CONJOINT ANALYSIS: A MANAGER'S GUIDE

I. Introduction

In the early 1970s, market researchers developed conjoint analysis to overcome some key shortcomings of a standard concept test. Conjoint has been widely used in the new product development process—for selecting among alternative product designs, targeting, and pricing. Cattin and Wittink's two surveys of market research firms (Cattin and Wittink (1982) and Wittink and Cattin (1989)) document over 1,000 applications from 1981 to 1985. They estimate approximately 400 studies were performed each year in the mid-1980s. Applications cover a broad range of industries with extensive use noted at Boston Consulting Group (Prensky (1987)), Procter & Gamble (Tumbusch (1987)), Smith, Kline and French (Marshall (1987)), and Xerox (Vaccarelli (1987)). Some other companies using conjoint are:

- Ashton-Tate—computer software (Eisenhart (1988))
- Fujitsu America—cellular telephones (Eisenhart (1988))
- ISU International—insurance distribution systems (Eisenhart (1988))
- Levi Strauss—blue jeans (Tyner and Weiner (1990))
- Marriott Corporation—hotels (Wind, Green, Shifflet and Scarbrough (1989))
- Sunbeam—food processors (Page and Rosenbaum (1987))

Applications have also been reported for a variety of types of products/services.

Consumer durables:

condominium design and pricing (Fiedler (1988))
snowmobiles (Huber (1987))

For a discussion of the standard concept testing, see, "Note on Concept Testing," by Robert J. Dolan, HBS Case Services, No. 590-063.

Professor Robert J. Dolan prepared this note as the basis for class instruction.
Consumer non-durables:
  rug cleaner (Green and Wind (1975))
  clothing (Ettensohn, Gaeth, and Wagner (1988))

Consumer services:
  credit cards (Stahl (1988))
  rural health care systems (Parker and Srinivasan (1976))
  energy conservation systems (Bennett and Moore (1981))
  performing art series (Currim, Weinberg and Wittink (1981))

Business products:
  aircraft (Green and Wind (1975))
  lift trucks (Clarke (1981))
  computer software (Dolan (1990))

Business services:
  technical information services (Wind, Grashof and Goldhar (1978))

Conjoint has become a tool in the repertoire of all major market research firms and within many companies. Easy-to-use software is widely available. This note provides a nontechnical introduction to the procedure. Section II explains the basic idea behind the procedure, i.e., the decomposition of a product into its attributes and subsequent valuation of the utility of each individual attribute. Section III covers analyzing conjoint results to derive managerial implications. Section IV discusses the accuracy of the methods and Section V provides guidelines on when it should and should not be used.

II. How Conjoint Works

a. Defining a Product

A fundamental idea in conjoint analysis is that a product can be broken down into a set of relevant attributes. For example, Parker and Srinivasan (1976) describe a rural health care alternative by five attributes:

1. residence to facility travel time
2. time lag in obtaining an appointment
3. waiting time at the facility
4. hours of operation
5. facility type (nurse practitioner, doctor's office or health care center)

By defining products as collections of attributes and having the individual consumer react to a number of alternatives, one can infer each attribute's (i) importance and (ii) most desired level.

Conjoint estimates an individual's "value system," which specifies how much value a consumer puts on each level of each of the attributes. If we know an individual's value system, we can predict which of a
set of available alternatives he will buy. Individuals usually do not find it easy to state their value system reliably. Rather than forcing consumers to think separately about individual attributes, conjoint asks the consumer to make judgments about products overall and then uses mathematical analysis to uncover the value system which must be behind the preference judgments.

The trick in conjoint is that, via construction of the value system, we bootstrap ourselves up from asking about preferences on a small subset of products to being able to make predictions about relative preference for any products. This will become clearer as we go along. First, we consider how one can calculate a "value system" from some overall judgments.

