

ACTIVITY SYSTEMS AS A SOURCE OF INPUTS FOR LAND USE MODELS

F. STUART CHAPIN, JR. *

This is a time of transition to what may well be a whole new direction of emphasis in land use modeling (and possibly, too, in transportation modeling). While we are just in midstride in the course of achieving a capability in land use modeling, there are indications that increasingly research effort will be focusing on a new challenge—what might be thought of as the “behavioral antecedents” of location decisions. The discussion that follows centers around some work in these directions. It has to do with the analysis of daily routines of land users coupled with an analysis of policies (of firms or institutions) and preferences (of individuals or households) which govern location behavior that we seek to simulate in land use models.

There are several reasons for putting the spotlight on urban phenomena of this kind. A case can be built for this kind of emphasis in modeling efforts purely in terms of the need for developing more sensitive inputs for land use models. But there are other reasons which reinforce this purely technical need. It is becoming increasingly evident that there is a range of variables influencing the behavior of “users of land use” (and users of transportation systems) which in our kind of advanced society cannot be adequately represented in modeling systems by constants or by proxies. Not only has technology altered the chemistry of locational choices, but also coming into play in these decisions are new value emphases which need to be given explicit recognition.

In this paper the position is taken that the use of land in a metropolitan area at any particular point in the normal course of its growth is the sum total effect, aggregated over time, of man’s accommodation to activity routines and to his felt needs concerning environmental qualities. This position holds that location behavior can no longer be disassociated from a larger behavioral system. This is not to disavow the role that the market place plays in the location decision of users of land use. Rather it is to introduce a different point of beginning, an additional and perhaps more fundamental stage to the study of location behavior. It is argued here that causes of location behavior are tied up complexly with daily routines of land users and associated value and policy bases concerning environmental qualities. The emphasis of such an approach goes into factors that location theorists normally treat as constants in their

* Professor of City and Regional Planning, and Director, Center for Urban and Regional Studies, University of North Carolina at Chapel Hill

analysis of the location decision of a firm, a household, or other entities within the city. In emphasizing this pre-analysis stage to location behavior, this paper in effect stresses the importance of stratifying demand for space along lines sensitive to activity systems and preference patterns of space users. The position is taken that the tipping point in location choices, particularly in advanced societies, is more and more to be found in how well behavior patterns are accommodated and how appealing the environment is to the user of space. It is argued that if entirely satisfactory land use forecasts are to be achieved, we can no longer bury these considerations.

There is one other reason that makes it timely to consider such an emphasis. It seems quite clear that the evolution of the state of the arts and the remarkable growth in data handling technology have reached a stage which makes it possible for the first time to move in these directions. Consider the road we have come. Once, all we expected of a model was that "it works." Then as we began using these simple models, we soon discovered that to be really useful to decision-makers these models needed some values where policy changes could be injected. Whether we wanted to or not, we had to ask why it works if we were to be able to incorporate into the design a capability for taking account of differing policy assumptions. The why-question has led to more complex formulations, and fortuitously, computer technology has reached a state of development that makes it possible to execute them.

Yet even as we have begun to approach a capability of this kind through improved models and increased data-handling capabilities, we are experiencing pressures from decision-makers for some means of responding more directly to public preferences. These new pressures thus create an imperative for the application of the new technical capability of the kind we have developed in land use modeling to the more complex area of activity and value systems. Certainly support for this line of emphasis was implicit in the deliberations of the Second National Transportation Conference in 1965 at Williamsburg where much discussion centered around community reaction to highway location decisions and became explicit in discussions of community values at the 1967 Highway Research Board meetings. Taken together, these signs of interest and need lend support to the approach discussed in this paper.

While it is timely to move into a larger behavioral system approach, at the scale of research and development support now available, it is necessary to work with one subsystem at a time. For example, economists have been working for several years on a social accounts system for the metropolitan areas.¹ This work can be viewed as one system in the larger behavioral systems approach. Results from this kind of analysis can be expected to supply inputs for industrial and commercial land use models. In addition to defining the net-

¹ For example, see Charles L. Leven, *Theory and Method of Income and Product Accounts for Metropolitan Areas, Including the Elgin-Dundee Area as a Case Study* (Pittsburgh: Center for Regional Economic Studies, University of Pittsburgh, 1963).

work of relationships among firms by analysis of "from-to" accounts in the flow of products or services within a metropolitan area and with the outside world, this kind of study might well investigate firm policies that affect expansion or contraction of these flows. Essentially this would be an investigation of an institutional set of values I will not go into this work and these possibilities. Rather, since my own experience with land use modeling has been concerned with residential land development I will endeavor to illustrate the possibilities of activity analysis by focusing on household activities as one system in a systems approach to metropolitan area activities.

While this paper reports on several years of work on household activity systems, it must be stressed that what is presented is still quite tentative in nature. At its present stage, this work is distinctly an off-line investigation. As it progresses and begins to clarify the nature of household behavior in the use of city space, we hope to be able to introduce one or more models for the simulation of household activities and preference patterns in forms compatible to a main-line land use modeling system.

Outlined first in what follows is a sketch of the household activity systems conceptual framework. Next, there is a description of some experimental studies made to identify activity routines and to determine the mix of accessibilities that go with households of various life styles. This is followed by a description of some efforts at identifying housing and environmental preferences and in defining the mix of living qualities that go with households of these life styles. Finally, there is a brief listing illustrative of some of the problems faced in operationalizing the activity schema.

THE CONCEPTUAL BASIS OF HOUSEHOLD ACTIVITY SYSTEMS

The analysis of household activities (sometimes called time-budget studies) has a fascination for social scientists. For some it provides a snapshot of society, a means of describing it and noting cross-national differences between societies.² For others it provides a basis for studying social change in a particular society, for example, tracing out the possible consequences of automation for leisure time.³ As intimated above, I come to the use of time-budget techniques with somewhat different purposes in mind. In this discussion, I want to use these techniques in ways which will demonstrate their applicability to urban development models.

² For example, see Alexander Szalai, "The Multinational Comparative International Time-Budget Project," *The American Behavioral Scientist*, X (December 1966) See also Szalai's "Trends in Comparative Time-Budget Research," *The American Behavioral Scientist*, IX (May 1966).

³ For example, see Sebastian de Grazia, *Of Time, Work and Leisure* (New York: The Twentieth Century Fund, 1962), and Marion Clawson, "How Much Leisure, Now and In the Future?" in *Leisure in America: Blessing or Curse?* J. C. Charlesworth, ed. (Philadelphia: The American Academy of Political and Social Science, April 1964).

