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Paul E. Green

Marketing Applications of MDS: Assessment and Outlook

After a decade of development, what have we learned from MDS in marketing?

MULTIDIMENSIONAL scaling (MDS) has played an important role in modern marketing analysis. Since 1938, when Richardson published an abstract of the first application of MDS,[1] numerous applications of the technique have been described in various social science publications. During the 1960s and 1970s, in particular, several important descriptions of marketing applications of MDS procedures have appeared in the literature.

To invoke the theme of the recent cigarette commercial, it would seem that we "have come a long way, baby." Or, have we? Just what of significance *has* MDS contributed to marketing analysis over the past several years? Just as importantly, what is the future outlook for these techniques and what problems are most in need of research?

Surely, with the current, almost faddish, interest in product positioning, marketing applications of MDS show few signs of decreasing, even if multidimensional scaling were confined to product design. However, whether these applications represent good science, or even good practice, may be something else again.

This article tries to assess some aspects of the current state of the art in MDS, how we got here, and where we might be going. In spots it is opinionated and speculative; certainly, the author's views may not be shared by others working in the field.

First, a review of the developments made in multidimensional scaling since Richardson's 1938 publication will help to give the reader an idea of how MDS has evolved over the past several decades. Then, two aspects of MDS deserve separate comment:

1. Methodological developments and new scaling models
2. Applications to marketing, in particular to predictive studies in marketing

Each of these topics is discussed separately, leading up to the third purpose of the article—to comment on where marketers are (or, perhaps, should be) going in future research and application.

MDS in Review

The Richardson application followed on the heels of significant mathematical work that provided ways (via matrix decomposition methods similar to those often used in factor analysis) to transform Euclidean distances into a set of point coordinates.[2] Three years later Klingberg published an MDS study of students' perceptions of nations—complete with a picture of a three-dimensional wax model of the stimulus coordinate positions.[3]

In the early 1950s Torgerson,[4] while making extensive contributions to the methodology of metric MDS, rather casually conducted the first marketing study involving consumers' perceptions of various silverware designs as developed, for pretest purposes, by a New England manufacturer.[5]

Aside from a few rather isolated social science applications, and the seminal theoretical work of

1. M. W. Richardson, "Multidimensional Psychophysics," *Psychological Bulletin,* Vol. 35 (1938), pp. 659–660 (abstract).

2. Gale Young and A. S. Householder, "Discussion of a Set of Points in Terms of Their Mutual Distances," *Psychometrika,* Vol. 3 (1938), pp. 19–22; and Charles Eckart and Gale Young, "The Approximation of One Matrix by Another of Lower Rank," *Psychometrika,* Vol. 1 (1936), pp. 211–218.

3. Frank L. Klingberg, "Studies in Measurement of the Relations Among Sovereign States," *Psychometrika,* Vol. 6 (December 1941), pp. 335–352.

4. Warren S. Torgerson, *Theory and Methods of Multidimensional Scaling* (New York: John Wiley & Sons, 1958).

5. Personal communication from W. S. Torgerson.

Journal of Marketing, Vol. 39 (January 1975), pp. 24–31.

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Coombs and his colleagues, activity in multidimensional scaling remained fairly dormant until 1962.[6] It was then that Shepard published the first operational procedure for the multidimensional scaling of rank order (nonmetric) input data.[7] Less than a year later researchers at Du Pont were applying nonmetric MDS to a variety of problems in consumer perception and evaluation.[8]

Few developments have touched off the intensity of activity—in marketing and elsewhere—that has followed Shepard's theoretical and algorithmic contributions, as aided by developments in computer science itself. Activity proceeded along both the methodological and applied fronts, more or less concurrently.

In particular, published applications to marketing began with the rather methodologically crude (but conceptually insightful) suggestions of Stefflre[9] and Morgan and Purnell[10] for finding "holes" or "gaps" in product or service attribute spaces. Green and Carmone, in the first marketing-oriented book on the subject, then described how MDS could be used in a variety of marketing problems, including market segmentation, life cycle analysis, and product/service evaluation.[11] More recently, marketing has witnessed the publication of three comparatively sophisticated models—those of Pessemier and Root,[12] Shocker and Srinivasan,[13] and Urban[14]—that employ MDS procedures for new product design and evaluation.

