6 Extension of Present Methodology

Paul Shuldiner, University of Massachusetts

The 3 sections of this report are methodology, application, and strategy. The first 2 sections draw heavily on the resource papers by Brand, Burnett, and Gilbert in this Special Report. The last section reflects the discussions and issues raised during the conference.

A word is perhaps in order regarding some of the words used with regard to demand models. It is assumed that the underlying motive of our efforts is to build "better" models of travel choice and that better models require greater behavioral content. It then follows that models that deal most directly with true behavioral units, that is, disaggregated models, are called for, and that leads us almost inevitably to probabilistic rather than deterministic mathematical structures. We leave for others the questions as to whether we should speak of probabilistic or stochastic processes and whether aggregate models cannot capture certain behavioral qualities of society more effectively and with greater fidelity than disaggregate ones.

METHODOLOGY

Primary concerns in the area of methodology revolve around problems of aggregation and the relative advantages—and behavioral validity—of direct versus sequential models of travel choice. The aggregation problem (not without some justification at times appearing as the "aggravation" problem) is an inherent concomitant of the disaggregated approach just as the "ecological fallacy" is a natural hazard in aggregative procedures. We have, it seems, in forsaking areal aggregations for more discrete analyses gone from the unsupportable to the intractable. (As one of the authors put it, "There is a sporadic but by no means pervasive recognition that the problem of the ecological fallacy has been replaced by the problem of finding ways to add together models for different individuals in different locations at different times.") That individual behavior can more accurately be observed at the individual level goes almost without saying; that models of such behavior will provide more accurate predictions of future aggregated actions in geographic space has not yet been proved.

Two approaches to dealing with the aggregation problem were discussed by the workshop. The first involves a compromise in which individual behavioral units (e.g., persons or households) are grouped on the basis of similarities in socioeconomic and other presumed behavior-determining attributes rather than lumped together as a consequence of geographic proximity. This approach reduces but does not obviate the danger of generating spurious correlations between group attributes and group travel behavior and still leaves unsolved the problem of aggregating these subgroups into areally specified

populations. A second suggested approach relies on mixing probability distributions for individual decisions to obtain predictions of choice decisions for a heterogeneous group comprising such individuals.

Whether these and other similar efforts will lead to techniques for overcoming the problem of aggregation remains to be seen. It may be that the problems associated with aggregation will prove to be no less serious—and no less fundamental—than those associated with ecological correlations; indeed, the two may simply be mirror images of each other. In any case, it is hard to argue with the conclusion that "...finding a plausible, mathematical, operational and logical resolution of...the aggregation problem seems the most crucial question for modeling travel decisions other than mode choice."

Striking very close to the heart of the behavioral approach to travel choice modeling is the issue of sequential versus simultaneous models. The 4-step sequence of trip generation, distribution, mode choice (or, if we wish to enter into what has been called "the most actively debated issue in modal split," we may transpose the order of the distribution and mode-split steps), and assignment models, so long the mainstay of the urban transportation planning (UTP) process, has in recent years been questioned and, in some instances, successfully challenged by models that treat these 4 steps as a single (simultaneous) decision. Fundamental to this issue is the question of whether travel decisions are made as a whole or step by step in some sequence based on the relative importance of each step to the traveler.

Under either assumption, identification and valuation of transport system attributes remain central issues. Direct demand models in which the parameters associated with each attribute are estimated simultaneously involve no strong assumptions regarding travel choice sequence but tend to be very complex because of the vast number of combinations of alternatives at each level. Models of this type may be simplified by limiting sharply the number of system attributes that are assumed to influence travel choice behavior.

Alternatively, strong (one might suggest heroic) assumptions may be made about the separability of travel choices in the interest of fashioning more simple models. In keeping with the separability property of the Independence of Irrelevant Alternatives Axiom, it may be assumed that the trade-offs at the margin between attribute variables that govern one travel choice do not vary between travel choices. This assumption allows separation of travel choices and a more easily estimated model but still requires an a priori determination of travel choice sequence (or an iterative process) to ensure that the relative marginal utilities among attributes are equal for each travel choice.

Since no attempt is made in estimating the classical UTP chain of models to ensure equality of trade-offs among attributes in each step, significantly different results will follow from different choice orderings. However, if the marginal utilities are preserved at each step, choice ordering will not influence the results and the models can be applied in any order or combination. Conversely, if all choices are estimated simultaneously, the conditional and marginal probabilities of travel choice may be derived and separate submodels or combinations may be applied in any sequence desired.

Closely associated with the issue of separable travel choices is the problem of choice set definition. It would seem, for example, that mode and route choice decisions are logically connected and might profitably be modeled as a joint decision. However, because of the separability property and because of the strong similarity of alternative routes within a given mode, combining these 2 choice sets may lead to erroneous conclusions. The example of the "red bus, yellow bus" problem in certain mode-abstract models also applies. It would appear that judicious use of common sense rather than blind obedience to arbitrary mathematical structures may be of some use in overcoming this dilemma.