As an example, consider a fitness facility, interested in optimal design of its locker rooms. Two attributes are potentially important to users: (i) whether or not there is a sauna and (ii) the size of available lockers. There are two alternative "levels" for the sauna ("yes" and "no") and three levels for lockers:

A. Small (20" x 20" x 20") storage lockers permanently assigned plus large hanging ones (72" x 20" x 20") for daily use.

B. Mid-size only (36" x 20" x 20") permanently assigned.

C. No permanently assigned locker; hanging locker (72" x 20" x 20") available on daily basis with mirror inside door.

There are thus $2 \times 3 = 6$ different sauna/locker combinations or products. One might in practice ask individuals how important these alternative attributes are. Alternatively, one can simply ask the respondent to rank order the six possible combinations from most to least preferred. The individual might respond as follows:

<table>
<thead>
<tr>
<th>Sauna</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small storage, large daily</td>
<td>Rank 2</td>
<td>Rank 4</td>
</tr>
<tr>
<td>Locker</td>
<td>Medium storage only</td>
<td>Rank 1</td>
</tr>
<tr>
<td>Large daily with mirror only</td>
<td>Rank 5</td>
<td>Rank 6</td>
</tr>
</tbody>
</table>

With these ranks, we can give utility points (where higher is better) to the options to capture these expressed preferences. For example, we might code the best as 5 points and then go down from there, so the least desired alternative gets a zero. That would yield:
Sauna

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLD</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Locker</td>
<td>MSO</td>
<td>LDMO</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Average = 3.33  Average = 1.67

Since each locker size is rated with both levels of the sauna attribute, we can calculate the utility of an attribute level as the average of the score across all choices where it appears. Following this, we would have:

**Sauna:**

Yes = 3.33  
No = 1.67

**Locker:**

MSO = 4  
SSLD = 3  
LDMO = 0.5

This is the individual's "value system." Note that it recaptures the stated original ranking data:

<table>
<thead>
<tr>
<th>Product</th>
<th>Value System Score</th>
<th>Value System Score Rank</th>
<th>Stated Original Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSO + Sauna</td>
<td>4 + 3.33 = 7.33</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SSLD + Sauna</td>
<td>3 + 3.33 = 6.33</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>MSO + No Sauna</td>
<td>4 + 1.67 = 5.67</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SSLD + No Sauna</td>
<td>3 + 1.67 = 4.67</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>LDMO + Sauna</td>
<td>.5 + 3.33 = 3.83</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>LDMO + No Sauna</td>
<td>.5 + 1.67 = 2.17</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

This is the objective of the procedure, i.e., to have an individual provide overall preference judgments for various products and then use mathematical analysis to tease out the individual's underlying "value system," i.e., the value of each level of each attribute. The procedure allows us to assess a consumer's willingness to trade off one feature for another. The value system shows that this individual is averse to the idea of not having a storage locker (LDMO = 0.5) and would be unwilling to trade in a storage locker on a daily basis (since at minimum this decreases his utility by 3 - .5 = 2.5 points) in order to get a sauna (since this increases his utility by only 3.33 - 1.67 = 1.66).

This simple example is meant only to provide some intuition for how the procedure works. The trade-off matrix approach (suggested by Johnson (1974)) works fine for problems with a small number of attributes, each with a small number of alternative levels (see Morton and Devine...
(1985) for a four-attribute example. Slightly different approaches work better for larger scale problems. Although not demonstrated in our example, a key point is that the respondent need not rank all possible products in order to be able to derive the value system. For example, Green and Wind's (1975) respondents ranking 18 products allowed estimation of a value system for a product of five attributes (3 attributes with 3 levels and 2 attributes with 2). With the value system, however, one could then predict the preference for the $3 \times 3 \times 3 \times 2 \times 2 = 108$ possible products.

The term "conjoint analysis" applies to a variety of procedures developed to estimate individual value systems from overall product judgments. The remainder of this section covers input data and data analysis alternatives.

b. Study Design

A conjoint study has five design stages as shown in Figure A. The first two decisions basically relate to what a respondent will be asked about; the second two relate to how the respondent replies; the last relates to how the respondent's data will be analyzed.