The framework around which household activity systems are conceived utilizes choice theory to connect up the value system of a person and his activity system. It should be made clear that throughout this discussion activities refer to behavior patterns of persons or households and not the physical counterpart—housing or residential land use. Activities are viewed first in terms of discrete episodes which may be thought of as homogeneous intervals in the life of a person.⁴ These episodes are generated by a motivational input drawn from a set of values and have an activity output produced by the choice mechanism. Choice of activity in each episode is thus seen to be governed by a set of values, but it is seen to be constrained by certain socioeconomic requisites—requisites which for purposes of activity analysis finally become grouped into specified life styles which then provide the basis in land use models for stratifying the demand side of the housing market. Stated another way, these life style characteristics become the basis for the analysis of household populations and for making the connection from activity behavior of household populations holding distinct values, to their locational propensities in the market place.

Activities can next be viewed in terms of “routines.” A person’s or household’s routine is defined as a recurring sequence of episodes in a given unit of time.⁵ When we examine the dynamics of routines, we are focusing on what may be called “activity systems.” At the micro level of analysis, the activity system of the individual is viewed in terms of an evolutionary flow of activities, with reaction to each episode feeding back through the social system and producing changes in the value component, altering subsequent choices, and eventually modifying activity sequences. These rounds of activity, if followed over a period of sufficient time, appear to compose into routines or activity sequences at four time scales: the daily cycle, the weekly cycle, the seasonal cycle, and the life cycle. In the applications we make of these concepts, we are

⁴ An episode is the pure outcome of a choice, an activity is a classificatory concept that groups outcomes into classes. Thus one person might go to a concert in response to a highly developed musical knowledge and an interest in comparing the conductor’s rendition to another conductor’s techniques; whereas another may go for a great love of Mozart and the sheer delight of hearing a live performance of Mozart. Some may go for relaxation, some may go because they have season tickets and they have nothing else to do. Still others may go because of a dinner party and as part of entertaining out-of-town business connections. Some may go for prestige purposes; still others may go for social purposes, *i.e.*, seeing friends at a concert. For each person this is an “episode”; episodes become “activities” when they are grouped under “going to a concert.”

⁵ While we give special attention to routines in household activity analysis, it should be noted that the recurring aspect of routines is a relative phenomenon. There is variability in the sequence of episodes and this tends to increase with time.

particularly concerned with the system of episodes that fall into a week's routine and how these ultimately affect location behavior (which is an episode in the fourth time scale, the life cycle of a household).⁶

Since work has not progressed to the point where it is possible to give attention to the causal connections in time, only very tentative observations on this score are made. In short, the key cause and effect relationships hypothesized here, to borrow a concept from statistics and subverting it to our purposes, consists of a "within-time-system set of relationships" and a "between-time-system set of relationships." The within-time-system relationships involve sequenced relationships among activities within say, a week's routine which can be traced via the motivation → choice → activity path. The between-time systems relationships of particular concern to us are the relationships between the weekly routine and the life cycle. In using this approach, we are aggregating time and assuming a cause and effect connection between dysfunctions experienced in weekly routines and the propensity of a household to move which evolves as an episode in the life cycle. The lag from the time dysfunctions are experienced in the weekly cycle until the time when corrective action is taken can thus be viewed as a segment in the life cycle. These dysfunctions arise as a difference between actual accessibility opportunities available to a household in following its weekly routine as compared to accessibility requirements defined from preference patterns and functional needs of the household at its particular stage in the life cycle.⁷

The "within" aspect of the weekly routine has been discussed elsewhere.⁸ Very briefly, it utilizes as an organizing concept the motivation → choice → activity set of relationships following the Ackoff model and choice theory.⁹ It will be recalled that choice theory calls for a statement of pertinent objectives, the determination of possible courses of action to achieve these objectives, and the specification of a context with respect to the environment and to the behavior of others involved and the choices they make—all relevant to a particular person or persons as the decision-maker(s).¹⁰ In the present ap-

⁶ For a fuller statement, see the author's "Activity Systems and Urban Structure: A Working Schema," *The Journal of the American Institute of Planners*, XXXIV (January 1968).

⁷ As will become apparent below, we hypothesize that households enter the housing market under two kinds of motivations (a) dysfunctions between the weekly activity cycle and the life cycle, as brought out here, and (b) disutilities between values held about living qualities and the actual living environment, the second of which will be taken up presently.

⁸ See author's article, *Journal of AIP*, *op. cit.*

⁹ Russell L. Ackoff, *Scientific Method: Optimizing Applied Research Decisions* (New York: John Wiley & Sons, Inc., 1962), Chapter 3.

¹⁰ It may be argued that choice theory imputes a rationality to activity selection which is not fully borne out in the real world. Indeed, it may be argued that many people fall into activities quite by default because they see nothing better to do, or they are functioning by whim and their activity patterns are random occurrences

plication of the model, *objectives* are defined in terms of motivations which are drawn from the value system of the individual. These motivations have been tentatively classified into (a) security bases of choice, (b) personal achievement orientations, (c) a sense of need for social status, and (d) a residual set of felt needs.¹¹ The *alternative courses of action* are the choices of activity perceived by the decision-maker(s), each to be examined in the choice process according to the satisfaction anticipated. The *context* is both the physical environment and the social system consisting of the myriad activities of others that the decision-maker(s) perceives to be relevant to his (their) choices. Applying this theoretical construct, the individual examines the activity alternatives available and consciously or unconsciously searches for an optimal combination of satisfactions based on the suboptimization of a particular set of basic motivations he possesses at a particular time, finally making his trade-offs based on the satisfaction levels anticipated from the particular set of motivations stressed in each combination. The output of this process is an activity choice, fitted into an activity routine.

What emerges from the "within" analysis which is of significance for location behavior is the definition of the activity locus for persons of different life styles. In making his choices of activities, the individual consciously or unconsciously considers the spatial configuration of his activity routine. He is constantly storing in his memory experience on the fit or misfit of his routine to a set of needs and preferences. If the spatial configuration is a serious misfit, a marked propensity to move develops. It is this aspect of the "within" analysis which has significance for land use models. Thus, from activity analysis we seek to define a set of accessibility opportunities—a spatial configuration of opportunities for engaging in activities which achieve some kind of optimum level in terms of satisfying needs and preferences of a household.

