

A MULTI-DIMENSIONAL STUDY OF DIFFERENCES IN
PERCEPTIONS AND PREFERENCES OF THE
SOCIAL RESPONSIBILITIES OF MARKETERS

A Dissertation
Presented to
the Faculty of the College of Business
University of Houston

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy in Business Administration

by
Richard Edward Homans

December, 1973

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ABSTRACT

This study was undertaken in an effort to illustrate a potential method for examining the attitudes of different groups of people with respect to selected social and consumer issues facing marketers. Such a technique, if successful and communicable, could aid the understanding of differences in attitudes of marketers, critics, customers, and other members of society. Marketers would then be better able to respond to the demands of vocal critics and to the needs and desires of customers and other members of society.

Fifteen issues were studied. In general, they were selected to represent the criticisms discussed in current literature. The subjects represented three groups: 19 housewives, 28 business (25 industrial and 3 retail), and 23 students. No group was selected to be representative of a larger population.

Attitudes were studied with respect to perception and with respect to preferences. Techniques of multidimensional scaling were used for this examination. To provide the necessary data for the multidimensional scaling programs, the subjects were asked to complete two questionnaires. The first questionnaire contained ten pairs of semantic differentials. Subjects rated each of the fifteen issues on each pair of semantic differentials. Euclidean distances were calculated between each pair of issues for each individual and used as input for the perceptual scaling program. The second questionnaire asked the subjects to rank the fifteen issues in order of preference. This data was used as input to the preference scaling program.

The perceptual scaling algorithm that was used was designed by J. D. Carroll and J. J. Chang of Bell Laboratories. This program, INDSCAL, developed an overall perceptual scaling (called a group stimulus space) for all subjects. Each subject, however, was assigned idiosyncratic weights for each dimension. These weights, or saliences, indicate the degree that the dimension was used by the individual in developing his perceptual differences between the issues.

The best scaling of the fifteen issues appeared to be in four dimensions. These were interpreted as follows:

Dimension 1. This dimension is dominated by one issue, layoffs of workers in times of sales decline.

Dimension 2. The second dimension ranges from product oriented issues to price and promotionally oriented issues.

Dimension 3. This dimension ranges from promotionally oriented issues to product and price oriented issues.

Dimension 4. The fourth dimension includes societal oriented issues on the negative side and consumer oriented issues on the positive side.

When the scalings were recomputed in three dimensions for fourteen issues (without the layoff issue), the dimensions matched dimensions 2, 3, and 4 of the four dimensional scaling of fifteen issues.

When the perceptual saliences were tested for overall differences between the groups (using multivariate methods) the hypothesis of significant differences between the groups was rejected at the .05 level. In other words, no overall significant difference between the groups was proved with respect to perception. However, analysis of the individual dimensions showed some apparent differences. In these "univariate" analyses, the following interpretations were made:

--Housewives tend to lump product and price oriented issues together and compare these with promotional issues.

--Students tend to perceive layoffs more closely to the other issues than do the other groups.

--Students tend to attach more salience to the difference between promotionally oriented issues and the issues of price and product than do the others. Further, students tend to perceive the issues as price, product, and promotion issues more distinctly than the other groups.

--Students tend to see less difference between issues on the basis of being societal or consumer issues than do the other groups.

The first of these is significant at the .05 level using univariate t-tests (i.e., housewives do not perceive a difference between product and price oriented issues which is significantly different from other groups).

Preferences were analyzed using Carroll and Chang's PREFMAP algorithm. This program allows four models of analysis. The simplest model, a vector representation of preferences, provided adequate representations. Using this model, a preference vector was fitted for each individual on the group stimulus space provided by the INSCAL model. The relative preferences for the dimensions can be interpreted by analyzing the projections of the vectors on the dimensional axes.

The following interpretations were made from the preference vectors:

--Housewives have less preference for action on product oriented issues than the other groups.

--Businessmen have less preference for action on price oriented issues than the other subjects.

--Students prefer actions on societal oriented issues while businessmen and housewives prefer action on consumer oriented issues.

The last of these observations is significant at the .05 level using univariate t-tests (i. e., students prefer societal oriented issues significantly more than housewives and businessmen).

When tested for overall differences in preference between the three groups (using multivariate methods) the hypothesis of overall significant

differences between the groups was accepted at the .05 level. In other words, there were overall significant differences between the groups on the basis of preference.

While the findings listed above are interesting and may point to true differences between the populations of students, housewives, and businessmen, the true value of this study is in the method which it presents. If some improvements are made in data collection procedures and in the computer programs, the method shown here can be used by marketers to evaluate the opinions of the various populations regarding issues relevant to their business. These evaluations should aid the marketers in formulating policy regarding social and consumer issues.

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CHAPTER 1

INTRODUCTION

"The buyer needs 1,000 eyes, the seller not one." (saying in a fortune cookie) . . . (L)egally correct, but ethically dubious marketing practices seem to have become almost the hallmark of our large consumer goods manufacturers.¹

"Business is more than 99.44 per cent pure. . ." (Maurice Stans)²

"Yes, Virginia, a large corporation these days not only may engage in social responsibility, it had damn well better try to do so." (Paul Samuelson)³

Many different, and often conflicting, points of view have been stated concerning the consumer and social responsibilities of marketers. Confronted with the myriad of criticism, compliments, threats, orders, and often plain noise, marketers have often attempted to respond by starting affirmative programs, pointing out their past and present actions, and occasional "do-good" puffery.

However, any response by marketers appears to be vulnerable to three major types of error.

- They may react with respect to their own values and not deal with the complaints of the critics. In the eyes of the managers, this may be better, but it will not decrease the criticism.
- They may react to the most vocal critics and alienate their regular customers. An illustration of this error would occur if critics spoke against the design of a product which most customers prefer. If the company changes the design to meet the wishes of the critical minority, it may no longer satisfy the desires of its customers.
- They may react to the vocal critics and alienate the rest of society. Like the second point, this one deals with reactions to minority groups. However, here the effect is to alienate members of society who affect the legal, social, and technological environments of the organization.

To minimize the effects of these errors marketers need to use a method of studying the perceptions of assorted social issues and obtaining

information concerning the relative importance of the different issues. Ideally this method should be able to isolate individual differences so that characteristics of each segment of society may be pointed out. It is hoped that the technique presented in this study shall be one such method.

The overall objectives of this study is to present a method for:

- (1) studying the perceptions and preferences of some members of society with regard to selected social/consumer issues of importance to marketers;
- (2) representing the perceptions and preferences in a manner that facilitates study by those unfamiliar with statistical techniques; on the basis of the representations a classification system for these issues should be apparent;
- (3) analyzing differences between specified segments of society.

Multidimensional scaling is an appropriate tool for analyzing these perceptions and preferences.

Multidimensional scaling was introduced into the behavioral sciences by a number of researchers who were concerned with determining the underlying patterns in empirical data and representing these patterns in scalings using a relatively small number of dimensions. In marketing, multidimensional scaling has been used to research the underlying attitudes of customers about products and their relationships. To this writer the strength of multidimensional scaling in marketing appears to be twofold. First, it uncovers latent dimensions without stating these dimensions prior to the study. This property indicates the value of multidimensional scaling in empirical research when data is desired while the restrictive assumptions are minimized. This also leads to one of the difficulties of evaluation of multidimensional scalings; since the dimensions are not specified beforehand they must be interpreted afterwards, a process which is more an art than a science.

The second strength of multidimensional scaling is in the representation it provides. The scalings produced by these techniques are appropriate for presentations to management and others who must review the results before actions are implemented. These presentations may be completed without using statistical techniques.

Once the multidimensional scaling has been prepared for this study, further statistical analysis will be conducted to further the third objective given above. However, the reader who is ignorant of these statistical techniques should not feel restricted in understanding the study as it fulfills either of the first two objectives.

ISSUES TO BE STUDIED

The issues to be studied are listed in Exhibit 1 - 1. These and the other points described in this chapter are discussed in detail in later chapters.

HYPOTHESES TO BE TESTED

The hypotheses to be tested are as follows:

- H_1 : Multidimensional scaling expresses some of the perceptions and preferences of the subjects, (as compared to unidimensional scaling).
- H_2 : There are no statistically significant perceptual differences between the groups.
- H_3 : There are no statistically significant preference differences between the groups.

It should be noted that while it is the desire of the writer to show differences between the groups, the second and third hypotheses are stated in terms of showing no differences between the groups. This is in accordance with standard statistical conventions.

EXHIBIT 1 - 1

The Issues To Be Studied

- (1) Manipulation of demand by marketers
- (2) Sale of unsafe products
- (3) Unemployment which follows sales declines
- (4) Collusion among competitors to fix prices
- (5) Extravagant claims by marketers
- (6) High credit charges
- (7) Excessive advertising
- (8) Depletion of natural resources caused by the manufacture of products
- (9) Planned obsolescence
- (10) Inadequate service after the sale
- (11) Excessive charges for service calls after the sale
- (12) Air pollution which is aggravated by the sale of products that are not designed to minimize pollution
- (13) Failure to provide for recycling products after their use
- (14) Water pollution in the manufacture of products
- (15) Use of children as target groups for advertisements.

GENERAL PROCEDURE

The basic procedure for the study will be the following:

- (1) Develop and Pretest the questionnaire on ten or more individuals;
- (2) Select three different groups of subjects;
- (3) Administer the following questionnaires to members of each group:
 - a) Derived Similarity Questionnaire - Each subject will be asked to rate each of the issues on ten semantic differential scales,
 - b) Preference Questionnaire - Each subject will be asked to rank all issues in order of importance;
- (4) Analyze the data using the multidimensional scaling programs, INDSCAL and PREFMAP.

These points will be briefly described in this chapter. A full discussion is in Chapter 4.

Questionnaire Development & Pretest

A pretest will be given to at least ten subjects, chosen to include representatives of each group. Subjects will be asked to complete a derived similarity questionnaire, rating each of the issues on 25 sets of semantic differentials. They will then be asked to rank order the 15 issues.

The pretest will be used to evaluate the questionnaire on the basis of the subjects' comments and a factor analysis of the scores of each of the 25 semantic differentials. Ten pairs of semantic differentials will be selected for use in the final questionnaire.

Administration of the Questionnaire

As stated earlier, a similarity questionnaire and a preference questionnaire will be administered to each subject. The results of the derived similarity questionnaire will be used to develop a derived similarities

distance matrix composed of the distances between each pair of issues for each individual. A computer program has been developed for obtaining this matrix.

The preference questionnaire will instruct the subjects to rank the issues in the order of importance he assigns to the elimination of the actions (or issues).

Analysis of Perception

The study of perceptions of the issues will be conducted with the aid of the INDSCAL multidimensional scaling program developed by Dr. J. D. Carroll and Mrs. J. J. Chang of Bell Telephone Laboratories. The derived similarity distances (calculated between each pair of issues for a given individual) will be used as inputs to the program to obtain a composite representation of the issues for all subjects and the saliences of each dimension for each subject.

The INDSCAL program develops a representation of the issues in as many dimensions as the user selects. It attempts to isolate the points in such a way that the distances between points for each individual, d_{jk}^i , are linearly related to distances in the similarities matrix. The resultant distances are given as follows:

$$d_{jk}^i = \left[\sum_{t=1}^r w_{it} (x_{jt} - x_{kt})^2 \right]^{\frac{1}{2}}$$

where d_{jk}^i = the distance between issues j and k as seen by the i^{th} individual,

x_{jt}, x_{kt} = the value of issues j, k on dimension t ,

r = the number of dimensions,

w_{it} = the weight that the i^{th} individual places on the t^{th} dimension.

Thus, there is only one overall representation provided for all subjects, but each subject is assigned his own weight (or salience) for each of the dimensions. The differences in perception will be studied by analyzing these weights. Multivariate analysis of variance (MANOVA) will be used for this analysis.

Analysis of Preference

Preferences for the issues will be studied by developing "ideal points" and "ideal vectors" on the scalings. The perceptual scalings and individual preferences will be used as inputs for the PREFMAP computer program of Carroll and Chang. The program will include four different types of analysis to develop ideal points (or vectors). Ideal vectors will be used to study differences between the groups. Again MANOVA will be used to test for statistical differences.

SCOPE AND LIMITATIONS

The procedure for this study should indicate the largest limitation of this study to be the selection of the subjects. The subjects will not be representative of larger populations; therefore the generalizability of the study will be severely limited. The most important outcome of the study will not be the direct results but the illustration of the use of multidimensional scaling to indicate perceptions and preferences of social issues and to evaluate the differences in perceptions and preferences between groups of respondents.

It should also be pointed out that the scope of this study does not include the testing of whether subjects perceive the occurrence of some issues to be more likely than the occurrence of others. In other words, it is not the intention of this writer to determine which issues the subjects believe actually occur.

PREVIEW OF 'OTHER CHAPTERS

The chapters which follow are intended to cover in-depth the background, procedure, and results of this study.

Chapters 2 and 3 represent literature searches of social issues regarding marketers and multidimensional scaling. Chapter 2 reviews some of the frameworks for categorizing the social issues which are suggested in the literature. It is hoped that one of the by-products of this study will be a system for categorizing these issues as the respondents perceive them. In addition, Chapter 2 presents a discussion of each issue and a review of previous studies involving social and consumer issues.

Chapter 3 includes an overview of a theory of data and related techniques which are similar to multidimensional scaling. The theory behind some of the multidimensional scaling techniques will be discussed with particular attention given to the INDSCAL and PREFMAP algorithms used in this study. Finally previous multidimensional scaling studies will be surveyed to make the reader familiar with the level of current research involving this technique.

Chapters 4, 5, and 6 discuss the procedure and results of the study. Chapter 4 presents an in-depth review of the steps taken in this project, from planning the study to conducting the analysis.

Chapter 5 presents the results of the analysis with respect to perceptions. The chapter proceeds from a visual interpretation of the scalings and their dimensions to an analysis of the differences between the groups on the basis of their dimension saliences. The material is presented in such a way that the reader who is unfamiliar with statistical techniques should be able to understand the visual interpretation of the scalings and their dimensions and a visual analysis of the dimension saliences.

The statistical analysis of dimension saliences may require a background in univariate and multivariate statistical methods.

Chapter 6 presents the results of the analysis with respect to preferences. Evaluation of differences between the groups will be conducted in both visual and statistical terms. Again, the reader who is unfamiliar with statistical methods should be able to follow the visual analysis.

Chapter 7 will review the results and evaluate the hypotheses presented in the first chapter. The implications of the study and future research needs will also be discussed in this final chapter.

An Appendix is enclosed at the end of this report. It includes sections on the issues and the questionnaire, the statistical tests used and their results, and the computer programs which were designed to be used in addition to the INDSCAL and PREFMAP routines.

CONCLUSION

The results of this study should suggest a method of categorizing the social issues studied for the three groups selected. The differences between the groups in perceptions and preferences should also be noted. The generalizability of the specific results will be severely limited since the groups will not be chosen as representatives of larger populations. But the study should demonstrate a technique for analyzing the attitudes towards relevant social issues for marketers.

FOOTNOTES

1. E. B. Weiss, "Shopper is Damned . . . in Grey Tints," Modern Marketing Thought, Second Edition, ed. J. Howard Westing and Gerald Albaum, (London, 1969), p. 203.
2. Newsweek, "The American Corporation Under Fire," Annual Editions: Readings in Marketing '73 - '74, (Guilford, Connecticut, 1973), p. 43.
3. Ibid., p. 41.

CHAPTER 2

THE SOCIAL ISSUES REGARDING MARKETERS

Before discussing the study presented in this project, it is necessary first to discuss the background of the issues to be studied. In this chapter a framework for considering the social issues will be discussed, followed by a discussion of each of the issues to be studied. Finally, a presentation will be provided of several previous studies of these social issues and different segments of the population.

THE DEVELOPMENT OF CONSUMERISM

The broad area of consumerism is certainly not new. Emperor Cyrus of Persia is described as saying the Greek market was a place "Where people go and cheat each other under oath."¹ Later in the 16th Century the maxim "Caveat Emptor" was stated in a horse trade: "If he be tame and have ben rydden upon then caveat emptor."²

In the more recent American history, consumers were active near the turn of the century, leading to the passage of The Sherman Act, The Pure Food and Drug Act, The Meat Inspection Act, The Clayton Act, and the Federal Trade Commission Act. A consumer movement in the mid-1930's culminated in the strengthening of the Pure Food and Drug Act and in the enlargement of the FTC's powers.

The most recent consumer movement is generally considered to have started in the 1960's. (Although some of the initial actions occurred in the late 1950's.) For example, William J. Gaskill considers 1960 to be the benchmark for consumerism and other social movements. He considers about all events since 1960 to have influenced the movements, including the following:

The election of John F. Kennedy to the Presidency,
 Publication of Rachel Carson's Silent Spring,
 Civil Rights Act of 1964,
 Riots of 1964 and 1965,
 Rise of articulate minorities,
 Student militancy,
 The 1968 Presidential campaign,
 Dramatic Government actions on consumerism,
 The assassinations of John F. Kennedy, Robert F. Kennedy,
 Martin Luther King, and Medger Evers,
 Man's Landing on the Moon,
 The Vietnam War.³

Others say President Kennedy's 1962 speech to The Congress was an early indicator of beginning consumerism. In this speech, the President spoke of four rights of consumers. These rights are:

The right to safety--to be protected against the marketing of goods which are hazardous to health or life.

The right to be informed--to be protected against fraudulent, deceitful, or grossly misleading information, advertising, labeling, or other practices, and to be given the facts he needs to make an informed choice.

The right to choose--to be assured, whenever possible, access to a variety of products and services at competitive prices; and in those industries in which competition is not workable and Government regulation is substituted, an assurance of satisfactory quality and service at fair prices.

The right to be heard--to be assured that consumer interests will receive full and sympathetic consideration in the formulation of Government policy, and fair and expeditious treatment in its administrative tribunals.⁴

These rights have been reiterated by Presidents Johnson and Nixon.

The commonly listed causes of consumerism include inflation, increased leisure time, rising incomes, higher educational levels, low unemployment, active consumerist leadership (like Ralph Nader), and increase product complexity. Two additional causal factors that may distinguish the environment of the present consumer movement from the 16th Century environment of the horse trader are the inequality of product knowledge and the lack of personal relationships in today's marketplace.

The buyer today is an amateur; the seller is a highly trained professional. As Rosenthal says,

(I)n the drugstore aisle, on the auto showroom floor, and across from the cash register everywhere, the consumer must face Madison Avenue, the whirling computer, and the motivational research psychologist. . . . Standing alone, the American consumer cannot deal with this power in the marketplace.⁵

Philip Kotler discusses the unequal powers by listing the traditional rights of the sellers and buyers in the U.S. economic system. The sellers rights are:

Sellers have the right to introduce any product in any size and style they wish into the marketplace so long as it is not hazardous to personal health or safety; or, if it is, to introduce it with the proper warnings and controls.

Sellers have the right to price the product at any level they wish provided there is no discrimination among similar classes of buyers.

Sellers have the right to spend any amount of money they wish to promote the product, so long as it is not defined as unfair competition.

Sellers have the right to formulate any message they wish about the product provided that it is not misleading or dishonest in content or execution.

Sellers have the right to introduce any buying incentive schemes they wish.

The buyers rights are:

Buyers have the right not to buy a product that is offered to them.

Buyers have the right to expect the product to be safe.

Buyers have the right to expect the product to turn out to be essentially as represented by the seller.⁶

CLASSIFYING CONSUMERISM ISSUES

Organizing and classifying the issues of consumerism is difficult.

As Herrman says,

Since the consumer movement lacks a carefully planned program of action, its choice of issues is largely the result of historical accidents.⁷

One classification system which can be seen in Day and Aaker is the suggestion that consumerism issues be considered in three facets of the relationship between consumers and businesses. These three facets are:

Protection against clear-cut abuses. This encompasses outright fraud and deceit that are a part of the "dark side of the marketplace," as well as dangers to health and safety from voluntary use of a product. . . .

Provision of adequate information. The concern here is with the economic interests of the consumer. The question is whether the right to information goes beyond the right not to be deceived, to include the provision of performance information that will ensure a wise purchase. . . .

The protection of consumers against themselves and other consumers. Some of the thrust behind consumerism comes from the growing acceptance of the position that paternalism is a legitimate policy.⁸

Other classification systems can be seen in the work of Philip Kotler and Robert J. Lavidge. Kotler says marketing criticisms fall into three categories: Marketing's impact on society, Marketing's impact on business competition, and Marketing's impact on consumer welfare.⁹ Lavidge suggests five areas of expanding marketing opportunity and responsibility. These are (1) consumerism, (2) the struggle of the poor for subsistence, (3) the marketing of social and cultural services, (4) the day-to-day functioning of the economy, and (5) the use and pollution of society's resources.¹⁰

The usefulness of these classification systems lies in the aid they provide us in understanding the various aspects and varied issues of consumerism and businesses' social responsibility. All of the classifications were developed after the issues had been brought to the public's attention in what might appear to be a random manner. The categories were named by

experts with little empirical research of how the consumers or businessmen view the issues. It is hoped that this study will aid in categorizing issues as businessmen and consumers view them.

It is important to note that none of the present systems are either always consistent or all-inclusive. Even the "experts" have difficulty in agreeing which issues should be assigned to each of the categories.

Hoping that the preceeding review of classification systems will aid the reader in viewing the issues, the writer will now direct the reader's attention to these issues.

THE ISSUES

The issues selected for analysis in this study were chosen to represent many of the issues discussed in the current literature. They can be roughly broken down into the categories: product complaints, ecological concerns, promotional complaints, price complaints, and production aspects. These categories are not mutually exclusive. Actually ecological concerns may be classified in the other four categories. The obvious category of distribution complaints is not included.*

The 15 issues are listed in Exhibit 2 - 1. Each of these issues will be examined by itself. To start, the issues of the category "product complaints" will be discussed.

Product Complaints

Product complaints include issues concerning product safety, planned obsolescence and poor service. The first of these, the sale of unsafe products, is often considered to be the most clear-cut example of a consumerism issue. Each year twenty million Americans are injured or killed

* One possible issue under distribution complaints would be the deviant distribution system that is criticized for not serving the needs of minorities effectively or efficiently.

EXHIBIT 2 - 1

Issues StudiedProduct Complaints

1. Sale of unsafe products,
2. Planned obsolescence,
3. Inadequate service after the sale,
4. Excessive charges for service calls after the sale

Ecological Concerns

5. Depletion of natural resources caused by the manufacture of products,
6. Air pollution which is aggravated by the sale of products that are not designed to minimize pollution,
7. Failure to provide for recycling products after their use,
8. Water pollution in the manufacture of products,

Promotional Complaints

9. Manipulation of demand by marketers,
10. Extravagent claims by marketers,
11. Excessive advertising,
12. Use of children as target groups for advertisements,

Price Complaints

13. High credit charges,
14. Collusion among competitors to fix prices,

Production Aspects

15. Unemployment which follows sales declines.

in product-related accidents."¹¹ Examples of product safety complaints range from a drug (such as thalidomide) that may cause a person to be maimed or crippled, to the Federal law which requires buzzers to warn car riders when their seat belts are not fastened. The drug is generally considered to be a "clear cut abuse", as classified by Aaker and Day. However, the seat belt law is a "protection of consumers against themselves and others."

When dealing with the issue of product safety, the concept of reasonable risk should be considered. Corwin Edwards defines reasonable risk in his statement:

(P)reventable risk is not reasonable (a) when consumers do not know it exists; or (b) when, though aware of it, consumers are unable to estimate its frequency and severity; or (c) when consumers do not know how to cope with it, and hence are likely to incur harm unnecessarily; or (d) when risk is unnecessary in . . . that it could be reduced or eliminated at a cost in money or in the performance of the product that consumers would willingly incur if they knew the facts and were given the choice.¹²

Valid product safety complaints would be, in the opinion of the writer, complaints about preventable, unreasonable risks.

Product safety is the basic issue that spurred much of the consumerism activity of the 1900's and 1930's. Today its current importance can be seen in the comments of J. W. Bishop, Jr. and H. W. Hubbard, who contend that consumerism movements have forced and need to force industry to make safety a primary objective.¹³ Present concern about product safety deals extensively with automobiles, tires, drugs, and food products.

Planned obsolescence is the second type of product complaint considered in this study. While it generally does not provide them with any immediate danger, planned obsolescence is an issue of concern to many consumers, particularly those who, in times of high inflation, feel they are "paying more"

and "getting less." Critics of planned obsolescence condemn manufacturers for intentionally designing products to be obsolete after a set time period. The length of the time period is the critical question in this issue, since any good manufacturer should attempt to design the parts of his products to have approximately the same life span (otherwise some parts are overdesigned increasing the costs and hence the price of the product).

Philip Kotler lists three types of planned obsolescence: material obsolescence, planned functional obsolescence, and planned style obsolescence. Material obsolescence occurs when "manufacturers deliberately choose materials and components that are subject to higher breakage, wear, rot, or corrosion." Functional obsolescence occurs when manufacturers deliberately withhold attractive features from products so that they may be added to later models, and thereby encourage obsolescence of the present models. Style obsolescence occurs when manufacturers follow a deliberate policy "to change users" concepts of acceptable appearance to make them dissatisfied with their present goods."¹⁴

Service complaints are the last of the product issues considered in this study. These complaints are familiar to many consumers and businessmen. The most frequently mentioned service complaints deal with automobiles or appliances. Walter McQuade discusses the problems with appliances:

(T)he conking out of an appliance is likely to bring a series of irritations for the owner. He may tinker with the machine at first, thinking he can fix it, but almost inevitably he has to telephone for professional assistance. Then the usual complaints about servicemen begin to accumulate, ranging from their casualness about keeping appointments to their bothersome habit of so often not having the needed new parts on the truck. When it is the appliance owner who is paying, the very keenest of the complaints have to do with the cost of the repair service. In most communities it is at least comparable to the cost of a physician's consultation; frequently it is higher.¹⁵

In this study two aspects of service complaints are considered: inadequate service (i.e., not servicing products in a reasonable period of time, so that they work as portrayed at the time of sale) and excessive service charges. Inadequate service is blamed on several factors, including the lack of adequately trained servicemen, the alleged failure of marketers and other businessmen to design for easy service, and the poor habits of purchasers. The extent of the dissatisfaction with service can be seen in the results of a 1968 survey by Better Homes and Gardens. That survey showed that of the 84 percent of the new car owners who stated that they followed the specified warranty requirements, approximately one-third (or about 28% of all respondents) were only partly or not at all satisfied with the warranty work. The survey also noted that those who did not have complaints about warranty service were generally better educated than those who did have complaints.¹⁶

ECOLOGICAL CONCERNS

The effects of products on the environment is of great concern to some people. As Business Week says,

Until a decade ago, a few groups. . . and a few lone voices were pretty much talking to themselves in decrying our deteriorating habitat. But now, after years of choking smog, Torrey Canyons, Santa Barbaras, and the threat of silent springs, an aroused public is challenging the despoilers. With President Nixon's endorsement of environment as a major concern, it promises to become the issue of the '70's.¹⁷

Four ecological issues were selected for this study. They are: (1) air pollution caused by use of products, (2) water pollution caused by the production of products, (3) depletion of natural resources and (4) recycling. The first two issues are actually representative of four related concerns, as shown below:

	Product Use	Production
Air Pollution	Auto emissions	Factory emissions
Water Pollution	Use of Phosphate Detergents	Plant Waste Disposal

Air pollution is a major cause of some diseases now, and will get worse if no affirmative action is taken. As William Steif says,

The air is ambient--that is, all-encompassing. . . . Man used to consider the air infinite, but it actually is finite, amounting to between five and six quadrillion tons. That amount would seem to suffice for eternity, but many scientists now worry that we are expelling so many poisons into the air so quickly that we are in danger of changing its nature--in which case, "filter-tipped people" may become a necessity.¹⁸

Product-use air pollution is generally blamed on the automobile. However the total amount of air pollution attributed to the auto is subject to great debate. Air pollution caused by the manufacture of products is the other major contender for the pollution of the air. (It is interesting to note that the automobile was originally hailed for the reduced amount of pollution it created when compared to the horse and buggy.) Other product-use pollution concerns water pollution. In water pollution due to product-use, we see some of the real complexities in dealing with these problems without complete study. William Simon Rukeyser discussed the controversy of phosphate detergents and their replacements.

The outcry against phosphates rose to a crescendo in the first half of 1970, and phosphate-free detergents soon began arriving in the stores. By the middle of 1971, phosphate-free products--some eighty brands in all--had clipped more than half a dozen percentage points from the combined market share of the big three "soapers." . . .

The heyday of the nonphosphate brands was brief, however. Last September the Surgeon General and other federal officers cautioned that some phosphate-free detergents are hazardous to human health. Since then, sales of nonphosphate products--in which phosphate is replaced mostly with old-fashioned washing soda--have slid by a third.¹⁹

Water pollution due to production can occur in plant waste disposal. The effects of industrial waste created by the manufacture of products (added to municipal wastes) has caused many of the nation's rivers to be highly polluted. The Cuyahoga River in Cleveland, Ohio, is so polluted that it has literally burst into flames. Another river, the "Beautiful Ohio" sung of in the song of yesteryear now

contains hundreds, perhaps thousands, of simple and complex pollutants. . . . Some of the substances listed can be toxic in even small quantities. About 100 million Americans get their drinking water from rivers and lakes that contain such pollutants. The water usually goes through some kind of treatment before people drink it, but the treatment has little effect on most of the pollutants.²⁰

The third ecological concern in the study is the depletion of natural resources. Natural resources is becoming of greater concern with the so-called "energy crisis." Earlier awareness was increased by studies by the Club of Rome,²¹ the Ford Foundation funded Resources for the Future, Inc.,²² and the National Academy of Sciences Committee on Resources and Man.²³ Recently a U.S. Government Agency supported these reports in the 1973 Geological Survey.²⁴ Much of the criticism of marketers dealing with resource depletions is aimed at the promotion of products using the resources in short supply. Others limit their criticisms to the wasteful use of resources in low priority ways.

The last ecological concern included in this study deals with the recycling of resources. Recycling is one effort that helps minimize two ecological problems. First it reduces demand for natural resources, and second, it reduces the amount of wastes to be disposed. This policy treats customers as "users" instead of "consumers". Kenneth Boulding uses the analogy of the Spaceship Earth. He says we must move from a "cowboy economy" -- where success is determined by the amount of throughput from the

factors of production -- to a "spaceman economy" -- where throughput is minimized. (Moving to a spaceman economy would also eliminate many of the other issues discussed in this chapter. Doing this, however, might cause additional problems which are beyond the scope of this study.) Much of the burden of implementing a realistic recycling plan falls on marketers who must develop a reverse distribution system carrying goods from the homes to the factories.

