decision maker must choose from among alternatives on the basis of the information which he has, it is necessary for the researcher either to identify that information or make some assumption about it and its effect on the decision maker. In some cases a decision as to whether to choose immediately or to obtain more information before choosing may be made as a subsidiary to the main decision. In order to make his information about alternatives more certain or complete, the decision maker must undergo a cost. Since the extra cost incurred in obtaining information may limit the set of feasible alternatives, the effects of such a subsidiary decision must be taken into account in analyzing the main decision.

If each characteristic in an alternative is a variant of a characteristic which enters into every alternative in the set, and if the decision maker is able to order these variants, then the set of alternatives is partially ordered. Using any single alternative as a reference point, the set can be partitioned into (a) those alternatives having a higher rank, (b) those having a lower rank, and (c) the remaining alternatives. Using characteristic variants as reference points, it is possible to identify the feasible
of alternatives, containing those which it is possible for the decision maker to choose, and the preferred subset, containing those alternatives preferred in all characteristics to any alternative not in the preferred subset.

If the preferred subset contains only one alternative, the decision maker should choose it. If not, he must base his choice on a decision rule. Three types of decision rules are suggested for the case of complete information and certainty: (a) the lexicographic rule; (b) random choice; and (c) a complex function based on preference order and constraints on feasibility. In the risk situation, an additional decision rule is needed. Again, the additional rule might be one of three types: (d) maximize the probability that the chosen alternative is included in some specified subset; and (f) maximize the probability that the chosen alternative is the preferred one subject to the requirement that the probability of the alternative being included in a specified subset is within some acceptable range.

On the basis of relationships predicated in the model, research might be designed to identify those characteristics which constrain choice and those which the decision maker wishes to maximize, measure the association between preference and physical measures, identify constraints, furnish evidence concerning the nature of decision rules, or estimate demand for commodities under varying conditions with respect
to maximized and constrained characteristics. This would make possible a better understanding of decision behavior, particularly with respect to the practices of consumers and the situations within which they can be expected to make particular kinds of choices. More exact prediction and wiser recommendations for action should result from an improved understanding of the logic of choice.
XI. GLOSSARY

Abstraction  Set of essential qualities of a thing or things, considered apart from the thing itself.

Acceptable  Satisfying integral criteria of a model.

Accuracy  Exactness of conformity to real conditions.

Activity  A structure of acts, including some that are resource consuming.

Admissible set  Set of elements to which a problem is applicable.

Alternative  One of a set of incongruous elements, each capable of fulfilling a common objective in some degree. Each alternative is a structure including an activity of the decision maker which he might conceivably choose to perform, persons and material objects related to the activity, and time and space relationships.

Application to reality  Congruence of selected elements and relationships in a model with selected elements and relationships perceived in a real situation.

Bounds (of a set)  Elements of a set whose relationship with other elements indicates whether or not those other elements are also members of the set.

Certainty  Condition in which the decision maker has a strongly confirmed belief that a particular relationship falls within a subset of its universal set. The degree of
confirmation is such that belief is consistent with all other beliefs held with certainty within the model.

**Characteristic** Any feature, trait, quality, or property which serves to classify an element.

**Characteristic set** Set of elements, each recognizable as a perceivable characteristic of some alternative or element of a decision situation, where the entire set is a single concept and elements within the set are referred to by a common name or by an indication of relationship to other elements in the set.

**Choice** Selection of an alternative, with the entire decision implied in a static manner.

**Choice maker** Individual who selects an alternative.

**Choice making** Act of selecting an alternative.

**Choice making behavior** Actions involved in or related to choice making, as perceived by an observer.

**Coherent** Making a logical whole; consistent.

**Competing alternatives** Alternatives belonging to a single decision situation.

**Competition** Relationship between elements such that the inclusion of one in a structure renders the inclusion of the other less possible.

**Complementarity** Relationship between elements such that the inclusion of both in a structure is associated with a valuation of either or both higher than the valuation
had only one been included.

**Complete ordering**  A set is completely ordered if, between any pair of elements in the set, one is either greater than, less than, or equal or indifferent to the others.