6. Clyde H. Coombs, *A Theory of Data* (New York: John Wiley & Sons, 1964).

7. Roger N. Shepard, "The Analysis of Proximities: Multidimensional Scaling with an Unknown Distance Function, Part One," *Psychometrika,* Vol. 27 (1962), pp. 125–139.

8. David H. Doehlert, "Similarity and Preference Mapping: A Color Example," in *Proceedings of the Denver Conference of the American Marketing Association,* R. L. King, ed. (Chicago: American Marketing Assn., 1968), pp. 250–258.

9. Volney J. Stefflre, "Market Structure Studies: New Products for Old Markets and New Markets (Foreign) for Old Products," in *Application of the Sciences in Marketing,* F. M. Bass, C. W. King, and E. A. Pessemier, eds. (New York: John Wiley & Sons, 1969), pp. 251–268.

10. N. Morgan and J. Purnell, "Isolating Openings for New Products in a Multidimensional Space," *Journal of the Market Research Society,* Vol. 11 (July 1969), pp. 245–266.

11. Paul E. Green and Frank J. Carmone, *Multidimensional Scaling and Related Techniques in Marketing Analysis* (Boston, Mass.: Allyn & Bacon, 1970).

12. Edgar A. Pessemier and H. Paul Root, "The Dimensions of New Product Planning," JOURNAL OF MARKETING, Vol. 37 (January 1973), pp. 10–18.

13. Allan D. Shocker and V. Srinivasan, "A Consumer-Based Methodology for the Identification of New Product Ideas," *Management Science,* Vol. 20 (February 1974), pp. 921–937.

14. Glen L. Urban, "PERCEPTOR: A Model for Product Design" (Working paper 689-73, Massachusetts Institute of Technology, December 1973).

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Methodological Developments

Since Shepard's 1962 publication, literally scores of computer programs have been developed for metric or nonmetric scaling of similarities or preference data. Ancillary techniques for configuration matching, cluster analysis, property scale fitting, and the like, have also been developed and applied, at least on a limited basis.

In the course of this activity, a number of ideas and myths have developed, often based on tentative research findings, that have frequently confused (and possibly even misled) the applications researcher. With the luxury of hindsight, several of these more tentative impressions about nonmetric MDS can be clarified.

Computer Program Differences. A number of researchers have developed programs for performing nonmetric MDS, ranging from the omnibus programs of Kruskal and Young[15] to the collection of special-purpose programs by Guttman and Lingoes.[16]

Despite earlier publicity that the programs were "really different," it has become quite clear that algorithms designed for pretty much the same thing have provided pretty much the same results. Comparison studies of approaches and algorithms in MDS are now on the wane.[17] The applied researcher has tended to settle on a subset of the programs that fits his own tastes and experience.

The Metric versus Nonmetric "Controversy." The initial debate about the relative merits of the two approaches has turned out to be more of theoretical than practical interest. In many applied problems, metric and nonmetric methods yield very similar solutions—at least if the scaling is done in the correct dimensionality. The principal difficulty with the metric methods is their tendency to produce artifact dimensions if linear assumptions are not met. However, the configuration in the "correct" dimensionality is often not disturbed by this.[18]

15. Joseph B. Kruskal, Forrest W. Young, and Judith B. Seery, "How to Use KYST, a Very Flexible Program to Do Multidimensional Scaling and Unfolding," multilithed (Murray Hill, N.J.: Bell Laboratories, April 1973).

16. James C. Lingoes, *The Guttman-Lingoes Nonmetric Program Series* (Ann Arbor, Mich.: Mathesis Press, 1973).

17. As illustrations, see Paul E. Green and Vithala R. Rao, *Applied Multidimensional Scaling: A Comparison of Approaches and Algorithms* (New York: Holt, Rinehart & Winston, 1970); and James C. Lingoes and Edward E. Roskam, "A Mathematical and Empirical Analysis of Two Multidimensional Scaling Algorithms," *Psychometrika Monograph Supplements,* Vol. 38 (December 1973).

18. Roger N. Shepard, "A Taxonomy of Some Principal Types of Data and Multidimensional Methods for Their Analysis," in *Multidimensional Scaling: Theory and Application in the Behavioral Sciences,* Vols. 1 and 2, Roger N. Shepard, A. Kimball Romney, and Sara B. Nerlove, eds. (New York: Seminar Press, 1972), pp. 23–51; and personal communications at Bell-Penn Workshop on MDS Methods, June 1972.