Figure A

Decision Stages in Conjoint Study

1. Determine Relevant Attributes

2. Choose: Stimulus Representations (i.e., how products will be described to respondents)

3. Choose: Response Type (i.e., judgments respondents will give: choice among alternatives, rankings, ratings)

4. Choose: Criterion (i.e., the standard to be used by respondents: liking, preference, likelihood of purchasing)

5. Choose: Method of Data Analysis

We will now discuss each of these in turn.
(i) Determining Relevant Attributes

In conjoint, the burden is on the analyst to prespecify the attributes impacting a consumer's purchase decision. If an attribute of no real importance is included in the study, the value system will indicate this attribute's limited role. However, the conjoint analysis will not indicate the absence of an important attribute. Consequently, one must be confident that the right attributes have been included. In practice, the preliminary attribute list is usually developed in-house via contact with company people from a variety of functions--new product development, advertising, manufacturing, etc. Tumbusch (1987) advocates using all attributes that are known to consumers and feasible for change. He notes three kinds of attributes considered in conjoint studies at Procter & Gamble:

1. Physical attributes--refers to product itself, e.g. legcuffs on disposable diapers.
2. Performance benefit--refers to outcome, e.g. dryness of baby.
3. Psychological positioning--refers to user, e.g. assurance.

MacLachlan, Mulhern and Shocker (1988) present a similar list, and note "the stimuli descriptions must convey all the information that respondents feel they need to make their decisions." Consequently, for unfamiliar product categories, a small scale consumer research project may be needed prior to the conjoint phase.

(ii) Stimulus Representation

The second design question is how to present products to the respondent: partial or full profile method. In the full profile approach, each product is described on all the relevant attributes. An example of this is Ettenson, Gaeth and Wagner's 1988 study of the impact of made-in-the-U.S.A. labeling on clothing. Female respondents in the study rated 40 profiles of blouses which were described to them on all six attributes in the study. For example, a sample rating task is:

Blouse XYZ

1. The style of the blouse is classic.
2. The quality of the blouse is better than average.
3. The fiber content of the blouse is 65% cotton/35% polyester.
4. The price is several dollars more than the average.
5. The blouse is made in the U.S.A.
6. The label on the blouse is a designer label.

Based on the information above, how likely is it that you would purchase this blouse?

<table>
<thead>
<tr>
<th>Not at All Likely</th>
<th>Very Likely</th>
</tr>
</thead>
</table>

This "full profile" approach is utilized by many analysts because it is felt to be the most realistic representation of a consumer's actual decision process. The alternative "partial profile" approach describes
concepts on only a subset of the full attribute list. The argument for this is that while the full list is in some sense the reality, its use may render the rating task too complex and confusing for respondents. By using partial profiles, the analyst gets a better understanding of the desired level and relative importance of secondary attributes. In the partial profile method, the attributes which are specified vary systematically from one judgment to the next, so that in the end, the value system for the full set of attributes can be estimated.

(iii) Response Type

Design decision three is the manner in which respondents express their judgments, viz. as ratings or ranks. The made-in-the-U.S.A. study noted above is a ratings scale application, i.e., without explicitly considering other options, consumers were asked to state how likely they would be to purchase an item.

In ranking methods, respondents are asked to consider explicitly the relevant options. Preferences are expressed in one of two ways—a "paired comparison" task or a top-to-bottom ranking. In paired comparisons, the respondent is presented with a number of pairs of products and is asked to choose one or the other. For example, execution of the made-in-the-U.S.A. study in this format would replace the purchase likelihood rating with a series of questions such as:

Which blouse do you prefer?