It should be noted that in the "between" aspect of the schema each household move made during the life cycle involves the application of choice theory to one other key area of study. This concerns motivations ———> choice ———> action with respect to livability opportunities. This is to posit that, given a certain cost limitation and needed dwelling space, the consumer also is searching for housing and environment of a certain quality. Essentially, the inputs for modeling consumer behavior in the housing market in a residential

where no choice is exercised. On the other hand, it may be argued that these people may be drawing on recall of previous consciously made choices and are simply short-circuiting the formal choice-making process. In this connection, it might be observed that circumstances in making activity choices are quite different than those involved in making political decisions. Although some of the same reasons for questioning the synoptic rational model of decision-making apply in choice theory, the circumstances surrounding political decisions are quite different than those surrounding activity choices.

¹¹ See author's article, *Journal of AIP, op cit.*

model can draw on activity analysis to define the accessibility mix sought and can draw on environmental preference analysis to define the mix of living qualities sought; these two inputs form the key elements in modeling the demand for housing, within constraints of income, size of accommodation needed, and other relevant constraints.

These two focal areas of analysis thus supply inputs in the analysis of moving behavior, and this analysis, of course, provides estimates of one of the four sources of inputs for a residential land use model, the total number of households in the market consisting of (a) voluntary movers, (b) forced movers, (c) newly formed households, and (d) in-migrant households. While this paper does not dwell on this part of the linked system of models, it might be observed in passing that the modeling of moving behavior involves a Type 1 round in the application of choice theory revolving around a decision to move or not to move, and then a Type 2 round involving a try at finding a new place. The second round is a part of the household allocation model. If the try at finding a new place is successful, not only is the household allocated to a new location, but its vacated place becomes available as part of the supply of housing on which the allocation model operates in the course of matching demand with supply in subsequent flows of the system.

With this capsule description of the conceptual framework, we can proceed to some of the experimental work in progress. In the section immediately following is a brief summary of work on activity analysis as a beginning step in defining accessibility opportunities, and following that is an even sketchier summary of work on preference analysis as an approach to defining livability opportunities.

SOME STEPS TOWARD MODELING HOUSEHOLD ACTIVITY SYSTEMS

"Activity analysis" is a rubric used for the study of urban living patterns. In this discussion it will have a somewhat narrower usage and will be concerned with aspects of these patterns which have particular relevance for land use models. It is too early to draw any conclusions from our experimental work in this area, and it is therefore not possible yet to evaluate fully the possibilities of achieving a capability for modeling the foregoing schema in simulating weekly routines of households. Nevertheless, it may be useful to touch on two themes: (a) some first thoughts on the translation of the micro level schema we have been discussing to a macro level version, and (b) some initial efforts taken to record activities and measure them, including some very tentative steps in identifying activity preferences.

A Macro Level View of Household Activities

A conversion from the micro level view of activity systems to a macro level perspective is essential if the foregoing schema is to be operationalized, and a macro approach calls for certain compromises if the schema is to be fitted to the real world. First of all, the changeover to a macro type approach involves

an aggregative approach, and then it involves the development of a method of recording episodic data on activities that is feasible and economical for an agency to undertake.

To operationalize the causal chain set forth in the micro level schema, we can aggregate in three ways. We can aggregate episodes; we can aggregate time; and we can aggregate persons or households. Instead of dealing with each episode in the routine as a discrete kind of activity, we can group episodes into some simplifying classification system. Likewise, in place of tracing routines from the daily cycle through the entire life cycle, as noted earlier, we can infer a causal connection from one time scale to another. Thus, we propose to infer a causal connection between the weekly routine and location behavior of households (the activity of searching for and selecting a place of residence at one or more times during the life cycle). Similarly, in place of dealing with each person or household, we can aggregate them into subpopulations, differentiated by characteristics or life styles.

As an aggregative concept, classification reduces the complexity of activity analysis. A shift from tracing episodes to tracing classes of activities enables the analyst to develop a set of building blocks for describing the content of urban life in a more synoptic version, as well as in a more manageable form. The classification system in use in our studies involves the following major classes of activity grouped along functional lines:

- Income-Producing and Related Activities
- Child-Raising and Family Activities
- Education and Intellectual Development Activities
- Church and Human Welfare Activities
- Socializing Activities
- Recreation and Relaxation Activities
- Participation in Organizations and Their Activities
- Participation in Public Affairs, Action or Service Activities
- Activities Associated with Food, Shelter, Medical and Similar Needs

Within this coarse-grained classification system are nested subclassifications.

The second form of aggregation, time aggregation, offers some problems. As indicated earlier, we will need to carry our work somewhat further before we will have much to say about the aggregation of time in the "between-time-system." Within the weekly routine, the level of aggregation depends in part on the level of detail sought in the classification of activities and in part on practicalities of securing listings of activities in surveys. Since it is one of the key requisites of the study of routines to be able to identify the rhythmical characteristics of the routine, it is relevant to comment briefly on some thoughts we have for dealing with cyclical features of the weekly routine. Perhaps the simplest way to conceive of routines is to think of them as composed of obligatory and discretionary activities. Conceptually, the distinction is fairly

simple. Obligatory activities in the routine include such things as sleep, work, attending school, or going to the doctor for emergency treatment; discretionary activities might include going to a movie or shopping, or going off for a weekend holiday. Upon reflection, however, one can find discretionary aspects for most obligatory activities, especially in generalized levels of the classification employed above. Thus, while work may be considered obligatory in the sense that in our society it is essential as a means of supporting the household, given a basic skill, the individual has some latitude as to where he works.

The concept of interest in making this differentiation is the interrelationship between obligatory and discretionary activities. To take an illustration, if work in the weekly routine involves a routinized set of work activities within the work portion of the routine, intuitively we suspect that there will be some causal connections between this obligatory portion of the routine and the discretionary portion, particularly in the choice of activities for recreation and relaxation. Clearly, obligatory activities occur more or less in cycles with almost the same regularity as time itself. Indeed, they are much more likely to be scheduled by the clock or the calendar than discretionary activities, and to a significant extent they serve as "a governor" and regulate choices and timing of discretionary activities. It is this kind of regularity to the routine that strongly suggests the possibilities that activity routines can be modeled with some success.