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More importantly, it is not only easy but generally desirable to scale data, for comparative purposes, by *both* metric and nonmetric methods. Many of the MDS procedures, in providing both metric and nonmetric solutions in a single run, allow this to be done quite efficiently.[19]

More Flexible Distance Functions. Another aspect of nonmetric algorithms, namely their ability to scale data with distance functions other than the familiar Euclidean metric, has turned out to be a somewhat illusory benefit. A number of researchers have independently found, through analyses of synthetic data (designed to depart substantially from the Euclidean metric), that Euclidean approximations have been so close as to obviate the need to search for the "correct" metric in all but the most esoteric of applications.[20]

Importance of Stress Values. Early (and, often, almost blind) reliance on statistical fit measures like Kruskal's stress as an indication of "correct" dimensionality has given way to the use of more sensible criteria such as replicability of results and interpretability of the solution. Increasing use is also being made of complementary techniques, like cluster analysis, for interpreting selected regions of the space. Indeed, Shepard has advanced the view that applications researchers might confine MDS solutions to two or three dimensions (regardless of high stress values) so that the visual aspects of the analysis are always maintained.[21]

Preoccupation with Dimension Interpretation. Approaches that initially emphasized dimensional interpretation of solutions have been augmented by the development of procedures for interpreting data structures that may be mixtures of class-like and dimensional variation. For example, subjective similarities of beverages may involve a combination of class-like descriptors (fruit juices, soft drinks, alcoholic beverages) and dimensional variation (color, sweetness). Researchers are developing typologies that seem capable of describing a wide variety of data patterns—dimensional or otherwise—that appear in the scaling of social science data.[22]

Proliferation of Algorithms. The widespread activity in algorithmic development, characteristic of MDS over the past decade, shows signs of leveling off. Fewer really new models have been developed over the past few years, as researchers explore the potentialities of the large number of models already available.

However, there are exceptions to this. In particular, individual differences models, exemplified by Carroll and Chang's INDSCAL, have increased the power of MDS tools to deal with multi-way data, such as similarities judgments of different persons over different testing occasions, as collected by different data collection procedures.[23] INDSCAL, for example, is capable of handling up to a seven-way data classification and possesses the further advantage of providing unique orientations of the configuration (assuming the model holds).

Future Prospects. Despite the current lull in new model development, a number of possibilities for innovation can be envisioned. For example, conjoint measurement, a related methodology, offers interesting potential for the marketing analyst.[24] Combination dimensional-categorical models and new ways of looking at hierarchical tree structures are examples of what may be on the horizon.[25]

In summary, algorithmic activity in MDS is far from moribund, although marketers will probably not see the type of fever pitch that characterized the field in its formative years. Moreover, philosophical views about the role of MDS methods in behavioral science appear to have moved from the more naive position that the models, per se, represent accurate descriptions of psychological phenomena, to the employment of MDS as a methodology for either (a) searching out patterns in data (dimensional patterns or otherwise) or (b) exploring the multidimensional aspects of psychophysics.[26] Clearly, both objectives can be pursued over a sequence of experiments.

Marketing Applications of MDS

Judging from the recent development of rather comprehensive models for generating and testing new products, one could get the idea that MDS in marketing has finally come of age.[27] It will be

19. Kruskal, Young, and Seery, same reference as footnote 15; and Lingoes, same reference as footnote 16.

20. Same references as footnote 18.

21. Same references as footnote 18.

22. Richard L. Degerman, "The Geometric Representation of Some Simple Structures," in *Multidimensional Scaling: Theory and Applications in the Behavioral Sciences,* Vol. 1, Roger N. Shepard, A. Kimball Romney, and Sara B. Nerlove, eds. (New York: Seminar Press, 1972), pp. 194–212.

23. J. Douglas Carroll and Jih Jie Chang, "Analysis of Individual Differences in Multidimensional Scaling via an *N*-way Generalization of Eckart-Young Decomposition," *Psychometrika,* Vol. 35 (1970), pp. 283–319.