<table>
<thead>
<tr>
<th>Classic style</th>
<th>Trendy style</th>
</tr>
</thead>
<tbody>
<tr>
<td>65% cotton/35% polyester</td>
<td>100% cotton</td>
</tr>
<tr>
<td>Made in U.S.A.</td>
<td>Made in China</td>
</tr>
<tr>
<td>Private label</td>
<td>Designer label</td>
</tr>
<tr>
<td>Quality is average</td>
<td>Quality is below average</td>
</tr>
<tr>
<td>Price is several dollars more than average</td>
<td>Price is several dollars less than average</td>
</tr>
</tbody>
</table>

The second type of ranking method is to rank order a set of concepts from most to least desirable. To facilitate this task, the respondent usually is first asked to sort the product descriptions into three piles, e.g., those which

1. Like very much
2. Like moderately
3. Like little or not at all

and then rank within the piles. This produces the full ranking from most desired to least. Ranking n concepts is equivalent to making \( \frac{n(n-1)}{2} \) paired comparisons, the number of distinct pairs which can be formed by taking two items at a time from a set of n items. This approach requires the concepts to be stated in full profile form.

Ranking and rating data generally produce very similar final results (Green and Srinivasan (1978)). Traditionally, ranking methods were preferred because providing a quantitative measurement of the "degree of liking" or "degree of intention to buy" was felt to be straining the
capabilities of respondents. However, Wittink and Cattin (1989) report that rating scales increased from 34% frequency of use in 1971-1980 to 49% in 1981-1985. The choice of one method or the other is largely situation-specific and relates to via which form a respondent is able to provide more reliable input.

(iv) Criterion

Whatever the stage 3 decision, there is still the related but distinct issue of the standard to be used in the judgments. The two major types of standards are:

- preference
- likelihood or intention to purchase

This is not a trivial task since the answer to a choice between:

Mercedes
5-year warranty OR 3-year warranty
$35,000 OR $15,000

might be different depending on the question being

Which do you prefer?

vs.

Which are you more likely to buy?

I may in some sense "prefer" the Mercedes option (even if it does involve parting with $35,000) but because I don’t have the $35,000 in the first place I may be more likely to purchase the Ford.

These two different standards are used about equally often in practice (Cattin and Wittink (1982)). The choice depends largely on whether the focus of the study is market share or unit sales where the market size is to be estimated. If the latter, then intention to purchase is necessary to gauge the likely market size.

(v) Methods of Data Analysis

The data analysis depends on the previous decisions made with respect to the input data collected. Most commonly, the following are used:

<table>
<thead>
<tr>
<th>Form of Judgment About Alternatives</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating Scores</td>
<td>Simple Regression</td>
</tr>
<tr>
<td>Probability of Purchase</td>
<td>Logit Model</td>
</tr>
<tr>
<td>Rankings</td>
<td>MONANOVA</td>
</tr>
</tbody>
</table>

If rating scores have been collected, e.g. "indicate how much you like this product on a scale from 1 to 10," the value system is derived through regression analysis. If the respondent has expressed a probability of purchase, a logit model (an adaptation of regression) is used to accommodate the fact that probabilities are between 0 and 1. Finally, if ranks are used, it is appropriate to recognize that we really do not know by how
much one alternative is preferred over another. We analyze only the ordering by a monotone analysis of variance (MONANOVA).

Each procedure yields an estimate of the value system of the respondent. For example, Montgomery and Wittink (1979) report the value system of Stanford MBAs (on average) with respect to job choice (we report only 3 of the 8 attributes here):

**Business Travel per Month**

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 night</td>
<td>.163</td>
</tr>
<tr>
<td>2-5 nights</td>
<td>.109</td>
</tr>
<tr>
<td>≥6 nights</td>
<td>-.273</td>
</tr>
</tbody>
</table>

**Geographic Location of Job**

<table>
<thead>
<tr>
<th>Location</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>.070</td>
</tr>
<tr>
<td>Midwest</td>
<td>-.198</td>
</tr>
<tr>
<td>South</td>
<td>-.321</td>
</tr>
<tr>
<td>West</td>
<td>.449</td>
</tr>
</tbody>
</table>

**Opportunity for Advancement**

<table>
<thead>
<tr>
<th>Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>.216</td>
</tr>
<tr>
<td>Moderate</td>
<td>-.216</td>
</tr>
</tbody>
</table>

From this value system, one can estimate the utility any given job offer would yield. Hence, one could predict which job the MBA would take. (Note: the other attributes in the study were company growth rate, functional activity emphasized, desirability of job location, salary, and competitiveness of co-workers). The following section more completely describes the type of analyses one can do with these data.