The third kind of aggregation is quite familiar to most who work with land use models. The aggregation of individuals into population classes for activity analysis can be approached in at least two ways. In one, we can use an *a priori* approach and sort households by conventional groupings based on income, occupation or some other characteristics or groups of characteristics, and then search the activity sequences of these classes of households to identify distinctive routines. The other is to aggregate according to patterns observed in activity sequences, with the range of patterns classified into a typology of life styles. We anticipate using a combination of the two approaches, where we make initial sorts on the basis of an occupational index of socioeconomic status, and then search the routines of these households for patterns. Household aggregates thus identified by life style provide control groups for the study of various dimensions of activity routines

Initial Investigations into Household Activities

From decisions of the kind discussed above, we have moved into what is an initial stage of activity analysis. At the macro level, we have been concentrating our efforts primarily on the output part of the choice process, namely on defining activities and developing measures which would be meaningful and feasible for model-building. However, exploratory work at the value end of the schema and the investigation of activity preferences using game techniques is under way as part of this effort. A brief commentary on both areas of investigation follows.

Exploratory Work in Activity Analysis. Perhaps a chronological rundown would be the simplest way to introduce the experimentation we have been doing in the activity analysis aspect of our work. We began these studies as an "out-of-a-suitcase" kind of effort, experimenting with home interview techniques in a series of three successive studies in Durham, North Carolina.¹² Building on this experience, under a U. S. Public Health Service grant, a pre-test of activity study techniques was undertaken in Minneapolis-St. Paul in 1966, and in the spring of 1968, under a continuation grant, the first full-scale study was mounted in Washington, D.C.¹³

The present emphasis of our investigations seeks to explore four dimensions of household activities. It aims to define *types* of activities, their *sequence*, their *timing*, and their *spatial distribution*. On the basis of activity listings obtained in home interview surveys, types of activities are grouped into classes compatible on the one hand with the analysis of preferences and on the other with their counterpart land uses. It is at this point that the technical distinction made earlier between an activity (which is studied in aggregates) and an episode (which is the pure and original form of an activity) is made. Under present procedures, the interview records all episodes which consume 15 minutes of time or more, with the assignment to a classification being made when results are coded. Should we ever enjoy the luxury of working with a micro level mode, undoubtedly we would be modeling episodes of an individual by the tick of a clock. As it is, we are struggling to reach a modeling capability working with populations of households who engage in certain classes of activity over aggregated intervals of time.

Sequence of activity is of interest to enable the investigator to search an activity routine for a pattern of choices. The simplest illustration chosen with a day's cycle is the sequence from meal preparation, to eating, to dish washing. A more useful illustration for modeling capability and an obvious one is the sequence in a week's cycle noted previously which moves from work to leisure-time pursuits. Obviously, the permutations and combinations in tracing out sequences of this kind are quite considerable. For example, it is reasonable to expect that when the man on the Ford assembly line moves into a leisure-time interval in his week's routine he might choose a different kind of recreation than the Ford executive who sits at a desk all day. Besides indicating how outcomes may vary with occupation and income, this illustration suggests the need for controlling the analysis of activity choices for the nature of a person's occupation and for his income level. Things get more complicated when other variables are taken into account, such as stage in the family cycle and sex,

¹² F. Stuart Chapin, Jr., and Henry C. Hightower, *Household Activity Systems—A Pilot Investigation* (Chapel Hill, N.C., Center for Urban and Regional Studies, May 1966).

¹³ U.S. Public Health Service Research Grant CH 00116, "Household Activity Patterns and Community Health."

each of which we intuitively see affects choices. The key concern in the analysis of sequence is to establish what the relatively stable choice patterns are in the routine, to be able to sort people into classes with similar choice patterns (defined in terms of life styles), and to use this property of stability and recurrence as a basis for studying the predictability of activities in a routine for each defined life style.

The timing aspect of a routine is obviously related to the sequence, and the concern here is to fit the sequence to some reasonable and recallable interval of time. The basic significance of time cycles has already been noted, and earlier references to time-budgets suggest the operational significance of studying the duration of activities as well as their start and ending time. In this connection, clearly the decision on level of time aggregation must be made in relation to the type of activity and the aggregation levels used in the classification system. Turning to spatial measurements, it is to be noted that for these purposes only a portion of the activity routine is involved—the out-of-home pursuits. Even though for land use modeling purposes the concern is primarily with the locus of out-of-home activities, it must be evident nevertheless that these choices cannot be studied out of context from the content of the full routine. In this connection, in order to provide a capability for studying accessibility opportunities, it is necessary to code activities to a grid coordinate system compatible with the system used for land use files. This is no simple task.

These dimensions to household activities are probably not exhaustive, but they do represent the component elements we wish to use in the analysis of the composition of activity routines and in studying the dynamics of activity choices within the routine. Although it would be informative to extend activity studies to different members of a household and to different days of the week, presently economy and feasibility of data collection dictate some hard decisions in this respect. Since the present application of this analysis is to location behavior, attention is being concentrated in activity listing on the decision-making members of the household—the head of the household and the spouse. Obviously, by omitting various other members of the household, the survey schedules presently in use do not yield data on the full range of a household's living patterns. The decision on days of the week has been a particularly difficult one, since so much emphasis in this work is placed on the week's routine. We have experimented with week-long diaries, and even disregarding costs of follow-through, we find that even when respondents are paid to keep diaries for that length of time, returns are not fully satisfactory. Besides the problem of incomplete returns, among those completed there is a tendency for responses to be biased toward a particular socioeconomic level and a particular personality type challenged by the idea of keeping track of time. To work with the concept of a weekly routine it has been necessary to sample days longitudinally during a week, systematically sampling different weekdays and weekend days and constructing for different socioeconomic

groups what might be thought of as a homogenized week's routine for each such group.

Obviously there are many problems that must be checked out before this effort reaches the point where it is possible to simulate activity routines. Hemmens has suggested a model using a transitional probability approach and involving the use of a semi-Markov model in the simulation of choice and spatial distribution of activities.¹¹ Hightower has proposed an adaptation of the population potential model to get at choice of activity and its location.¹² These represent some first thoughts, and in the next year or so when data from the full scale study are available, some tests of these approaches perhaps can be made.