24. Paul E. Green and Yoram Wind, *Multiattribute Decisions in Marketing: A Measurement Approach* (Hinsdale, Ill.: The Dryden Press, 1973).

25. J. Douglas Carroll and Jih Jie Chang, "A General Procedure for Fitting Tree Structure Models to Dissimilarity Data" (Working paper, Bell Laboratories, Murray Hill, N. J., 1974).

26. David H. Krantz, R. Duncan Luce, Patrick Suppes, and Amos Tversky, *Foundations of Measurement,* Vol. 1 (New York: Academic Press, 1971).

27. Pessemier and Root, same reference as footnote 12; Shocker and Srinivasan, same reference as footnote 13; and Urban, same reference as footnote 14.

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argued, however, that the utilization of such global, prescriptive models is still subject to a number of problems.

First, the Pessemier and Root, Shocker and Srinivasan, and Urban systems notwithstanding, it seems fair to say that most business applications to date have used MDS for the rather vague (but apt) purpose of "diagnostic aid." Perceptual and preference mapping has been applied to a wide variety of product classes—beers, soft drinks, cereals, fabric softeners, transportation modes, antacid compounds, and others—often with one or more of the following questions in mind:

1. What are the major perceptual and evaluative dimensions of the product class?
2. What existing brands are perceived as similar to what other existing brands?
3. What are the major perceptual points of view among consumers?
4. What new brand possibilities are suggested by the configurations of existing brands?
5. How are respondent ideal points or preference vectors distributed in the various perceptual spaces?
6. How compatible are various advertising messages, slogans, or other types of promotional materials with brand perceptions?

Business and consultative studies employing MDS have tended to utilize perceptual or evaluative maps in rather ad hoc ways to see what combinations of attributes might be useful for new product development or whether some current promotional campaign appears to be "moving" the brand toward some desired location in the space.[28] Indeed, as most researchers know, MDS procedures are usually woefully inadequate for generating, or testing, really new product ideas—those ideas that involve new dimensions (outside the consumer's experience) or juxtapositions of dimensions from nominally different product classes.

Now, of course, comprehensive MDS-type models are available for systematizing the new product generation and evaluation process. Although developed independently, these models all appear to be quite similar in the following respects:

1. Emphasis on developing product-service spaces by the use of consumer ratings on prespecified attribute scales
2. The general assumption of homogeneity of perceptual spaces across consumers
3. Fitting of preference data into previously constructed perceptual spaces via external (regression-type) methods involving ideal point and/or vector representations of preferences
4. Incorporation of some function for relating probability of choice to weighted distance from ideal point

In addition, Shocker and Srinivasan describe some procedures for searching the perceptual space to find coordinate representations that stand a good chance of enjoying a high share of choices, given the current distribution of brands and ideal points.

Other models with similar characteristics have been described by Green and Carmone,[29] but it is not the purpose here to cavil over differences in concept and methodology among the integrative models. Rather, it seems that the heart of the issue is whether *any* of these models supply much operational guidance for new product design. Put more simply, do the models provide one with the ability to design and synthesize new objects whose share of choices can be predicted?

In this author's opinion they do not; and, in this sense, they are more "diagnostic" than predictive. Shocker and Srinivasan put the matter in perspective when they talk about "actionable attributes" as a rationale for the direct rating of products or services. They are (correctly) interested in those product attributes that can be changed by the marketer. What appears to be missing, however, are descriptions of how *any* of the models propose to transform psychological dimensions—actionable or not—into "objective" dimensions. Moreover, the converse problem of predicting psychological response to physical changes in stimuli is also far from trivial and, indeed, is not treated in any of the models.

Thus, valuable though they may be for integrating certain aspects of perception-preference-choice, the comprehensive models may not be comprehensive enough. This is no indictment of their usefulness but, rather, a cautionary note that suggests other kinds of research that could be complementary to that leading up to the present models.

Prediction Problems

In discussing the problem of predicting response to some new stimulus, one could take the extreme view that objective-perceptual transforms are interesting only as intervening variables that underlie utility functions. That is, one could argue that the "ultimate" set of arguments of the utility function consists of the *objective* (physical) dimensions

28. Paul E. Green and John L. McNennamin, "Market Position Analysis," in *Marketing Manager's Handbook*, Steuart Henderson Britt, ed. (Chicago: Dartnell Corp., 1973), pp. 501–514.