Promotional Complaints

The criticisms of marketing's promotional efforts are legion. Many of these criticisms are in-line with the comments of Milton Marcus, a vice president of a small fashion agency, Claire Advertising. Marcus said, "The quality of life in a society is determined by the quality of its culture. Ours is rotten. The advertising industry has helped create it and is continuing to make it worse."²⁵ Researchers who have attempted to classify the criticisms of advertising include John A. Howard and Spencer F. Tinkham, and Stephen A. Greyser.

Four criticisms of promotion are included in this study. They are deceptive promotion, excessive advertising, demand creation, and child-oriented advertising.

Deceptive promotion encompasses many practices including, overstating the product's attributes, misrepresenting the guarantees, falsely photographing the product's accomplishments, luring the customer to the store for a bargain that is out of stock or downgraded by the salesman, and running rigged contests.²⁶

As Baker says,

To increase sales, most anything goes--misrepresentation, deception, lies--unless actionable. The approach is usually to produce the hardest-selling campaign without perpetrating recognizable fraud. This attitude inevitably breeds the permissible lie--the half-truth, of which it has been said: "A half-truth is generally the worst half."²⁷

But others have different views. Levitt has persuasively presented an argument that advertising, like poetry and art, embellishes and distorts reality into a symbollic interpretation.

Nobody knows this better, for example, than the creators of automobile ads. It is not the generic virtues they tout, but more likely the car's capacity to enhance its user's status and his access to female prey.

Whether we are aware of it or not, we in effect expect and demand that advertising create these symbols for us to show us what life might be, to bring the possibilities that we cannot see before our eyes and screen out the stark reality in which we must live. We insist, as Gilbert put it, that there be added a "touch of artistic verisimilitude to an otherwise bald and unconvincing narrative."²⁸

Others complain of the high costs of advertising. They say the \$20 Billion spent on advertising (or at least part of it) could be better allocated to education, health care, or other social benefits. Some say waste occurs whenever advertising is done for certain products that are essentially commodities (such as gasoline, aspirin, coffee, sugar, fluor, or cigarettes) because the advertising does not expand the market but merely increases costs without providing any service. Others say promotional allocations are appropriate only when they inform potential purchasers of the product's attributes. As Caves says, "At the point where advertising departs from its function of informing and seeks to persuade or deceive us, it tends to become a waste of resources."²⁹

A third area of complaint is the use of child-centered advertising. Critics say this advertising magnifies the benefits of the products, portrays fantasy situations where the children are endowed with marvelous powers by use of the product, arouse otherwise dormant desires, exploit children's suggestibility, teach vanity as a value, and understate the costs of products and the value of money. The child who later realizes

the misrepresentation develops a cynicism toward the entire free enterprise system. One recent example of this criticism was the testimony of Robert Choate, Jr., a nutrition expert to the F.T.C. Choate testified,

Our children are being deliberately sold the sponsor's less nutritious products; our children are being counter educated away from nutrition knowledge by being sold products on a non-nutritive basis.³⁰

The last area of promotional criticism is demand creation. For example, historian Arnold Toynbee said,

"It is argued that marketing--including the kinds of new products introduced, the design of those products, and advertising --reflects public wants and tastes rather than shapes them." I have been asked whether I believe this to be true. I do not believe that. If advertising were just an echo of desires that were already in the housewife's mind, it would be a superfluous expense of time, ingenuity and money. . . . I believe it stimulates consumption. . .³¹

This criticism is often identified with John Kenneth Galbraith, who states that demand is managed in order to insure that people buy what is produced. Advertising is seen as the central tool of this management.

Price Complaints

Two price-related issues are included in this study: price-fixing and high credit charges. The first of these, price-fixing is generally recognized in three forms: formal agreements between sellers, informal price leadership, and tacit collusion. Price-fixing is one of the issues that led to the original Antitrust statutes. In fact, the oldest Federal antitrust law, The Sherman Act (1890) is still used to prosecute price-fixing under its first section. It is possible that price-fixing is no longer considered as important as it once was because of the enforcement (and the threat of it) of the Sherman Act.

The second price-related issue, high credit, is included to provide an interesting perspective with an earlier more product-oriented issue,

high service costs. Perceptual differences between these two issues may provide an indication of the relative differences in reactions to service policies and price policies. It might be expected that high credit charges would be of greater concern to "low income" customers than to those surveyed in this project.

Production Aspects

Actions on many of these issues would cause increased prices (particularly with the ecological concerns) and worker layoffs. Some of the layoffs would be short term "shifts in priorities" where workers exchange one job and/or company for another. Actions on other issues may have long range effects of heavy unemployment, as less workers are needed to satisfy society's needs and desires.

The last issue, worker layoffs, is included in this study to measure the contrast between the consumer-oriented sides of consumerism and one possible production-oriented consequence of consumerism activities.

PREVIOUS SURVEYS

Most previous surveys of the social responsibilities of marketers has been of two types: (1) analysis of attitudes towards specific issues (generally advertising or ecology) and (2) analysis of the perceived general importance of consumerism.

Studies of Attitudes Toward Advertising

Some of the most complete surveys of attitudes toward advertising have been conducted by Raymond A. Bauer and Stephen A. Greyser. In 1967 they completed a study of attitudes toward advertising which was later published in book form. Overall the study found more people that regarded advertising as favorable (41%) than unfavorable (14%). In studies of

individual advertisements, Bauer and Greyser found that advertisements were more likely classified as annoying if the respondent was male (28% vs. 20% for females) or young (31% for the youngest group versus 20% for the oldest group). There was no relation between education and the respondent classifying an advertisement as annoying.

Bauer and Greyser also reviewed previous studies of attitudes toward advertising. It appears that there is a trend towards an increasing percentage of people who believe that advertising increases prices. In a 1935 survey (University of Toledo) 46% believed stores could not lower prices if they reduced advertising while 39% believed they could. In 1953 and 1961 the Field California Poll indicated the following:

% Agreement with statement "Advertising makes things cost more than they would without advertising"³²

	<u>1953</u>	<u>1961</u>
No	41%	32%
Yes	57%	64%
Don't Know	2%	4%

A 1964 study by the American Association of Advertising Agencies showed that 40% considered advertising as leading to lower prices, while 45% considered advertising as leading to higher prices.

Five of six previous studies of advertising as a hidden persuader have indicated that a majority of people (from 59% to 81%) believe advertising leads people to purchase products that they do not need.

Another study by Greyser and Reece in 1971 analyzed the attitudes of businessmen (2700 Harvard Business Review subscribers) toward advertising. It is a replication of a 1962 study by Bauer & Greyser. The survey showed that businessmen were more critical of advertising in 1971 than in 1962, but that they still believe it is essential to business and

is necessary for new product introductions. The businessmen showed that they believe overall, advertising decreases selling expenses, but they believe too much is now spent on advertising (obviously a little is good but now there is too much). Trends from 1962 to 1971 also indicated that businessmen agree--more strongly in 1971 than in 1962--that advertising has an unhealthy influence on children and that advertising does not present a true picture of the product (in 1962 a majority believed that advertising did provide an accurate picture). Overall on most key issues, businessmen's opinion moved 5 to 10 percentage points toward an anti-advertising position from 1962 to 1971.³³

Obviously businessmen are not alone in their fellyings about advertising. A 1972 study by the AAAA (American Association of Advertising Agencies) showed that of some 9000 students from 177 universities and colleges, only 53% considered advertising "believable some of the time."³⁴ In other words, 47% did not consider advertising believable at any time!

However, a 1972 survey of 18,304 people by Daniel Starch and Staff showed people generally believe advertising is more informative now than it was a few years ago (61.1% of men and 64.7% of women). When Starch asked if most advertising today tries to deceive people rather than inform them, 47.2% of men and 43.4% of the women agreed, while 32.2% of each disagreed (the remainder had no opinion). A 1971 Louis Harris poll showed only 13% of the respondents had a great deal of confidence in advertising. This was down from 21% in 1966.³⁵

However, Federal Trade Commission files indicate that only 5.7% of all complaints to them are about advertising. Most of their complaints concern faulty merchandise, product delivery, etc.³⁶ (This may be logical when one considers the relatively low threshold level for advertising

complaints.) And a 1971 Harvard study indicated that children at 5 years of age are already cynical of advertising.³⁷

Ecology and Pollution

The other area of issues on which much work has been done is ecology and pollution. In February, 1970, Fortune³⁸ printed the results of a Daniel Yankelovich survey of 270 chief executives of Fortune 500 firms.

When the executives were asked,

"(W)ould you like to see (the Federal Government) step up its regulatory activities, maintain them at the present levels or cut them back?"

their responses were,

Step up regulatory activities	57%
Maintain regulatory activities	29%
Cut Back regulatory activities	8%
Not Sure	6%

Later the executives responded to the question,

"Should the protection of the environment be taken into consideration even if it means

	<u>Should</u>	<u>Should Not</u>	<u>Not Sure</u>
Inhibiting the introduction of new products	88%	8%	4%
Foregoing an increase in production	84%	9%	7%
Reducing profits	85%	9%	6%

Other studies have been conducted of consumer attitudes and buying behavior in light of the pollution concern. One of these studies, by Roy A. Herberger, Jr. and Dodds I. Buchanan concerned brand choice of detergents and soft drinks with and without ecology information. In 1969, 202 housewives showed a statistically significant change of buyers intention from high phosphate detergents to low phosphate detergents when provided with information on the phosphate levels. The results for soft drinks

were not statistically significant. This part of the study (soft drinks) is questionable, however, since respondents would be forced to switch brands and products (from cola to other types of soft drinks) in order to use the more ecologically safe, returnable bottles. (In actual purchases they would be able to purchase the returnables in the same brand.)³⁹

In a 1970 study in California (an area well known for high amounts of air pollution), Harold H. Kassarian studied attitudes toward a supposedly low pollution gasoline marketed by Standard Oil Co. of California. Kassarian concluded:

Consumers, in general, were willing to try the product at premium prices. They claimed to be willing to pay more for it (with circumstantial evidence that this may have been true), and certainly appeared to be interested in the developments surrounding the product. . . .

In regard to the marketing correlates of air pollution, it is apparent from this study that there is no simple segmentation variable other than the attitude itself. Demographic variables such as age, sex, socioeconomic status, and political party membership do not seem to be relevant. Other variables, not presented in this article, such as selected sociopsychological ones, also do not discriminate between the two attitudinal groupings. The important variable of concern to the marketer is not related to the usual market segmentation criteria, but rather the level of concern about the issue at hand, whether it be nonreturnable bottles, high-phosphate detergents, aluminum cans, or excessive use of paper bags dispensed at supermarkets.⁴⁰

The Importance of Consumerism and Ecological Concerns

The Kassarian study (and several other studies) also collected data on what people considered to be the most serious problems facing society today. Kassarian's results of Los Angeles area respondents were as follows:

	<u>%</u>
Air Pollution	31.4
Vietnam War	11.6
Minority Problems (Blacks)	9.9
Inflation	8.7
Population	7.0
Crime	6.6
International Affairs	1.7
Taxes	1.7
Others / Unclear / No Opinion	21.4
	<u>100.0</u>

John S. Coulson reported in 1971 of a survey of 714 men and women. 98 issues were presented to each respondent, he was asked to respond on a 7 point scale of importance. The ten issues rated "most important" most often were:

Narcotics and other drugs	56%
Lack of respect for law and order	47%
Desecration of the flag	46%
Rising Cost of Living	40%
Crimes of violence	40%
Quality of medical care	38%
Quality of education in public schools	35%
Pollution of lakes and streams	35%
Organized crime	35%
Administration of justice	28%

Seven clusters (factors) were obtained by factor analysis. The clusters and their percentages of most importance are:

Personal finances	32%
Morality	30%
Ecology	27%
Consumerism	25%
War and rumors of war	24%
The ubiquitous "They"	19%
The ghettos	17%

Consumerism was made up of:

Quality of medical care	38%
Auto safety	31%
Food shortages	27%
Dishonest Advertising	24%
Consumer protection	20%
Adequate nutrition	19%
Truth in packaging	17%

Concern over consumerism was highest with the poor, poorly educated, and oldsters.⁴¹

A survey in 1971 of state consumer agencies showed the top consumer complaints in 1971 were:

Autos
 Advertising (misleading and deceptive)
 Credit (Billing, holder-in-due-course, debt collection)
 Non delivery of merchandise
 Magazine and book sales
 Home improvement sales
 Franchises and multi-level distribution plans
 Warranties and guarantees
 Sales tactics.⁴²

Consumerism is also of significant legal concern to corporations. A Fortune survey showed five areas of law which are of serious and widespread concern to corporate legal officers. These are antitrust, securities and stockholder matters, consumerism, environment, and fair-employment practices.⁴³

If the attitudes of the youth are any indicator, the future for business may not be any better. In 1968, Daniel Yankelovich conducted a survey for Fortune of attitudes among college-age youth.⁴⁴ Three groups of youth were considered--those with no college, those attending a "practical college," and those attending a "forerunner college," leading in the youth movement. When asked which of several social changes they would welcome, the respondents answered:

	<u>No College</u>	<u>Practical College</u>	<u>Forerunner College</u>
Less Emphasis on money	57%	53%	80%
More Emphasis on private enterprise	42%	55%	36%
More Emphasis on the arts	42%	55%	84%

When asked about the truthfulness of selected statements about business, the subjects responded:

	<u>No College</u>	<u>Practical College</u>	<u>Forerunner College</u>
Makes a Major Contribution to America			
Very true	70%	74%	56%
Not true	7%	3%	5%

	<u>No College</u>	<u>Practical College</u>	<u>Forerunner College</u>
A Major Factor in Society			
Very true	62%	82%	80%
Not true	8%	5%	5%
Meaningful			
Very true	49%	43%	23%
Not true	8%	9%	19%
Large and Overwhelming			
Very true	34%	44%	54%
Not true	20%	12%	8%
Rigid			
Very true	24%	33%	36%
Not true	25%	20%	10%

Surveys have also been conducted to analyze perceptions of the causes of consumer complaints and of the consumerism movement. Monroe Peter Friedman reported a study of 64 leaders of a 1966 consumer protest. The leaders were asked to evaluate factors responsible for higher supermarket prices. The results were:⁴⁵

	<u>Very Important</u>	<u>Important</u>	<u>Not Important</u>	<u>No Response</u>
Advertising-food products	55%	16%	27%	3%
Advertising-supermarkets	58%	30%	8%	5%
Cost of extra supermarket services	84%	11%	3%	2%
Excessive profits-farmers	0	5%	87%	8%
Excessive profits-supermkts	34%	34%	27%	5%
Excessive profits-whole-salers and distributors	45%	31%	14%	9%
High wages for supermarket workers	6%	12%	77%	5%
Devaluation of dollar due to inflationary government spending	34%	34%	28%	3%

A study by Ralph M. Gaedeke of business spokesmen, consumer spokesmen, and government spokesmen indicated that perceptions differed as to what consumerism is and what its causes are. While all groups agreed that the scope of consumerism is broadening, businessmen did not agree with consumer and government spokesmen who said consumerism is an attempt to preserve the free enterprise economy by making the market work better. The three groups were only able to agree on seven causes for consumerism out of 28 possible causes listed. Businessmen agreed with 9 of the causes, consumer spokesmen with 27, and government spokesmen with 21.

It is interesting to note that not a single business or government spokesman agreed that a deterioration of business ethics is an underlying cause of consumerism, while the majority--61 percent--of consumer spokesmen were of the opposite opinion. ⁴⁶

Both consumer and government spokesmen agreed that more legislation is needed on both federal and state levels. Businessmen disagreed.

Other studies have been conducted of the background of the socially conscious consumer. W. Thomas Anderson, Jr. and William H. Cunningham found little relation between either family income, education of the household head, or stage in the family life cycle and social consciousness of the consumer. But they did find the following:

<u>Variable</u>	<u>High Social Consciousness</u>	<u>Low Social Consciousness</u>
Occupation of the household head	Higher status occupations	Lower status occupations
Socioeconomic status	Above average socioeconomic status	Average and lower socioeconomic status
Age of the household head	Pre-middle age	Middle age and older
Alienation	Less alienated	More alienated
Dogmatism	Less dogmatic	More dogmatic
Conservatism	Less conservative	More conservative
Status consciousness	Less status conscious	More status conscious

<u>Variable</u>	<u>High Social Consciousness</u>	<u>Low Social Consciousness</u>
Personal competence	Less personally competent	More personally competent
Cosmopolitanism	More cosmopolitan	Less cosmopolitan

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Jack Engledow analyzed the Consumer Reports subscriber. He found the subscriber had greater than average purchasing power, high social status, high education, high occupational prestige, and highly regarded buying expertise. While the subscribers were decidedly more favorable toward business than others, they were also more critical of advertising. This study and the previously mentioned study by Better Homes and Gardens, appear to indicate that highly educated people are more careful about their purchases and warranties than the less educated. Because they act this way and feel that they can compete with businesses, the highly educated have better attitudes toward business.

This chapter shows that much work has been done to conceptually evaluate consumerism and to study selected issues. While work has been conducted to uncover the importance of consumerism to people, little work has been done to show how people perceive the relative issues of consumerism and social responsibility of businesses. It is in this area that the present study is oriented. By using multidimensional scaling techniques, as described in the next chapter, it is hoped to show the perceptions of these issues by different groups in society. It is also intended to show the interrelationships of the issues and the differences in perceptions between the groups. The most important problems will be represented on the resultant perceptual maps with multidimensional "ideal points."

FOOTNOTES

1. Leon Garry, "Consumerism Began With Cyrus of Persia," Business and Society Review/Innovation, (Winter 1972-73) p. 62.
2. E. T. Grether, "From Caveat Emptor to an Emerging Caveat Venditor: Whither?", Marketing and Society: The Challenge, ed. Robert J. Lavidge and Robert J. Holloway, (Homewood, Illinois, 1969), p. 21.
3. William J. Gaskill, "What's Ahead for Corporations in Social Responsibility?", Financial Executive, (July, 1971), p. 11-12.
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CHAPTER 3

MULTIDIMENSIONAL SCALING

In this chapter the writer provides an understanding of multidimensional scaling and its applications. The reader will find a brief overview of multidimensional scaling followed by a discussion of a theory of data and different methods of gathering data. Techniques which are similar to multidimensional scaling will then be reviewed, and the theory of some of the multidimensional scaling algorithms presented. Then the two algorithms which are used in this study, INDSCAL and PREFMAP, will be explained. Finally previous multidimensional scaling studies will be surveyed to provide the reader with an understanding of the present "state of the art."

INTRODUCTION TO MULTIDIMENSIONAL SCALING

The techniques of multidimensional scaling were originally developed by behavioral scientists for what Shepard calls the double purpose:

- (a) of somehow getting hold of whatever pattern or structure may otherwise lie hidden in a matrix of empirical data and
- (b) of representing that structure in a form that is much more accessible to the human eye--namely, as a geometrical model or picture.

The objects under study (whether these be stimuli, persons, or nations) are represented by points in the spatial model in such a way that the significant features of the data about these objects are revealed in the geometrical relations among the points.¹

When used in marketing, multidimensional scaling and related techniques are designed primarily to develop spatial representations of subjects' perceptions and preferences of various objects, issues, or stimuli. In this project, multidimensional scaling will be used to illustrate the perceptions of various social issues with respect to business and marketers, and the preferences of the subjects for actions with respect to these issues.

The two main elements of the resultant scalings are an attribute or perceptual space and ideal points. The perceptual space is a map of the stimuli as related to dimensions which reflect the subjects' perceptions of their interrelationships. Neither the dimensions nor the configurations of the perceptual space need agree with the true physical relationships between the stimuli. Also, individuals may be characterized as having an ideal stimulus in the perceptual space. This is the subjects' ideal point, an indication of their preferences among the stimuli.

A THEORY OF DATA

Before the writer can discuss the various methods of spatial representations of structures in data, including multidimensional scaling techniques, he should present a brief review of data theory.

Clyde H. Coombs is generally credited with writing the classic book on data theory. He suggests that all psychological data can be viewed as an interpretation of data in which:

- i. a relation exists on a pair of points (a dyad) or on a pair of dyads;
- ii. the elements of a pair of points are drawn from two distinct sets or from one set; and
- iii. the relation is either an order relation or a proximity relation.²

These three categories lead to 2^3 or eight separate kinds of data which Coombs considers as four quadrants with each quadrant subdivided into halves. This is shown in Exhibit 3 - 1.

The two forms of data that are considered most in multidimensional scaling techniques are Quadrant IV a, Similarities (dominance) data and Quadrant I a, Preference (dominance) data. It is important to realize that both of these data forms are distances. Quadrant IV a, Similarities data considers the relationships between two sets of distances and is generally used in

EXHIBIT 3 - 1

Four Data Quadrants³

	Pairs of Points	Pairs of Dyads
2 Sets of Points	<div>Q II a</div> <div>Q II b</div>	<div>Q I a</div> <div>Q Ib</div>
1 Set of Points	<div>Q III a</div> <div>Q III b</div>	<div>Q IV a</div> <div>Q IV b</div>

Generally Accepted Labels

Quadrant I a: Preference Data

Quadrant I b: Proximity Data on distances

Quadrant II a: Single-stimulus Dominance Data

Quadrant II b: Single-stimulus Proximity Data

Quadrant III a: Stimulus-Comparison Dominance Data

Quadrant III b: Stimulus-Comparison Proximity Data

Quadrant IV a: Similarities Data

Quadrant IV b: Proximity Data on Distances⁴

perceptual multidimensional scaling techniques. This form shall be referred to as similarities or dissimilarities data. Within the class of similarities data, there are two subclasses, disjoint similarities data and conjoint similarities data. Disjoint similarities data concerns the relationship between two distances concerning four points. As an example consider the case where the distance from A to B is greater (or less) than the distance from C to D. Conjoint similarities data concerns the relation between two distances concerning three points. As an example of conjoint data consider the case where the distance from A to B is greater (or less) than the distance from A to C.

Quadrant I a, Preference (dominance) data is generally referred to as preference data. It is used in preference (ideal point) multidimensional scaling techniques. Preference data generally concerns three points, one point of which must be an "ideal point" or point of preference. An example is the case where the distance from A to John's ideal is less than the distance from B to John's ideal. This is another way of stating that John prefers A to B. This could be rephrased as "A dominates B with respect to John's preference."

It is also important to make one more distinction about data types. This distinction concerns the type of scale used, whether nominal, ordinal, interval, or ratio. These are described by David A. Aaker:

In a nominal scale, the numbers merely label or identify objects. The number on a football jersey is an example. One type of nominal variable frequently encountered in the analysis of dependence is the 0-1 binary variable, sometimes called a dummy variable. ... Ordinal scales are used to rank objects along certain dimensions. There is no implication, however, that the difference between objects ranked 8 and 9 is the same as that between objects ranked 1 and 2. In contrast, an interval scale has a constant unit of measurement. The difference between two numbers has the same meaning no matter where on the scale the distance is taken. Interval scales do not necessarily have a unique zero. A temperature scale is a good example. A five-degree difference, in an

intuitive sense, has the same meaning throughout the scale. However, sixty degrees is not considered twice as (hot) as thirty degrees, since the zero point is arbitrary. Ratio scales are interval scales that have a unique zero. Length and weight are examples. Clearly one foot is one third of three feet.⁵

Ratio and interval scales may be referred to as metric scales; ordinal and nominal scales are nonmetric.

Another type of scale should also be explained, the ordered metric scale.

An ordered metric scale is one in which all possible intervals between scale positions can be ranked. Suppose we have ordered five objects, A, B, C, D, and E, along a continuum. Also assume that we can order all ten interpoint distances AB, AC, ..., DE, of the five objects taken two at a time. The scale is still a ranking or ordinal scale, but the order is on all distances separating pairs of points. Moreover, in the limit (by adding more and more points on the continuum whose end points are A and E) we will obtain an interval scale.

While a single ordering of objects which differ in only one aspect provides no basis for developing a stronger representation of the data (e.g., an interval scale), it turns out that orderings of pairs of points (objects), or interpoint "distances" imply more information about the scale positions of the points than might be first imagined.⁶

The reader's understanding of this may be improved if he realizes that there are $\frac{1}{2} n (n - 1)$ similarities between n points. Due to this large amount of data, the ordered metric scale is used in most nonmetric multidimensional scaling techniques.

TYPES OF DATA GATHERING METHODS

Many methods of gathering similarity and preference data have been developed. Metric methods are used for metric multidimensional scaling and (logically) nonmetric methods are used for nonmetric multidimensional scaling. The nonmetric multidimensional scaling techniques, which develop metric representations from nonmetric data, should be distinguished from

"fully nonmetric" multidimensional scaling methods which use nonmetric data to provide nonmetric scalings. In this paper, no fully nonmetric techniques will be discussed.

Methods of Obtaining Similarity Data

Similarity data gathering techniques have been classified as "direct" and "derived" methods. Direct methods require the respondents to judge similarities themselves. These judgements are generally made only partially; further processing is needed to develop overall similarities matrices from the subjects' responses. Derived methods require the respondents to provide other judgements which are used to calculate the overall similarities matrices. Generally derived methods use profile data in the form of matrices of n objects as measured on m variables. Each element in the profile data matrix is a measure of the value of an object with respect to one variable.

Methods of obtaining direct similarities judgement are generally classified as "selecting k out of $n-1$ items," "Ordering k out of $n-1$ items," or their subsets. Sample methods of obtaining these two main types of direct similarities judgements and their subsets are shown in Exhibit 3 - 2.

Many of the direct gathering methods supply data which is converted into a similarities matrix by programs using the triangulization procedure suggested by C. H. Coombs. One computer program, TRICON, has been developed for this purpose.

Derived methods commonly develop Euclidean distance similarities matrices from ratings on semantic differentials or other scales. Other techniques of developing derived similarities include the use of correlations and the use of Mahalanobis distances (developed from multiple discriminant analysis programs). A complete discussion will be given in the next chapter

EXHIBIT 3 - 2

Methods Of Obtaining Direct Similarities Judgements

Selecting k out of n-1 items. For each of the following lists, select those k objects which you believe are similar to the first item:

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
B	A	A	A	A
C	C	B	B	B
D	D	D	C	C
E	E	E	E	D

Ordering k out of n-1 items. For each of the following lists, rank the items in order of their similarity to the first item:

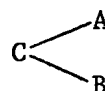
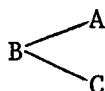
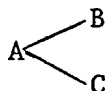
<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
B	A	A	A	A
C	C	B	B	B
D	D	D	C	C
E	E	E	E	D

Examples of some of the subsets of these are shown below:

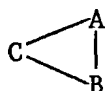
Dyads. For each of the following sets of pairs of objects, pick the most similar pair: ⁷

AB vs. AC
BC vs. AC
BC vs. AB

Triad I. In each of the following sets, pick the object that is most similar to the object on the left: ⁸



Triad II. In the following set select the most similar and least similar pair: ⁹



Rank Order. Order the following pairs of objects from most similar to least similar: ¹⁰

AB, AC, BC

Ratings Scale. For each of the following pairs indicate the degree of similarity in the elements of the pair by marking an appropriate number on the scale: ¹¹

	<u>Highly Similar</u>			<u>Not at all Similar</u>	
AB	1	2	3	4	5
AC	1	2	3	4	5
BC	1	2	3	4	5

Conditional Rank. For each object on the left, rank order the other objects in terms of similarity to that object: ¹²

	1st	2nd	
A	_____	_____	(B and C)
B	_____	_____	(A and C)
C	_____	_____	(A and B)

Subjective Grouping. Of the following seven elements, create three groups of similar objects:

A B C D E F G

of the method used in this study for calculating Euclidean distances from semantic differential ratings.

Some studies have been conducted to determine the relative characteristics of the different similarities gathering methods.

James R. Taylor and Thomas C. Kinnear studied six data gathering methods for similarities: Dyads, Triad I, Triad II, Rank order, Rating Scale, and Conditional Rank. Their results (for 14 subjects) in tabular form are given in Exhibit 3 - 3.

Lester A. Neidell evaluated three methods: Triadic combinations (Triads II), Rotating rating scales (ordering k out of $n-1$ items) and Semantic differentials (derived Euclidean distances using semantic differentials).

Neidell found:

The data clearly indicate that in terms of both response rate and quality of response, the triadic combination questionnaires performed poorly. . . . In terms of quality of response, the triadic combination questionnaires yielded a rate of 66.7%, the rotating anchor points 88.7%, and the semantic differential 75%.

. . . While rotating anchor points yielded response rates approximately equal to the semantic differential, the anchor point procedure may be effective only with n less than 10. Based on these results and others, one might conclude that the economies of collecting similarities data, particularly when the number of stimuli is large, dictates the use of derived measures. ¹³

For these reasons derived techniques for obtaining similarities data were used in this study.

Paul E. Green and Vithala R. Rao used simulated data to study the number of scales to be used in obtaining derived data. While there are many good criticisms of their work, their statement that "Once one deals with more than eight vectors (simulated rating scales), little improvement in recovery is noticed,"¹⁵ provides a rough order of magnitude for selecting the number of scales.

EXHIBIT 3 - 3

Subjects' Evaluation and Completion Time For Each
of the Data Collection Methods

	<u>Time (min.)</u>	<u>Difficulty</u>	<u>Accuracy</u>	<u>Reaction</u>
Rating Scale	1.8	3.2	2.1	2.7
Conditional Rank	4.4	2.7	1.9	1.9
Triad II	5.4	2.5	1.9	2.1
Rank Order	5.9	3.9	2.1	1.6
Triad I	7.2	2.4	2.1	2.7
Dyads	21.7	3.9	2.7	2.5

The perceived difficulty of the methods was indicated by the subjects on a 7 point scale (1 was extremely easy, 7 extremely difficult). Perceived degree of accuracy was indicated on a 5 point scale (1 was very good throughout, 5 very poor). Overall reaction was indicated on a 4 point scale (1 was fun, 4 was boring).

Methods of Obtaining Preference Data

There are three main methods of obtaining preference data. The first is of the form of ordering k out of n stimuli (similar to the method discussed in obtaining similarity data). The second method involves using rating scales to assign values to each stimulus. The third method involves the treatment of the subjects' ideal points as one of the stimuli in the similarities data gathering methods. This third method develops what will later be referred to as an explicit ideal point.

The first method, ordering methods, involves presenting the subject with a group of objects and asking him to select those objects which he prefers, or to rank objects in the order of preference. The group of objects presented may be all the objects tested, or only a small sample of them. If only some of the objects are presented at a time, it is likely that the subject will be asked to repeat his judgements with several samples. Indications of a subject's consistency may be obtained through the transitivity of the results. This method is similar to most of the direct similarities methods except the objects are ordered individually instead of pairs of objects.