Investigations of Activity Preferences

The investigation of preferences is undertaken to put the spotlight on variables that affect our capability for forecasting activities. It is inherent in the activities schema outlined earlier that the cutting-in point in forecasting activity choices is an analysis of motivations connected with an activity and an analysis of the extent to which these motivations are fulfilled as determined subsequent to the activity. We can see that there are almost insurmountable problems of getting data on these pre-activity and post-activity phenomena. To get some insight into the problem, we introduced into our survey a parlor-like game for simulating choices. At present the game is only a partial experiment. It simulates choices and records satisfaction levels from these choices, but it does not yet get at motivations for choices. To go this one further step will involve the development and use of attitudinal scales in conjunction with the choice-making step in the game.

The game focuses on the leisure-time portion of the week's routine, which is the part of the routine subject to the greatest variability in choice. To sustain the interest of the respondent, it borrows on the green stamp ritual that merchants use as a come-on to bring in the customers. The respondent receives a limited number of stamps corresponding to the number of hours presently available to him as free time during the week. He is given a game board (corresponding to the green stamp catalog of available goods) which indicates a range of choices from which he can shop. He is told that his present time budget, his present income situation and his present family circumstances are the only constraints on his choices and that he should make choices of leisure-time activities that suit him best within these constraints. The game may be thought of as a primitive form of linear programming in which, under the given constraints, choices result in an optimal level of satisfaction based on the suboptimization of some unspecified motivations. As in the analysis of actual activity data, it is necessary to aggregate choices from the game into classes of

¹¹ George C. Hemmens, *The Structure of Urban Activity Linkages* (Chapel Hill, N.C., Center for Urban and Regional Studies, September 1966).

¹² Chapin and Hightower, *op cit*, pp 54-73

choices. We do this to simplify the analysis, but also to filter out fadism that goes with particular activities at a particular era of time. Obviously one can examine choice patterns, weight them by satisfactions reported, and examine for consistency of response for the life style group established from activity analysis.

Changes in the pattern of choices may come from changes in conditions under which choices are made. To get some feel for this aspect of the problem, we have introduced a second stage to the game where we relax the constraints on amount of time. We inform the respondent that he is to imagine a shorter work week and that there is an extra eight hours to use for the game. Here we are still experimenting in the options open for the use of the time (extra day off, two afternoons off, or a 1½ hours additional each day). As in the initial phase of the game, again satisfactions are recorded. The notion here is to get at the class of choice which is presently marginal, but which would be a standby choice when constraints are lifted. If we are willing to forego the study of marginal choices and allow the respondent to reallocate all his stamps in the second stage of the game as presently conceived, we may find significant patterns to realignments in choice. Other constraints might be lifted, for example, the respondent might be told to imagine the situation where his children are ten years older in the process of making his choices. This form of experimentation would bring the analysis into a stage in which, by posing conditions and observing choices, it may be possible to infer motivations from our data, in which case we might not need to include extensive attitude questions as previously mentioned.

SOME EFFORTS IN IDENTIFYING ENVIRONMENTAL PREFERENCES

In the micro level model discussed earlier, for the typical household already established in a metropolitan area, moving behavior involves two rounds through the decision-making sequence. The first round focuses both on dysfunctions of accessibility in the weekly routine and on disutilities in the way in which housing accommodations and the environment match up with a household's felt needs. The first round thus leads to a decision to search for housing. In the second-round decision the moving household mingles in the market with other households involved in the search process. The other households include (a) forced-move households; (b) the newly formed ones, and (c) the new arrivals. The second-round decision, thus, is the subject of the classic market-type model and is well covered in other works. For purposes of this discussion, we will consider only the first decision, *i.e.*, the decision of the household whether or not to move.

In narrowing the focus to the Round 1 decision, the discussion will center on that part of the decision to move which develops from disutilities between current housing circumstances and felt needs and desires in this respect. While it is recognized that the two parts to the Round 1 decision must be treated as

a joint set of considerations, for purposes of these investigations they are handled singly. Having covered the accessibility aspect of the decision in the study of activity routines and activity preferences, I turn now to the work we have been doing on housing and environmental preferences. Following the approach in the preceding discussion, this portion of the paper will briefly touch on some conceptual elements and then allude to directions of exploratory investigations. Since our work in this area is still quite exploratory and is not as far along as activity analysis, this part of the discussion necessarily will be short.

Some Conceptual Considerations

The outcome from applying choice theory to the Round 1 decision sequence (motivation \longrightarrow decision \longrightarrow search) is a choice either to proceed or not to proceed with Round 2—the housing search. This means that the household's satisfactions with its particular circumstances in both accessibility and living conditions are subjected to a test to establish whether the household wants to move or stay put. Because this particular kind of application of choice theory involves no measured outputs but only a simple yes-no decision, the more complex part of the formulation is at the input end of the sequence. This becomes eminently clear when the nature of the phenomena involved in these inputs is considered. For obviously if we are to understand the origins of motivations, this takes us directly into the subject of value systems which is among the most elusive areas of study the researcher faces.

Initially it should be noted that to go behind the motivational inputs of the Round 1 decision, we must recognize that the value systems of the household decision-makers are not static, that they involve an evolutionary mix of values which in the first instance are culturally transmitted to the individuals via the particular subculture in which each was reared and which become modified by subsequent social mobility and the experience acquired through each household member's lifetime. The problem is made more complicated, if the motivations concerning livability are to be disentangled from motivations concerning accessibility in the formulation of a Round 1 decision.¹⁶ To be able to trace the dynamics of the decision to move or not to move at this micro-scale level of research, clearly requires the expertise of the social psychologist. In our work, we still have ahead of us this kind of interdisciplinary effort, and how far we go in this direction depends on progress in the present explor-

¹⁶ Of course, at the micro level the problem is infinitely more complicated when one stops to consider how the decision process would be formulated considering all members of the household, the value system of each, their personalities and their roles in household decisions. As in the previous analysis the study of livability centers around the attitudes of the presumed decision-makers of the household—the head and the spouse. For the conjugal household, we assume that there is a process in husband-wife decision-making which homogenizes the values and thus the attitudes of the two personalities involved. This assumption needs to be checked.

atory phase of the investigation. A great deal depends on the results obtained from the present primitive effort in dealing with environmental preferences at the macro level.

A macro type version of this decision process involves aggregation in ways comparable to what has been discussed under activity analysis. In this application of choice theory, we deal in aggregates of households possessing similar livability motivations. In effect, we are dealing with statistical means of behavior in which many of the variables operative in a micro level model are locked into the formulation and become treated as constants. The idea here, of course, is that the dominant factors influencing decisions will surface in statistical analyses of attitude data and can be isolated and treated as motivational inputs to a Round 1 model.