III. Analyzing the Outputs

In conjoint, each individual provides a set of judgments and his value system is computed separately. There is no assumption that all consumers have the same value system. The three major types of analysis are:

1. Aggregate analysis of attribute importance and desirability.
2. Segmentation analysis.
3. Competitive scenario simulations to predict sales levels.

We will now discuss each in turn.

**Aggregate Analysis**

Although one of the virtues of conjoint is its separate treatment of each individual, the most common first interpretation step is to average the utilities of each attribute level across the entire sample of respondents to give the analyst an overall feeling for which attributes are generally important and what is the most desired level of each. Consider again the average value system for Stanford MBAs regarding job choice:
<table>
<thead>
<tr>
<th>Business Travel</th>
<th>Geographic Area</th>
<th>Opportunity for Advancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 night</td>
<td>East</td>
<td>Rapid</td>
</tr>
<tr>
<td>2-5 nights</td>
<td>Midwest</td>
<td>Moderate</td>
</tr>
<tr>
<td>≥6 nights</td>
<td>South</td>
<td>-216</td>
</tr>
<tr>
<td></td>
<td>West</td>
<td>.449</td>
</tr>
</tbody>
</table>

First, the scores indicate the relative desirability of alternative levels of each attribute. Not surprisingly, Stanford MBAs prefer jobs which have rapid advancement opportunities and are in the West. With respect to business travel, they prefer one night or less per month. The fact that this is preferable to 2-5 nights may be surprising as some travel would provide an opportunity to see the country.

Second, the difference among the scores for levels for a given attribute gives a rough measure of that attribute's importance. In general, the relative importance is proportional to the range covered by the levels. The business travel attribute levels range from -273 to .163, a range of .436. Geographic area levels range from -.321 to .449, a range of .770. Opportunity for advancement levels range from -.216 to .216, a range of .432. Dividing each of these ranges by the sum of the three ranges gives a set of relative importance numbers which sum to one:

\[
\text{Business Travel} = \frac{.436}{.436 + .770 + .432} = 26.6\% \\
\text{Geographic Area} = \frac{.770}{.436 + .770 + .432} = 47.0\% \\
\text{Opportunity for Advancement} = \frac{.432}{.436 + .770 + .432} = 26.4\%
\]

We say that this is a rough indicator of importance, because the percentages are dependent on the specific levels of the attribute used in the study. For example, suppose the business travel variable levels were:

- ≤1 night
- 2-15 nights
- ≥15 nights

This would increase the importance of the business travel attribute given this method of calculation because ≥15 nights would have a large negative utility. This must be kept in mind when interpreting the results. It is a good estimate of importance only if the variable levels specified cover the range of relevant options.

b. Segmentation Analysis

While the averages provide a convenient, easy-to-comprehend summary measure, in most marketing situations one courts disaster by not investigating the variation among customers. The data matrix containing the value system of each individual can be analyzed (most often via a
procedure called cluster analysis) to produce "benefit segments" wherein
segments are defined so values are similar within a segment but quite
different across.

Wind, Grashof and Goldhar (1978) performed this type of analysis
in their technical information delivery service study. They identified
five segments which displayed different values from one another. At the
overall market level, price was the most important variable of the 12
considered (with a relative importance of 26.6%). However, when a segmen-
tation analysis was done, the largest segment identified (48% of consumers)
was a performance-oriented segment wherein price played only an 8.9% role.
The second largest segment was price oriented. For this segment's members,
price accounted for 34.8% of their decision.