It might help in these situations to rely on choice-specific rather than choice-abstract models, particularly when one is dealing with mode choice. The presumed ease with which new, even exotic, models can be introduced into a multiple-choice situation may be more than overbalanced by the restrictions on market-share ratios and cross elasticities imposed by the structure of these models. Realistic (but untestable) a priori assumptions about the differential impacts of new modes might be preferable to em-

pirically testable models based on unrealistic and overrestrictive assumptions and separability conditions. Choice-specific models would likely be less useful in situations other than mode choice where the irrelevance of many alternatives is of far greater importance.

No such simple remedy is available when one is dealing with the identification of choice sets for models of spatial choice. The assumption that all individuals (or aggregations of individuals, for the problem exists at all levels of disaggregation) share the same choice sets is insupportable, yet it forms the basis of all aggregate and most disaggregate trip distribution models. True, we have adjusted our models so that they no longer send ghetto blacks to executive jobs in nearby office towers, but assumptions of universal knowledge and universal opportunity still underlie most spatial-choice models in use today. The natural attenuation of knowledge with distance may minimize this problem in models that make use of an impedance function of one kind or another, but that is a very blunt instrument for the job of delineating choice sets for all but the most ubiquitously distributed activities.

Associated directly with the development of disaggregate probabilistic models of travel choice behavior is the need for improved procedures for testing the statistical validity of the estimates that are obtained through the use of such models. Standard statistical tests appropriate for the standard least squares formulations are not well-suited to the newer class of models. A corollary to this problem is the need for estimation techniques that yield better classification criteria and aid in the selection of explanatory variables.

We should not leave this discussion of methodology without raising some basic questions concerning the fundamental nature of the models that we call "behavioral." As put most forcefully by Burnett, "By far the most serious difficulties for the development of disaggregate, behavioral models of travel stem from the dubious status of the mind as an object of scientific inquiry." (It has been said, with no little justification, that our models of trip-making are Newtonian but that our understanding of the process is pre-Aristotelian. Might it not be self-deluding to think that, simply because our models are now clothed in Freudian garb, our understanding of travel behavior has suddenly leapt ahead by 2 centuries?) If it is true that words describing mental processes are alternative words for overt behavior, then studies of perceptions, attitudes, and preferences may not be analyses of the causes of overt travel behavior and may be inherently and unavoidably tautologies. In the presence of such possibilities, it may be wise to treat behavioral models as nothing more than plausible, convenient constructs for the prediction of travel choices.

The above concerns strengthen the position that disaggregate models can, at best, describe the mean behavior of a group of individuals on the basis of observations of individuals whose actions can be assumed to represent a group with similar traits. Such an interpretation would suggest that even behavioral models can be expected to provide good predictions only in choice situations that closely parallel the situations used in calibrating the model and only for groups whose attributes are not too dissimilar to those whose mean traits are represented in disaggregate observations. As a corollary, it might be argued that disaggregate behavioral models are better suited for explicitly determining aggregation criteria than for predicting. If we cannot escape the ecological fallacy completely, at least we can learn to live with it.

APPLICATION

One of the obvious questions relating to the extension of present disaggregate behavioral models is the set of travel choice situations to which such models might usefully be applied. Disaggregate models of the sort that concerned this conference were first developed for, and have for the most part been applied to, mode choice, particularly the journey to work. Their extension to other trip purposes and to other travel decisions is well justified, if not inevitable.

It may be convenient for the purposes of this discussion to divide travel decisions into 2 broad categories: (a) spatially oriented decisions, which include destination

choice and route choice; and (b) mode choice. Related to both categories are decisions pertaining to trip frequency and trip purpose. These 2 categories are not so separate as the above division might imply, as evidenced by the earlier discussion of separable versus simultaneous models. Nevertheless, investing certain travel decisions with a high degree of spatial content allows for the convenient introduction of a wide variety of disaggregate behavioral models derived from theories of intraurban spatial-choice behavior.

Looking at the issue from a somewhat different point of view, we may identify certain trip purposes—namely, shopping, recreational, and social travel—as representing significant opportunities for application of disaggregate behavioral models. Together these trip purposes constitute about 40 percent of total travel and, in contrast to the journey to work, are governed by behavioral influences not so readily subsumed within classical economic theory. In trips of this type, route and destination choices fluctuate over time and trips are often multipurpose; the sequence of activities varies from trip to trip. The complexity of such travel invites, if not demands, application of disaggregate behavioral models.

There is yet another way of looking at the need and opportunity for extending the use of the newer types of models. By and large, travel modeling has concerned itself with the "average" man. For a variety of reasons, this has resulted in an emphasis, perhaps an overemphasis, on the travel behavior of white males with steady jobs. Recent concern for the handicapped notwithstanding, there are large segments of society whose travel behavior and travel needs have, at least insofar as travel modeling is concerned, been treated with benign neglect. A useful but by no means exhaustive list of such ignored travel includes shopping trips, especially those made by women; work trips by those who are employed either irregularly or for less than a full day; trips by children (from, say, 6 to 17) other than those by school bus; and all non-home-based trips.