Before turning to our survey efforts at defining livability motivations, it will be helpful to spell out a little more clearly a few terms that crop up in these studies. In the usage here, livability in an urban setting refers to those qualities of an urban resident's surroundings which induce in him feelings of well-being and satisfaction. Values imply the existence of norms, and so when we refer to livability attitudes, we are assuming the existence of a set of initially undefined norms—a set of glasses, if you will, through which a person perceives his surroundings and makes evaluations. Although presently we are working only in terms of one snapshot in time, it is recognized that just as glasses must be changed to accommodate eye changes over time, a person's norms will change with his aspirations at different stages in the life cycle. Superimposed on these changes, there are others from the culture generally, which will serve to modify statistical means in this respect over time. To take account of this last source of change requires logitudinal studies; for the kind of exploratory effort involved in our work we must ignore this last source of variation.

Using "test borings" from a representative sample of households, the research strategy is to construct a crude picture of the hidden understructure of norms. Through attitudinal questions in which we get the respondent to indicate for a range of livability dimensions of his intensity of feeling on a series of "ought to be" statements, we seek to block out a continuum of qualities about housing and its environs associated with life style and stage in the family cycle. Analyzing a population first by life style, we anticipate finding a continuum extending at one end from norms described in terms of basic subsistence needs of food, clothing, and shelter, with gradations toward the other end involving shifts in emphasis toward social concerns (for example, prestige considerations), intellectual concerns (for example, opportunities for pursuing the arts), and physical concerns (for example, emphasis of the visual environment). Then controlling for life style and analyzing preferences by stage in the family cycle, we anticipate finding significant preference patterns concerning facilities and spatial arrangements of housing and surroundings for each stage in the family cycle. Of course, these investigations must be inter-

preted against the background of the respondent, the range of his experience with differing housing and environmental situations.

In addition to attitudinal questions to establish norms, we include in our survey work a whole line of questioning aimed at eliciting respondent satisfactions with features about their present accommodations and environment. Although some consideration is given to previous housing experience, we are inclined to discount the usefulness of retrospective reactions. From these two lines of inquiry, controlling for life style and stage in the family cycle, our strategy in this exploratory work is to identify a range of housing and environmental qualities and facilities where there is consensus in taste norms and within these areas examine for high, medium, and low-order livability satisfactions. From this kind of analysis, we look to the possibility of reducing the motivational basis of choice to a few key factors in which there are high intensity feelings of dissatisfaction concerning qualities available in present housing and surroundings as compared to norms held about needs and desires in this respect. Obviously, in a macro level analysis of this kind, we are dealing with the propensity to move of aggregates of population. We acknowledge that there are highly individual bases of reaching decisions on whether or not to search for housing which must be accommodated. So, in adapting these studies to a model of the Round 1 decision, we anticipate that outputs will take a probabilistic form as opposed to a deterministic one.

Exploratory Studies of Resident Tastes and Preferences

Investigation of residential tastes and preferences about their environment setting has a fascination for the researcher accustomed to dealing with inanimate forms of data on acres of land, square feet of floor area, or even with descriptions of families and their residences gleaned from housing surveys. Somehow there is a feeling of homing in on the why part of the phenomena usually dealt with in the inanimate forms of bulk data, perhaps a sense of expectancy that comes in working with a new data form, or perhaps it is simply the amateur psychiatrist in us—the opportunity to get our subjects to come clean on all the things that long have puzzled us. Whatever the reason for being drawn to this source of information, it is no panacea for model inputs.

In all of this work, it was simple enough to record moving behavior and to register the facts contingent on the move, on the premise that this was some reflection of what the respondent wanted in the way of housing and environmental surroundings in making the move. Even discounting the serious problems of a retrospective approach of this kind, our own experience tells us that housing choices are made under a host of conditions, involving whim and expediency as well as rationality. Yet, if studies of actual behavior offer problems for the investigator, studies of what people say they want offer even more. A number of panel-type studies where respondents are revisited at intervals for a checkout on intentions against actual subsequent behavior indicate considerable variability in this respect. Although the conditions of variability

in the intended-versus-actual behavior can be pinpointed fairly well, this complicates the use of such data. However, if these kinds of data offer difficulties, the study of respondent feelings about their surroundings in relation to subsequent moving behavior is much more difficult and the pinpointing of qualities about the housing and the environment that consistently are associated with moving behavior offer more problems.

Yet with all the difficulties, the schema outlined earlier surely indicates the importance we hold for this source of data. Our work on preferences draws on some past experimental interviewing under a range of situations and settings—boom-town conditions facing newcomer defense plant employees, the colorless gridiron environment slowly obsolescing in suburbia, Harlem, Radburn, Greenbelt, and so on. While much of this work was aimed at learning ways of asking questions in forms meaningful to respondents of differing value orientations and with differing levels of schooling, we began experimenting with ways of circumventing the problems noted above concerning recall and the costs inherent in checking out the variability of responses in this respect by using simple parlor-type gaming devices. One of the most promising of these prototype devices was Wilson's "game" for choosing a neighborhood and a lot, patterned around the TV give-away programs of that era.¹⁷ Since then we have experimented with house-hunting "games" of various forms, all aimed at simulating real world conditions under which the respondent would make choices. A great deal of experimentation and testing is required to develop such instruments and test both their validity and reliability for getting at the variables needed in the analysis of conditions that trigger Round 1 decisions.

Recently we have been analyzing preference patterns of a national sample of households obtained under a National Cooperative Highway Research Program study. In this and other work, we are seeking to identify preference data which show some promise for predicting Round 1 decisions. This requires a line of questioning which will enable us to identify taste norms as well as preferences. Although others easily come to mind, two control variables for these analyses are life style and stage in the life cycle. As this work proceeds, it is quite probable we will seek to establish the degree of consensus in taste norms, controlling for these and other factors for a range of housing and environmental facilities and qualities, and then test for high, medium, and low-order preference against these norms. Although work presently in progress will not permit us to do this now, we look to the time when we can define for different life styles and stages in the life cycle, those housing and environmental factors where deviations of actual living conditions from norms were pivotal in the Round 1 decision to move. Thus, in a prospective kind of investigation

¹⁷ Robert L. Wilson, "Livability in the City: Attitudes and Urban Development," *Urban Growth Dynamics*, ed. Chapin and Weiss (John Wiley & Sons, Inc., 1962), Chapter 11.

we would hypothesize that individuals grouped today into life styles (identified from activity patterns) and then further grouped by stage in the life cycle, will show consensus on a number of norms and that extreme deviations from these norms registered for the present place of residence will be highly associated with subsequent moves. We suspect that life style will affect preferences that are more concerned with the neighborhood environment, whereas stage in the life cycle will be more closely associated with housing facilities and arrangements and access to community facilities.