**Completeness of information field**

- **global**  Mapping on the information field of all relationships within and among all elements in the alternatives and the decision situation, no matter how these elements are defined.
- **complete**  Mapping on the information field of all relationships within and among all elements in the alternatives and the decision situation which it is possible for the decision maker to know, provided he is a keen and careful observer and has at his command all instruments which have been devised for the detection and measurement of relationships.
- **partial**  Less than a complete mapping of the information field.

**Concept**  A mental image of an element and the characteristics and relationships essential to that element.

**Condition**  Specific measures of environmental relationships.

**Conditions to be met**  Conditions by which a set called an admissible set is bounded.

**Congruence**  Equality of relationships.

**Consistency**  Congruity of parts.
internal Condition in which relationships among elements within a model remain effective for all measures of those relationships.

external Condition in which relationships among elements within a model remain effective for all measures of relationships among elements in other models believed to be applicable.

Constraining characteristics Characteristics having variants which form the bounds of the feasible set of alternatives.

Consumer (or consuming unit) The entity which consumes resources and realizes outcome.

Consumer behavior Those actions of the consumer which are related to consumption.

Consumer choice Selection from among alternatives of which consumption is a part.

Consumer goods Goods and services used up by the consumer in obtaining outcomes.

Consumption The using up of resources, including commodities and services.

Cost of information Change in characteristic variants attached to alternatives or to the decision situation as a result of behavior by the consumer intended to make his information field more complete or certain.
of evaluating information  Change in characteristic variants attached to alternatives or to the decision situation as a result of valuation by the consumer of characteristic variants or of partitioning the set of alternatives into subsets according to certain criteria, including criteria having to do with preference, with feasibility, or with certainty.

**Criterion**  Boundary of a set.

**Decision**  A dynamic view of a decision situation; a process, including identification of objectives and alternatives, gathering and evaluating information, and selecting an alternative.

**Decision making**  Performance of the steps in decision.

**Decision rule**  Set of criteria defined with operational precision and capable of identifying a solution for any admissible set of alternatives.

**Decision situation**  A situation including a set of alternatives and all elements related to those alternatives.

**Description**  Identification of inclusion relationships.

**Durability**  Ability to continue in a particular condition; measure of change in characteristic variants due to the action of some agent.

**Dynamic**  Viewed as change or process.

**Effective**  Associated with variation in outcome.

**Effective variant**  One which is associated with a variation
in outcome for each alternative belonging to a set.

**Element** A statement of a relationship; an embodiment of characteristics and relationships.

**Environment** All real elements related to and including an individual and the relationships among and within those elements.

**Evaluation** Ordering and partitioning a set according to preference relationships.

**Expenditure** The using up of resources to obtain commodities and services.

**Factors** Elements of a situation.

**Feasibility** Capability of being effected.

**Field of choice** Set of alternatives known to the decision maker; those mapped onto his information field.

**Hypothesis** The postulate that some conclusion or premise of a model corresponds to some reality.

**Identification** Perception of relationships.

**Information** Facts or data concerning relationships and elements in the real world.

- **correct** Information consistent with the real outcome of choice.
- **incorrect** Information inconsistent with the real outcome of choice.

**public** Having to do with aggregates, averages, or types of situations.
**individualized** Having to do with particular situations.

**Information field** Information set pertaining to a single situation.

**Information problem** Identification of condition when mapping of an information field is sufficiently complete and certain as to enable a satisfactory choice to be made.

**Information set** Information known to an individual.

**Logic of choice** Relationships between the chosen alternative and other elements in the decision situation.

**Maximized characteristic** Characteristic whose most preferred variant from the feasible set is attached to the chosen alternative.

**Measure** Ordering relationship among elements in a characteristic set.

**cardinal** Measure such that the ratio of two cardinal measures is subject to exact numerical calculation.

**ordinal** Measure such that the ratio of two ordinal measures can be described but not subjected to exact numerical calculation.

**Measurement** Perception of measure.

**Model** An abstraction from a type of real situation.

**Objective** Goal or purpose which the decision maker wishes to have accomplished.

**Objective measure** Measure which has the characteristic of exact transmissibility to all persons familiar with the
model in which the measure occurs.

Outcome State of affairs not adequately described in money terms, which measures fulfillment of objectives and which is regarded as the termination of consumption.

Partial ordering A set is partially ordered if it can be divided into at least three subsets A, B, and C, such that for any elements a and b where a is a member of A and b is a member of B, a is greater than, equal to, or indifferent to b and b is less than, equal to, or indifferent to a, but this is not true of all possible pairs a and c or b and c, where c is a member of subset C.