Understanding this variation of attribute importance and desired
levels across consumers is crucial for target market selection. As Wind,
Grashof and Goldhar conclude, "An examination of these utilities suggests
quite clearly that there is no universally desirable STI system. . . . The
managerial question, therefore, is which of these segments should manage-
ment select as their target market?"

c. Scenario Simulations

The third major use of conjoint analysis is in predicting market
shares or unit sales in various scenarios. Given the value system of a
consumer and a description of alternative available products, one can
calculate the value of alternative products. These values permit predic-
tion of choice the consumer would make if confronted with these products in
the marketplace.

```
Consumer Judgments

\[
\text{Competitive Product Profiles} \rightarrow \text{Value System} \rightarrow \text{Product Valuations} \rightarrow \text{Probability of Choice}
\]
```

The process works as shown in the figure. Consumer judgments are
made about alternative products and these are analyzed to produce the value
system. Given this value system, one can derive the value of any product
(not just the ones originally used to derive the value system) which can be
described by the set of attributes included in the analysis. Note that the
value system expresses consumer preferences and is independent of the
competitive products available in the marketplace.

Consider an example of the personal computer and, to keep things
simple, let's say there are four attributes of importance: weight, battery
life, quality of resolution of screen, and price. A standard conjoint
analysis produces the following value system for an individual.
<table>
<thead>
<tr>
<th>Weight</th>
<th>Battery Life</th>
<th>Quality of Resolution</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤2 lbs.: 1.2</td>
<td>1 hour: 0.0</td>
<td>Below Average: 0.0</td>
<td>$1,000: 1.0</td>
</tr>
<tr>
<td>2-5 lbs.: .9</td>
<td>2 hours: .2</td>
<td>Average: .4</td>
<td>2,000: .5</td>
</tr>
<tr>
<td>&gt;5 lbs.: 0.0</td>
<td>4 hours: 1.5</td>
<td>Above Average: .5</td>
<td>3,000: 0.0</td>
</tr>
<tr>
<td>8 hours: 1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Given a set of product descriptions on these attributes, one can calculate the value of each alternative and make a prediction about which system would be purchased. For example, if the three products available are:

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight</th>
<th>Battery Life</th>
<th>Resolution Quality</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 lbs.</td>
<td>1 hour</td>
<td>Below Average</td>
<td>$2,000</td>
</tr>
<tr>
<td>B</td>
<td>5 lbs.</td>
<td>4 hours</td>
<td>Average</td>
<td>3,000</td>
</tr>
<tr>
<td>C</td>
<td>≥5 lbs.</td>
<td>8 hours</td>
<td>Average</td>
<td>1,000</td>
</tr>
</tbody>
</table>

We can calculate the value of each product as follows:

\[
\text{Value of Product A} = \text{Value of 2 lbs. weight} + \text{Value of 1-hour battery life} + \text{Value of below-average resolution} + \text{Value of $2,000 price} \\
= 1.2 + 0 + 0 + .5 = 1.7
\]

Similarly, the value of products B and C for this individual are 1.9 and 3.0, respectively.

There are two major rules used to translate these values into choice predictions: the "first choice" rule and the "share of preference" rule. In the first choice rule, we simply say the person will buy the product that has the highest value. In this case, we predict this individual would purchase product C. Its low price and eight-hour battery life more than make up for its disadvantage on weight compared to the other two products. We do this for each individual in the sample. A product's market share is simply the percentage of consumers for whom that product "wins," i.e., has the highest value.

The second rule used is the "share of preference" rule which in effect gives a probability estimate that a consumer will buy a brand. In our example, the values are:

\[
\begin{align*}
\text{Value} & \\
\text{Product A} & = 1.7 \\
\text{Product B} & = 1.9 \\
\text{Product C} & = 3.0 \\
\text{Sum} & = 6.6
\end{align*}
\]
In the "share of preference" approach, we say that the probability that this individual chooses the "best" product C is $\frac{3.0}{6.6} = 45\%$. The probability of choosing A or B is 26% (1.7/6.6) and 29% (1.9/6.6), respectively. The market share for a product is the average purchase probability across all subjects in the study. The rationale behind the share of preference method is that consumers do not always buy their most preferred brand (due, e.g., to availability which is not considered in the conjoint analysis) and the value system estimates are in fact estimates, not the truth. Many conjoint users report that the first choice rule tends to overpredict for high share brands. Most commercial conjoint packages offer the analyst the option of choosing which of these two rules to use. Further discussion of these issues are in Finkbeiner (1988) and Elrod and Kumar (1989).