SOME PROBLEMS AND ISSUES

In the light of this progress report on our work on the behavioral antecedents of land use modeling, it seems appropriate to conclude with the recognition of a few of the problems and issues involved in this work.

One issue worthy of note centers around the aggregation problem. The identification of routines is directly affected by levels of aggregation in activity classification, in time, and in population selected by the analyst. Thus a routine may emerge or be wiped out as a measurable phenomenon simply by virtue of the level of aggregation chosen in each of these three ways of aggregating data. How broadly or how narrowly should activity classes be drawn? What rules should govern time aggregation or population aggregation? Are there *a priori* bases for making decisions on aggregation appropriate here?

Another even more elusive issue is the problem of operationalizing attitudinal investigations. Ostensibly the purpose of including an attitudinal dimension to the study is to enable us to evaluate activity patterns. We construct routines on the basis of actual recorded behavior, and we wish to know under what circumstances these routines might be expected to change in the future. Our micro level conceptual framework posits that not only do changes of income, changes in stage in the family cycle, and similar status variables generate changes in routines, but also certain security, achievement, social status, and other situational variables may modify routines. If attitudinal data are to be used in evaluating the parameters of behavioral variables used in activity forecast models, can the cause and effect relationships of these sources of variation in behavior be established and defined sharply enough to permit us to calibrate models? What decision rules can be introduced to govern adjustment of parameters?

A third issue that certainly should be acknowledged here concerns the implicit assumption in our work that value systems not only should, but can be taken into account in modeling systems. Considering the infinitely complex nature of value systems and granted that the above issues can be resolved, do surface responses of an attitudinal nature adequately represent value systems? Is it pure bravado to be seeking motivational inputs to behavior?

One last issue concerns a problem which lies ahead of us but which is not directly involved in the work reported here. This relates to the uses in location models of analyses of activity systems and consumer preferences as described

above. How are results from these analyses to be brought into unidimensional space? What forms of output from these behavioral systems are required to insure compatibility with land use modeling systems?

COMMENTS

FREDERICK T. ASCHMAN, *Barton-Aschman Associates, Inc.*

I should say at the outset that I do have a couple of outstanding but negative qualifications to be on this panel. I am completely ignorant in the area of mathematical technique and I have neither the potential nor the desire to overcome this. Secondly, my own experience in urban development has been in the city of Chicago, which is well known as one of the great centers of intuitive decision-making.

Many of us involved in necessarily pragmatic decision-making abhor the kind of planning that simply accommodates projections of past trends. The reasons for this, of course, are that many of us see very little point in continuing to build cities to patterns with which we are obviously dissatisfied. What is needed is a true attitudinal investigation, which will replace the use of superficial indicators with an effort to give us a much better understanding of the basic needs and aspirations of people. I think this topic clearly relates to the previous discussions because decision-makers, particularly in our very loosely organized and largely incapable metropolitan area structures, really have two great, immediate needs that must be met by planners.

The first is help in goal setting. Aid especially is needed in defining what you might call the boundary conditions, or the specifications as to what decisions ought to produce and what they ought to accomplish. Second, it seems to me that we need much more creative and workable types of possibilities that decision-makers, chiefly elected officials, can pose to the public and gain public support for through the exercise of political leadership. This must be done at two levels. We have potential capabilities for controlling at least the certain elements of metropolitan development, essentially elements involving the land use/transportation relationship. We also have a very strong need for creative policy proposals which go into the actual components of metropolitan plans. We all will agree that modeling techniques certainly offer great promise of meeting these needs, both in the identification of realistic goals and in the assessment of goal achievement potentials involving forms of action. The important thing to realize is that our urban conditions have got to be defined generically for models to meet these needs. Hopefully we have given up long-term master plans which are really wish lists, responding to the planners' quest for certainty, and in that event it becomes extremely important that the urban condition be defined generically, and that solutions be posed in some generic form. Otherwise there will be no utility whatsoever in policy-making.

As I see it, Stuart Chapin is attempting to give us a much sounder base for

this kind of generic definition. However, I do have some concern with the semantics of the statement which deals with the term preferences, and in which he says that planners are experiencing pressures from decision-makers for some means of responding more directly to public preference. It seems to me that this can open up some legal misunderstandings. These pressures do exist, but it seems to me that progressive mayors and other officials are not really asking planners today to respond simply to what the public wants. Instead, they are asking us to bring about a creative expansion of the options; that is, the addition of options that presently are not known to the public. There is great danger, it seems to me, in oversimplifying this matter of preferences. Those of us who were in World War II remember that we were questioned as to how much we wanted to pay for an apartment when we got back, and we all said fifty dollars. So the government wasted two full years attempting to provide fifty dollar apartments. For this reason, I think it is very important to recognize that our public officials are not quite as concerned as they seem to be with the superficial problems of taking land off the tax rolls and whether or not they can be elected two or four years hence. I think they really are calling very strongly for the expansion of available options. And here, it seems to me, is one of the most exciting uses for the techniques which modelers are developing.

I would also hope that along with the discussion of preferences we could consider the constraints on widening available options. For example, we may have to broaden options simply to accommodate some of the spatial requirements that we have. I think we should investigate such questions as: what we can do about higher density in terms of environmental design; the possibilities and problems of the new cities, and the possibility of accelerating growth in smaller cities. We must try to acquire options to meet the problems that cannot be handled on the basis of present public preference.

I would hope, also, that we might deal somewhat with the fluctuating restraints imposed by groups of people upon other groups of people. Quite obviously this refers specifically to racial prejudices, to kinds of institutional practices that impose constraints on the preferences and aspirations of some of our citizens. This relates to the zoning question, to the old question of restrictive practices and how these hinder achievement of national housing goals. Our tax system also poses a kind of constraint.

In conclusion, I wish to say that when we examine preferences we have to be conscious also of the parallel constraints. I see much potential in the work that Chapin has presented. His work attempts to meet the problem of simply accommodating projections. And this, in my view, is the proper approach to take.