Rating scales can take several forms. Two common forms are a numerical "thermometer" scale where subjects are asked to assign degrees to each object depending on the amount of preference, and smaller semantic differential scales (five to eleven points) with values ranging from like to dislike. The data obtained from rating scales may be treated as either metric or non-metric.

The third method, explicit ideal points, will be discussed later.

Related Forms of Analysis Using Different Types of Data

At this point, before analyzing multidimensional scaling programs for perception and preference, it may be of help to discuss some related techniques that evolve from different types of data. Shepard¹⁶ considers four major classes of analysis, based on data types. Using the terms stated in this chapter, these classes would be similarities data, preference data, profile data, and conjoint measurement data.

Similarities data is used for metric and nonmetric multidimensional scaling (as discussed elsewhere in this chapter). It is also used for hierarchical clustering, a technique which attempts to show relationships in clusters of varying degrees of similarity.

Preference data is used in unidimensional and multidimensional scaling or unfolding. These scalings can be developed either with preference data alone or with preference data and similarities data as discussed later in this chapter.

Profile data is obtained in the form of an $n \times m$ matrix of n objects measured on m variables. Profile data is used for classic metric factor analysis, nonmetric factor analysis, parametric representation (methods that develop representations which attempt to preserve the relationships within small clusters, yet use nonlinear relationships and fewer dimensions than factor analysis), and cluster analysis. Profile data may also be used to develop derived similarities data for multidimensional scaling.

Conjoint measurement data is presented in the form of $n \times m$ matrices of n levels of one variable and m levels of another variable. Each element indicates the level of effect arising from the contribution of both variables at their levels. Conjoint measurement is used for simple (additive) representations such as MONANOVA (Monotone Analysis of Variance) and other techniques.

PERCEPTUAL MULTIDIMENSIONAL SCALING USING SIMILARITIES DATA

With this background, it is now possible to discuss the methods of scaling used in this study. The history of perceptual multidimensional scaling goes back to the 1930's. However, the first model for metric multidimensional scaling appears to be Torgerson's model presented in 1952. Later in 1962 Shepard proposed the first nonmetric program for analysis of interpoint distances¹⁷. Kruskal's method (M-D-SCAL) of modifying Shepard's program appeared in 1964¹⁸ and has been adopted in most nonmetric multidimensional scaling programs since. Other programs have been developed by L. Guttman and J. C. Lingoes (the Smallest Space Analysis series) and by F. W. Young and W. S. Torgerson (TORSCA). J. D. Carroll and J. J. Chang have developed several programs, one of which (INDSCAL) uncovers individual differences (this program will be discussed later). Other programs for individual differences have been developed by C. B. Horan, and L. R. Tucker and S. Messick.

The INDSCAL Model - Individual Differences Scaling

The INDSCAL model is used in this study to analyze perceptions. In the model, it is assumed that each subject perceives the set of stimuli in a common set of dimensions. Each subject is allowed an individual weight or salience on each dimension. The modified Euclidean distance between two stimuli is then:

$$d_{jk}^{(i)} = \left[\sum_{t=1}^r w_{it} (x_{jt} - x_{kt})^2 \right]^{\frac{1}{2}}$$

where: $d_{jk}^{(i)}$ = the distance between stimuli j and k as perceived by individual i .

w_{it} = the weight or salience of individual i for dimension t .

x_{jt}, x_{kt} = values of stimuli j and k (respectively)
on dimension t .

r = the number of dimensions.

Although there are no mathematical restrictions on the weights, w_{it} , psychological theory dictates that they be between zero and one. In the extreme case of a zero weight, the respective dimension would have no relevance to the individual.

While nonmetric variations of the program are available, INDSCAL itself is metric. Therefore, it assumes that there is a linear (negative) relationship between the judged similarities of the subjects and the modified Euclidean distances, $d_{jk}^{(i)}$. A technique known as "Canonical decomposition of N-way tables" is used to obtain the values of W and X . As input to the canonical decomposition, scalar products between the vectors are developed by a method suggested by Torgerson.¹⁹

Torgerson's Scalar Product Matrix

Torgerson (using previous work by G. Young and A. S. Householder) suggests that a matrix B_h may be developed of elements b_{jk} , which are the scalar products of vectors from h to points j and k . The values of b_{jk} are computed as follows:

$$b_{jk} = d_{hj} d_{hk} \cos \theta_{jkh}$$

From the Cosine Law:

$$d_{jk}^2 = d_{hj}^2 + d_{hk}^2 - 2d_{hj} d_{hk} \cos \theta_{jkh}$$

Therefore,

$$b_{jk} = \frac{1}{2} (d_{hj}^2 + d_{hk}^2 - d_{jk}^2)$$

where:

b_{jk} = the scalar product of vectors from h to j and k .

d_{hj}, d_{hk}, d_{jk} = the perceived psychological distances of the subjects.

If it is positive semi-definite, the matrix B may be factored to obtain the matrices X and W_i , as follows:

$$B_i = X W_i X'$$

where: X = the $n \times r$ matrix of n stimuli in r dimensions,

W_i = the $r \times r$ diagonal matrix of weights for r dimensions for individual i ,

B_i = the $n \times n$ B matrix for individual i .

In practice the point h , which is the base point for the vector scale products of B , is selected as the centroid of all n stimuli. Equations for calculating the b_{jk} from the centroid are given by Torgerson.

Another problem arises if the perceived distances are comparative (interval) distances and not absolute (ratio) distances. In this case the absolute distances used in calculating d_{jk} are as follows:

$$d_{jk} = h_{jk} + c$$

where: h_{jk} = the comparative distance provided by the subject,

c = an additive constant used to change the comparative into absolute distances.

In the study at hand, the derived distance measures are assumed to be absolute and no additive constants are calculated. If they are desired, however, an option on the INDSCAL program will calculate them according to formulae given by Torgerson.

Canonical Decomposition in INDSCAL

Once the INDSCAL model has developed the B_i matrices, the W_i and X matrices are calculated from the equation:

$$b_{jk}^{(i)} = \sum_{t=1}^r w_{it} x_{jt} x_{kt}$$

This process is completed by canonical decomposition using an iterative least squares process known as NILES (Nonlinear Iterative Least Squares). The program calculates m , diagonal, $r \times r$, W matrices (m subjects and r dimensions) and two, $n \times r$, X matrices (n stimuli by r dimensions). Initially random values are assigned to the two X matrices and values are calculated for the W matrices by least squares. Then using these values for the W matrices and the random numbers for the second X matrix, values are calculated for the first X matrix. The calculated values for the W matrix and the first X matrix are then used to calculate values for the second X matrix. After several iterations the two X matrices are set equal and one more iteration calculates the final values for the W matrices and the (two equal) X matrices.

The basic similarities with other multidimensional scaling programs can be seen when one realizes that the other programs calculate distances in the same manner without the weights. Obviously their calculations are made much simpler without the W matrices. In general these distance relationships are:

$$d_{jk}(p) = \left[\sum_{k=1}^r |x_{ik} - x_{jk}|^p \right]^{\frac{1}{p}}; \quad p \geq 1$$

which is known as the Minkowski p -metric. Some programs require $p = 2$, giving the Euclidean distance relationship:

$$d_{jk} = \left[\sum_{k=1}^r (x_{ik} - x_{jk})^2 \right]^{\frac{1}{2}}$$

Other programs allow the p to be any value (greater than or equal to one) selected by the user.

The early metric multidimensional scaling programs calculate an X matrix of stimuli from Torgerson's equation:

$$B = X' X$$

Nonmetric Multidimensional Scaling - Kruskal's Stress

Most nonmetric multidimensional scaling programs use methods based on the "stress" developed by J. B. Kruskal.²⁰ Stress is defined as:

$$S = \left[\frac{\sum (d_{ij} - \hat{d}_{ij})^2}{\sum d_{ij}^2} \right]^{\frac{1}{2}}$$

where: d_{ij} = the distances in the scaled representation,
 \hat{d}_{ij} = the values that minimize S subject to the requirement that they be monotonic with the original distance judgements.

Iterative methods are usually developed to minimize the stress, S, using the method of steepest descent.

Other Models of Individual Differences

As stated earlier, other methods of multidimensional scaling which evaluate individual differences have been developed by Tucker and Messick, and by Horan. Tucker and Messick's model was the first of these (1963). Their "points of view" analysis computes an $n(n-1)/2 \times N$ matrix of $n(n-1)/2$ similarity judgements and N individuals. They use factor analysis to group the individuals by "points of view." Some of the criticisms of this are stated by J. Douglas Carroll:

J. Ross (*Psychometrika*, 1966) has criticized this procedure on the grounds of lack of mathematical justification for the factor analysis of subjects based on interpoint distances, while (N.) Cliff (*Psychometrika*, 1968) has answered this by arguing, essentially, that the factor analysis should be regarded as only

a vehicle for clustering subjects and finding "ideal" subjects. The present author would argue that, if this is the object of the analysis, a clustering rather than factor analysis of the subjects should be the first step of the analysis.²¹

Horan proposed a model similar to that of INDSCAL. Horan's model assumed the following relationship:

$$d_{ij}(g) = \left[\sum_{k=1}^r (a_{ik} - a_{jk})^2 w_{k(g)}^2 \right]^{\frac{1}{2}}$$

$$b_{ij}(g) = \sum_{k=1}^r a_{ik} a_{jk} w_{k(g)}^2$$

where: $d_{ij}(g)$ = the distance between points j and k for individual g in the scaling,

a_{ik} = the value of point i on dimension k ,

$w_{k(g)}$ = the weight on dimension k for individual g ,

$b_{ij}(g)$ = the elements of the B matrix.

Horan's method of analysis provides an additional problem (when compared to INDSCAL) because the axes are not unique and a method of rotation must be determined. In Carroll's model (INDSCAL) the axes are determined uniquely and no rotation is required.

PREFERENCE MAPPING - IDEAL POINTS

The concept of ideal points can be seen as an extension of the perceptual mapping previously discussed. Consider the situation where a respondent is asked not only to rate the similarities of n various objects, but also to rate the similarity of his ideal object with each of the n objects. In effect the result of a scaling of these similarities is a representation of $n+1$ points, including the n objects and the ideal object.

In the original ideal point model, the farther an object or stimulus point is from an individual's ideal point, the less the individual likes the object or stimulus. Levels of preference can be represented by "iso-preference contours," pictured as concentric circles (spheres or hyperspheres in higher dimensions) with centers at the respective ideal point. All points on a given circle are equally preferred.

A related type of ideal point is the vector model where each subject is represented by a vector. The preference order for an individual is assumed to be given by the projection of stimuli onto his representative vector. This can be seen as a special ideal point where the ideal point is moved extremely far out.

Representatives of ideal points can be developed using three types of data: similarities data alone, preference data alone, or similarities and preference data together. Using similarities data alone, an explicit ideal point formulation may be conducted using a perceptual scaling program, as discussed above. Using preference data alone, an internal analysis can be conducted (assuming homogeneity of perception across all subjects) which yields both a perceptual space and the ideal points. Results of some internal analyses have been disappointing; the method is definitely inferior to the external analysis discussed next.

Similarities and preference data can be analyzed together in an external analysis where a perceptual representation is first determined using the similarities data in a multidimensional scaling program such as INDSCAL, TORSCA, etc. After the perceptual representation is obtained, the resultant stimuli space is used with the preference data as inputs to a perceptual multidimensional scaling program such as PREFMAP (to be discussed later).

Preference analysis, in the form of unidimensional "unfolding" was first proposed by Clyde H. Coombs. In this case it is assumed that the stimuli and persons are located on a common (unidimensional) attribute scale. The rank order of an individual's preferences is assumed to be shown if the scale is "folded" at his ideal. The object of the technique is to "unfold" the data so as to recover the scale of stimuli and individual's ideal points. The technique was generalized to the multidimensional case by J. F. Bennett and W. L. Hays.

PREFMAP - Preference Mapping Via a Generalization of Coomb's Unfolding Model

Carroll and Chang's PREFMAP program performs metric or nonmetric external analysis of preference scalings. It provides both vector and ideal point representations in addition to two generalized ideal point representations. Starting with the least general model first, the four preference models available in PREFMAP are described by Green and Carmone as follows:

- (a) The simplest model is a vector model in which a direction is found for each person (in the common similarities space) whose stimulus point projections are maximally correlated with the scale values of the manifest preference data.
- (b) The second model is a straightforward Coombsian ideal point model in which all subjects are assumed to share the same "evaluative" space (possibly rotated and differentially stretched from the original similarities configuration).
- (c) The third (ideal-point) model subsumes the above and also permits idiosyncratic stretching of the axes, using as a reference the evaluative space of the average subject.
- (d) The fourth (ideal-point) model is completely individualistic and includes rotation and differential axis stretching for each subject (though within the framework of a common space).²²

The PREFMAP program allows for both positive and negative ideal points. Positive ideal points (as described earlier) are ones in which the preference for objects increases as the distance between the objects and the ideal point declines. Negative ideal points are ones in which the preference

decreases as the distance declines. In other words, negative ideal points represent the "least-liked" points. In addition to positive and negative ideal points, combinations of positive and negative points are possible where certain dimensions are treated in a negative manner.

A technical look at the PREFMAP program is now in order. Much of this material is adapted from "Individual Differences and Multidimensional Scaling" by J. Douglas Carroll.²³

It is simplest to discuss the metric options of PREFMAP first, then show the modifications of the nonmetric option. In general the PREFMAP routine attempts to match the preference distances of the subjects with the following modified Euclidean distances of the stimuli-subject space:

$$d_{ij} = \left[\sum_{t=1}^r w_{it} (y_{it} - x_{jt})^2 \right]^{\frac{1}{2}}$$

where: d_{ij} = the distance from ideal point i to stimulus point j ,
 w_{it} = the preference weight applied to the t^{th} dimension by subject i ,
 y_{it} = the value of ideal point i as measured on dimension t ,
 x_{jt} = the value of stimulus point j on dimension t .

It should be pointed out that the preference weights (or saliences) are not necessarily the same as the perceptual weights of the INDSCAL model.

The four phases of PREFMAP may be seen in a hierarchical sense, i.e. the more simple models are special cases of the more complex models. It is convenient to explain the most complex models first.

Phase I: The General Model

In the general model all individuals are assumed to share a common stimuli space, but each individual is allowed to rotate the space in order to choose his own "reference axes" and then to differentially weight each of his axes. He is then allowed to pick his own ideal point.

In this model, it is assumed that there is a matrix X , the elements of which (x_{ij}) represent the coordinates of n stimuli in r dimensions. Any row of X , X_j , denotes the coordinates of the j^{th} point. Also, the elements s_{ij} of a data matrix S represent the preference scale values of the j^{th} stimulus for the i^{th} individual. Here it is assumed that low values represent greater preference.

Carroll's general unfolding model assumes that the scale value, s_{ij} , is linearly related to the square of the Euclidean distance from the stimulus to the individual's ideal point. Thus,

$$s_{ij} = a_i d_{ij}^2 + b_i + e_{ij}$$

where a_i and b_i are arbitrary constants.

It is also assumed that both X_j and Y_i are operated on by an orthogonal transformation matrix T_i . Thus,

$$X_j^* = X_j T_i$$

$$Y_i^* = Y_i T_i$$

and

$$d_{ij}^2 = \sum_{t=1}^r w_{it} (x_{jt}^* - y_{it}^*)^2$$

where x_{jt}^* and y_{it}^* are elements of X_j^* and Y_i^* .

Carroll shows that the least squares estimators can be obtained from the following relationships:

$$1a) \quad s_{ij} \approx X_j R_i X_j' + B_i X_j' + c_i$$

$$\text{or} \quad 1b) \quad s_{ij} \approx \sum_t \sum_{t'} r_{tt'}^i (x_{jt} x_{jt'}) + \sum_t b_{it} x_{jt} + c_i$$

$$2) \quad Y_i = -\frac{1}{2} B_i R_i^{-1}$$

In equation (1) dependent variable values of s_{ij} are regressed against the independent variables $x_{jt} x_{jt'}$ (all t and t' such that $t \leq t'$) and x_{jt} (all t). The resultant coefficients of x_{jt}^2 are estimates of $r_{tt'}^i$. The coefficients of $x_{jt} x_{jt'}$ ($t < t'$), when divided by 2, are estimates of $r_{tt'}^i$ and $r_{t't}^i$. The coefficients of x_{jt} are estimates of b_{it} . The elements $r_{tt'}^i$ and b_{it} form the matrix R_i and vector B_i , respectively. The estimates of Y are obtained from (2).

Phase II: The Weighted Unfolding Model

Unlike the first phase, the second phase does not assume a different orthogonal transformation for each individual. Instead the rotated model of Phase II uses the rotated model of the average subject from Phase I, if Phase I is performed first. Phase II does allow differential weighting of dimensions according to the general distance model of Phase I.

Carroll shows that Phase II is a special case of Phase I where T_i is restricted to be the identity transformation for all individuals. The resultant estimates are obtained from the relationships:

$$3a) \quad s_{ij} \approx X_j W_i X_j' + B_i X_j' + c_i$$

$$\text{or} \quad 3b) \quad s_{ij} \approx \sum_{t=1}^r w_{it} x_{jt}^2 + \sum_{t=1}^r b_{it} x_{jt} + c_i$$

$$4a) \quad Y_i = -\frac{1}{2} B_i W_i^{-1}$$

$$\text{or} \quad 4b) \quad y_{it} = -\frac{1}{2} b_{it} / w_{it}$$

In equations (3a) and (3b), dependent variable values of s_{ij} are regressed against independent variables x_{jt}^2 and x_{jt} (all t). This differs from the relationship (1) of Phase I because the identity transformation T_i leaves W_i in its original form as a diagonal matrix. The estimates of W_i and B_i are then used to calculate estimates of Y_i by (4a) or (4b). Equation (4) is also made simple by the diagonal form of W_i .

Phase III: The Simple Unfolding Model

Phase III is the simple unfolding model with the added provision of restricted dimension weights of ± 1 . Again Phase III is a special case of Phase I where all subjects share the same stimulus space. This space may be rotated and differentially stretched according to the rotated and stretched space of the average subject in Phase II, if Phase II is performed first.

The weights of each individual are all essentially equal in Phase III, except that the vector of weights for one individual may be the negative of the vector of another individual's weights. In Phase III the weights w_{it} are independent of i and can be replaced with $u_t = \pm 1$. Therefore, the $r \times r$ diagonal matrix U can replace W_i in (3a) to give the following:

$$5a) \quad s_{ij} \approx a_i X_j U X_j' + B_i X_j' + c_i$$

or

$$5b) \quad s_{ij} \approx a_i \left[\sum_{t=1}^r u_t x_{jt}^2 \right] + \sum_{t=1}^r b_{it} x_{jt} + c_i$$

$$6) \quad y_{it} = -\frac{1}{2}(b_{it}/a_i u_t)$$

Replacing the term in the brackets (in (5b)) with a single "pseudo-independent variable," the regression equation is solved for a_i and b_{it} .

Equation (6) is used to calculate y_{it} for each individual. The weights u_i are restricted to be ± 1 , depending on the sign of the weights w_{it} for the average subject in Phase II, if Phase II is conducted first (otherwise they are $+1$). If the estimated values for a_i are negative for some individual, it means that the pattern of saliences (the sign of the vector of weights) is reversed for that individual.

Phase IV: The Vector Model

Phase IV conducts an analysis which finds a direction to be used as a preference vector for each individual. In this case the regression equation is:

$$7) \quad s_{ij} \approx a_i Y_i X'_j + c_i$$

where Y_i is the row vector of coordinates of the unit vector onto which the stimulus points are projected. Equation (7) is equivalent to the following:

$$8a) \quad s_{ij} \approx B_i X'_j + c_i$$

or

$$8b) \quad s_{ij} \approx \sum_{t=1}^r b_{it} x_{jt} + c_i$$

if

$$B_i \equiv a_i Y_i$$

Using regression to solve for B_i in (8) leads to the values of Y_i by the following relationship:

$$y_{it} = b_{it} / \left(\sum_{t'=1}^r b_{it'}^2 \right)^{\frac{1}{2}}$$

After completing all phases, values are calculated and a table is printed of the correlation coefficients for each subject by each phase, and corresponding F-ratios. Also printed are the F-ratios associated with the inclusion of additional parameters calculated by computing the F-ratios between phases.

Nonmetric PREFMAP

The nonmetric option of PREFMAP follows the general procedure of the metric option with a few changes. As Carroll states:

Suppose we replace (the equation: $s_{ij} = a_i d_{ij}^2 + b_i + e_{ij}$)
with: $\tilde{s}_{ij} = d_{ij}^2 + e_{ij}$
where: $\tilde{s}_{ij} = M_i(s_{ij})$

with M_i an arbitrary (nondecreasing) monotone function, and furthermore interpret " $s_{ij} \sim$ " to mean " $\tilde{s}_{ij} - e_{ij} =$ " with \tilde{s}_{ij} as defined above. If we could, then, solve for the various parameters of the implied regression equations, and for the monotone function M_i , yielding a best least-squares fit, our procedure would be fully nonmetric.²⁴

To accomplish this, PREFMAP uses the following steps:

- (1) Assume values of \tilde{s}_{ij} which are linearly related to s_{ij} .
- (2) Use the appropriate regression function ((1), (2), or (3)) to predict \tilde{s}_{ij} 's.
- (3) Using the predicted s_{ij} 's, calculate an estimate of the monotone function M_i by minimizing the "stress" value according to the procedure suggested by J. B. Kruskal. The resultant function is denoted: $M_i^{(1)}$.
- (4) Compute $\tilde{s}_{ij}^{(1)} = M_i^{(1)}(s_{ij})$. Replace s_{ij} with \tilde{s}_{ij} .
- (5) Repeat steps (2) through (4) until the process converges.

The final F-ratios are also calculated for the nonmetric option. Obviously they are no longer statistically valid.

EXAMPLES OF PREVIOUS STUDIES USING MULTIDIMENSIONAL SCALING

Having now considered some of the technical aspects of multidimensional scaling programs, it is now appropriate to discuss a few examples of their use. In doing this, simulated studies will be discussed first, illustrating the ability of multidimensional scaling methods to produce the configurations submitted, followed by discussions of studies of individual differences. Finally, a quick overview will cover other studies.

Studies of simulated data have been conducted to test the abilities of multidimensional scaling programs to reproduce predetermined structures. Ian Spence conducted a Monte Carlo evaluation of three nonmetric multidimensional scaling algorithms, Kruskal's M-D-SCAL, Guttman-Lingoes' SSA - I, and Young-Torgerson's TORSCA-9. In studying 2160 scaling solutions, Spence found that "differences between the solutions obtained by the algorithms were typically so small as to be of little practical importance," and that "deviant solutions were occasionally produced by each of the algorithms, but most often by M-D-SCAL and furthermore, most frequently in one dimension."²⁵

Charles R. Sherman studied the basic parameters of nonmetric multidimensional scalings. In his study, he found,

that nonmetric scaling may produce better models if (1) the true structure is of low dimensionality, (2) the dimensionality of recovered structure is not less than the dimensionality of the true structure, (3) degree of error is low, and (4) the degrees of freedom ratio is greater than about 2.5. It was also found that (5) accurate estimation of the Minkowski constant leads to a better model only if the dimensionality has been properly estimated. ²⁶

Lester A. Neidell rank ordered the 105 (road mileage) distances between 15 U.S. cities and used this nonmetric data in Young and Torgerson's TORSCA. He found that errors due to the differences between road mileages

and actual straight-line distances caused some of the cities to be slightly "out of place." (However, it appears the nonmetric TORSCA program did a better job of correctly assigning the location of Houston than did the experimenter in drawing his own map.) Nevertheless, the general structure was still preserved.²⁷

Other studies in recovering the forms of alphabetic letters in perceptual and preference programs, have been conducted by Green and Carmone.²⁸ A similar study by the writer with nine points forming a letter 'A' produced accurate perceptual results with the INDSCAL program, but produced many errors with the PREFMAP program. The number of points was probably too small for the nonmetric PREFMAP option.

Studies of individual differences have been conducted using the INDSCAL model, Tucker and Messick's point of view model, and various preference programs. Ronald E. Turner and Dennis H. Gensch studied differences in the perceptions of products among salesmen and management using INDSCAL, Tucker and Messick's points of view model, and PREFMAP. They found similarities within the group of salesmen but great differences between the managers.²⁹

Carroll and Chang used INDSCAL to reanalyze color data that had been previously studied by other researchers. The INDSCAL model determined that certain subjects were color blind and unable to see certain types of color.³⁰

Wish, Deutsch, and Brener used INDSCAL to evaluate the perceived similarity of nations by foreign students at Columbia University. The results were analyzed with respect to political statements of the students.³¹

Vithala R. Rao analyzed subjects' perceptions of razor blades and electric shavers with INDSCAL. He compared the saliences of perceived quality and another dimension with subjects' product knowledge and price information.³²

Tucker and Messick first used their points of view model to model and examine political judgement data.³³ It was later used by Landis, Silver, Jones, and Messick to evaluate the viewpoints of problem similarity of 51 air traffic controllers. It was found that the perceptions could be grouped by training and competency level of the controller. Those groups of greater proficiency tended to view the stimuli in terms of the responses required for air-traffic control; other viewed the stimuli in terms of physical characteristics.³⁴

Other studies of individual differences have been conducted in market segmentation studies. Volney Stefflre's work³⁵ in market structure is well known in this area. Norman L. Barnett used Stefflre's market structure analysis to develop effective advertising for new products.³⁶ Frank, Massy, and Wind also discuss the use of multidimensional scaling in market segmentation in their book Market Segmentation.³⁷ Richard M. Johnson uses multidimensional scaling to analyze segments in the Chicago beer market.³⁸

Probably the most comprehensive study of one set of data using multidimensional scaling was conducted by Green and Rao in their book Applied Multidimensional Scaling. They studied the perceptions and preferences of 21 Wharton School M.B.A. students and their wives (a total of 42 respondents) towards 15 breakfast food items. Their analysis includes several different multidimensional scaling models and computer programs applied to both direct and derived similarities and preference data. Other studies

by Paul Green and his associates include perceptions of 17 automobile brand names,³⁹ a comparison of perceptual mappings of advertisements and magazines,⁴⁰ and an example of the use of correlation coefficients as inputs to multidimensional scaling programs.⁴¹ Vithala R. Rao has also separately used brand choice, price/quality models to interpret multidimensional scaling results of the INDSCAL and PREFMAP programs.⁴²

Other multidimensional scaling studies include the following:

- Perceptions of Words by Rapoport and Fillenbaum,⁴³
- Analysis of the perceptions of 60 occupations by Burton,⁴⁴
- Perceptions of diseases by Mexican-Americans and native (European) Americans,⁴⁵
- Perceived personality trait relationships by Rosenberg,⁴⁶
- Perceptions of candidates in the 1968 Presidential election and electoral substitution,⁴⁷
- Another study of the 1968 Presidential candidates and voter segments,⁴⁸
- Similarities and preferences of colors,⁴⁹
- Structure of personality impressions with Kruskal's multidimensional scaling model,⁵⁰
- Multidimensional mapping of colors and a comparison with the theoretical "Munsell" scale,⁵¹
- Limitations of information processing through analysis of subjects who scaled a sample of random polygons under 15 different task conditions.⁵²

It can be seen that the techniques of multidimensional scaling have been used for many different purposes. It can also be noted that the techniques are in that stage of development when many different models and programs perform similar, yet slightly different, functions. A basic overall model is still to be developed.

With the background in the social issues affecting marketers, which was presented in Chapter 2, and the overview of the theory, models, and

experience of those using multidimensional scaling, which was presented in this chapter, the reader should now be able to follow the development of this project as presented in the next chapter.

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CHAPTER 4

THE PROCEDURE OF THE STUDY

With the background of the preceeding two chapters, the reader should be able to understand the procedure for the development of the project. This procedure is basically to:

- Determine the issues to be studied,
- Design and pretest a questionnaire,
- Select the subjects and administer the questionnaire,
- Decide to use the programs INDSCAL and PREFMAP,
- Develop the data in forms that can be submitted to the programs,
- Select the representations to be used and interpret them,
- Examine differences between the groups on the basis of perceptions and preferences.

While the decision to use the programs INDSCAL and PREFMAP is listed fourth in this discussion, it should be obvious that this and other decisions were necessary before the others were finalized. At this point the writer will merely note that the techniques of multidimensional scaling were chosen because the project centered around the analysis of perceptions and preferences and the presentation of them in an understandable form.

Selection of Issues

As indicated in Chapter 2, most of the issues were selected to represent the issues discussed in the literature. Consideration was also given to the following factors:

- The issues should be appropriate to all possible groups. (It is for this reason that the issue of deviant distribution systems was avoided.)
- The range of the issues should be broad enough to show the entire field of consumerism and social issues regarding business.
- The issues should be narrow enough to provide a meaningful representation on all issues (previous researchers have noted that the dimensions will not be appropriate to analyze closely related stimuli if other stimuli are not closely related).

The decision to use 15 issues was partially influenced by Shepard's finding that 15 points were adequate for nonmetric multidimensional scaling.

Questionnaire Development and Pretest

The original plans of the researcher were to use nonmetric methods of direct similarity judgements. However, these were changed because of the belief that it would be extremely difficult for many subjects to judge the relative similarity of abstract issues. In place of the direct similarity judgements, derived similarities were obtained with ten sets of semantic differentials. The decision to use ten scales (and not five or twenty) was made considering two factors: (1) as the number of scales used increases the time required of respondents, and hence their fatigue, also increases, and (2) as the number of scales increases the likelihood that the derived distances accurately represent the actual distances also increases. The findings of Paul E. Green and Vithala R. Rao (as discussed in Chapter 3) that eight scales are adequate also influenced the choice of ten scales. Because of the extremely hypothetical nature of their data these findings were considered by the writer to establish a minimum number of scales.

To develop the ten scales, over 25 bipolar pairs of words were evaluated. The pairs were developed by (1) considering scales used in previous research, and (2) asking associates and advisors to suggest scales. Once the initial bipolar scales were developed, 25 pairs were selected for further testing. In selecting these scales, attempts were made to retain as many different factors of the original scales as possible, including the three factors of Osgood: Evaluative, Potency, and Activity. These 25 scales are given in the Appendix.

A pretest was then conducted on 18 subjects using the 15 issues and 25 scales. The pretest subjects were selected to include those who would represent the subjects of the full study. The members included students in a graduate marketing class (studying social issues) and friends and acquaintances of the researcher and his associates. Subjects were asked which scales they thought allowed them to indicate the differences between the issues. In addition to the subjects' comments, the scales were factor analyzed and the standard deviations were calculated. The standard deviations were used under the assumption that subjects would vary their ratings more on scales that were meaningful than on scales that they considered useless. Those scales on which subjects varied their ratings would correspondingly have higher standard deviations.