29. Green and Carmone, same reference as footnote 11.

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under control of the researcher or product designer.

One limitation of this viewpoint is that different people may like some stimulus object for different reasons; that is, they may perceive it differently. If perceptual judgments are not obtained, evaluative dimensions become confused with differences in perception; hence, intermediate information on perception is lost. Pragmatically speaking, the researcher may not view the information loss as particularly important as long as he can still predict preferences for new stimuli.

However, even granting the desire to concentrate on physical characteristics and their utilization in predicting preferences, in many applied problems of managerial interest the possible objective dimensions are myriad and the psychological transformations complex. Viewed from the other side—that is, from the perceptual space—all one can do is ask the product designer to develop a "sportier" car or a more "full-bodied" beer. The burden of transforming psychological dimensions into manipulable dimensions is left to the designer to be "solved" in some ad hoc way. The researcher can then (hopefully) "test" to see whether these new objects are positioned where they "should be" in the space. This has been the view adopted by Stefflre, among others.

If this is the kind of situation that prevails, then the comprehensive models leave one of the most crucial problems—the bilateral relationship of psychological dimensions to manipulable dimensions —unsolved. As such, it would seem that the models are much more diagnostic than the more naive researcher might think they are.

The diagnostic nature of comprehensive MDS models is also apparent at the product concept-testing level in the context described by Wind.[30] Indeed, if anything, the problem is exacerbated by the presence of *two* sources of uncertainty: (a) the consumer's uncertainty about what the real object, whose verbalized description he is being asked to evaluate, will be like; and (b) the designer's uncertainty about translating a verbalized description into a physical prototype (for those concepts that receive high consumer evaluations).

Multidimensional Psychophysics

Perhaps all product design situations are not this bleak. One would hope that situations exist where one can deal with stimuli that are relatively simpler, from a physical or chemical standpoint (or a significant portion of the problem can be so described). For example, one might wish to examine the relationship between subjective judgments of "full-bodiedness" and the alcoholic content, specific gravity, and color of beer. While these variations may not fully capture the perception of "full-bodiedness," the presumption is that a number of problem situations occur in which one could predict subjective judgments of diverse kinds—perception, imagery, preference—to changes in manipulable characteristics. Many problems in package design and pricing appear to be of this type.

The models of conjoint measurement appear particularly relevant in this regard. They emphasize the synthesis of objects according to controllable attribute levels, either by construction or by selection from existing objects. The focus is on the provision of explicit, manipulable dimensions so that one can make up new combinations of attributes and predict how consumers will react to them.

A small-scale illustration of this approach appears in Figure 1, which is taken from a study of the imagery evoked by three physical characteristics of bar soaps: color, type of fragrance, and intensity of fragrance.[31] In this study *actual bars* (not verbalized descriptions) of soap were made up by laboratory technicians who systematically varied the preceding characteristics. Respondents were allowed to handle and smell the soaps prior to making various judgments about their relative degree of appropriateness for various uses.

An additive conjoint measurement model was then used to develop psychophysical functions. The psychological scale values appear on the ordinate scales in each panel of the figure and are measured in common unit (but arbitrary origin). In particular, one can see how the psychological response, end-use appropriateness, is related to physical changes in the bar soaps.

As noted, type of fragrance represented the primary contributor to judged appropriateness for the four use-scenarios described in the figure. In particular, the medicinal-type scent was judged most appropriate for oily skin and a man's deodorant soap, while the floral fragrance was judged most appropriate for dry skin and a woman's deodorant soap.

The main point of interest, however, is that subjects judged factorially designed stimuli, with research emphasis placed on the development of psychophysical transformations of multidimensional objects. This research view is in rather sharp contrast to the large-scale models in which the

30. Yoram Wind, "A New Procedure for Concept Evaluation," JOURNAL OF MARKETING, Vol. 37 (October 1973), pp. 2–11.

31. Paul E. Green and Yoram Wind, "Recent Approaches to the Modeling of Individuals' Subjective Evaluations" (Paper presented at the Attitude Research Conference, Madrid, Spain, December 1972).