Recreational travel of all sorts constitutes an increasingly important travel market and, therefore, an important area of inquiry. Tourism now accounts for a significant proportion of externally derived income in certain areas of the country. As leisure time and disposable income continue to rise, recreational travel will become an even more significant factor in the transportation investment decisions of many states. Although we tend to think of rural areas when we think of recreational travel, the need to understand (model) better urban recreational trip-making should not be ignored. Coney Island, or for that matter Times Square, probably attracts far more trips than do all national parks combined. And urban recreation travel is undoubtedly as rich in behavioral content warranting disaggregate analysis as is its country cousin.

The final point to be made about extending the sphere of application of disaggregate behavioral models deals with the socioeconomic context within which transport investment and travel choice decisions are made. In these days of "oil diplomacy" on both the foreign and domestic fronts, it is naive to assume, explicitly or implicitly, that transport investment decisions, and the travel choices that follow, are not inextricably bound up in the social, economic, and political life of the nation. The logical consequence of this argument is that transport planning, and the travel choice models that aid in this planning, must be sensitive to long-run (and perhaps short-run) changes in tastes (e.g., the ecological issue and the bicycle craze), taxation (e.g., higher gas taxes, parking fees), equal opportunity in housing and employment, income maintenance, transit operating subsidies, and a host of other influences that are normally ignored by most travel-choice equations.

The above argument also suggests that the dichotomization of travel choice into long-run and short-run classes may obscure important real-world behavior. This is not to suggest that only general equilibrium models that capture the interaction of everything with everything else should be allowed. It is to suggest that a somewhat more open mind is needed to deal with the fuzzy gray area in which the short run and the long run merge. For example, the decision to buy (or sell) a car when a second member of the family gets a job is a "middle-run" decision that is influenced by earlier long-run decisions (where to live and work) and will influence subsequent short-run travel choices. As another example, it is reasonable to assume that people who use public transit (a short-run choice) do so not only because they happen to live near a bus line but also

because they have other characteristics that predisposed them to locate near the line they use (a long-run choice).

STRATEGY

There are few things that cannot be improved and, as the foregoing sections would suggest, disaggregate behavioral demand models do not yet fall into that select number. There was general agreement that considerable research is needed and that an improved data base is an essential ingredient in any such effort. Agreement was not reached, however, as to the best way to go about gathering these data, nor was the nature of the research effort specified. Principal areas of disagreement centered about the scale and timing of data acquisition and on how new model developments should relate to the classical methods gathered under the UTP rubric. The brief statements that follow make no pretense of summarizing this debate or of offering a balance of views expressed. They were presented as a part of the workshop's report to the plenary session and are repeated here as such.

Relation to the Current Set of UTP Models

As imperfect as the classical approach may be, the models are in widespread use and will serve as the standard against which newer disaggregate behavioral models will be judged. A mixed strategy of parallel, and perhaps competitive, research to improve elements of the UTP package while wholly new models of travel choice behavior are developed may prove to be not only the soundest but also the most feasible course of action. Perhaps this could best be done in an operational rather than in a pure research context. However, it would certainly be unwise, given past experience in this respect, to attempt to build and apply a complete system of disaggregate behavioral models as a part of an ongoing transportation study. Rather, models for specific travel choices or for a portion of a region should be developed and supported in the background by more prosaic but more predictable models of the classical type. It would be well to be able to show by means of such competition that the newer approaches not only are sounder theoretically and more elegant mathematically than present models but also provide answers more cheaply, more accurately, and more quickly to questions that public administrators require answers to.

Data Collection

There is little question that more and better data are badly needed if significant progress is to be made in the development of disaggregate behavioral models of travel choice. In this regard, the efforts of the U.S. Department of Transportation are to be applauded. However, the case is strong for a continuing rather than a massive one-shot effort. In the first place, the most useful data for these kinds of studies are time series data, preferably before and after. Furthermore, we must be willing to conceive of the possibility of our making mistakes in the specification of data sets and in the design of data collection instruments. There is no way of ensuring against such mistakes, but we can put ourselves in a position to learn from them. By trying to use the data gathered through our first efforts, we can learn how to improve the data as well as the travel choice theories that should provide the basis for subsequent data collection efforts.

Concluding Remarks

It may be of value to contrast the present proposals for large-scale research efforts in travel choice modeling and data acquisition with the development of what has become the urban transportation planning process. By and large the original models were de-

veloped on an incremental basis by people who were seeking answers to pressing problems that they had the responsibility for solving. These people were practitioners, not researchers, and they developed tools that satisfied them as to their usefulness. I am uneasy over the prospects of moving in force directly from the research laboratory to the field of battle. The hazards of making major mistakes and of discrediting what, if done more slowly, could be a continuing process of significant improvement are not to be ignored. The danger is real, and it speaks for the mixed strategy.