Factor analysis was used to indicate which scales tend to indicate independent factors. Four types of factor analysis were used: varimax rotation of ten factors (using the Biomed BMD03M program), equimax rotation of ten factors (using the SPSS, Statistical Package for the Social Sciences, program), equimax rotation of five factors (with eigenvalues greater than 1.0, using SPSS), and oblique rotation of five factors (using SPSS). Overall, the same general set of factors was obtained in each of

the programs. Bipolar scales representative of the factors were included in the final ten scales.

In addition to aiding the development of the questionnaire, the pretest also showed an apparent need for a fairly high level of intelligence or education in the subjects to allow them to complete the questionnaire. A few respondents had great difficulty in completing the questionnaire. On the basis of past knowledge of these respondents, the person administering the pretest classified these individuals as less intelligent and less educated than the other respondents. The main reason for their problems appears to be the abstract nature of the issues.

Group Selection

Original plans called for three groups of respondents--one group of businessmen, one group of average consumers, and one group of consumerists. The consumerists would be defined by the fact that they regularly met to discuss consumerist activities. The consumers were to be defined by the fact that they regularly met for other purposes than to discuss consumerist activities. No group of willing and available consumerists were found. A group of undergraduate students were used in their place.

The following groups were used:

19 Housewives, members of a local Jewish woman's group, (only 18 completed the preference questionnaire),

25 Industrial Businessmen, working in management level positions for a national engineering-construction firm,

3 Retail Businessmen, working in management level positions for a chain store doing business in Houston,

23 Undergraduate Students, attending the first day's class of an introductory marketing course.

Of necessity, there were differences in the administration of the questionnaire to the groups. The housewives were given the questionnaire during a meeting at their synagogue. A contribution was given to their sisterhood in consideration of their participation. The students and industrial businessmen were given the questionnaire at the University of Houston. The students were attending the first day of classes for the summer semester. The industrial businessmen were attending a series of classes at the Management Development Center at the University. Neither group was paid for their efforts. The group of retail businessmen administered their own questionnaires individually. Obvious biases may be attributed to the differences in administration of the questionnaire, but the effects of these were believed to be minimal due to the use of calculated distances between the issues. Completion times ranged from 20 to 45 minutes. Approximately equal time variances were experienced by all groups, although the students were slightly faster than the other groups.

Presentation of the Issues and Semantic Differentials

Since the distances between issues is calculated by comparing the scores of the issues in each of the bipolar scales, the researcher desired to maintain continuity of judgement on each scale. Accordingly, each scale was presented by itself and respondents were asked to judge all issues on the scale before continuing to the next scale. (The reader may see an example in the sample questionnaire in the Appendix.) The order of presentation of the scales was randomized by randomly collating the questionnaires. For each bipolar scale, the order of the issues was selected using tables of random numbers.

Obtaining Preference Data

The preference judgements were obtained by asking the subjects to rank the issues in the order that they would like to have them eliminated, most important first. The precise instructions are shown in the sample questionnaire in the Appendix. Two lists of issues were used in presenting them for preference judgements. The lists differed only in the order the issues were presented. Each questionnaire included one of these two lists.

Other Questions on the Questionnaire

To provide information for additional analysis and to uncover differences between the groups, several questions were added to the final questionnaires. As illustrated in the sample questionnaire attached in the Appendix, these questions ask the subjects to:

Select the "three most important issues in society today,"

Broadly describe their occupation and years on the job,

State their last year of formal education,

Indicate whether they subscribed to any of the magazines, Consumer Reports, Consumer Bulletin, and Money,

Mark their proper age classification,

Indicate whether they have any children between the ages of 15 and 25,

Mark their correct income classification.

Subjects were allowed to skip any question that they considered to be too personal. Accordingly, two housewives did not mark their income classification. Subjects were also asked to select the four most important issues in society instead of the three most important issues; five subjects marked only three issues. The meaning of the question about the last year of formal education is ambiguous, the question was therefore skipped in the

analysis. The meaning of the question about family income was also ambiguous for the students, therefore; their responses are not included here. The results of these questions are summarized in Exhibit 4 - 1.

By analyzing the responses to the "three most important issues in society today" question, it can be seen that the housewives considered the wars in Southeast Asia and the Middle East to be more important (and ecology to be less important) than the other groups. The students apparently consider drugs and morals to be less important but population control to be more of a problem than the other groups. Businessmen were generally between the extremes of the housewives and students in their responses. The importance of the wars to the housewives may be explained by their interest (and presumably their synagogue's interest) in the fate of Israel in the Middle East. Also the higher importance given to the concern for population control by the students indicates that, of these three samples, the concern for population and birth control is strongest in the age group that is of child-bearing age.

The answers to the other questions provide no insights by themselves. They will be used in analyzing perceptions and preferences.

Selection of INDSCAL and PREFMAP

As stated earlier, multidimensional scaling was considered an appropriate group of techniques for consideration. Among the many multidimensional scaling algorithms, the perceptual scaling program INDSCAL was chosen for its superior ability to analyze differences in individual perceptions. Consideration was given to the writings of a few previous researchers¹ who noted that the INDSCAL program may lead to the consideration of representations in more dimensions than desired (due to its consideration

EXHIBIT 4 - 1

SUMMARY OF RESULTS OF SUPPLEMENTARY QUESTIONS

<u>Top Three Issues In Society Today</u>										
	<u>1</u> <u>WARS</u>	<u>2</u> <u>DRUGS</u>	<u>3</u> <u>INFLATION</u>	<u>4</u> <u>MORALS</u>	<u>5</u> <u>CONSUMERISM</u>	<u>6</u> <u>ARMS RACE</u>	<u>7</u> <u>PRODUCTIVITY</u>	<u>8</u> <u>ECOLOGY</u>	<u>9</u> <u>Z.P.G.</u>	<u>TOTAL</u>
Housewives	13 69%	13 69%	10 53%	11 58%	2 11%	0	0	7 37%	1 5%	19
Industrial Businessmen	7 28%	13 52%	13 52%	11 44%	5 20%	2 8%	2 8%	16 64%	6 24%	25
Retail Business	1 33%	2 67%	1 33%	2 67%	0	0	0	2 67%	1 33%	3
Students	7 29%	9 38%	14 58%	3 13%	3 13%	4 17%	1 4%	18 75%	13 54%	24
Total	28 39%	37 52%	38 54%	27 38%	10 14%	6 8%	3 4%	43 61%	21 30%	71

EXHIBIT 4 - 1

(Cont.)

	<u>Magazine Subscriptions</u>				<u>Age</u>				<u>Number of Respondents</u>
	<u>Consumer Reports</u>	<u>Consumer Bulletin</u>	<u>Money</u>	<u>Number of Respondents</u>	<u>20-29</u>	<u>30-39</u>	<u>40-49</u>	<u>50+</u>	
Housewives	5 28%	0	1 6%	18	0	10 56%	6 33%	2 11%	18
Industrial Businessmen B	7 28%	1 4%	2 8%	25	2 8%	10 40%	8 32%	5 20%	25
Retail Business	2 67%	0	0	3	0	0	3 100%	0	3
Students	4 17%	2 9%	1 4%	23	22 96%	1 4%	0	0	23
Total	18 26%	3 4.4%	4 5.8%	69	24 35%	21 30%	17 25%	7 10%	69

EXHIBIT 4 - 1

(Cont.)

Summary Of Results Of Supplementary Questions

	<u>Children (Age 15-25)</u>		<u>Income (Annual Estimate)</u>					<u>No Response</u>	<u>Totals</u>
	<u>Yes</u>	<u>No</u>	<u>\$5000 or less</u>	<u>\$5,000- \$10,000</u>	<u>\$10,000- \$15,000</u>	<u>\$15,000- \$25,000</u>	<u>\$25,000 or more</u>		
Housewives	10 56%	8 44%	0	0	4 22%	2 11%	10 56%	2 11%	18
Industrial Businessmen	8 32%	17 68%	0	0	1 4%	18 72%	6 24%	0	25
Retail Businessmen	2 67%	1 33%	0	0	0	0	3 100%	0	3
Students	0	23			Ambiguous Responses				
Total	20 29%	49 71%							
Total, Not Including Students	20 43%	26 57%	0	0	5 11%	20 43%	19 41%	2 4%	46

of each individual subject), but this disadvantage was considered to be minor compared to the program's ability to analyze individuals' differences.

The algorithm PREFMAP was chosen because it allows the researcher to analyze several models, from very general to fairly restrictive. Further consideration was given to the favorable reception given both programs in the literature.

The writer was fortunate to have Bell Telephone Laboratories provide these programs at no cost. In providing these programs, Bell Labs stipulated that the source listing and instructions not be communicated to others.² The writer intends to follow this stipulation in all areas where the information is not regularly available in other sources.

Preparation of the Data for Submission to the Multidimensional Scaling Programs

In order to use the multidimensional scaling programs the following input data were needed:

For INDSCAL:

Similarities or dissimilarities matrices composed of indications of the perceived distance between each pair of issues for each individual.

For PREFMAP:

A group stimulus space, and

The rank order of preferences for each individual.

The perceived distances were in the form of Euclidean distances; the group stimulus space was the perceptual representation from the INDSCAL algorithm; and the rank order preferences were obtained directly from the subjects.

The Euclidean distances were calculated from the standard ratings for each issue. The ordering of the scales and issues in a common order (instead

of the random orders as administered), the calculations of the standardized scores, and the derivation of Euclidean distances were computed by DREAD, as illustrated in the Appendix. DREAD also ordered the preference rankings in the common order (instead of the two orders as presented to the respondents).

Preliminary Perceptual Data Analysis

Although the results of the data analysis will be presented in the next chapter, the procedure for the analysis and the decisions made in the analysis will be discussed here. After the Euclidean distances were obtained, the INDSCAL program was used to analyze perceptions. To reduce computer time, an initial configuration was used. This initial configuration was obtained from analysis of the first two groups. Since the time required per iteration appears to increase linearly with the number of subjects, and the number of iterations needed also increases, the use of small samples of large groups to obtain initial configurations appears, to the writer, to decrease the overall amount of computer time needed. While the authors of the INDSCAL program (Carroll and Chang) state that 15 - 20 iterations are usually sufficient, this writer chose a maximum of 25 iterations to assure convergence. Scalings of one through seven dimensions were developed.

The INDSCAL program computes the higher dimensional scalings first, then using the higher dimensional scalings as initial configurations, computes the lower dimensional scalings. All scalings were completed in less than 25 iterations with the exception of the five and seven dimensional scalings. These were extended for another 25 iterations; the five dimensional scaling stopped before completing the additional 25 iterations; but the seven dimensional scaling still had not converged after the second run.

Selection of the Number of Dimensions to Use In the Analysis

The selection of the number of dimensions to use in the analysis involved a choice between the seven resultant configurations. Criteria used included the following:

Evaluation of correlations between the scalar product matrices and the estimated data,

Interpretability of the results,

Evaluation of the dimension weights to determine if certain dimensions were salient to only a few respondents.

The correlations for the scalings of 15 stimuli are given in Exhibit 4 - 2. In examining the correlations the researcher attempted to select a scaling such that there was not significantly more variance (as indicated by the correlation coefficients) accounted by the scaling with one more dimension. The procedure for this involved examining the changes in correlations between the scalings (i.e., between the scaling for one dimensions and that for two dimensions, between the scaling for two dimensions and that for three dimensions, etc.) in the conventional manner used in regression analysis.

In the examination of the correlation coefficients, it was determined that scalings of three, four, and five dimensions were candidates for consideration. For each of these scalings all the resultant dimensions were readily interpretable with the exception of one of the dimensions for the five dimensional scaling. Also, all dimensions were salient to many respondents with the exception of that dimension of the five dimensional scaling which was not readily interpretable. The four dimensional scaling was therefore chosen.

As stated earlier previous researchers have said that the stimulus points in multidimensional scaling should all be relatively homogeneous.

EXHIBIT 4 - 2

Correlation Between Estimated Scalar Products &
Calculated Scalar Products For Each Scaling of 15 Issues

<u>Number of Dimensions</u>	<u>R, Correlation Between Y & Y</u>	<u>R²</u>	<u>1 - R²</u>	<u>ΔR²</u>	<u>Average Subject R</u>
7	0.707	0.500	0.500		0.788
6	0.680	0.462	0.538	0.038	0.669
5	0.662	0.438	0.562	0.024	0.653
4	0.629	0.395	0.605	0.043	0.614
3	0.591	0.349	0.651	0.046	0.575
2	0.522	0.273	0.727	0.076	0.498
1	0.400	0.160	0.840	0.113	0.365

If some of the issues are not homogeneous it is likely that the dimensions chosen may not accurately represent the perceptual relationships between the stimulus points. Accordingly the INDSCAL program was also run for only 14 issues--eliminating the issue of workers' layoffs. In this case the correlations (for 14 issues) are given in Exhibit 4 - 3.

In the case of 14 stimuli, the three dimensional scaling was chosen, using similar reasoning to that used to choose the four dimensional scaling for 15 stimuli.

The three dimensions of the 14 stimuli scaling closely match three of the four dimensions of the 15 stimuli scaling. The fourth dimension mainly accounts for the difference between the layoff issue and the other issues.

Examination of the Perceptual Results

In examining the results of the four dimensional scaling for 15 issues, the first step was to analyze the group stimulus space and interpret the perceptual dimensions. This was conducted visually and therefore, is subject to other interpretations. The results reported in Chapter 5 appear (to the writer) to be extremely logical.

To uncover differences between the groups, the perceptual saliences or weights of the INDSCAL model were examined. To determine the types of differences that might exist, visual analysis of the saliences was first conducted. The means were then examined using a profile analysis chart and traditional unidimensional statistical tests on each dimension. Analysis of significant overall differences between the groups was conducted by means of multivariate analysis of variance and the related test of equality of covariance matrices.

EXHIBIT 4 - 3

Correlation Between Estimated Scalar Products &
Calculated Scalar Products For Each Scaling of 14 Issues

<u>Number of Dimensions</u>	<u>R, Correlation Between Y & \hat{Y}</u>	<u>R^2</u>	<u>$1 - R^2$</u>	<u>ΔR^2</u>	<u>Average Subject R</u>
7	0.717	0.514	0.486		0.710
6	0.692	0.479	0.521	0.035	0.684
5	0.659	0.435	0.565	0.044	0.645
4	0.628	0.394	0.606	0.041	0.611
3	0.591	0.349	0.651	0.045	0.573
2	0.539	0.290	0.710	0.059	0.519
1	0.433	0.187	0.813	0.103	0.402

The weights were also analyzed visually for differences between groups, differences between age classifications, differences between income classifications, and differences due to having older children. The plotting subroutine of the INDSCAL program was modified to provide scalings of the weights for these analyses.

The writer expects that the reader who is unfamiliar with statistical methods will be able to follow the visual analysis of the group stimulus space, the interpretations of the dimensions, and the visual analyses of the perceptual saliences.

Preliminary Preference Data Analysis

In analyzing preferences, the PREFMAP program was used in the metric option for all four phases and in the nonmetric option for phases II - IV. By using the metric option for all phases it was possible to statistically evaluate the differences between the phases and thereby select a phase. Once a phase was selected, the nonmetric option for that phase was used for further study. Since the PREFMAP program is designed to analyze up to 50 individual preferences, the subjects were split and two runs conducted of the PREFMAP program. To better understand the differences between the phases, the reader may want to refer to the discussion of PREFMAP in Chapter 3.

Exhibit 4 - 4 provides the reader with the correlations of the average subject correlation and F-ratios for each of the four phases and the F-ratios for the average subject between the phases. The number of individual subjects who have significant F-ratios is also listed. Significance implies that there is a significant difference between the phases and, therefore, that the more general phase (lower phase number) is desired.

For the four dimensional scaling, the metric scalings indicate the simple ideal point model of phase III to be appropriate and the vector model of phase IV to be sufficient. Because the vector model provides better comparisons between individuals and groups, and appears to be adequate, it will be used in this analysis. The relative preferences of the three groups were compared by examining the direction cosines of the ideal vectors for each individual with respect to each dimension (using the non-metric option). Again, visual examination of differences is followed by multivariate analysis of variance to test for differences between the groups. Less sophisticated comparisons are used to study the differences on each dimension.

This study proceeded from decisions on the use of multidimensional scaling and the selection of fifteen issues to an evaluation of differences between groups based on their perceptions and preferences. While it should be obvious to the reader that the groups cannot be called completely representative of larger populations, he should also note that with representative samples, this procedure can be used to determine perceptions and preferences from larger populations. The results of this analysis will be discussed in the next two chapters.

EXHIBIT 4 - 4

Comparisons Of The Correlations and F-Ratios
Of The Four Phases Of PREFMAP (Metric Option)

	<u>Correlation (Phase)</u>				<u>F-Ratio (Phase)</u>			
	<u>R(1)</u>	<u>R(2)</u>	<u>R(3)</u>	<u>R(4)</u>	<u>F(1)</u>	<u>F(2)</u>	<u>F(3)</u>	<u>F(4)</u>
Average Subject								
Run 1	.9400	.9400	.9400	.9022	13.66	18.98	27.83	26.27
Run 2	.9541	.9541	.9541	.9016	18.25	25.35	37.19	26.07
Degrees of Freedom					5,9	4,10	3,11	2,12
Table F-Ratios								
95%					3.48	3.48	3.59	3.89
99%					6.06	5.99	6.22	6.93
Number of Subjects Significant								
95%					28	25	35	30
99%					9	10	16	16

	<u>F-Ratio (Between Phases)</u>					
	<u>F(1-2)</u>	<u>F(1-3)</u>	<u>F(1-4)</u>	<u>F(2-3)</u>	<u>F(2-4)</u>	<u>F(3-4)</u>
Average Subject						
Run 1	0.0	0.0	1.79	0.0	2.99	6.57
Run 2	0.0	0.0	3.25	0.0	5.42	11.93
Degrees of Freedom	1,9	2,9	3,9	1,10	2,10	1,11
Table F-Ratios						
95%	5.12	4.26	3.86	4.96	4.10	3.71
99%	10.56	8.02	6.99	10.04	7.56	9.65
Number of Subjects Significant						
95%	5	5	10	3	10	15
99%	2	2	1	0	1	2

Total Number of Subjects: 69

EXHIBIT 4 - 4 (cont.)

Note: Average subject value denotes the value given to a hypothetical "average" subject for each group of calculations. Since the data was split, and run twice, there are two average subjects.

The values were considered to be significant for a subject if they exceeded the Table F-ratios. These may be interpreted as rejecting the following hypotheses:

(For a given phase) H_o : The results could be caused by error alone.

(Between phases) H_o : There is a significant difference between the phases.

FOOTNOTES

1. See for example, Paul E. Green and F. J. Carmone, Multidimensional Scaling and Related Techniques in Marketing Analysis. Boston: Allyn and Bacon, Inc., 1970.
2. I. B. Biren, Personal Communication and Attachments, December 13, 1972.

CHAPTER 5

ANALYSIS OF PERCEPTIONS

Analysis of perception will initially cover a discussion of the group stimulus space (perceptual) in four dimensions for the 15 issues, and in three dimensions for 14 issues (not including the layoff issue). Attention will then be devoted to analyzing differences in perception as indicated by the dimension weights or saliences. Differences in perception will be related to group membership and demographic variables.

VISUAL ANALYSIS OF THE FOUR DIMENSIONAL STIMULUS SPACE FOR 15 ISSUES

In a visual examination of the four dimensional scaling for 15 issues the dimensions appear as given below. (It is suggested that the reader analyze these scalings as they appear in Exhibits 5 - 1 and 5 - 2. The key is Exhibit 5 - 3.)

Dimension 1. This dimension is dominated by the layoff issue, at the negative end of the scale. Possibly this scale could be labeled as "Production oriented--Marketing oriented," but caution should be taken against analyzing differences between the "marketing oriented" issues on the basis of this dimension alone.

Dimension 2. This dimension appears to range from product oriented issues (on the negative side) to price and promotional oriented issues. Further analysis of this dimension will be undertaken later.

Dimension 3. The third dimension ranges from promotional oriented issues to product and price issues.

Dimension 4. The fourth dimension runs from societal-oriented issues to consumer-oriented issues.

Because of the apparent similarities of dimensions 2 and 3, further analysis is necessary to provide insights into their differences. When these two dimensions are plotted against each other, (Exhibit 5 - 4), it would be expected that the promotional issues appear in the (+, -) quadrant,

product issues in the (-, +) quadrant, and price issues in the (+, +) quadrant. If the classification system developed for these two dimensions is used, the following categories would result:

Product Oriented Issues.

Water Pollution caused by production of products,
Failure to design products to be recyclable,
Air Pollution caused by products in normal use,
Promotion of products using scarce natural resources,
Failure to design products for safety in extreme uses,
Inadequate service after sale,
Planned obsolescence.

Price Oriented Issues.

Excessive charges for service,
Excessive charges for credit,
Price-fixing.

Promotional Oriented Issues.

Extravagant claims,
Excessive advertising leading to high prices,
Demand creation,
Child oriented advertising.

It is interesting to note that all ecology issues (the first four product oriented issues) form one cluster in the product category, even though some were phrased as promotional issues. It may also be observed that Inadequate Safety Testing and Inadequate Service fall together in what might be called an "Inadequate Product Design" cluster. This cluster is also close to the issues of Planned Obsolescence and High Service Charges. Planned Obsolescence is the one product issue which is seen as closest to a promotional or price issue.

Among the price issues, High Service Charges is the most product oriented, and price fixing is seen as the most promotionally oriented issue. The latter may be explained by a vague cluster called "Consumer Control and Manipulation," including Price Fixing, Extravagant Claims, Demand Creation, and Excessive Advertising leading to High Prices.

EXHIBIT 5 - 1

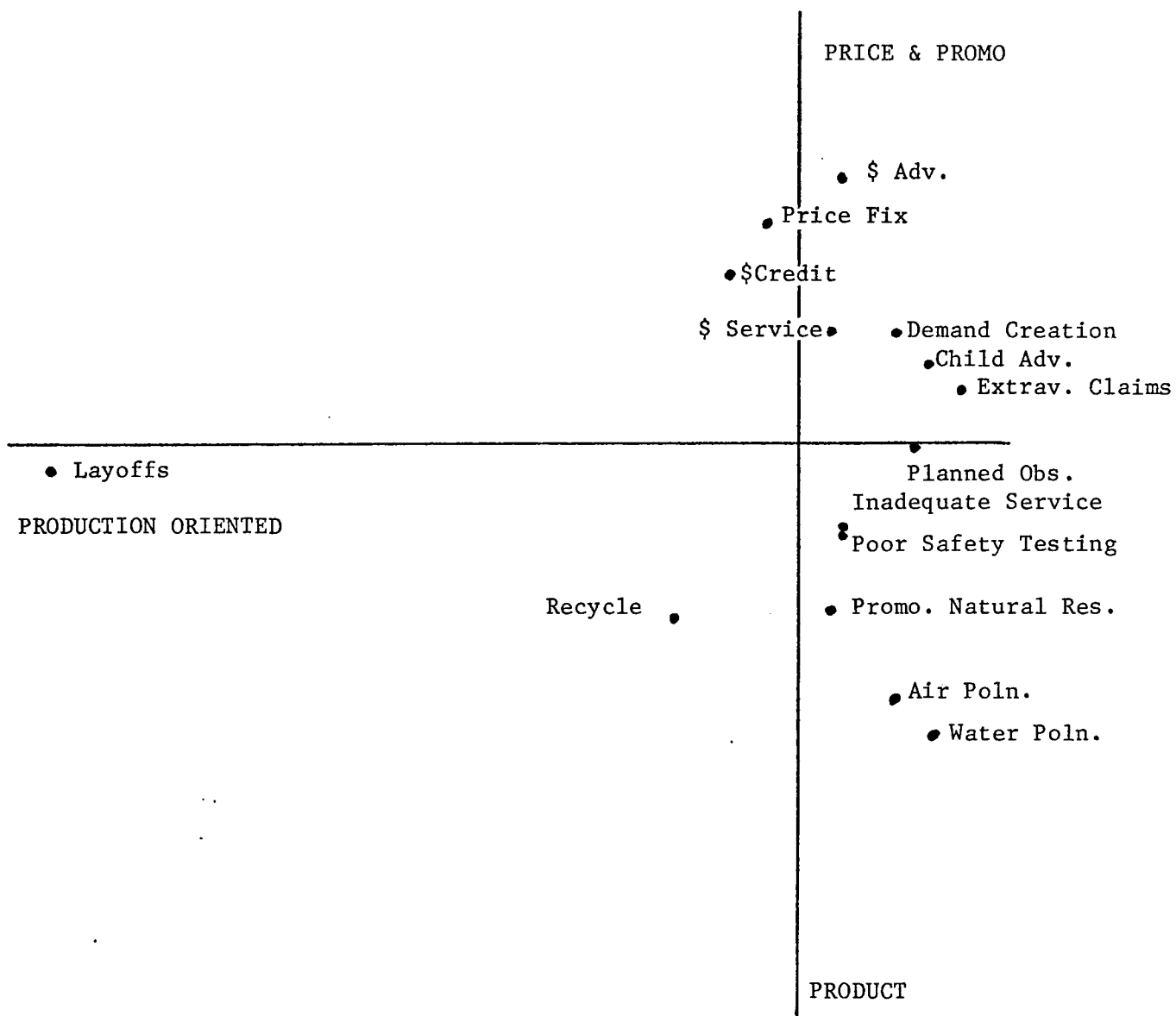
Dimension 1 Vs. Dimension 2 In Four Dimensional Perceptual Scaling

EXHIBIT 5 - 2

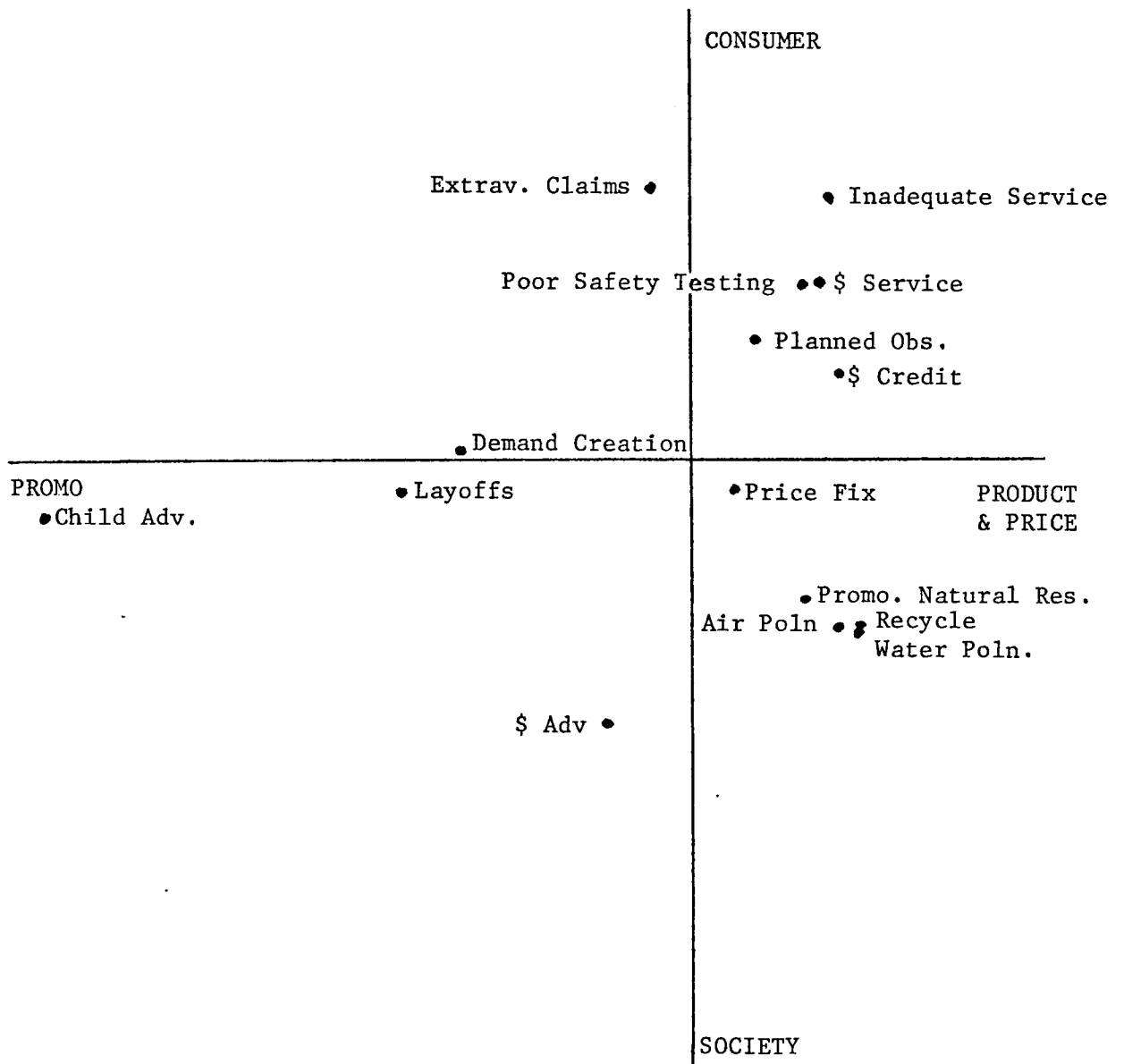
Dimension 3 Vs. Dimension 4 In Four Dimensional Perceptual Scaling

EXHIBIT 5 - 3

Key To The Statement Of The Issues

<u>As Stated On Scalings</u>	<u>As Stated on The Questionnaire</u>
Demand Creation	A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.
Poor Safety Testing	A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).
Layoff	A company lays off workers immediately when sales decline.
Price Fix	A company encourages industry efforts to increase prices.
Extrav Claims	A company claims its products can do more than they are actually capable of doing.
\$ Adv.	A company spends money on advertising that could be passed onto consumers through lower prices.
Promo Natural Res	A company promotes products which use natural resources that are in short supply.
Planned Obs	A company develops products intentionally so that they will wear out and need replacement.
Inadequate Service	A company does not service products adequately after sales.
\$ Service	A company charges much higher rates for service calls than their costs justify.
Air Poln	A company does not attempt to decrease the amount of air pollution emitted by its products under normal use
Recycle	A company does not design products so that they can be recycled.
Water Poln	A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

As Stated
On Scalings

Child Adv.