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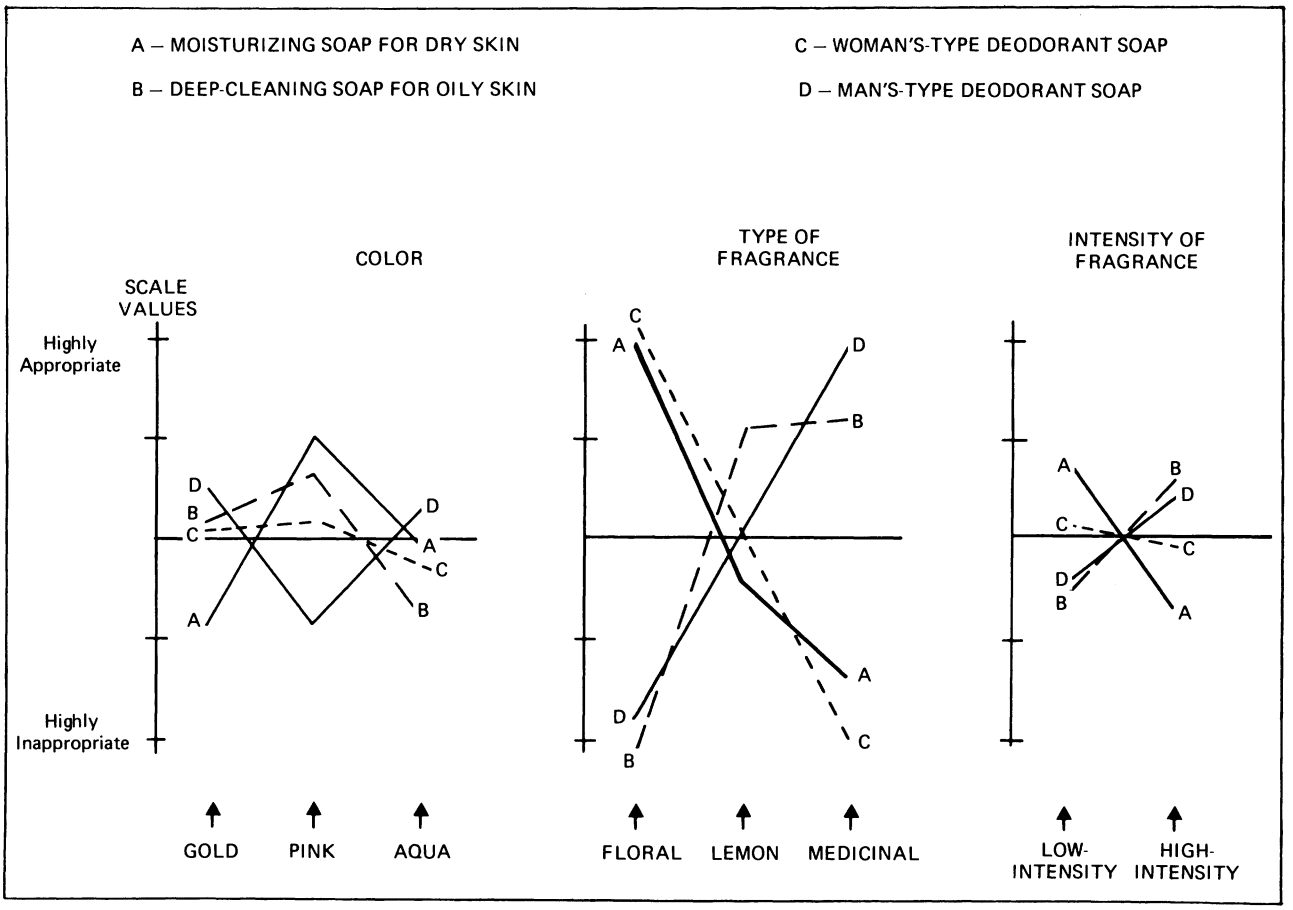

FIGURE 1. Conjoint measurement of judged appropriateness of bar soaps for various uses.

arguments of the preference functions are still verbalized dimensions, either attribute ratings as such or dimensions obtained from dissimilarities indexes constructed across consumers' ratings of the brands on prespecified scales.