Partition Identify subsets.

Pattern A set of situations separated in time and/or space, some elements in each situation being related to corresponding elements in all other situations in the set.

Perception The sensing of a structure of real or conceptual elements and relationships.

Personal model A model not fulfilling some or all of the criteria for a scientific model.

Physical relationships Relationships capable of objective measurement.

Plane of living Real pattern related to a single consuming unit.
Precision

**conceptual** Exact measurement of relationships pertaining to a concept.

**operational** Exact identification of conceptual with real elements and relationships.

### Preference relationships
Ordering relationships derived from value standards.

### Problem
An interrelated set of concepts, the complete statement of which includes (a) identification of an admissible set of alternatives, and (b) a decision rule.

### Process
Regular relationships among elements identified at different points in time.

### Rationality
Consistency of choice behavior in a real situation with solution indicated by problem and model accepted as applicable.

### Real
Having an actual as opposed to conceptual existence.

### Relationship
Association of several elements in a particular manner.

**mapping** Relationship between elements belonging to different sets.

**inclusion** Relationship between elements of a set and the bounds of that set.

### Relevant set of alternatives
Those feasible alternatives which are known to the decision maker, i.e., those alternatives which are both elements of the feasible set
and mapped onto the information field.

**Resources** Real elements which are limited in quantity, have alternative uses, and can be combined in varying quantities in producing outcome.

**Risk** Condition in which the decision maker believes but is not certain that a particular relationship falls within a subset of the set containing all perceivable variations of that relationship. He may be able to assign a probability measure to the degree of his belief.

**Satisfactory choice** Choice which does in reality satisfy the criteria according to which it was chosen.

**Scientific model** Model which is internally and externally consistent, precisely transmissible, and whose applicability to real situations is governed by rules which are either part of the model itself or are part of the science to which the model belongs.

**Set** Aggregate of elements having identifiable bounds.

**Situation** "A number of stimuli, external to the organism but action upon it, organized as a unit and with a special relatedness to one another as stimuli of the specific organism involved."\(^1\) A set of interrelated elements having relationships with a decision maker.

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Solution  Subset of alternatives identified according to criteria included in or implied by the problem.

Space relationship  Relationship describing extent and contiguity of one element with respect to other elements at one point in time or apart from time.

extent  Degree and manner in which an element displaces other elements.

contiguity  Location of an element with respect to other elements.

Static  Viewed as a timeless organic whole, or viewed at some moment in time.

Structure  A set of interrelated elements.

Subjective measure  Measure which cannot be transmitted precisely.

Subset  Aggregate of bounded elements which are members of a set but whose bounds are not identical with the bounds of that set.

Substitution  Relationship between elements such that the inclusion of both in a structure is associated with a valuation of either or both lower than had only one been included.

Theory  A conceptual structure.

Threshold effect  Manifestation of the lack of ability of the decision maker to classify all elements into subsets of one, due to inability to measure relationships with
infinite precision.

**Time relation** Relation which describes duration or contiguity in time of one relationship with respect to other relationships, apart from considerations of space.

**duration** Permanence of relationships.

**contiguity** Location of a relationship with respect to other relationships.

**Transmissibility** (of concepts) Capability of comprehension and use by persons other than the originator.

**Type** Element or structure which is or is believed to be representative of some set of elements or structures.

**Uncertainty** Condition in which either the decision maker has no reason to believe that a particular relationship falls within any particular subset of the universal set or the subset within which he believes the relationship to fall is so large that it cannot serve to classify alternatives into subsets.

**Universal set** Aggregate of all perceivable elements within the bounds of a set.

**Usefulness** Capability of identifying satisfactory choices.

**Utility** Measure associated with in value standards.

**Valuation** Ordering according to value standards.

**Value standards** Set of criteria which enable a decision maker to order elements in a set according to preference.

**Variant** Specific measure of an element.
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ACKNOWLEDGMENTS

The writer is grateful to the many persons who read the manuscript in part or in whole and who gave comments, criticisms, and encouragement. A special acknowledgment is due to two people: Dr. Margaret I. Liston, for sharing her high standards and special insights into human behavior; and Dr. Bob R. Holdren, for introducing the writer to the methods of thought which led to this dissertation.