\$ Credit

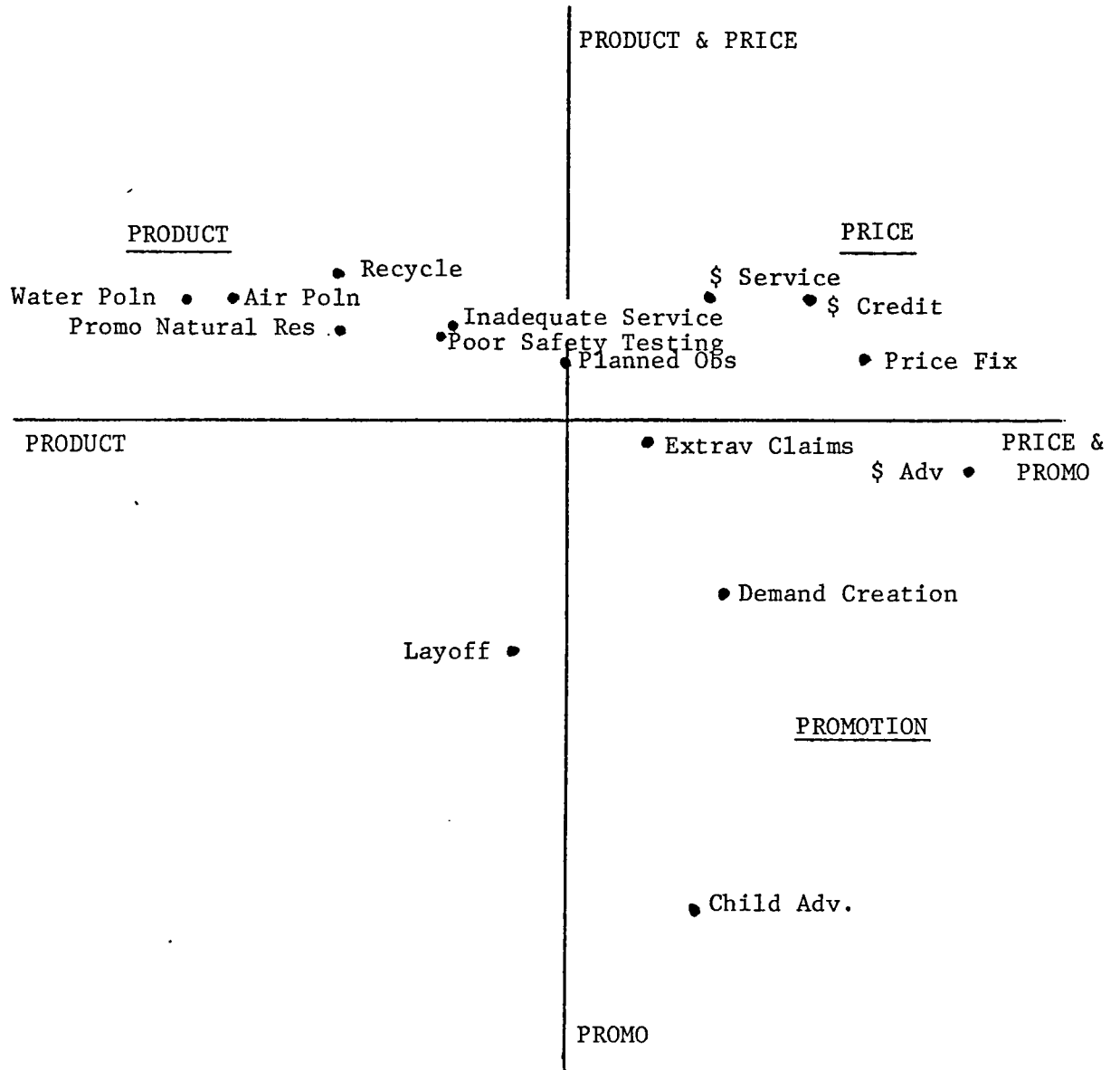
As Stated on The Questionnaire

A company aims its advertising at children so that the children will convince their parents to buy the product.

A company sells its products on credit terms which are higher than their credit costs justify.

EXHIBIT 5 - 4

Dimension 2 Vs. Dimension 3 In Four Dimensional Perceptual Scaling



Among the promotional issues, Child Oriented Advertising may be seen as the least product or price oriented issue.

Analysis of the scaling on dimension 3 vs. dimension 4 again shows the clusters of Inadequate Product Design (Poor Safety Testing, Inadequate Service) and Ecology. The one issue which appears to be out of place is Excessive Advertising leading to High Prices, which appears as the most societal-oriented issue by this interpretation of the dimensions.

Among the issues forming groups which were analyzed earlier, it can be seen that Excessive Credit charges and Excessive Service Charges are seen as fairly similar, but Excessive Service Charges is generally considered to be more product oriented, closer to the Inadequate Product Design (including Inadequate Service), and more consumer oriented. This last observation may be attributed to the higher income levels of these samples of respondents and their resultant lower personal concern for excessive credit charges than for excessive service charges.

In the Ecology group, it appears that Recycling is seen as closer to Layoffs than the other issues, and both Recycling and Promotion of Products using Natural Resources are more price and promotionally oriented than the pollution issues.

The Layoff issue is difficult to evaluate accurately due to its great perceived difference with the other issues.

VISUAL ANALYSIS OF THE THREE DIMENSIONAL STIMULUS SPACE FOR 14 ISSUES

The three dimensional perceptual space for 14 issues is included (in Exhibits 5 - 5 and 5 - 6) to show the differences in the perceptual scaling when the Layoff issue is not included. It should be noted that the differences between the three dimensional scaling of 14 issues and the four

EXHIBIT 5 - 5

Dimension 1 Vs. Dimension 2 In Three Dimensional Perceptual Scaling
(14 Issues)

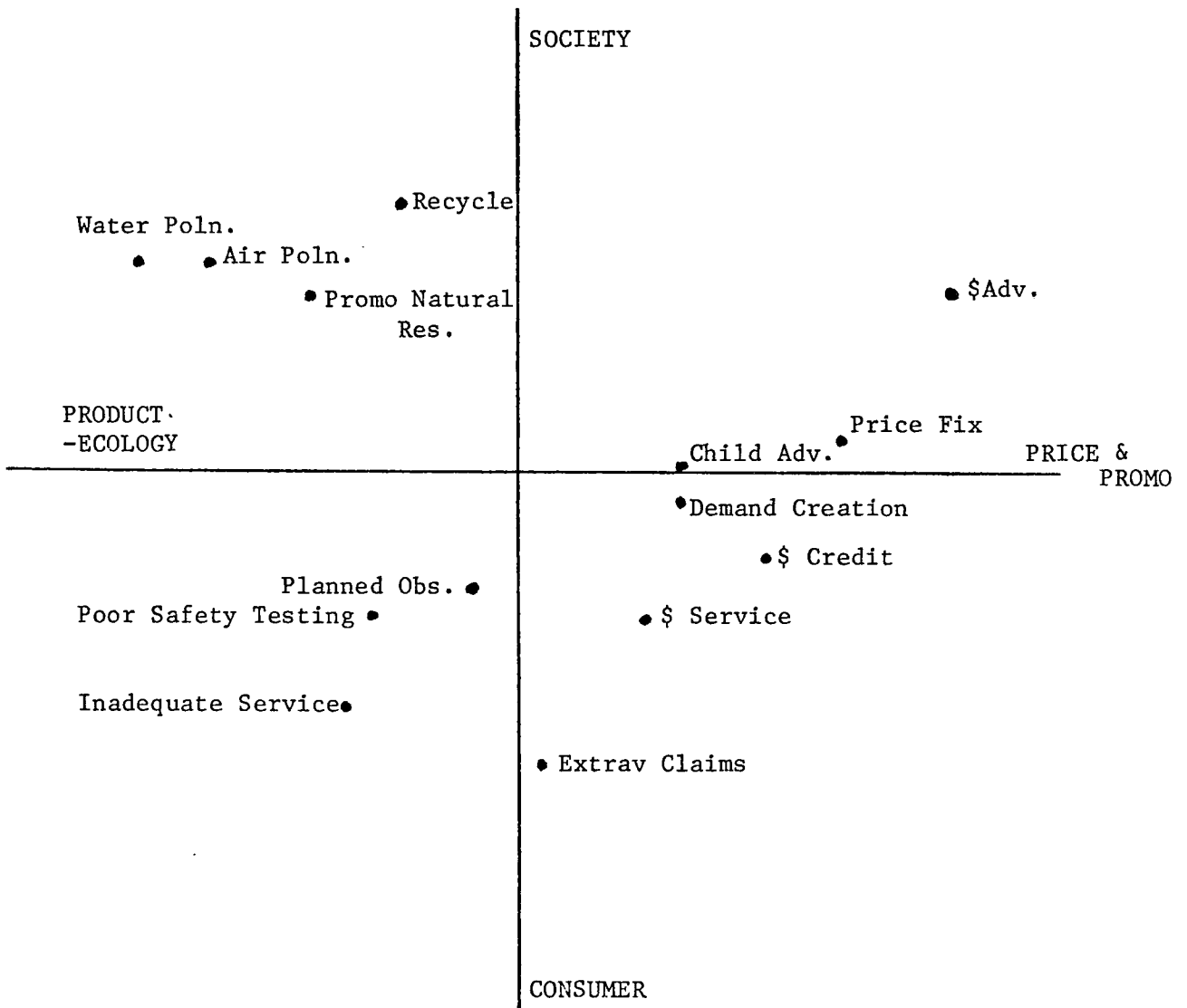
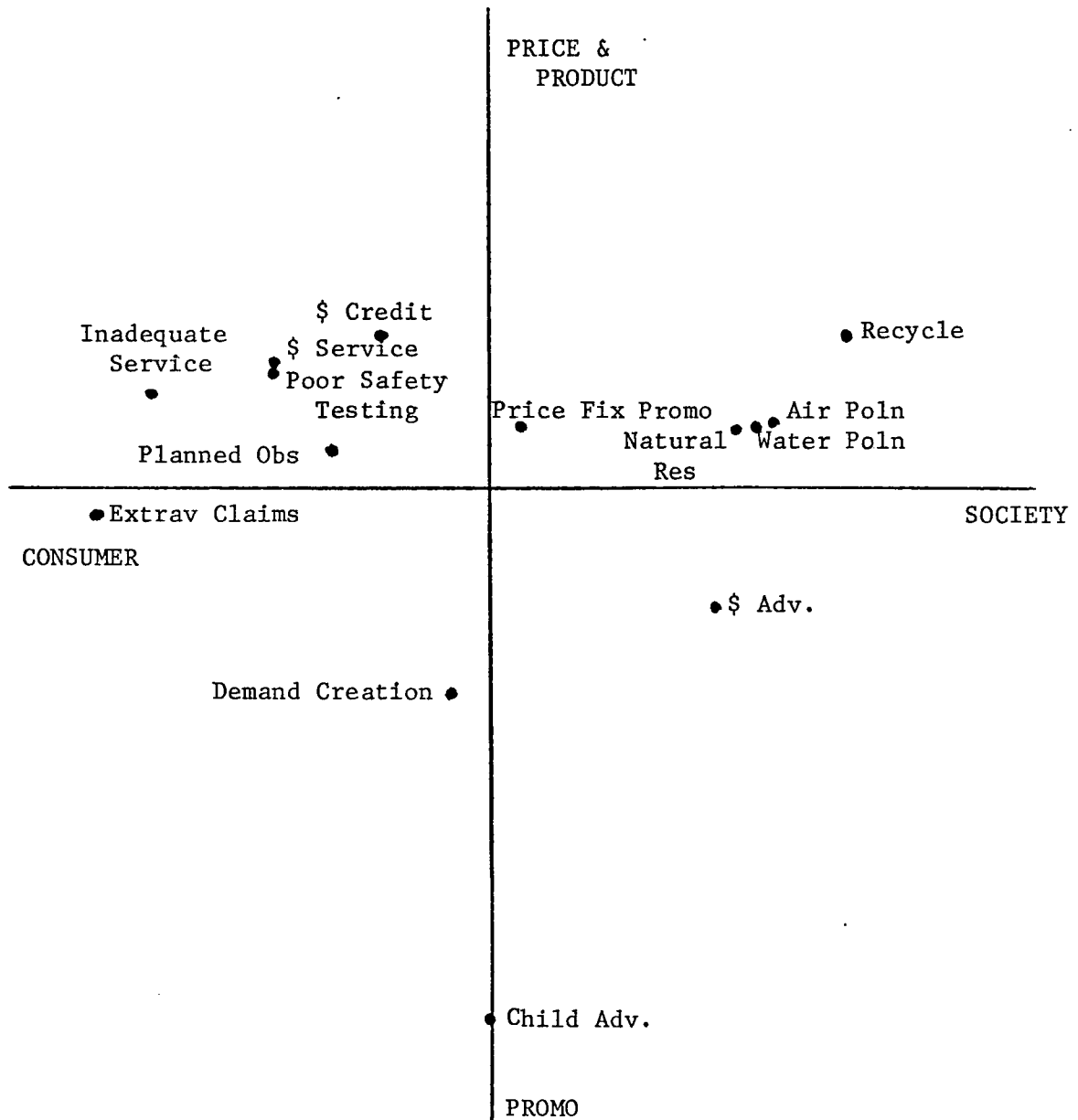


EXHIBIT 5 - 6

Dimension 2 Vs. Dimension 3 In Three Dimensional Perceptual Scaling
(14 Issues)



dimensional scaling of 15 issues are due to the manner that the INDSCAL program developed the scalings--there is no difference in the original input data between the 14 issues that are common to both scalings.

The three dimensions of the scaling of 14 issues tend to match three of the four dimensions of the scaling of 15 issues. These three dimensions are as follows:

Dimension 1. This is a product vs. price and promotional dimension that roughly matches Dimension 2 of the four dimensional representation. The only differences between the two dimensions are slight movements of recycling, excessive service charges, and child oriented advertising. These changes are minor.

Dimension 2. This dimension represents consumer-societal orientation, similar to the negative of dimension four of the 15 issue scaling. Slight movements of the recycling and increased advertising leading to high prices are the only changes of note.

Dimension 3. The third dimension is similar to the third dimension of the 15 issue scaling, ranging from promotional issues to product and price issues. In the 14 issue scaling, the planned obsolescence issue appears slightly less product and price oriented while the recycling issue is slightly more product and price oriented than in the 15 issue scaling.

It may be noted that the one issue which has shifted in all three dimensions (although only slightly) is the issue of recycling. Furthermore, all shifts in the 14 issue scalings have moved recycling away from the other issues. In the layoff dominated first dimension of the 15 issue scaling, recycling was located away from the other dimensions; apparently this dimension accounts for the distance between these issues in the 15 issue scaling.

In summary of the results so far, four dimensions were interpreted for the 15 issue scaling and three dimensions were interpreted for the 14 issue scaling. The one dimension that is not common between the scalings is dominated by the layoff issue (which is not contained in the 14 issue scaling). The three common dimensions represent product vs. price and

promotional orientation, promotion vs. price and product orientation, and societal vs. consumer orientation.

ANALYSIS OF THE DIMENSION WEIGHTS (SALIENCES)

The dimension weights or saliences of the four dimensional, 15 issue scaling were analyzed to determine differences due to groups and other demographics. The analysis starts with a visual examination of the perceptual saliences to determine any differences between the groups. This visual examination is followed by an examination of the profile analysis chart of means and a univariate statistical analysis of differences between the groups in each dimension. Finally a multivariate analysis of variance and test for equality of covariance matrices is conducted to statistically check for overall equality of salience means.

Visual Analysis

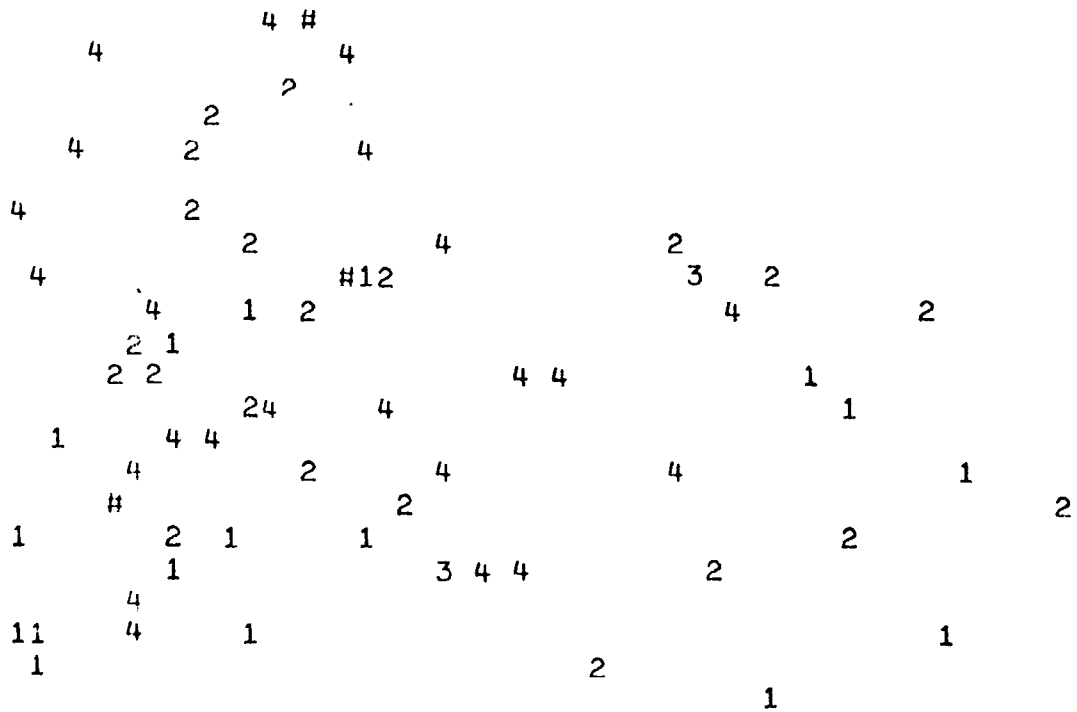
Using visual examination of the plot of weights for groups on dimensions one and two, (Exhibit 5 - 7), it appears that students put less emphasis (i.e., closer to origin) on dimension one (layoff oriented issue) and housewives put less emphasis on dimension two (product vs. price and promotion) than do the other groups. Possibly one reason for the apparent lower emphasis on dimension one of the students may be their lower dispersion (standard deviation) of their saliences in this dimension.

Visual analysis of dimensions three and four (Exhibit 5 - 8) shows only an apparent lower salience of dimension 4 (societal-consumer orientation) on the part of the students.

Analysis of Mean Values

These observations are confirmed when the weights themselves are examined. Mean values are shown in Exhibit 5 - 9 along with the standard deviations.

EXHIBIT 5 - 7

SCALING OF WEIGHTS ON DIMENSION 1 VS. WEIGHTS ON DIMENSION 2Points Marked By Group

KEY: 1 - Housewives
 2 - Industrial Businessmen
 3 - Retail Businessmen
 4 - Students
 # - Multiple Points

EXHIBIT 5 - 8

SCALING OF WEIGHTS ON DIMENSION 3 VS. WEIGHTS ON DIMENSION 4

EXHIBIT 5 - 9

Perceptual Dimension Weights15 Issues In Four Dimensions

<u>DIMENSION</u>	1	2	3	4
	<u>Layoff</u>	<u>Product/ Price & Promo</u>	<u>Promo/ Price & Product</u>	<u>Society/ Consumers</u>
<u>MEANS</u>				
Housewives	.273	.191	.234	.245
Businessmen	.298	.306	.226	.259
Students	.245	.315	.290	.215
Overall	.274	.279	.250	.241
<u>STANDARD DEVIATIONS</u>				
Housewives	.203	.110	.224	.122
Businessmen	.165	.150	.138	.146
Students	.126	.143	.152	.126
Overall	.165	.138	.170	.133

The mean weights tend to confirm the visual findings, but also indicate that the students place higher perceptual weights on the third dimension, promotion vs. price and product, than do the other groups, and that businessmen put more weight on dimension 1 (layoff) than do other groups. In fact, on dimension 1 businessmen tend to have higher weights than housewives, who in turn tend to have higher weights than students. All these observations are confirmed by the profile analysis chart of mean perceptual weights on the four dimensions for the three groups (Exhibit 5 - 10). In examining the profile analysis chart, the reader should concentrate on differences between the three groups on each dimension (i.e., read for differences on the vertical lines).

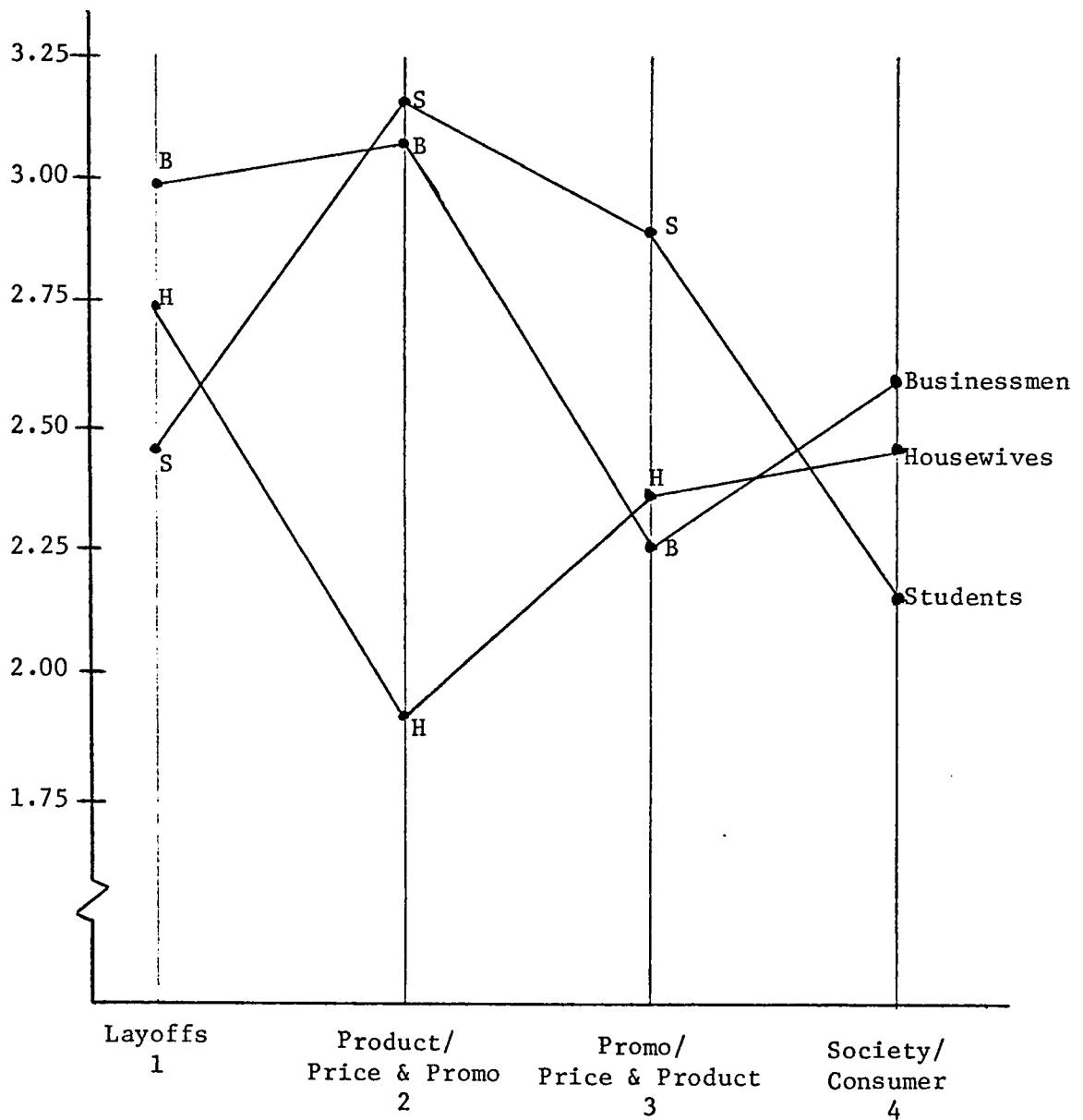
When univariate t-tests were conducted on each dimension, the only significant difference was found with respect to the housewives on dimension two (product vs. price and promotion). Here the mean value of the housewives was outside the 95% t-test confidence interval for means on the second dimension. On the basis of this one would say that there is a significant difference between the saliences of the housewives and those of the other groups on the dimension of product vs. price and promotion.

The differences in salience might be interpreted as follows:

- Housewives tend to lump product and price oriented issues together and compare these with promotional issues.
- Students tend to perceive layoffs more closely to the other issues than do the other groups.
- Students tend to attach more salience to the difference between promotion oriented issues and the issues of price and product than do the others. Further, students tend to perceive the issues as price, product, and promotion issues more than the other groups.
- Students tend to see less difference between issues on the basis of being societal or consumer issues than do the other groups.

EXHIBIT 5 - 10

Profile Analysis Chart of Mean
Perceptual Weights On Four Dimensions



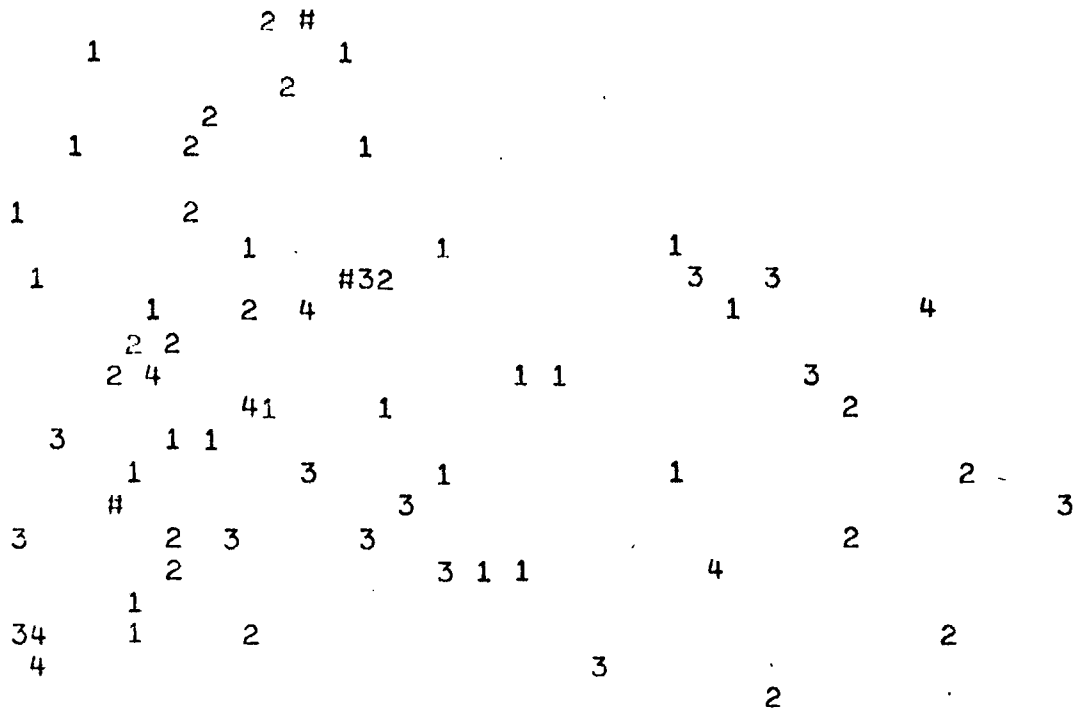
In testing for significant differences between the groups (as shown in the Appendix), the covariance matrices were first tested for equality. The hypothesis of equality of covariance matrices was accepted at the .05 level, but would have been rejected at the .10 level. The MANOVA hypothesis of equal salience means for the groups was also accepted at the .05 level, but would have been rejected at the .10 level. Overall, therefore, we cannot statistically prove that there are differences between the groups at the selected 95% level of confidence.

VISUAL ANALYSIS OF DIMENSION WEIGHTS WITH RESPECT TO DEMOGRAPHICS

The dimension saliences have also been scaled with marks for age classification, child status (having children between the ages of 15 and 25), and income classification. Visual examination of the scaling of saliences of dimensions one vs. two as marked by age (Exhibit 5 - 11), shows tendencies for the older respondents to assign lower saliences to dimension two (product vs. price and promotion) than the others. Earlier it had been noted that housewives tended to assign low salience to dimension two; here it is noted that those housewives who assigned the higher salience (for their group) to this dimension, were the young housewives. Little differences are seen on dimension one (layoffs). There also appear to be few differences based on age (Exhibit 5 - 12) with respect to dimensions three or four (with the exception of differences based primarily on different responses of the students).

When analyzing the perceptual weights (Exhibits 5 - 13 and 5 - 14) with respect to child status (having children between the ages of 15 and 25), the only apparent tendency is that those with older children tend to assign low salience to dimension two. This is in agreement with the above observation on age.