The scenario simulation capability is a powerful tool with respect to assessing new product introduction strategy. By describing a prospective new product on the salient attributes, one can obtain not only a market share estimate, but also an indication of which competitive products will be hurt most. This is achieved by first simulating the scenario of only the current competitive products being available and then the environment of current competitive products plus the prospective new product.

IV. Accuracy of Conjoint Methods

As noted in the introduction, conjoint analysis has been used for a wide variety of applications. Many firms are "repeat buyers" of the methodology, suggesting satisfaction with the accuracy of the results and their utility in managing a business.

There are, however, very few published studies which examine the validity of the conjoint results (see Montgomery and Wittink (1979) as one of the few). Therefore, it is important in an individual situation to be able to check the validity of the findings before implementing actions based on the result. The three primary checks are: (i) red-face test, (ii) holdout prediction, and (iii) actual vs. predicted market share.

In the "red-face" test, one simply asks if the results make sense given everything else we know. For example, we may have a prior, strongly held belief, that price is the most important attribute in a category. We maybe can't quantify this, but our whole experience with the category tells us it's the most important. If we run a conjoint and price does not come up as key, we should question the appropriateness of using conjoint. A second possible check of this type is to see if the parameter estimates vary across individuals in a reasonable way. Going back to our computer example, battery life is one of the key attributes. If we also collected data from students on whether or not they planned to use their PCs in four-hour examination situations, those who indicated "yes" would logically place more value on a battery life that can make it through four hours than those who do not plan to use the computer in such a way. We could check to see if this holds up across our sample.

The second possible test is a holdout prediction. This was used by Wind, Grashof and Goldhar (1978), for example. In this test, a small number of the original products rated by the respondent are "held out" from
the calculation of the value system. (Wind et al. held out 4 of 22 rated concepts.) Once the value system is computed, the value of all concepts (those held out and those not) is calculated. The test can be made if the value system-based calculations rate the held-out concepts correctly with respect to the other concepts. In their study, Wind et al. report 84% of the held-out concepts being correctly classified, "suggesting a high level of validity" (p. 36).

Finally, in some cases it is possible to simulate the current market situation and compare the market share estimates from the conjoint model with those observed in the marketplace. Also, if it is possible to observe what an individual respondent's "current brand" is, a check can be made to see if that brand has the highest value of all products currently available. This was the test used by Parker and Srinivasan (1976) in their study of rural health care facilities.

The ultimate test, of course, is whether the predicted results "come true" in the marketplace when certain actions are taken. While there is little documentation of such comparisons, the regular use of conjoint suggests it meets the market test on this dimension.

V. Guidelines for Use

Necessary assumptions underlying conjoint have been mentioned throughout this discussion. We collect them here to summarize situations wherein conjoint would be most applicable.

1. Product as a Bundle of Attributes

The product must be able to be specified as a collection of attributes. There are some largely image products, e.g., a perfume, for which this is just not possible.

2. Must Know Important Attributes

Conjoint requires that we either know or find out by another method what attributes are salient in the product category. We need to specify a set of attributes which consumers view independently, i.e., the value of one attribute should not be dependent on the level of another.

3. Respondents Can Reasonably Rate Products

The input data we require from respondents are overall preference or purchase likelihood judgments. This requires a level of respondent familiarity with the product category. Consequently, conjoint is not appropriate for situations where the category is totally revolutionary.

4. Attributes Should be Actionable

The firm should, in most cases, be able to act upon the output of the conjoint by constructing products which deliver the attribute levels used in the analysis.

This note has tried only to communicate the basic principles of conjoint analysis. Many researchers are currently at work expanding the domain of applicability and accuracy of conjoint. For example, hybrid