Of course, there are trade-offs encountered in an approach that emphasizes controllable dimensions. Insofar as any single experiment is concerned, one is limited in the number of factors that can be experimentally varied, even if fractional layouts are used. In most cases of interest, a sequence of experiments would have to be designed to cover the domain of interest adequately. In addition, present techniques of response surface exploration might have to be modified substantially to cope with judgmental-type responses. In particular, new experimental layouts involving incomplete block designs and orthogonal arrays may need to be developed.[32]

Thus, the multidimensional psychophysics approach may not appeal to all researchers, perhaps because of the relative slowness by which transformational rules are constructed and the limitations imposed by the presupposition that all dimensions be manipulable in an explicit, replicable way. However, if psychophysical studies are completely neglected, it is hard to see how the product design problem can ever move outside the realm of individualistic interpretation of verbalized dimensions.

In summary, the comprehensive models stop with verbalized dimensions, based either on direct ratings or some linear composite of attribute ratings. Two sources of error in predictive studies are involved: translation to manipulable characteristics and back-translation to psychological dimensions. Unfortunately, little is known about the seriousness of either of these potential errors.

The Future Outlook for MDS in Marketing

The development of comprehensive models of the Pessemier and Root, Shocker and Srinivasan, and Urban variety should be welcomed by the marketing community. These models are evidence of the fact that MDS has progressed from curiosity-type tools to a set of integrated techniques that provide ways to incorporate perceptual and evaluative information for policy-type decisions.

32. Paul E. Green, "On the Design of Choice Experiments Involving Multifactor Alternatives" (Working paper, University of Pennsylvania, November 1973).

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If coupled with experimental work of a multidimensional psychophysics nature, the large-scale models might become even more comprehensive by inclusion of relationships between psychological judgments and manipulable dimensions. Still, predictive problems remain, even if the researcher does not want to restrict his attention to controllable dimensions. That is, even if subjective judgments are incorporated at various stages in the product design models, one still has the problem of predicting outcomes at subsequent stages.

In this regard, Green and Rao have tried to sketch out a series of controlled experiments ranging from the prediction of preferences for stimuli designed according to objective characteristics only, to the incorporation of various intermediate judgments about the new stimuli, as obtained from respondents themselves.[33] Research in this area is painstaking, and only a few attempts (e.g., Huber's work)[34] have been made to examine the predictive aspects of various MDS models under anything approaching closely controlled conditions.

Fortunately, an apparatus (in the form of INDSCAL) exists to enable the researcher to explore perceptual domains systematically. Many researchers have independently found that on any specific testing occasion only two or three dimensions are required to account for an individual's impressions of stimulus similarity. This may be due to inherent difficulties in perceiving changes along more than two or three dimensions at a time, or the possibility that finer discriminations are not required. In any case, the individual's full cognitive domain appears to be highly scenario dependent: different dimensions are evoked in different contexts.[35]

Thus, the domain may be of high dimensionality, even though only a subspace is used for a specific scenario. INDSCAL permits the researcher to synthesize the domain from a series of separate experiments in which only a few dimensions may be tapped in any single task. In the author's view, INDSCAL can provide a valuable tool for constructing more complex cognitive domains than single-shot studies are able to develop.

33. Paul E. Green and Vithala R. Rao, *Applied Multidimensional Scaling: A Comparison of Approaches and Algorithms* (New York: Holt, Rinehart & Winston, 1972), pp. 147–151.

34. Joel Huber, "The Psychophysics of Taste: Perceptions of Bitterness and Sweetness in Iced Tea," in *Proceedings of the 4th Annual Conference of the Association for Consumer Research,* S. Ward and P. Wright, eds. (Urbana, Ill., 1974), pp. 166–181.

35. As illustrations, see R. M. Fenker and D. R. Brown, "Pattern Perception, Conceptual Spaces and Dimensional Limitations on Information Processing," *Multivariate Behavioral Research,* Vol. 4 (July 1969), pp. 257–272; and Paul E. Green and Frank J. Carmone, "The Effect of Task on Intra-Individual Differences in Similarities Judgments," *Multivariate Behavioral Research,* Vol. 6 (October 1971), pp. 433–450.

Other Models

If progress in applied MDS is to continue, it also seems clear that other models are needed in addition to the aforementioned research on comprehensive new product models and multidimensional psychophysics. A few glimmerings of new —and potentially useful—models are already evident. In the context of MDS, Pessemier has described a discriminant model that is applicable to a single subject.[36] Green has developed a model for describing product-features associations.[37] Both of these models, while still tentative and relatively untested, represent departures from the mainstream of modeling efforts in MDS.