EXHIBIT 5 - 11

SCALING OF WEIGHTS ON DIMENSION 1 VS. WEIGHTS ON DIMENSION 2Points Marked By Age Classification

KEY: 1 - Age 20 - 29
 2 - Age 30 - 39
 3 - Age 40 - 49
 4 - Age 50 or above
 # - Multiple Points

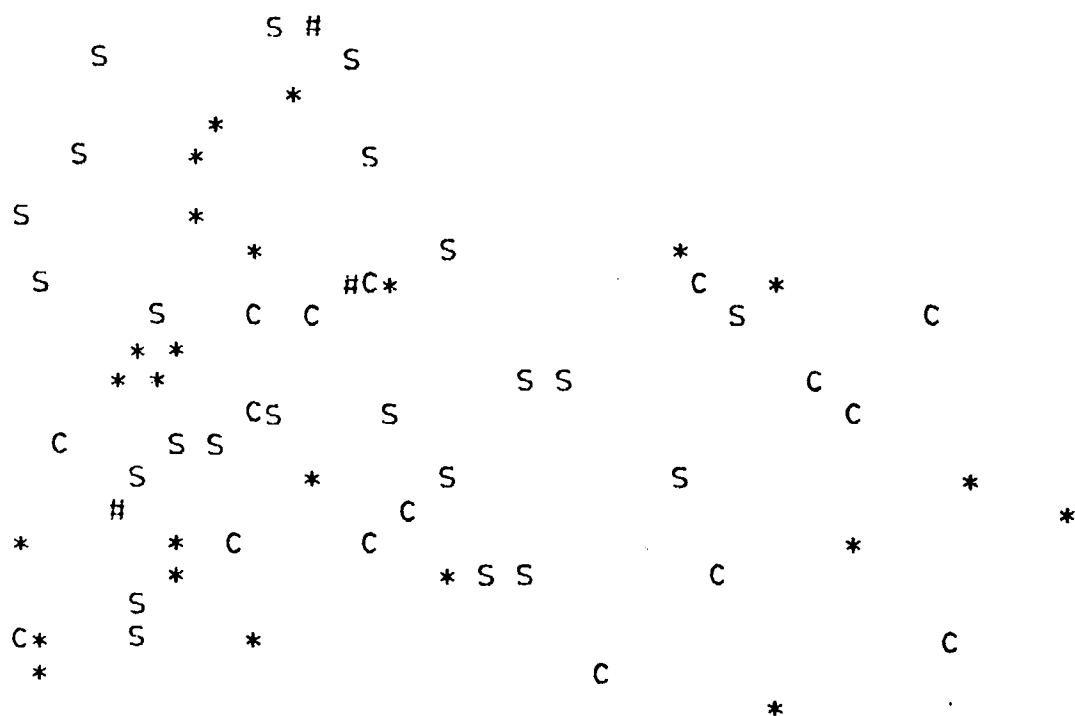
EXHIBIT 5 - 12

SCALING OF WEIGHTS ON DIMENSION 3 VS. WEIGHTS ON DIMENSION 4

EXHIBIT 5 - 13

SCALING OF WEIGHTS ON DIMENSION 1 VS. WEIGHTS ON DIMENSION 2

Points Marked if Respondent is Student or has Children
Between the Ages of 15 - 25

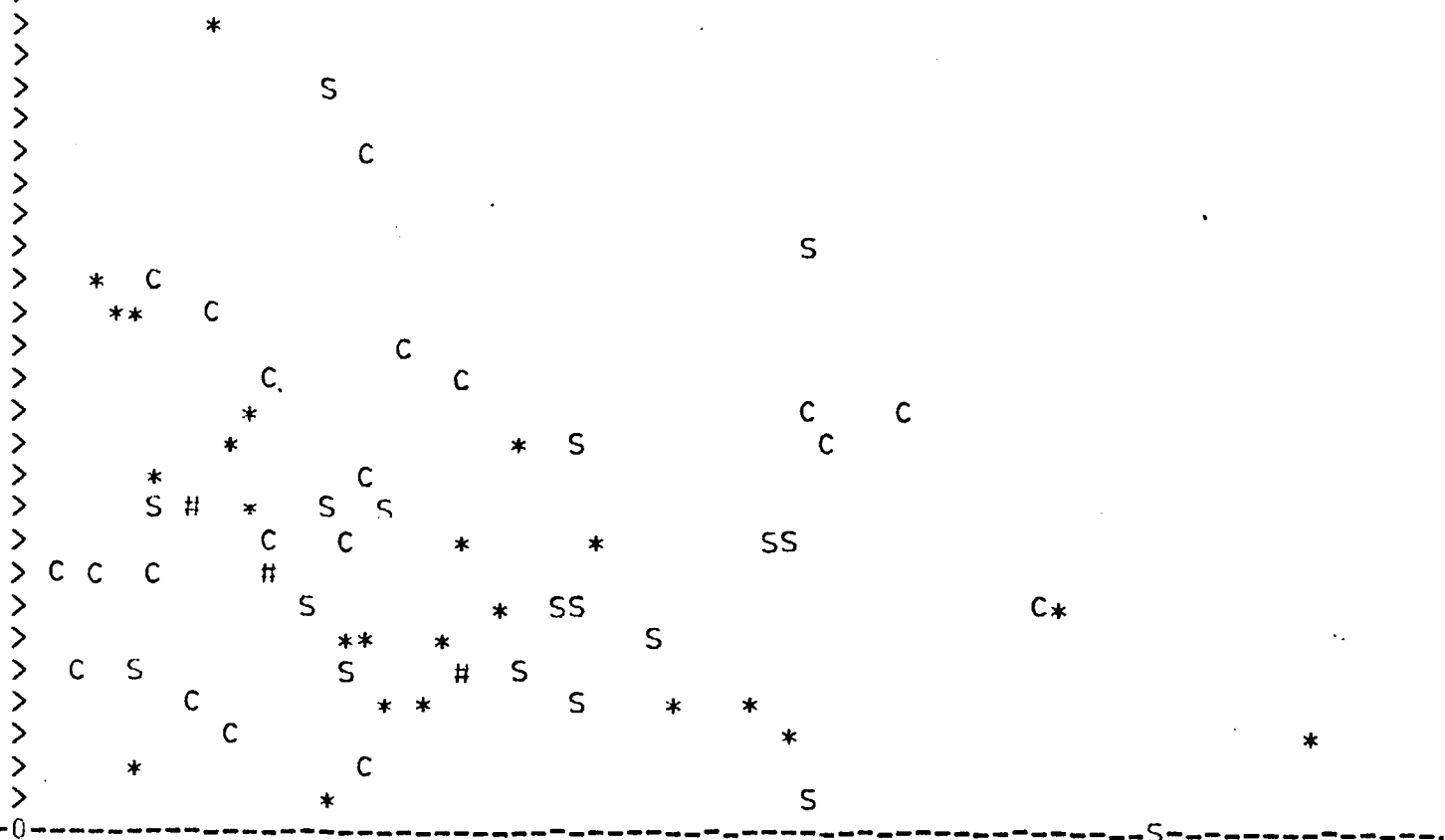


KEY: S - Respondent is a Student
 C - Respondent has children aged 15 - 25
 * - Respondent is neither of the above
 # - Multiple Points

EXHIBIT 5 - 14

SCALING OF WEIGHTS ON DIMENSION 3 VS. WEIGHTS ON DIMENSION 4

Points Marked if Respondent is Student or has Children
Between the Ages of 15 - 25



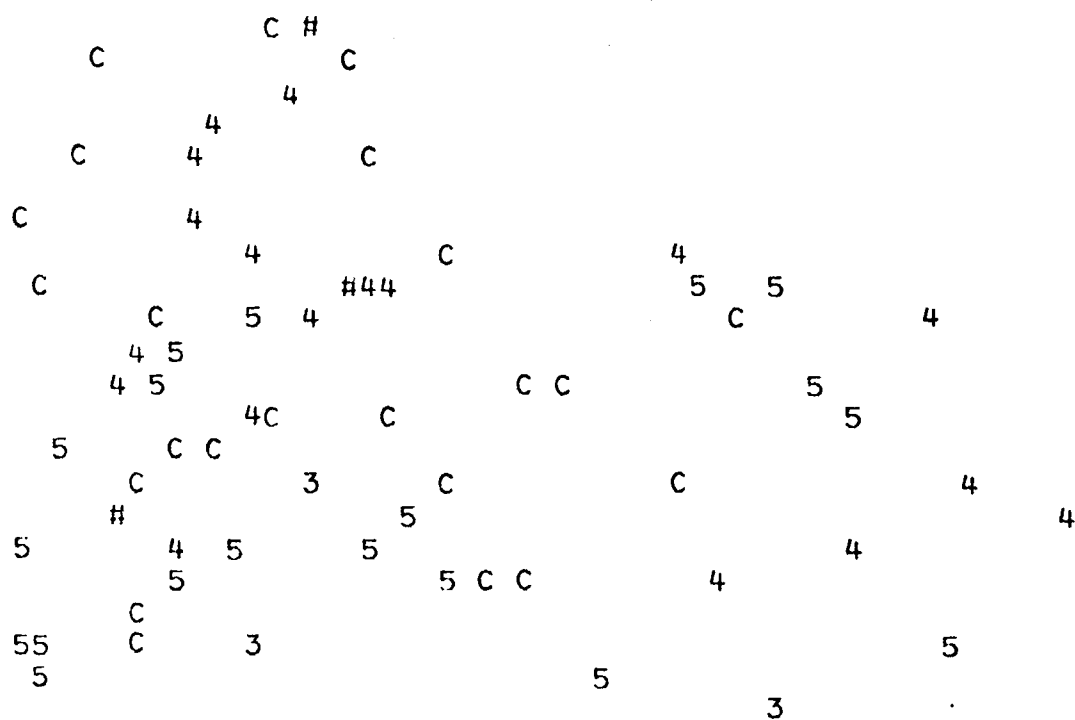
KEY: S - Respondent is a Student
 C - Respondent has children aged 15 - 25
 * - Respondent is neither of the above
 # - Multiple Points

With respect to income (Exhibits 5 - 15 and 5 - 16) there is a trend towards low weights on dimension one (layoffs) for those with incomes above \$25,000. This closely follows the above observation that housewives score low on dimension one. Little is noted about the other dimensions.

Since the purpose of the examination with respect to demographics was to indicate differences that might not be accounted for in the groups no statistical tests were calculated with respect to these supplementary demographics.

In summary of the analysis of the perceptual scalings, it has been noted that reasonable interpretations of the dimensions exist for the four dimensional scaling of 15 issues. Our confidence in these dimensions increases when three of them are found (with few minor differences) in the perceptual weights has shown some interesting differences, however, the multivariate statistical hypothesis of equal salience means cannot be rejected. Therefore, although the results do not indicate any overall significant differences between the groups at the .05 level, interesting differences are noted.

EXHIBIT 5 - 15

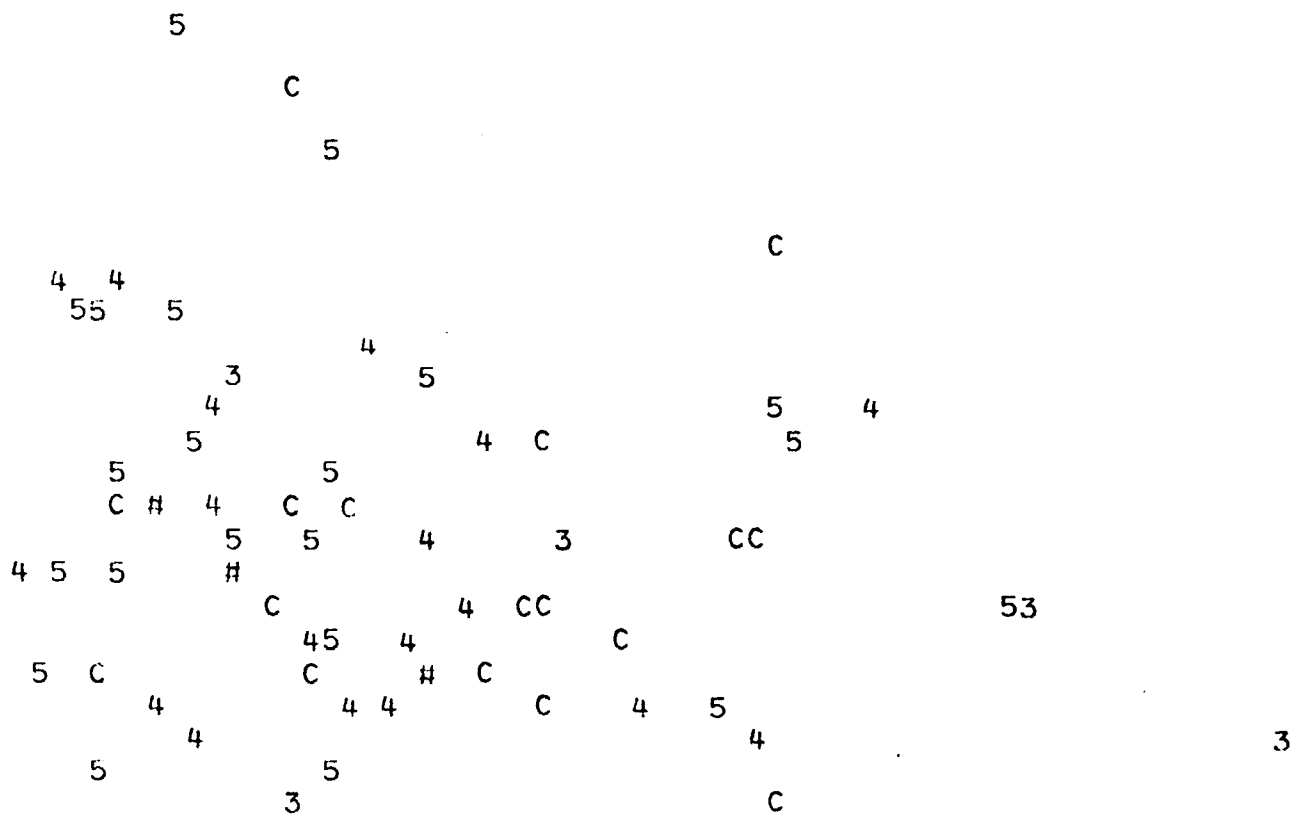
SCALING OF WEIGHTS ON DIMENSION 1 VS. WEIGHTS ON DIMENSION 2Points Marked By Income Classification

KEY: 1 - Income is less than \$5,000
 2 - Income is \$5,000 - \$10,000
 3 - Income is \$10,000 - \$15,000
 4 - Income is \$15,000 - \$25,000
 5 - Income is above \$25,000
 C - Respondent is a Student
 # - Multiple Points

EXHIBIT 5 - 16

SCALING OF WEIGHTS ON DIMENSION 3 VS. WEIGHTS ON DIMENSION 4

Points Marked By Income Classification



KEY: 1 - Income is less than \$5,000
2 - Income is \$5,000 - \$10,000
3 - Income is \$10,000 - \$15,000
4 - Income is \$15,000 - \$25,000
5 - Income is above \$25,000
C - Respondent is a Student
- Multiple Points

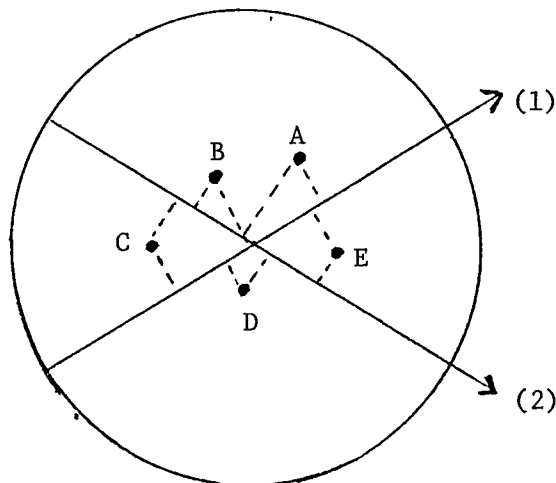
CHAPTER 6

ANALYSIS OF PREFERENCES

This chapter will study the preferences of the respondents in an attempt to identify any differences between the groups. Analysis of preferences will center on differences between the groups using ideal vectors as indicators of individual preferences. The ideal vectors will be illustrated by the cosines between the vectors and each of the dimensional axes. Analysis of differences will start with visual observations of the plots of the cosines followed by studies of the signs of ideal vector cosines for each group and the mean values of the cosines. A profile analysis chart of the means will be included to illustrate the differences in means. Comparisons of the preferences with the perceptual saliences will be made and then the equality of the group covariance matrices and the group vector cosine means will be tested with the multivariate statistical techniques discussed earlier.

USE OF THE VECTOR MODEL OF PREFERENCES

The vector model of preference provides a representation of each subject as a vector or directed line segment extending from the origin of the scaling outward. A hypothetical example is illustrated below:



The ideal vectors are illustrated as lines (1) and (2) while the stimulus points are A through E. The preference order for a given subject is assumed to be given by the projection of the stimuli onto the vector representing that subject.* Thus, the preference order for subject (1) is A-E-B-D-C while that for (2) is E-D-A-B-C.

One way of interpreting the vectors is in terms of the relative importance of the dimensions to the preference judgement. The cosines of the angles of the vectors with the coordinate axis or dimensions directly measure these importances.** For scalings representing more than two dimensions, plots of the direction cosines for two given dimensions will indicate the projection of the vector on the plane of those two dimensions. In the plots shown in this chapter, the projections of the vectors would be illustrated by drawing lines from the origin to the plotted points. The lines are omitted for the sake of clarity.

ANALYSIS OF THE SIGNS OF THE DIRECTION COSINES FOR EACH GROUP

The scalings of the projections of the vectors on the plane made by dimensions one and two and the plane of dimensions three and four are given in Exhibits 6 - 1 and 6 - 2 along with the key (Exhibit 6 - 3) for interpreting the plotted points. To provide an indication of the differences between the groups, the number of individuals with positive and

*The projection of a stimulus point on a vector occurs where a line from the point, perpendicular to the vector, intersects the vector.

**Any directed line segment of a given length may be considered as the sum of lines parallel to each of the axes. A directed line segment of unit length from the origin may be represented as the sum of lines on each of the dimensional axes; each of length equal to the cosine of the angle between the directed line segment and the dimension axis.

EXHIBIT 6 - 1

SCALING OF COSINES OF IDEAL VECTORS WITH
DIMENSIONS 1 AND 2

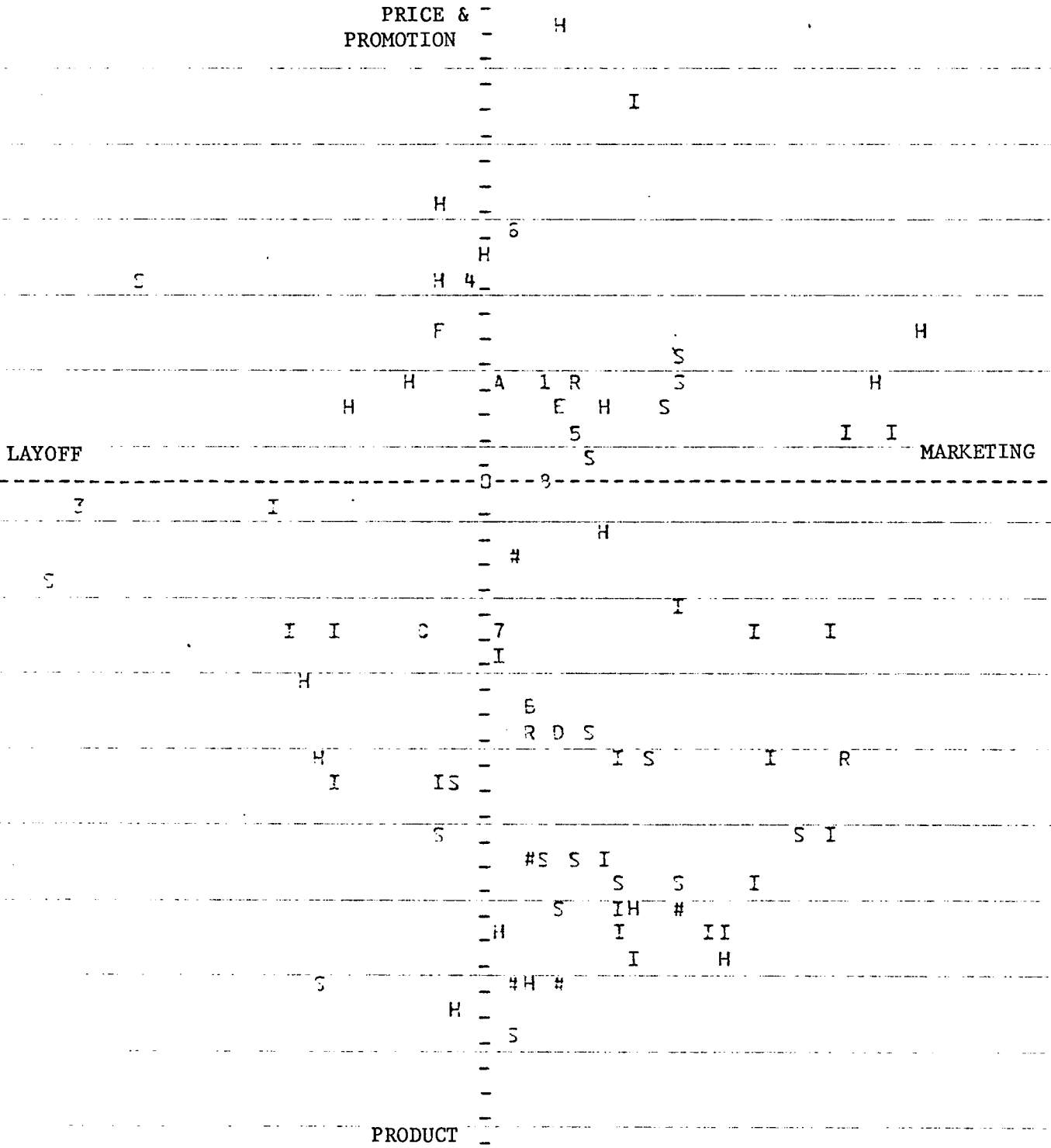


EXHIBIT 6 - 2
SCALING OF COSINES OF IDEAL VECTORS
WITH DIMENSIONS 3 AND 4

CONSUMER

S H R

I I

I H

H I 5 9 I H

H I I H

S 2A R I I

I H8 S H

I I F S H

PROMOTION

1 C R H S PRODUCT & PRICE

3 4 H I S H

E I H I S

IS IS

7 S E# S H

I I S

6 S S I

I S S

S # I S

S S
S.

I

H

SOCIETY

EXHIBIT 6 - 3

Key To The Scalings Of Cosines Of The
Ideal Vectors With The Dimensions

SUBJECTS

- H - Housewives
- I - Industrial Businessmen
- R - Retail Businessmen
- S - Students

ISSUES

- 1 - Demand Creation and Control
- 2 - Inadequate Safety Testing
- 3 - Layoffs when Sales Decline
- 4 - Price Fixing
- 5 - Extravagant Claims
- 6 - Heavy Advertising Costs leading to Higher Prices
- 7 - Promotion of Products using Scarce Natural Resources
- 8 - Planned Obsolescence
- 9 - Inadequate Service
- A - High Service Charges
- B - Air Pollution Caused by Use of Products
- C - Failure to Design Products for Recycling
- D - Water Pollution in Production of Products
- E - Child Oriented Advertising
- F - High Credit Rates
- # - Multiple Points

negative cosines of the ideal vector with each dimension were counted and listed in Exhibit 6 - 4.

The chart in Exhibit 6 - 4 indicates (comparing the percentages vertically) the following:

- More housewives (than average for the other groups) are concerned about layoffs and the consumer, and less are concerned about product oriented issues.
- Less industrial businessmen (than average) are concerned about price oriented issues.
- More retail businessmen (than average) are concerned with consumer oriented product and price issues.
- More students (than average) are concerned about product and price issues and societal oriented issues.

ANALYSIS OF THE MEANS OF THE DIRECTION COSINES FOR EACH GROUP

Most of these findings of the analysis of the number of vectors with positive and negative cosines on each of the dimensions tend to be confirmed by analysis of the cosine means for each dimension. The means and standard deviations are given in Exhibit 6 - 5, followed by a profile analysis chart in Exhibit 6 - 6. The means, as illustrated on the profile analysis chart, indicate the following:

- Businessmen are less concerned about layoffs than the others (i.e., they are more concerned about the societal and consumer effects).
- Housewives are less concerned about product oriented issues than the other groups.
- Businessmen are less concerned about price oriented issues than the others.
- Students are concerned about societal issues while businessmen and housewives are concerned about consumer oriented issues.

When univariate t-tests were conducted on each dimension, the only significant difference in preference was found with respect to the students on dimension four (societal vs. consumer orientation). Here the mean value

EXHIBIT 6 - 4

Number of Vectors With Positive and
Negative Cosines on Each Dimension

Dimension	1		2		3		4	
	Layoff/ Marketing		Product/ Price & Promo		Promotion/ Product & Price		Society/ Consumer	
	-	+	-	+	-	+	-	+
Group:								
Housewives	7 39%	11 61%	9 50%	9 50%	5 28%	13 72%	6 33%	12 67%
Industrial Businessmen	5 20%	20 80%	22 88%	3 12%	9 36%	16 64%	11 44%	14 56%
Retail Businessmen	0	3 100%	2 67%	1 33%	0	3 100%	0	3 100%
Students	5 22%	18 78%	18 78%	5 22%	3 13%	20 87%	18 78%	5 22%
Overall	17 25%	52 75%	51 74%	18 26%	17 25%	52 75%	35 51%	34 49%

EXHIBIT 6 - 5

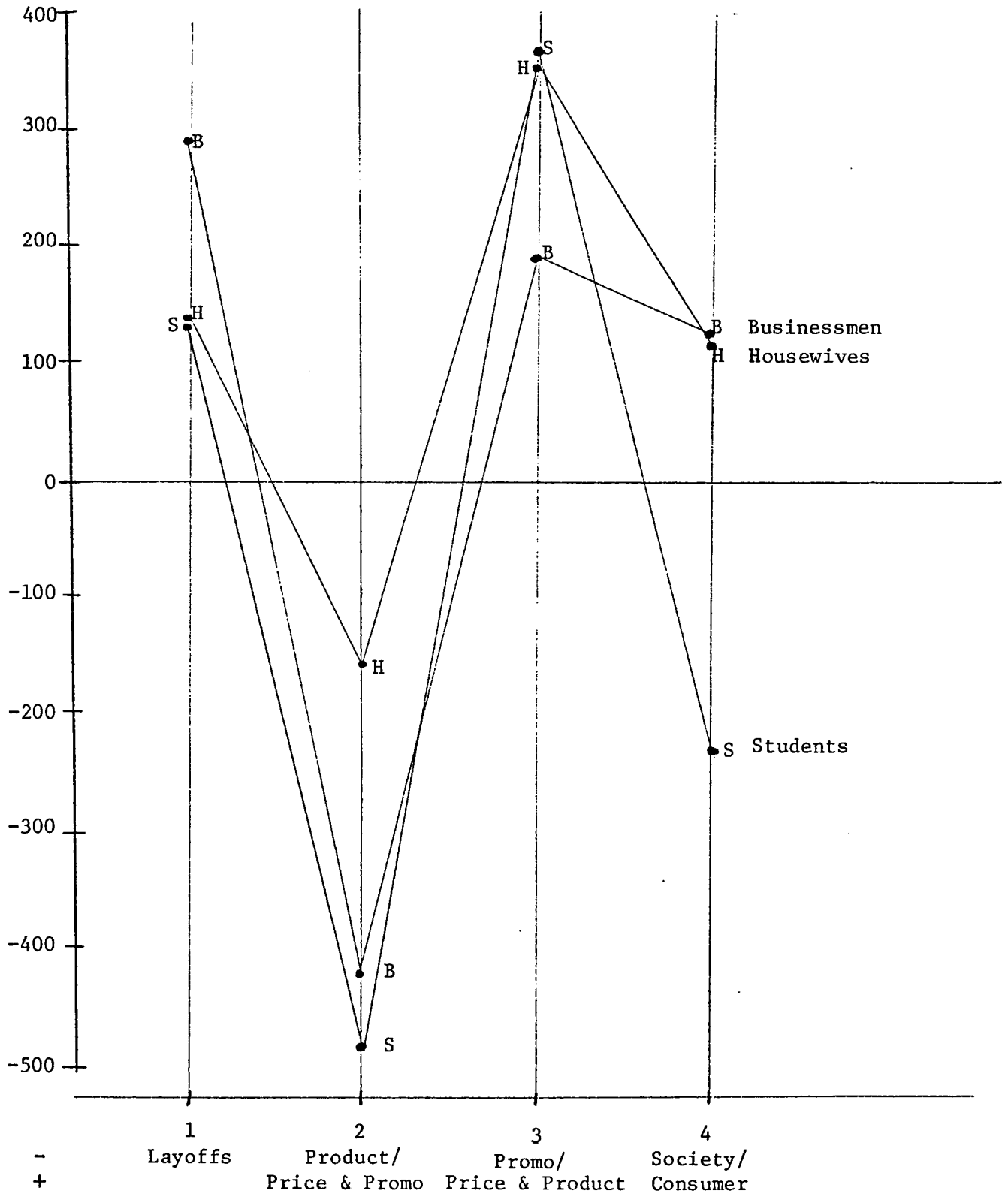
Means and Standard Deviations
Of The Preference Vector Cosines

Dimension - +	1 Layoff/ <u>Marketing</u>	2 Product/ <u>Price & Promo</u>	3 Promotion/ <u>Product & Price</u>	4 Society/ <u>Consumer</u>
<u>MEANS</u>				
Group:				
Housewives	0.136	-0.167	0.351	0.112
Businessmen	0.292	-0.424	0.191	0.121
Students	0.133	-0.485	0.369	-0.231
Overall	0.198	-0.378	0.291	0.0016
 <u>STANDARD DEVIATIONS</u>				
Group:				
Housewives	0.386	0.565	0.477	0.412
Businessmen	0.388	0.374	0.474	0.440
Students	0.391	0.403	0.357	0.373
Overall	0.389	0.440	0.430	0.412

EXHIBIT 6 - 6

Profile Analysis Chart Of Mean Preference

Vector Cosines On Four Dimensions



of the student ideal vectors on dimension four is outside the 95% t-test confidence interval for means. Therefore, there appear to be significant differences in preference between the students and the other groups in this dimension.

The only inconsistency between the two methods (analysis of signs and analysis of means) used to examine vector cosines on each dimension was with respect to the layoff dimension (dimension one). On that dimension it was noted that a greater percentage of housewives had negative cosines on the dimension than other groups. However, housewives and students had the same mean values. One reason for this is that a few of the students with negative values have much lower values (i.e., larger absolute values) of the cosines than do the housewives. Also when the scores of the businessmen are combined in calculating the means, the positive cosines of the retail businessmen cause the overall businessmen mean to rise, providing a larger difference between the business and the students.

THE ANALYSIS OF COMBINATIONS OF DIMENSIONS

The analysis of individual dimensions alone does not provide insights into their combinations. It was noted in previous chapters that dimensions two and three together indicate interest in product, price, and promotional issues (The reader is urged to examine the perceptual scaling of these two dimensions again in Exhibit 5 - 4). An Examination of the signs of the cosines on these two dimensions provides the total in Exhibit 6 - 7.

The scalings of the preference vectors for dimensions 2 and 3 are shown in Exhibit 6 - 9. Analysis of Exhibit 6 - 9 leads to the following observation:

- Less housewives are concerned about product issues than average, and more are concerned with price issues.

EXHIBIT 6 - 7

Number of Respondents With SignsOf Ideal Vector Cosines on Dimensions 2 & 3

Quadrant Signs	(- -)	Promotion (+ -)	Product (- +)	Price (+ +)	Total
<u>Group:</u>					
Housewives	5 28%	0	4 22%	9 50%	18
Industrial Businessmen	8 32%	1 4%	14 56%	2 8%	25
Retail Businessmen	0	0	2 67%	1 35%	3
Students	3 13%	0	15 65%	5 22%	23
Overall	16 23%	1 1.4%	35 51%	17 25%	69

EXHIBIT 6 - 8

Number of Respondents With SignsOf Ideal Vector Cosines On Dimensions 2, 3, 4

Signs	(- + -)	(- + +)	Total	Total
Sector	Ecology	Consumer Product Design	Product Quadrant	Number of Respondents
<u>Group:</u>				
Housewives	2	2	4	18
Industrial Businessmen	7	7	14	25
Retail Businessmen	0	2	2	3
Students	13	2	15	23
Overall	22	13	35	69

The ideal vectors in the (- -) quadrant are difficult to interpret. Since many of these ideal vectors also have positive cosines on the first dimension, an interpretation of preference for layoff issues is not correct. Analysis of the actual preference orders for some of these subjects indicates that they tend to have equally high preferences for both product and promotional issues.