In the broader area of multiattribute stimulus evaluation, the work by Bettman, Capon, and Lutz in functional measurement is illustrative of the potential for whole new classes of models,[38] as in the portfolio-type model developed by Farquhar and Rao.[39] Extensions of conjoint measurement to deal with complementarity[40] and the incorporation of others' evaluations[41] also appear promising. Moreover, Johnson's work in applying conjoint measurement to a variety of business problems suggests a favorable potential for these procedures in marketing research.[42]

In conclusion, the development and diffusion of any new methodology like MDS tends to proceed more or less simultaneously (and, perhaps, fitfully at times) along several fronts. Comprehensive new product models of the type proposed by Pessemier, Root, Shocker, Srinivasan, and Urban represent only one—albeit important—research path.

What has been argued here is that researchers should consider other gaps in the field's development. In particular, models of the psychophysics of product design, consumer imagery, the construction of more complete cognitive domains, the utili-

36. Edgar A. Pessemier, "Joint-Space Analysis of the Structure of Affect Using Single-Subject Discriminant Configurations: Part I" (Working paper 435, Purdue University, Lafayette, Ind., November 1973).

37. Paul E. Green, "A Model of Product Features Association," *Journal of Business Research,* Vol. 2 (April 1974), pp. 107–118.

38. James R. Bettman, Noel Capon, and Richard J. Lutz, "Cognitive Algebra in Multiattribute Attitude Models" (Working paper No. 10, Center for Marketing Studies, University of California, Los Angeles, February 1974).

39. Peter H. Farquhar and Vithala R. Rao, "A Balance Model for Evaluating Subsets of Multiattribute Items" (Working paper, Cornell University, Ithaca, N. Y., January 1974).

40. Paul E. Green and Michael T. Devita, "A Complementarity Model of Consumer Utility for Item Collections" (Working paper, University of Pennsylvania, March 1974).

41. Paul E. Green, "On the Analysis of Interactions in Marketing Research Data," *Journal of Marketing Research,* Vol. 10 (November 1973), pp. 410–420.

42. Richard M. Johnson, "Trade-Off Analysis of Consumer Values," *Journal of Marketing Research,* Vol. 11 (May 1974), pp. 121–127.

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ty for item collections, the influence of others' judgments on one's own utility, and interobject complementarity are illustrative of areas for productive future research in MDS and related methodology.

Perhaps we "have come a long way, baby." Perhaps not. At any rate, there's still a long way to go. At least let us hope so.

MARKETING MEMO

Suburbs, Our New Industrial Centers . . .

Most classifications broadly divide suburbs into residential and employment types. But though the ring communities are popularly viewed as dormitories for big cities, several actually got their start as manufacturing centers. . . .

Although several ring communities owe their origins to industry, a far greater number acquired an economic base when new businesses were created to serve exploding populations or when plants and offices took flight from core cities. Much has been made of city ills that drive industry out; yet the changed complexion of industry in recent years has probably had more to do with the exodus.

A few of the factors: lower labor-capital ratio made possible by automation, declining demand for unskilled labor as jobs become more complex, changeover in production processes from vertical to horizontal plant layout, growing supply of part-time labor provided by working suburban wives, revolution in communications technology, reducing the need for face-to-face contact, and the greater use of truck transport for distributing goods from decentralized production and warehousing points. All work to the suburbs' advantage.

. . . beltways weaken the links between central cities and their suburbs in another manner. . . . compared with earlier highways that interconnected core cities, the new beltways connect the suburbs of a single city so that you can travel from one satellite to another without once passing through the central city. Thus you create a new set of travel and commuting patterns which can only increase the independence of these suburbs from the parent city.

Another recent trend that promises to pull more industry into the suburbs is the outward thrust of industrial parks and airports, both requiring large tracts of land, to the outer fringes of metro areas. The new Dallas-Fort Worth airport, for example, already has 146 industrial parks ringing it.

—Thayer C. Taylor, "Urbanizing Suburbia," *Sales Management,* Vol. 112 (March 4, 1974), pp. 23–36, at pp. 24, 26, 27. Reprinted by permission from *Sales Management,* The Marketing Magazine. Copyright 1974.

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