Further analysis of the product quadrant (of dimensions two and three) with dimension four (society/consumer) is informative. Here, it may be interpreted that those with ideal vectors in the product quadrant and negative cosines (societal orientation) on dimension four are primarily concerned about ecology issues while those with positive cosines on dimension four indicate concern about consumer product design issues. As expected from the earlier analysis the students showed primary concern for the ecology issues. The results are shown in Exhibit 6 - 8. Here, the equal distribution of both housewives and industrial businessmen is in contrast to the definite ecology swing of the students. Over half (13) of all student respondents (23) have ideal vectors in the ecology sector of the three dimensions.

COMPARISON OF PERCEPTUAL WEIGHTS WITH COSINES OF PREFERENCE VECTORS

Further results of interest can be obtained by examining the perceptual weights and preference vector cosines together. Perhaps the easiest way for the reader to do this is to examine the two profile analysis charts, Exhibits 5 - 10, and 6 - 6.

On dimension 1, the businessmen had the highest perceptual weights and also the highest perceptual vector cosines mean. This group of businessmen appear to perceive great differences between the social costs of

layoffs and the social issues studied. They also believe that the social issues are most deserving of action. Overall this is an interesting observation.

On dimension two (product vs. promotion and price) the housewives have the lowest perceptual salience and also the lowest absolute value preference cosine. They apparently consider product oriented issues to be less important than the other groups do. They show this in both their preference vectors and perceptual weights.

On the third dimension (promotion vs. product and price) it is observed that students have the highest perceptual weights and yet have preference cosines that are almost equal with those of the housewives. Possibly this may be interpreted as showing that housewives consider price to be of extreme importance but that they need only one dimension to interpret them (price vs. not price). Therefore, their perceptual weights are split between the two dimensions, at lower values.

On dimension four (societal vs. consumer orientation) it is noted that students have definite societal preferences yet have lower perceptual saliences on this dimension than the other groups have. Perhaps this may be explained by two factors. First, students have high perceptual weights on dimensions two and three, allowing them to perceive product oriented issues easily, therefore, dimension four is used by them only to perceive differences among the product oriented issues. Secondly, perhaps dimension four should be interpreted as a consumer oriented dimension for the businessmen and housewives. Their saliences on it would indicate that they are interested in consumer oriented issues that will directly affect them as consumers.

MANOVA AND TESTING FOR EQUALITY OF COVARIANCE MATRICES

In testing for significant preference differences between the groups, the covariance matrices were first tested for equality (the calculations are in the Appendix). The hypothesis of equality was rejected at all levels .025 and above. It would have been accepted at the .01 level.

The MANOVA test for equality of means is not applicable if the covariance matrices are not equal. However, the numerical values for the MANOVA would lead to rejection of the hypothesis of equal means up to and including the .01 level. Therefore, the overall statistical tests show that there are significant differences between the groups on the basis of preference.

In summary, this chapter shows definite differences between the groups --both as measured on individual dimensions and as indicated in the multivariate tests. The largest difference between the groups is the large gap between students and the others on the fourth dimension (societal vs. consumer orientation). Housewives and businessmen urge action on consumer oriented issues while students prefer action on societal oriented issues. Also noted were a strong interest in price issues by housewives and a corresponding decrease in their interest in product issues. Perhaps this indicates the greater perceived effects of inflation on the household purchasing agents. The businessmen indicated a lower preference towards price oriented issues and higher preferences for marketing (non-layoff) issues.

CHAPTER 7

CONCLUSIONS

To conclude the report of this study, the writer will review the findings and follow this with a discussion of the value of this study to marketers. A brief discussion will then cover further research which is necessary to allow for practical studies and to complement those studies.

REVIEW OF THE RESULTS OF THE STUDY

The study generally showed that the resultant dimensions allow the development of three types of classification:

Production Cost (Layoffs) Vs. Marketing Issues (Dimension 1).

Product, Price, or Promotion Issues (Dimension 2 and 3).

Societal Vs. Consumer Orientation (Dimension 4).

The differences in perceptions and preferences with respect to these classifications by the three groups was noted in the examination of the perceptual saliences from the INDSCAL model and the ideal vectors from the PREFMAP model. The largest differences were with respect to the preferences on the fourth dimension, societal/consumer orientation. The students generally preferred actions on societal-oriented issues while housewives and the businessmen tended to prefer actions on consumer-oriented issues. Also noted were preferences for price-oriented issues by housewives and preferences for marketing (non-layoff) issues by businessmen.

Smaller differences were found in the perceptions of the issues. Housewives tended to combine product and price oriented issues and to compare these with promotional issues. Students tended to perceive the

production costs (as indicated by layoffs) closer to the other issues than the other groups. Other differences of the students included their trend towards placing more perceptual salience on the differences between promotionally oriented issues and the issues of price and product, their tendency to perceive price, product, and promotion issues more distinctly than the other groups, and their perception of less difference between issues on the basis of societal/consumer orientation than the other groups. With these apparent findings in mind, it is now appropriate to discuss the statistical tests of the hypotheses.

TESTS OF HYPOTHESES

Three hypotheses were stated in Chapter One. Each of these will be stated and examined below, starting with hypothesis H_1 .

H_1 : Multidimensional scaling expresses some of the perceptions and preferences of the subjects.

By analyzing the correlations presented in Exhibit 4 - 1, it can be seen that the overall correlation between the scalar products and the estimated scalar products was 0.395 for four dimensions (15 issues) but only 0.160 for one dimension. The big jump between one and two dimensions (0.160 to 0.273) tends to confirm the hypothesis that one dimension is not sufficient for representing the overall perceptions of all subjects. This does not imply that each individual's perceptions could not be represented in one dimension. The possibility of representing each individual's perceptions separately (i.e., developing a distinct scaling for each individual) was not attempted.

H_2 : There are no significant perceptual differences between the groups.

Tests of the second hypothesis involved testing the perceptual saliences with multivariate analysis of variance (MANOVA). The differences

between the saliences of members of each group were used to provide an overall estimate of error. Before using the MANOVA tests the covariance matrices were first tested for equality. A full discussion of these tests is given in the Appendix.

The tests of equality of covariance matrices (for perceptual saliences) was accepted at the .05 level but would have been rejected at the .10 level. The MANOVA test of perceptual means led to the acceptance of the hypothesis of equal group means at the .05 level, but again this would have been rejected at the .10 level. Hypothesis H_2 , therefore, cannot be rejected and must be accepted at the .05 level. In other words, there is no overall statistical difference between the groups with regards to perception. The overall statistical differences were tested with multivariate statistical methods which examine all groups and variables together.

H_3 : There are no preference differences between the groups.

Again testing for preference differences involves testing for equality of covariance matrices and MANOVA. The cosines between the individual preference vectors and the dimension axes are used to indicate preference on each dimension. The test of equality of covariance matrices was rejected at the .05 level and all other levels .025 and above. It would have been accepted at the .01 level. The MANOVA test of equality of means is not applicable if the covariance matrices are not equal. The writer believes that there were also substantial differences between the means but is unable to test this by the methods planned.

Since there are overall statistical differences between the groups with respect to the preference covariance matrices, hypothesis H_3 is rejected. In other words there are differences between the groups when

the preference covariance matrices of the groups are examined. It is expected that there are also significant differences between the groups with regards to the preference means, but these tests cannot be made because of the differences in the covariance matrices.

It should be noted that we have found significant differences between the groups on preference but not on perception. This finding is in accordance with the work of V. J. Stefflre who generally noted larger differences in preferences than in perceptions.

THE VALUE OF THESE FINDINGS TO MARKETERS

The value of this study to marketers is threefold. First, it presents one system of classifying these issues. Second, it shows some possible differences between these groups. Third, it illustrates a method by which marketers may study the perceptions and preferences of social issues and the differences in these of different groups. It is this final point that is the most important, since obviously the generalizability of the other findings is severely limited.

The advantages of this technique over other possible techniques are essentially the same as the advantages of multidimensional scaling over other techniques in marketing research. As described in Chapter 1 with regard to multidimensional scaling, this technique provides two main advantages. First, it provides a convenient scaling for use in presenting the results of a study to those unfamiliar with sophisticated quantitative methods. Secondly the technique allows the researcher to proceed in a study with very few restrictive assumptions.

As was stated in the first chapter, marketers dealing with social and consumer criticisms can make three types of errors:

- They may react with respect to their own values and not deal with the complaints of the critics.
- They may react to the most vocal critics and alienate their regular customers.
- They may react to the vocal critics and alienate the rest of society.

The study can be used to deal with each of these types of error. By participating as respondents, marketers may determine how closely their perceptions and preferences match those of other respondents. By analyzing representative samples a marketer may analyze differences between the vocal critics and customers and other members of society.

Marketers must remember, however, the potential effects of the vocal critics as opinion leaders. Therefore, evaluating the results of a study such as this, a marketer must implicitly or explicitly evaluate not only the differences between the critics and others but also the future effects of the critics in molding public opinion and policy.

FURTHER WORK REQUIRED ON MULTIDIMENSIONAL SCALING

The practical use of these techniques by marketers requires improvements in the techniques of multidimensional scaling. These improvements are in two areas: improvements in the multidimensional scaling algorithms, and improved methods of data gathering.

Improved multidimensional scaling programs are necessary if larger sample sizes are to be used. The limitations of the INDSCAL program restrict its use with 15 stimuli to sample sizes of 80 or less. Additionally the computer time required was extremely high. For example, a 25 minute limit was used on the UNIVAC 1108 for the combined run of 7, 6, 5, 4, 3, 2, and 1 dimensions on 14 issues. An initial starting configuration from the 15 issue scaling was used. The 25 minute limit was reached before

the program was completed (the 3, 2, and 1 dimensional scalings were not calculated). It can easily be seen that excessive amounts of computer time are involved, particularly if several runs are contemplated.* The PREFMAP program has less serious limits.

Some time can be saved on the INDSCAL program if initial stimulus configurations are used instead of the random configuration. (The use of an initial configuration is discussed in Chapters 3 and 4.) Therefore, one approach for cutting the amount of computer time required would be along the avenue of developing initial configurations within the INDSCAL algorithm. However, more basic changes to the entire iterative process of the algorithm should be considered as these changes are possibly the only way to reduce markedly the amount of computer time required.

Improved methods of data gathering are also needed to deal with the abstract issues involved in this study. The method used here (for gathering dissimilarities data) severely limits the samples used and leads to great amounts of respondent fatigue. The methods surveyed in Chapter 3 appear to be no better than the derived method used in this study.

The writer suggests two improvements in data gathering methods. These improvements are the use of personal interviews and the addition of a preliminary pretest to develop the semantic differentials. The use of personal interviews instead of group interviews should reduce the effect of fatigue and increase the motivation of those who would have difficulty in completing the questionnaire. The added expense of personal

*The final computer runs for this study involved approximately one hour of computer time. At \$400/hr., the reader should easily see that extremely high computer time charges would result if several runs are needed to test the routines and provide interpretative experience to the researcher.

interviews should be worthwhile on the assumption that the interviewers would give the subjects sufficient encouragement to place more effort on completing the questionnaire. This should reduce the effects of the difficulty of the questionnaire and allow subjects to work against fatigue.

The addition of a preliminary pretest should improve the quality of the semantic differential scales. Representative subjects should be queried about the facets that they consider in comparing the issues. These facets could be used in developing the semantic differential scales. Hopefully the semantic differentials would be easier for the subjects to complete than the ones used in this study. In this study the original semantic differentials were generated by the researcher and his advisors and associates.

In addition to the two areas of improvements listed above, the writer suggests an alternative, more elaborate study that could be used if practical nonmetric techniques for studying individual differences were developed. (Although Carroll and Chang have reportedly developed a nonmetric variation of INDSCAL called NINDSCAL, the writer expects this variation to consume far greater amounts of computer time than the original INDSCAL algorithm.) The alternative method would involve developing a list of positive and negative issues (only negative issues were used in the study presented in this paper). The positive and negative issues could be combined in scenario descriptions of the companies. The subjects would be asked to rank the similarity of the scenarios (using a variation of the "ordering k out of $n-1$ items" method of Chapter 3). Using an additive conjoint measurement model, such as J. B. Kruskal's MONANOVA,² the issues may be separated and both the positive and negative aspects scaled using a nonmetric multidimensional scaling algorithm such as a nonmetric INDSCAL.

This method provides the advantages of putting the respondents in the position of realizing both the costs and the benefits of these types of issues.

Additional work should also be aimed at improving the interpretation of the dimensions. One method which is possible if semantic differentials are not used for gathering similarities judgements is to use semantic differentials from some of the respondents to correlate (with regression or canonical correlation) the dimensions with the semantic differentials' scores. This method requires great foresight in planning and choosing the semantic differentials, since the researcher must anticipate all possible dimensional interpretations beforehand.

RELATED STUDIES WHICH ARE NEEDED

This study examined the attitudes of respondents to the issues if the issues were assumed to occur. Studies are also needed to examine which issues and areas are actually considered to be existing problems. The writer doubts that multidimensional scaling is appropriate for the study of which issues are considered to be problems since subjects are likely to believe discrete issues to be current problems. This may be restated as follows: Although the issues may be perceived in an overall space, the elimination and/or accentuation of issues is likely to be on a hit-or-miss basis.

In summary this study shows that multidimensional scaling may be used in evaluating perceptions and preferences of social issues which are of interest to marketers. Just as multidimensional scaling is one of the many tools in the "bag of tricks" of the conventional marketing researcher, it should also be considered as one of the available techniques for the researcher investigating public opinions towards social

issues which are of importance to marketers. It has the advantages of providing convenient representations for presentation and a minimal number of restrictive assumptions. But multidimensional scaling applied to social issues also has the disadvantages of difficult data gathering methods (particularly with abstract issues) and high costs per subject. Some suggestions have been made in this report for future research to minimize these problems. The actual usage of multidimensional scaling in this type of research will depend on the amount of desire that marketers have to investigate these issues and the amount of background and experience (in the form of staff and consultants) they have in using these techniques.

FOOTNOTES

1. Volney Stefflre, "Market Structure Studies: New Products for Old Markets and New Markets (foreign) for Old Products," Applications of the Sciences in Marketing Management, ed. Frank M. Bass, Charles W. King, and Edgar A. Pessemier (New York, 1968), p. 251-268.
2. J. B. Kruskal, "Analysis of Factorial Experiments By Estimating Monotone Transformations of the Data," Journal of the Royal Statistical Society, 27: p. 251-263, (1965).

APPENDIX

APPENDIX

This Appendix is divided into three major parts:

A1 - Issues and Questionnaire

- A1 - 1: 25 semantic differentials used in pretest,
- A1 - 2: 10 semantic differentials used in final questionnaire,
- A1 - 3: Final Questionnaire.

A2 - Statistical Tests

- A2 - 1: One dimensional t-test,
- A2 - 2: Results of one dimensional t-test,
- A2 - 3: Rational of test for equality of covariance matrices.
- A2 - 4: Rational of MANOVA test,
- A2 - 5: Results of multivariate tests on perceptions,
- A2 - 6: Results of multivariate tests on preferences.

A3 - Computer Programs

- A3 - 1: DREAD, program for ordering scales, calculating standardized scores and Euclidean distances,
- A3 - 2: MATRIX, program for computing test of equality of covariance matrices and MANOVA test.

A1 - Issues and Questionnaire

A1 - 1: 25 Semantic Differentials Used In Pretest

A1 - 2: 10 Semantic Differentials Used In Final Questionnaire

A1 - 3: Final Questionnaire

A1 - 1

Original 25 Semantic Differentials Tested

Reputable.	Not Reputable
I Would Like To Be Employed.	I Would Not Like To Be Employed
By This Company	By This Company
Controls Others.	Does Not Control Others
Liberal.	Conservative
Efficient.	Not Efficient
Costly	Not Costly
Thrifty.	Wasteful
Tries To Fool Others	Does Not Try To Fool Others
Considers Others	Does Not Consider Others
Economic	Not Economic
Promotes Public Welfare.	Does Not Promote Public Welfare
Misleading	Not Misleading
Cooperative.	Not Cooperative
Helps Its Customers.	Does Not Help Its Customers
Improves the Environment	Does Not Improve the Environment
Responds Quickly to Changes.	Does Not Respond Quickly to Changes
Fair	Unfair
Desirable.	Not Desirable
Optimistic	Not Optimistic
Presents the Complete Picture.	Does Not Present the Complete Picture
Workers are Safe	Workers are Not Safe
Operates In Legitimate	Does Not Operate In A Legitimate
Manner	Manner
Good	Bad
Short-Sighted.	Far-Sighted
Most Likely a Big Business	Most Likely a Small Business

A1 - 2

10 Semantic Differentials Used On Final Questionnaire

All scales are prefaced by "In the view of the consumer:"

- | | |
|-------------------------------------|--|
| Company Is Most Likely A Big. . . . | Company Is Most Likely A Small
Company |
| Company Responds Quickly To | Company Does Not Respond Quickly To
Changes |
| Company Acts In Consumer's. . . . | Company Does Not Act In Consumer's
Interest |
| Company Controls Others | Company Does Not Control Others |
| Company's Actions Are | Company's Actions Are Not Misleading
Misleading |
| Company Operates in A Legitimate. . | Company Does Not Operate in A Legi-
Manner |
| Company's Actions Are Costly. . . . | Company's Actions Are Not Costly |
| Company's Actions are Far-. | Company's Actions Are Short-Sighted
Sighted |
| Company's Actions Work To | Company's Actions Work To Spoil The
Improve The Environment |
| Company Appears To Be Optimistic. . | Company Does Not Appear To Be Optimistic |

A1 - 3

The following questionnaire is being given to you as part of a study conducted by a Doctoral student at the University of Houston.

Of the following issues, please mark the three that you believe to be most important in society today. Mark the most important with a ' 1 ', the second most important with a ' 2 ', and the third most important with a ' 3 '.

- _____ The wars in Southeast Asia and the Middle East.
- _____ Narcotics and other drugs.
- _____ Inflation.
- _____ The breakdown of moral standards.
- _____ Making Business more responsive to consumer interests.
- _____ The Arms Race.
- _____ Improving productivity in industry.
- _____ Cleaning up the environment.
- _____ Stabilizing the world's population.

The purpose of this study is to determine differences in the ways people perceive some social issues regarding business. To assure consistency, all social issues are stated in a negative manner. The researchers are not necessarily suggesting that these issues occur commonly, nor that some of them occur at all. We merely wish to see how you would perceive these issues if they were to occur.

On each of the following pages you will note there is a descriptive scale followed by a list of 15 company's actions. You will be asked to rate each company's actions on the scales by placing a mark in one of the 7 spaces between the ends of the scales.

Please use the viewpoint of the consumer, looking at a company which acts in the manner described. It may help you to picture in your mind a company that you know (or can imagine) which fits the description. Respond on the scales with this company in mind.

For example, if the scale was "Company's actions work to improve the environment" / "Company's actions work to spoil the environment," the scale would appear as follows:

Company's Actions Work To Improve the Environment	_ _ _ _ _ _	Company's Actions Work To Spoil the Environment
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If you believed the company's actions worked to an extreme amount to improve the environment, you would place a mark in the left-most space. If you believed it worked a fair amount to improve the environment, you would place a mark in the second space. If you believed it worked only slightly to improve the environment you would mark in the third space.

If you believed the action worked neither to improve the environment nor to spoil the environment, you would place a mark in the 4th space." Similarly you would mark in the 5th, 6th, or 7th space if you believed it worked to spoil the environment.

If you can see absolutely no relationship between the action and the environment, place your mark in the center.

Another example can be shown using the "Company's actions are costly" / "Company's actions are not costly" scale. If you believed the company's actions are costly (in the view of the consumer) you would place a mark in one of the first three spaces, depending on the amount of cost involved. If you believed a company's actions are not costly, you would mark one of the last three spaces.

IN THE VIEW OF THE CONSUMER:

Company's Actions Are Far-Sighted

Company's Actions Are Short-Sighted

A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

A company does not design products so that they can be recycled.

A company sells its products on credit terms which are higher than their credit costs justify.

A company does not service products adequately after sales.



A company develops products intentionally so that they will wear out and need replacement.

A company lays off workers immediately when sales decline.

1 1 1 1 1 1 1 1

A company claims its products can do more than they are actually capable of doing.

1 1 1 1 1 1 1 1

A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

111111

A company charges much higher rates for service calls than their costs justify.

1 1 1 1 1 1 1

A company encourages industry efforts to increase prices.

[illegible]

A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

1. 2. 3. 4. 5. 6. 7. 8.

A company spends money on advertising that could be passed onto consumers through lower prices.

1 1 1 1 1 1 1 1

A company promotes products which use natural resources that are in short supply.

1	1	1	1	1	1	1
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A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

1 2 3 4 5 6 7 8

A company aims its advertising at children so that the children will convince their parents to buy the product.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

In the view of the consumer:

Company Acts In Consumer's Interest

**Company Does Not Act
In Consumer's Interest**

A company spends money on advertising that could be passed onto consumers through lower prices.

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A company sells its products on credit terms which are higher than their credit costs justify.

A company claims its products can do more than they are actually capable of doing.

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A company does not service products adequately after sales.



A company charges much higher rates for service calls than their costs justify.

A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

A company does not design products so that they can be recycled.

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A company encourages industry efforts to increase prices.

A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

[illegible]

A company aims its advertising at children so that the children will convince their parents to buy the product.

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A company lays off workers immediately when sales decline.

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A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

1	1	1	1	1	1	1	1
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A company develops products intentionally so that they will wear out and need replacement.

A company promotes products which use natural resources that are in short supply.

1	1	1	1	1	1	1	1
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A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

1 1 1 1 1 1 1

Company Responds
Quickly to Changes

Company Does Not Respond
Quickly to Changes

A company spends money on advertising that could be passed onto consumers through lower prices.

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A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

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A company lays off workers immediately when sales decline.

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A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

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A company does not design products so that they can be recycled.

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A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

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A company sells its products on credit terms which are higher than their credit costs justify.

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A company promotes products which use natural resources that are in short supply.

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A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

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A company aims its advertising at children so that the children will convince their parents to buy the product.

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A company does not service products adequately after sales.

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A company encourages industry efforts to increase prices.

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A company claims its products can do more than they are actually capable of doing.

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A company develops products intentionally so that they will wear out and need replacement.

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A company charges much higher rates for service calls than their costs justify.

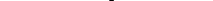
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Company's Actions Are Costly	Company's Actions Are Not Costly
<p>1. The company has a history of paying out large amounts of money in lawsuits.</p> <p>2. The company has a history of paying out large amounts of money in settlements.</p> <p>3. The company has a history of paying out large amounts of money in damages.</p> <p>4. The company has a history of paying out large amounts of money in fines.</p> <p>5. The company has a history of paying out large amounts of money in penalties.</p> <p>6. The company has a history of paying out large amounts of money in costs.</p> <p>7. The company has a history of paying out large amounts of money in expenses.</p> <p>8. The company has a history of paying out large amounts of money in losses.</p> <p>9. The company has a history of paying out large amounts of money in profits.</p> <p>10. The company has a history of paying out large amounts of money in revenues.</p>	<p>1. The company has a history of paying out small amounts of money in lawsuits.</p> <p>2. The company has a history of paying out small amounts of money in settlements.</p> <p>3. The company has a history of paying out small amounts of money in damages.</p> <p>4. The company has a history of paying out small amounts of money in fines.</p> <p>5. The company has a history of paying out small amounts of money in penalties.</p> <p>6. The company has a history of paying out small amounts of money in costs.</p> <p>7. The company has a history of paying out small amounts of money in expenses.</p> <p>8. The company has a history of paying out small amounts of money in losses.</p> <p>9. The company has a history of paying out small amounts of money in profits.</p> <p>10. The company has a history of paying out small amounts of money in revenues.</p>

Company's Actions Are Costly	Company's Actions Are Not Costly
<p>1. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>2. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>3. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>4. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>5. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>6. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>7. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>8. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>9. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>10. The company has a history of paying out large sums of money to settle lawsuits.</p>	<p>1. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>2. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>3. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>4. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>5. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>6. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>7. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>8. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>9. The company has a history of paying out large sums of money to settle lawsuits.</p> <p>10. The company has a history of paying out large sums of money to settle lawsuits.</p>



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**Company Does Not Appear
To Be Optimistic**

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1 2 3 4 5 6 7 8

[illegible]

IN THE VIEW OF THE CONSUMER.

Company Operates In A Legitimate Manner

Company Does Not Operate
In A Legitimate Manner

A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

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A company claims its products can do more than they are actually capable of doing.

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A company sells its products on credit terms which are higher than their credit costs justify.

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A company encourages industry efforts to increase prices.

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A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

A horizontal number line with tick marks. A vertical line is drawn at the center of the number line.

A company does not design products so that they can be recycled.

A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

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A company aims its advertising at children so that the children will convince their parents to buy the product.

A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

A company spends money on advertising that could be passed onto consumers through lower prices.

A company does not service products adequately after sales.

A company promotes products which use natural resources that are in short supply.

1 2 3 4 5 6 7 8

A company develops products intentionally so that they will wear out and need replacement.

1 1 1 1 1 1 1 1

A company charges much higher rates for service calls than their costs justify.

1 1 1 1 1 1 1 1

A company lays off workers immediately when sales decline.

<u>Company Is Most Likely A Big Company</u>	<u>Company Is Most Likely A Small Company</u>
<p>1. <u>Company Size</u></p> <p>2. <u>Company Location</u></p> <p>3. <u>Company History</u></p> <p>4. <u>Company Products</u></p> <p>5. <u>Company Services</u></p> <p>6. <u>Company Employees</u></p> <p>7. <u>Company Revenue</u></p> <p>8. <u>Company Assets</u></p> <p>9. <u>Company Liabilities</u></p> <p>10. <u>Company Cash Flow</u></p> <p>11. <u>Company Profitability</u></p> <p>12. <u>Company Growth</u></p> <p>13. <u>Company Risk</u></p> <p>14. <u>Company Reputation</u></p> <p>15. <u>Company Market Share</u></p> <p>16. <u>Company Industry</u></p> <p>17. <u>Company Competition</u></p> <p>18. <u>Company Customers</u></p> <p>19. <u>Company Suppliers</u></p> <p>20. <u>Company Partners</u></p>	<p>1. <u>Company Size</u></p> <p>2. <u>Company Location</u></p> <p>3. <u>Company History</u></p> <p>4. <u>Company Products</u></p> <p>5. <u>Company Services</u></p> <p>6. <u>Company Employees</u></p> <p>7. <u>Company Revenue</u></p> <p>8. <u>Company Assets</u></p> <p>9. <u>Company Liabilities</u></p> <p>10. <u>Company Cash Flow</u></p> <p>11. <u>Company Profitability</u></p> <p>12. <u>Company Growth</u></p> <p>13. <u>Company Risk</u></p> <p>14. <u>Company Reputation</u></p> <p>15. <u>Company Market Share</u></p> <p>16. <u>Company Industry</u></p> <p>17. <u>Company Competition</u></p> <p>18. <u>Company Customers</u></p> <p>19. <u>Company Suppliers</u></p> <p>20. <u>Company Partners</u></p>

A company claims its products can do more than they are actually capable of doing.

A company does not design products so that they can be recycled.

A company promotes products which use natural resources that are in short supply.

A company encourages industry efforts to increase prices.

A company lays off workers immediately when sales decline.

A company develops products intentionally so that they will wear out and need replacement.

A company sells its products on credit terms which are higher than their credit costs justify.

A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

A company charges much higher rates for service calls than their costs justify.

A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

A company does not service products adequately after sales.

A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

A company spend money on advertising that could be passed onto consumers through lower prices.

A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

A company aims its advertising at children so that the children will convince their parents to buy the product.

Company Controls
Others

Company Does Not Control Others

1 2 3 4 5 6 7

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1 1 1 1 1 1 1

L L I I I

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in the view of the consumer:

Company's Actions Work To Improve The Environment

Company's Actions Work To Spoil The Environment

A company does not design products so that they can be recycled.

A company lays off workers immediately when sales decline.

A company promotes products which use natural resources that are in short supply.

A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

1 1 1 1 1 1 1 1

A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.

1 1 1 1 1 1 1 1

A company sells its products on credit terms which are higher than their credit costs justify.

1 1 1 1 1 1 1 1

A company charges much higher rates for service calls than their costs justify.

A company aims its advertising at children so that the children will convince their parents to buy the product.

A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.

P **R** **S** **T** **V** **X**

A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.

1 1 1 1 1 1 1 1

A company encourages industry efforts to increase prices.

A company spends money on advertising that could be passed onto consumers through lower prices.

A company develops products intentionally so that they will wear out and need replacement.

1 1 1 1 1 1 1 1

A company does not service products adequately after sales.

A company claims its products can do more than they are actually capable of doing.

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Company's Actions Are Misleading

Company's Actions
Are Not Misleading.

[illegible]

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On the following page you will find a list of 15 descriptions of company's actions. We would like you to rank these in order of your preference for eliminating them. To do this, please consider yourself in the position of the president of an association of companies which has been asked by the member companies to eliminate certain practices in the industry. Please mark with a "1," the company's action which you would most like to eliminate. Then please mark with a "2" the action which you would next most like to eliminate. Continue with all 15 actions.

Please try not to have any ties in your answers. However, if you find it impossible to decide between 2 actions, mark them both with the same number.

- _____ A company sells its products on credit terms which are higher than their credit costs justify.
- _____ A company dumps wastes into a stream that feeds a lake, making the lake unfit for bathing or fishing.
- _____ A company does not attempt to decrease the amount of air pollution emitted by its products under normal use.
- _____ A company does not service products adequately after sales.
- _____ A company promotes products which use natural resources that are in short supply.
- _____ A company claims its products can do more than they are actually capable of doing.
- _____ A company lays off workers immediately when sales decline.
- _____ A company attempts to create and control consumer demand for its products rather than develop products which consumers truly want.
- _____ A company aims its advertising at children so that the children will convince their parents to buy the product.
- _____ A company does not design products so that they can be recycled.
- _____ A company charges much higher rates for service calls than their costs justify.
- _____ A company develops products intentionally so that they will wear out and need replacement.
- _____ A company spends money on advertising that could be passed onto consumers through lower prices.
- _____ A company encourages industry efforts to increase prices.
- _____ A company sells products which have not been tested for safety under extreme conditions (such as in the hands of children, or when left in a hot area too long).

In order that we may categorize some of your answers, please complete the following questions.

What is your present occupation? (Businessman, Housewife, student, etc.)

If you are a businessman, what is your position and how long have you held it? If you are a student, what is your year and major?

What is the last year of your formal education? _____

Do you subscribe to any of the following magazines?

Consumer Reports _____

Consumer Bulletin _____

MONEY _____

Which age classification do you fall in?

20 - 29 _____

30 - 39 _____

40 - 49 _____

50 or above _____

Do you have any children between the ages of 15 and 25? _____

Into which classification would you estimate your family earnings?

less than \$5,000 _____

\$5,000 - \$10,000 _____

\$10,000 - \$15,000 _____

\$15,000 - \$25,000 _____

Above \$25,000 _____

THANK YOU FOR YOUR TIME!

A2 - Statistical Tests

- A2 - 1: One Dimensional t-Test
- A2 - 2: Results of One Dimensional t-Test
- A2 - 3: Rational of Test for Equality of Covariance Matrices
- A2 - 4: Rational of MANOVA Test
- A2 - 5: Results of Multivariate Tests on Perceptions
- A2 - 6: Results of Multivariate Tests on Preferences

A2 - 1

One Dimensional t-Test

To test each group mean against the overall mean for the dimension the following hypothesis is tested:

H_o : The group sample mean equals the overall mean.

against the alternative:

H_a : The group sample mean is not equal to the overall mean.

The hypothesis H_o is accepted if:

$$|\bar{X} - \bar{X}_g| < t_{\alpha/2, n_g} s / \sqrt{n_g}$$

where:

\bar{X} = The overall mean for the dimension,

\bar{X}_g = The group mean for the dimension,

s = The overall standard deviation for the dimension,

n_g = The group sample size,

$t_{\alpha/2, n_g}$ = t Test statistic for $\alpha/2$ and n_g .

A2 - 2

Results of One Dimensional t-TestTEST OF PERCEPTUAL SALIENCES.

Table of s/\sqrt{n} :
g

	<u>Dimension</u>			
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
19 Housewives:	0.0379	0.0317	0.0390	0.0305
28 Businessmen:	0.0312	0.0261	0.0321	0.0251
23 Students:	0.0344	0.0288	0.0355	0.0277

t-Test Statistics

$$t_{97.5,19} = 2.093$$

$$t_{97.5,28} = 2.048$$

$$t_{97.5,23} = 2.069$$

For the Housewives, Second Dimension:

$$\text{Overall mean} = 0.279$$

$$-2.093 * s/\sqrt{19} = \underline{-0.066}$$

$$\text{Test value} = 0.213$$

$$\text{Actual mean} = 0.191$$

Therefore, Reject H_0 for the housewives on the second dimension (perceptions).

TEST OF PREFERENCE VECTOR COSINES:

Table of $s/\sqrt{n_g}$:

	<u>Dimension</u>			
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
18 Housewives:	0.0916	0.1038	0.1037	0.0971
28 Businessmen:	0.0734	0.0832	0.0831	0.0778
23 Students:	0.0810	0.0918	0.0917	0.0858

t-Test Statistics:

$$t_{97.5,18} = 2.101$$

$$t_{97.5,28} = 2.048$$

$$t_{97.5,23} = 2.069$$

For the Students, Fourth Dimension:

$$\text{Overall mean} = 0.0016$$

$$-2.069 * s/\sqrt{23} = \underline{-0.178}$$

$$\text{Test Value} = -0.176$$

$$\text{Actual Mean} = -0.231$$

Therefore, Reject H_0 for the Students on the fourth dimension (preferences).

A2 - 3

Testing For Equality Of Covariance Matrices

Before conducting a multivariate analysis of variance, the covariance matrices must first be tested for equality. Donald F. Morrison shows that the hypothesis:

$$H_o: \Sigma_1 = \dots = \Sigma_k$$

may be tested against the alternative,

$$H_a: \Sigma_i \neq \Sigma_j$$

by the statistic MC^{-1} where

$$M = (\Sigma n_i) \ln |S| - \sum_{i=1}^k n_i \ln |S_i|$$

$$C^{-1} = 1 - \frac{2p^3 + 3p - 1}{6(p+1)(k-1)} \left(\sum_{i=1}^k \frac{1}{n_i} - \frac{1}{\Sigma n_i} \right)$$

k = number of groups,

p = number of dimensions,

S = overall covariance matrix,

S_i = covariance matrix for group i ,

n_i = sample size of group i ,

n = overall sample size.

MC^{-1} is approximately distributed Chi Square with degrees of freedom $\frac{1}{2}(k-1)p(p+1)$. The approximation appears to be good if k and p are each less than 4 or 5 and n_i exceeds 20.

A2 - 4

Multivariate Analysis of Variance

As stated in Chapter 4, the model for the multivariate analysis of variance (MANOVA) is:

$$(1) \quad s_{ijk} = u_{jk} + e_{ijk}$$

where:

- s_{ijk} = the salience for individual i , in group j , on dimension k ,
 u_{jk} = the mean value of the salience for group j , on dimension k ,
 e_{ijk} = the error and individual differences for individual i , in group j , on dimension k .

The hypothesis to be tested is:

$$(2) \quad H_o: u_{1k} = u_{2k} = u_{3k}$$

In matrix form (1) and (2) can be restated as follows:

$$(3) \quad S = A\beta + e$$

$$(4) \quad H_o: L\beta = q$$

where

$$\beta = \begin{bmatrix} \mu'_1 \\ \mu'_2 \\ \mu'_3 \end{bmatrix} = \begin{bmatrix} \mu_{11} & \mu_{12} & \cdot & \cdot & \cdot & \mu_{1r} \\ \mu_{21} & \mu_{22} & \cdot & \cdot & \cdot & \mu_{2r} \\ \mu_{31} & \mu_{32} & \cdot & \cdot & \cdot & \mu_{3r} \end{bmatrix}$$

$$A = \begin{bmatrix} J_{N_1} & 0 & 0 \\ 0 & J_{N_2} & 0 \\ 0 & 0 & J_{N_3} \end{bmatrix}$$

$$L = \begin{bmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \end{bmatrix}$$

$q = 2 \times r$ matrix of zeroes.

$N_j =$ The number of subjects in group j ,

$r =$ the number of dimensions,

and $J_{N_j} =$ Column vector of 1's, of length N_j .

Estimates of β can be calculated from the familiar equation:

$$(5) \quad \hat{\beta} = (A'A)^{-1} A'S$$

The Likelihood Ratio Technique is used to test significance.

THE LIKELIHOOD RATIO TECHNIQUE

The likelihood ratio is defined as follows:

$$(6) \quad \lambda^{2/N} = \frac{Q(\hat{\beta})}{Q(\tilde{\beta})} = \frac{|E|}{|E + H|} = \frac{1}{|E^{-1}| |E + H|} = \frac{1}{|I + E^{-1}H|}$$

where:

$$Q(\hat{\beta}) = (S - A\hat{\beta})'(S - A\hat{\beta})$$

$\tilde{\beta} =$ the maximum likelihood ratio estimator such that $L\tilde{\beta} = q$

$$Q(\tilde{\beta}) = (S - A\tilde{\beta})'(S - A\tilde{\beta}) = Q(\hat{\beta}) + (L\hat{\beta} - q)'(L(A'A)^{-1}L')^{-1}(L\hat{\beta} - q)$$

$$E = Q(\hat{\beta})$$

$$H = Q(\tilde{\beta}) - Q(\hat{\beta})$$

$\lambda^{2/N}$ is distributed as the product of β distributions. By matching the first moments, approximate distributions may be found using the χ^2 statistic. In the general case the following approximation is used:

$$(7) \quad - (N - q - \frac{1}{2}(p - r + 1)) \ln \frac{|E|}{|E + H|} \sim \chi_{pr}^2$$

where:

- q = the number of groups,
- p = the number of dimensions,
- r = the rank of L,
- N = the total number of observations.

Solving for E

The matrix E may be derived as follows:

$$\begin{aligned} E &= Q(\hat{\beta}) = (S - A\hat{\beta})'(S - A\hat{\beta}) \\ &= S'S - 2S'A\hat{\beta} + \hat{\beta}'A'A\hat{\beta} \end{aligned}$$

Using (5),

$$\begin{aligned} E &= S'S - 2S'A(A'A)^{-1}A'S + S'A(A'A)^{-1}A'A(A'A)^{-1}A'S \\ &= S'S - 2S'A(A'A)^{-1}A'S + S'A(A'A)^{-1}A'S \\ &= S'S - S'A(A'A)^{-1}A'S \\ &= S'[I - A(A'A)^{-1}A']S \end{aligned}$$

Realizing the following value of $(A'A)^{-1}$ it is possible to solve for $A(A'A)^{-1}A'$:

$$(A'A)^{-1} = \begin{bmatrix} 1/N_1 & 0 & 0 \\ 0 & 1/N_2 & 0 \\ 0 & 0 & 1/N_3 \end{bmatrix}$$

$$A(A'A)^{-1}A' = \begin{bmatrix} \frac{1}{N_1} J_{N_1} J_{N_1}' & 0 & 0 \\ 0 & \frac{1}{N_2} J_{N_2} J_{N_2}' & 0 \\ 0 & 0 & \frac{1}{N_3} J_{N_3} J_{N_3}' \end{bmatrix}$$

and E is of the form:

$$E = S'(I - A(A'A)^{-1}A')$$

$$= S' \begin{bmatrix} I_{N_1} - \frac{1}{N_1} J_{N_1} J_{N_1}' & 0 & 0 \\ 0 & I_{N_2} - \frac{1}{N_2} J_{N_2} J_{N_2}' & 0 \\ 0 & 0 & I_{N_3} - \frac{1}{N_3} J_{N_3} J_{N_3}' \end{bmatrix}$$

In element form this works out to be:

$$e_{ij} = \left(\sum_{g=1}^3 \sum_{h=1}^{N_g} s_{hgj} s_{hgi} - s_{hgi} \bar{s}_{gj} \right)$$

$$= \sum_{g=1}^3 \sum_{h=1}^{N_g} s_{hgi} s_{hgj} - \sum_{g=1}^3 N_g \bar{s}_{gi} \bar{s}_{gj}$$

Solving for H

To obtain H the following reasoning may be used:

$$H = (L\hat{\beta} - q)'(L(A'A)^{-1}L')^{-1}(L\hat{\beta} - q)$$

since

$$L = \begin{bmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \end{bmatrix}$$

and

$$(A'A)^{-1} = \begin{bmatrix} 1/N_1 & 0 & 0 \\ 0 & 1/N_2 & 0 \\ 0 & 0 & 1/N_3 \end{bmatrix}$$

$$L(A'A)^{-1}L' = \frac{1}{N_1} \begin{bmatrix} \frac{N_1 + N_2}{N_2} & 1 \\ 1 & \frac{N_1 + N_3}{N_3} \end{bmatrix}$$

Since $q = 0$, $L\hat{\beta} - q = L\hat{\beta}$. Also,

$$\hat{\beta} = (A'A)^{-1}A'S = \begin{bmatrix} \bar{s}_{11} & \bar{s}_{12} & \cdot & \cdot & \cdot & \bar{s}_{1r} \\ \bar{s}_{21} & \bar{s}_{22} & \cdot & \cdot & \cdot & \bar{s}_{2r} \\ \bar{s}_{31} & \bar{s}_{32} & \cdot & \cdot & \cdot & \bar{s}_{3r} \end{bmatrix}$$

Solving for the ij^{th} element of $L\hat{\beta}$:

$$L\hat{\beta}_{ij} = \bar{s}_{1j} - \bar{s}_{(i+1)j}$$

Rewriting $(L(A'A)^{-1}L')^{-1}$ in element form gives the following:

$$(L(A'A)^{-1}L')^{-1}_{ki} = -\frac{1}{N(N_{i+1}N_{(j+1)})} + \begin{cases} N_{i+1} & \text{if } i = j \\ 0 & \text{if } i \neq j \end{cases}$$

Using the element notation shown above and the notation:

$$\bar{s}_{ij} = \frac{1}{N_i} \sum_{k=1}^{N_i} s_{ikj}$$

$$\bar{s}_j = \frac{1}{N} \sum_{i=1}^3 \sum_{k=1}^{N_i} s_{ikj}$$

then,

$$\begin{aligned} (L(A'A)^{-1}L')^{-1}L\hat{\beta}_{kj} &= \sum_{i=1}^2 (L(A'A)^{-1}L')^{-1}_{ki} * L\hat{\beta}_{ij} \\ &= -\frac{1}{N} \sum_{i=1}^2 (N_{i+1}N_{k+1})(\bar{s}_{ij} - \bar{s}_{(i+1)j}) + N_{k+1}(\bar{s}_{1j} - \bar{s}_{(k+1)j}) \\ (L\hat{\beta})'(L(A'A)^{-1}L')^{-1}L\hat{\beta}_{mk} &= \sum_{k=1}^2 L\hat{\beta}_{km} * (L(A'A)^{-1}L')^{-1}L\hat{\beta}_{kj} \\ &= \sum_{k=1}^2 (s_{1m} - s_{(k+1)m}) \left\{ N_{k+1}(s_{1j} - s_{(k+1)j}) \right. \\ &\quad \left. - \frac{1}{N} \sum_{i=1}^2 (N_{i+1}N_{k+1})(s_{1j} - s_{(i+1)j}) \right\} \end{aligned}$$

which works out to the following:

$$\begin{aligned}
 h_{mk} &= \hat{L}\beta(L(A'A)^{-1}L')^{-1}\hat{L}\beta_{mk} \\
 &= \sum_{k=1}^3 N_k \bar{s}_{km} \bar{s}_{kj} - N_j \bar{s}_j \bar{s}_m
 \end{aligned}$$

A2 - 5

Multivariate Tests on PerceptionsTest of Equality of Covariance Matrices:

$$M = 31.99089 \quad C^{-1} = 0.91176$$

$$MC^{-1} = 29.1 \sim \chi^2_{20}$$

$$\chi^2_{20,.05} = 31.41,$$

$\chi^2_{20,.10} = 28.4$, $\chi^2_{20,.25} = 23.8$, therefore, the hypothesis of equality is accepted at the .05 level but would be rejected at the .10 and .25 level.

Likelihood Ratio Test:

$$|I + E^{-1} H| = 1.2525$$

$$-(n - q - 0.5(p - r + 1)) \frac{|E|}{|E + H|} = 14.745 \sim \chi^2_8$$

$$\chi^2_{8,.05} = 15.5, \quad \chi^2_{8,.10} = 13.4, \quad \chi^2_{8,.25} = 10.2$$

Therefore, the hypothesis of equality of group perceptual means is accepted at the .05 level, but would be rejected at the .10 and .25 levels.

A2 - 6

Multivariate Tests on PreferencesTest Of Equality Of Covariance Matrices:

$$\begin{aligned}
 M &= 38.819 & C^{-1} &= 0.9096 \\
 MC^{-1} &= 35.3 \sim \chi^2_{20}
 \end{aligned}$$

Table Values:

$$\begin{aligned}
 \chi^2_{20,.10} &= 28.4; & \chi^2_{20,.05} &= 31.4; & \chi^2_{20,.025} &= 34.2; \\
 \chi^2_{20,.01} &= 37.6.
 \end{aligned}$$

Therefore, the hypothesis of equality of covariance matrices is rejected at all levels .025 and above. It would be accepted at the .01 levels.

Likelihood Ratio Test:

Although this test is not statistically correct since the hypothesis of equality of covariance matrices is rejected, it is included here for the reader's observation

$$\begin{aligned}
 |I + E^{-1} H| &= 1.366 \\
 -(N - q - 0.5(p - r + 1)) \frac{|E|}{|E + H|} &= 20.131 \sim \chi^2_8
 \end{aligned}$$

Table values:

$$\begin{aligned}
 \chi^2_{8,.05} &= 15.5; & \chi^2_{8,.025} &= 17.5; & \chi^2_{8,.01} &= 20.090; \\
 \chi^2_{8,.005} &= 22.0.
 \end{aligned}$$

Therefore, the hypothesis of equality of preference cosine means is rejected at all levels. 01 and above. It would be accepted at the .005 level.

A3 - Computer Programs

- A3 - 1: DREAD, Program for Ordering Scales, Calculating
Standardized Scores and Euclidean Distances
- A3 - 2: MATRIX, Program for Computing Test of Equality
of Covariance Matrices and MANOVA Test

A3 - 1

SOURCE LISTING FOR DREAD COMPUTER PROGRAM

Used to Order Issues, Calculate Standardized Scores, and Derive Euclidean Distances

```

      DIMENSION IORDER(15,10),SCORE(15,10),SD(10),ISCALE(10)
      DIMENSION DUMMY(10)
      DIMENSION DIST(15,15),R(15,10),KEY(15),ID(75)
C   SET PROGRAM SO THAT IT MAY BEGIN TO READ DATA
C   READ ORDER OF ISSUES FOR EACH SCALE
      READ(5,101)NKEY
C   NKEY =2, PREFERENCE RANK ORDERS,  NKEY = 10, 10 SCALE  PERCEPTUAL
      READ(5,101)((IORDER(I,J),I=1,15),J=1,NKEY)
      ISTOP=0
      DO 1 I=1,NKEY
      DO 9 J=1,15
9      KEY(J)=0
C   CHECK ORDER OF SCALES, IT SHOULD BE BETWEEN 1 AND 15.
      DO 1 J=1,15
      IF(IORDER(J,I).GE.1.AND.IORDER(J,I).LE.15)GO TO 11
10     WRITE(6,301)I,(IORDER(K,I),K=1,15)
      ISTOP=1
      GO TO 1
11     K=IORDER(J,I)
C   MAKE SURE ISSUES ONLY APPEAR ONCE FOR EACH SCALE
      IF(KEY(K).EQ.1)GO TO 10
      KEY(K)=1
1     CONTINUE
C   IF AN ERROR HAS BEEN MADE TO THIS POINT, STOP.
      IF(ISTOP.EQ.1)GO TO 12
C   READ NUMBER OF INDIVIDUALS
      READ(5,101)NMIND
      IF(NMIND.GT.75)WRITE(6,304)NMIND

```



```

C  START DO-LOOP #8, DATA READ, ORDER, AND COMPUTATION.
C
C  START ROUTINE FOR EACH INDIVIDUAL
    DO 8 INDIV=1,NMIND
      IF(NKEY.EQ.10)GO TO 30
C  THE FOLLOWING IS FOR 2 SCALE PREFERENCE DATA ONLY
      READ(5,403)ID(INDIV),ISCALE(1),(R(J,1),J=1,15)
      K=ISCALE(1)
      IF(K.LE.0.OR.K.GE.3)GO TO 31
      DO 32 J=1,15
        L=IORDER(J,K)
32      SCORE(L,1)=R(J,1)
        WRITE(6,401)ID(INDIV),(SCORE(J,1),J=1,15)
        WRITE(24,402)(SCORE(J,1),J=1,15)
        GO TO 8
30      CONTINUE
C  THE FOLLOWING IS FOR 10 SCALE PERCEPTUAL DATA ONLY
C  READ INDIVIDUAL'S ID NUMBER
      READ(5,103)ID(INDIV)
      DO 2 I=1,15
2      KEY(I)=0
C  READ DATA FOR INDIVIDUAL
      READ(5,102)(ISCALE(I),DUMMY(I),(R(J,I),J=1,15),I=1,10)
C  START DO-LOOP #28 - DATA ORDERING
      DO 28 I=1,10
        K=ISCALE(I)+1
25      IF(KEY(K).EQ.0)GO TO 26
C  ERROR CHECK - SCALE ALREADY USED
31      WRITE(6,303)ID(INDIV),ISCALE(I)
        GO TO 8
26      CONTINUE
        KEY(K)=1
        DO 28 J=1,15

          IF(R(J,I).GE.1.0.AND.R(J,I).LE.7.0)GO TO 27
C  ERROR CHECK - IMPROPER LIMITS ON VALUE READ
          WRITE(6,302)ID(INDIV),ISCALE(I),R(J,I)
          GO TO 8
C  L IS CORRECT ISSUE FOR K-TH POSITION ON THIS SCALE
27      L=IORDER(J,K)
        SCORE(L,K)=R(J,I)
26      CONTINUE
C  END DO LOOP #28 - DATA ORDERING
C  START DO LOOP #7 - STANDARDIZE SCORES
      DO 7 I=1,10
C  CALCULATE MEAN, SET ZERO MEAN
        AMEAN=0.0
        DO 3 J=1,15
3        AMEAN=AMEAN+SCORE(J,I)
        AMEAN=AMEAN/15.
        DO 4 J=1,15
4        SCORE(J,I)=SCORE(J,I)-AMEAN
        SD(I)=0.

```

```

C  CALCULATE STD. DEV., SET UNIT STD. DEV.
      DO 5 J=1,15
5      SD(I)=SD(I)+SCORE(J,I)**2
      IF(SD(I).LE. 0.00001)GO TO 7
      SD(I)=SD(I)/14.
      SD(I)=SQRT(SD(I))
      DO 6 J=1,15
6      SCORE(J,I)=SCORE(J,I)/SD(I)
7      CONTINUE
C  END DO LOOP #7 - STANDARDIZE SCORES
C  WRITE STANDARDIZED SCORES
      DO 20 J=1,15
      WRITE(22,202)(SCORE(J,I),I=1,10)
20     CONTINUE
C  COMPUTE DISTANCES AND WRITE
      DO 22 I=2,15
      L=I-1
      DO 22 J=1,L
      DIST(I,J)=0.0
      DO 21 K=1,10
21     DIST(I,J)=DIST(I,J)+(SCORE(I,K)-SCORE(J,K))**2
22     DIST(I,J)=SQRT(DIST(I,J))
      DO 23 I=2,15
      L=I-1
      WRITE(6,210)(DIST(I,J),J=1,L)
23     WRITE(23,210)(DIST(I,J),J=1,L)
8      CONTINUE
C  END DO LOOP #8
12     CONTINUE
101    FORMAT(30I2)
102    FORMAT(4(I1,A4,15F1.0))
103    FORMAT(I3)
201    FORMAT(I7,15(/,10F8.2))
202    FORMAT(10F8.2)
203    FORMAT(F10.1,3(/,10F10.5))
204    FORMAT(3(/,10F10.5))
210    FORMAT(14F9.5)
300    FORMAT(' ORDER TOO HIGH, ', I5,2I5)
301    FORMAT(' **ERROR ORDER ',I4,/,5X,15I4)
302    FORMAT(' **ERROR IMPROPER LIMITS',2I10,F10.5)
303    FORMAT(' **ERROR REPEATED CARD NAME ,ID ',I5,', ISCALE',I5)
304    FORMAT(' **ERROR NMIND = ',I5,', THIS IS GREATER THAN 75')
401    FORMAT(I8,/,15F7.1)

402    FORMAT(15F5.0)
403    FORMAT(I3,I1,15F2.0)
      END

```

A3 - 2

SOURCE LISTING OF MATRIX COMPUTER PROGRAMUsed To Test Equality of Covariance Matrices and To Compute MANOVA

(This program uses subroutines to multiply, invert, print, and take eigenvalues of matrices.)

```

      DIMENSION N(3),S(30,3,4),STOT(3,4),STT(4),E(4,4),H(4,4),LV(4),MV(4
      1),TEMP(4,4),EH(4,4),SIGMA(4,4),SS(4,4)
C   POSITION TAPE 23 STARTING AT SECOND RECORD
      READ(23,103)A
C   START.  READ DATA AND ZERO VARIABLES.
      C=0.0
      EM=0.0
      READ(5,101)NGRP,NDIM,N(1),N(2),N(3)
      NDND=NDIM*NDIM
      NN=N(1)+N(2)+N(3)
      WRITE(6,205)NN
C   ANNA = SUM OF ( N(I) - 1 )
      ANNA=NN-NGRP
      DO 11 J=1,NGRP
        M=N(J)
        DO 10 I=1,M
10      READ(23,102)(S(I,J,K),K=1,NDIM)
        DO 11 I=1,NGRP
11      SS(I,J)=0.0
C   END.  READ DATA AND ZERO VARIABLES.
C
C   CALCULATE STOT AND STT
C   STOT(J,I) = SUM OF S(K,J,I) FOR GROUP 'J' AND DIMENSION 'I'
C   STT(I) = SUM OF ALL S(K,J,I) FOR DIMENSION 'I'
      DO 2 I=1,NDIM
        STT(I)=0.0
        DO 2 J=1,NGRP
          STOT(J,I)=0.0
          L=N(J)
          DO 1 K=1,L
1          STOT(J,I)=STOT(J,I)+S(K,J,I)
2          STT(I)=STT(I)+STOT(J,I)
        DO 12 I=1,NGRP
          L=N(I)
          WRITE(6,206)((S(J,I,K),K=1,NDIM),J=1,L)
12      WRITE(6,207)(STOT(I,K),K=1,NDIM)
          WRITE(6,207)STT
C

```

```

C  START TEST OF COVARIANCE MATRICES.
C  SIGMA = COVARIANCE MATRIX OF EACH GROUP * ( N(I)-1 )
C  SS = OVERALL COVARIANCE MATRIX
      DO 34 I=1,NGRP
        L=N(I)
        DO 32 J=1,NDIM
          DO 32 M=1,NDIM
            SIGMA(J,M)=0.0
            DO 31 K=1,L
31      SIGMA(J,M)=SIGMA(J,M)+S(K,I,J)*S(K,I,M)
32      SIGMA(J,M)=(SIGMA(J,M)-STOT(I,J)*STOT(I,M)/FLOAT(L))/FLOAT(L-1)
        CALL PRINT(NDIM,NDIM,SIGMA)
        DO 33 J=1,NDIM
          DO 33 M=1,NDIM
33      SS(J,M)=SS(J,M)+FLOAT(L-1)*SIGMA(J,M)/ANNA
        CALL MINV(SIGMA,NDIM,D,LV,MV,NDND)
C  EM= ( SUM OF ( N(I)-1 ) ) * LOG (DETERMINANT OF SS) - SUM OF
C      ( ( N(I)-1 ) * LOG(DETERMINANT OF SIGMA) )
      EM=EM-FLOAT(L-1)*ALOG(D)
C  C = 1 - (( 2P**2 - 3P +1 )/( 6 (P+1) ( K-1 ) ))( SUM OF (1/( N(I) -1)
C      - 1 / ( SUM OF ( N(I)-1 ) )))
34      C=C+1.0/FLOAT(L-1)
      CALL PRINT(NDIM,NDIM,SS)

      CALL MINV(SS, NDIM,D,LV,MV,NDND)
      EM=EM+ANNA*ALOG(D)
      C=1.0-(FLOAT(NDIM*(2*NDIM+3)-1)/FLOAT(6*(NDIM+1)*(NGRP-1)))*(C-
11.0/ANNA)
      WRITE(6,112)EM,C
C  END TEST OF COVARIANCE MATRICES.
C
C  START CALCULATIONS OF E AND H MATRICES FOR MANOVA
C  E(I,J) = SUM OF ( S(M,K,I) * S(M,K,J) ) - SUM OF (STOT(K,I) * STOT(K,J)
C      / ( N(K) ) )
C  H(I,J)= SUM OF (STOT(K,I)*STOT(K,J)/ (N(K) ) ) - STT(I) * STT(J) / NN
      DO 4 I=1,NDIM
        DO 4 J=1,NDIM
          E(I,J)=0.0
          H(I,J)=0.0
          DO 3 K=1,NGRP
            H(I,J)=H(I,J)+STOT(K,I)*STOT(K,J)/FLOAT(N(K))
            L=N(K)
            DO 3 M=1,L
3          E(I,J)=E(I,J)+S(M,K,I)*S(M,K,J)
            E(I,J)=E(I,J)-H(I,J)
            H(I,J)=H(I,J)-STT(I)*STT(J)/FLOAT(NN)
            IF (I.NE.J)E(J,I)=E(I,J)
            IF (I.NE.J)H(J,I)=H(I,J)
4          CONTINUE

```

```

      CALL PRINT(NDIM,NDIM,H)
      CALL PRINT(NDIM,NDIM,E)
C
C   CALCULATING LAMBDA**2/N
C   LAMBDA**2/N = 1 / DETERMINANT OF ( IDENTITY + E-INVERSE * H )
C
C   CALCULATE E-INVERSE
      CALL MINV(E,NDIM,D,LV,MV,NDND)
      CALL PRINT(NDIM,NDIM,E)
C   CALCULATE E-INVERSE * H
      CALL MULT(NDIM,NDIM,NDIM,E,H,TEMP)
      CALL PRINT(NDIM,NDIM,TEMP)
C   CALCULATE I + E-INVERSE * H = TEMP
      DO 6 I=1,NDIM
        DO 5 J=1,NDIM
          5   EH(I,J)=TEMP(I,J)
          6   TEMP(I,I)=TEMP(I,I)+1.0
        CALL PRINT(NDIM,NDIM,TEMP)
C   CALCULATE DETERMINANT OF TEMP, ITS RECIPROCAL, AND THE TEST STATISTIC
      CALL MINV(TEMP,NDIM,D,LV,MV,NDND)
      WRITE(6,201)D
      D=1.0/D
      WRITE(6,202)D
      D=(FLOAT(NSRP-MN)+0.5*FLOAT(NDIM-NGRP+2))*ALOG(D)
      WRITE(6,203)D
C   CALCULATE MAX. CHAR. ROOT OF TEMP.
      CALL EIGEN(EH,R,NDIM,1,NDND,1)
      CALL PRINT(NDIM,NDIM,EH)
C   CALCULATE TEST STATISTIC FOR UNION INTERSECTION TEST
      QS=EH(1,1)/(1.0+EH(1,1))
      WRITE(6,204)EH(1,1),QS
101  FORMAT(6I2)
102  FORMAT(6X,5F13.5)
103  FORMAT(A6)
112  FORMAT(/,'0 M =',F15.7,10X,'C =',F15.7)
201  FORMAT(/,' DETERMINANT OF I + ( E INVERSE ) H =', F10.7)
202  FORMAT(/,' 1.0/DETERMINANT = ',F20.8)

203  FORMAT(/,' -(N-Q-0.5*(P-R+1))*LOG(1/DETERMINANT) =',F20.8)
204  FORMAT(/,' UNION INTERSECTION MAX. CHAR. ROOT =', F20.8,/, ' QS =
1',F20.8)
205  FORMAT(I5)
206  FORMAT(4F15.5)
207  FORMAT(/,4F15.5,/)
      END

```

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