DANIEL R. MANDELKER, *Professor of Law, Washington University, St. Louis*

I would like to start by telling you that I am a consumer of urban development models who has not the slightest idea of what goes into them. And I ex-

pect to preserve my ignorance. I think it gives me a useful perspective to look at what models of this kind can do for the urban development process.

I think I may be most helpful by indicating how I think the policy elements in the urban development process can be utilized in building development models that mobilize the legal system. I would like to suggest first of all that there is a good deal of confusion about how lawyers and decision-makers using legal tools attempt to reach decisions about different development patterns. I will illustrate this point with a few examples below, but I would like to suggest first of all that the legal system itself is a model. It is a very rough model, but it is also a fairly successful predictive model in which we begin with a series of inputs, apply a rough set of criteria, and come out with a decision. Given certain kinds of facts we are often able to predict how the decision-maker, whether a court or an administrative agency, will act in a particular case. Thus, it seems to me that it must be useful to consider building a separate model of the decision-making process which would be employed in the solution of legal problems suggested by urban development models. For example, you might produce for us a residential dynamic which indicates a preference for large areas of low-density residential development. You might then ask the decision-making legal model to make legal responses to this choice. You certainly can build different kinds of decision-making criteria into that decision-making model which will give you a wide spectrum of results.

However, speaking as an academic lawyer, I would say that you can assume that the legal system will build for you any kind of legal control you desire to have. Perhaps this is a radical position, but I think it is perfectly suitable. I can illustrate this point best, I think, by using as an example the location of shopping centers.

Let us assume a metropolitan area in which there are two existing regional shopping centers. Let us next assume that these centers are saturated; there is not enough parking, the stores are crowded, access is difficult, and more and more residential development is taking place outside their trading areas. So it is necessary to build a third regional shopping center in this metropolitan area. In building a model for the solution of this problem, planners may assume that we lawyers can give you a legal system which dictates a choice that is preemptive. Only one site will be selected for the third regional shopping center, and construction on other sites will be legally prohibited in one way or another.

But the legal system may not presently be able to dictate a preemptive choice. In this hypothetical region there may be a master plan or a comprehensive plan, and several sites may be indicated for the third shopping center. There may be several applications from interested developers, and there may be political pressures from all directions. Perhaps, as a result, two shopping centers will be built instead of one. A partial explanation of this result is the fact that lawyers have difficulty constructing legal criteria that are sensitive to mutually exclusive choices but which do not involve us in other difficulties.

For example, in the context of the shopping center problem the courts have been reluctant to consider business competition as a factor in land use and zoning decisions. A model of how the physical environment responds to competitive business pressures would help convince the courts that competitive interactions are related to decisions about physical development

I suggest that it would be possible either to build policy factors influencing legal judgments into the model itself, or to leave them outside. Either method is feasible provided the choice is made explicit. If the decision-making process is exogenous to the model, the modeler should be very much aware of exactly how the decision-maker can respond to the contributions of the model.

A decision on the way in which we use the policy element depends upon the extent to which discretion is built into the decision-making process. This is another problem of which you perhaps may not be fully aware. Occasionally, we can construct legal rules of decision which have a small discretionary element. For example, we could enact a statute which forbids the location of an Interstate highway within one mile of an historic site, with the latter term very carefully defined in the statute. This legal rule could be incorporated into the model, I presume, in such a way that every time the models showed an Interstate highway within a mile of an historic site the model would reject that location point. This is one kind of legal problem with which modelers can work in order to derive quantifiable criteria which can be very useful.

The same point can be made about market models of the housing market. To some extent, the legal rules applicable to demolition of housing are circumscribed and quite precise. It is very common for municipalities to pass ordinances or for states to pass statutes which stipulate that when needed repairs exceed 50 percent of reproduction value, the house may be demolished by the municipal authority. Information you collect must be concrete enough to enable the model to identify those dwellings that qualify for demolition under this statute. An assumed rate of demolition can then be built into the model which should be able to take out of the housing stock in every year those units that qualify under this statute and which the municipal authority is willing to subtract.

I would like to move now to another example where the policy outcomes are not as clear, and where it seems to me that we get into some evaluative problems that are difficult to resolve. I am referring to an assumed developmental model of the urban region in metropolitan areas—a model with which the appellate courts have been working. When I say that the appellate courts are working from a model, I mean that they are assuming a definitive norm of what an urban area ought to be like. From this assumption of what the urban area ought to look like comes a series of judgments in specific cases. If the court were informed about different patterns, it might render different judgments.

Here is an actual case in which a sensitive development model could help. The situation is that of a planned Interstate highway with the customary inter-

change areas. The comprehensive plan for this municipality indicated a large civic and commercial complex near this point. Now the approach road to this interchange passed very near a four-corner intersection at which there already had been constructed two gas stations on two of the corners. This corner was right at the center of the proposed complex. On a third corner a developer made application for a third filling station. Ordinarily, in a case like this, the court would accept the third applicant and would permit the gas station to be built. The reason is that the courts are working with an assumed model under which the pattern of development is incremental change, heavily influenced by the existing, built-up development pattern. This pattern also happens to fit our notions of equal protection of law, and beyond that, planners' conceptions of what a metropolitan area ought to look like. The courts accept the idea that development occurs through incremental change, and I can cite case after case in which they have acted on that assumption. Most courts would refuse to block a development proposal in order to gain future time for the municipality to implement a more ambitious plan. In this case, however, the planners said, "Oh, no, you can't build your filling station." "Why?" "Because this plan shows an unbuilt civic and commercial center at this point, and it is our conclusion that to build a filling station here as a secondary local business would so disturb traffic and shopping patterns that it would interfere with the objectives of the comprehensive plan." In this instance the court is being asked to render a judgment about land use in accordance with a master plan which as yet has not been implemented. This step is a very difficult one for the court to take, but in this case it took that step and denied the application.

There is one final point that I would like to make and it bears on the aggregation and disaggregation of data for purposes of model-building. For example, in the law of landlord and tenant no distinction is made between owners of substandard housing and owners of standard housing. Smart lawyers, however, come into court and say, "This man owns a slum or substandard unit and he should have a high degree of responsibility and different standards of care." These claims for the recognition and separate treatment of different classes of housing could lead to an effective categorization of housing that would have important legal significance. This kind of distinction then would be useful to model builders.

I could, if I had time, also go through a study we recently conducted in St. Louis of what happens to owners of slum housing when they relocate out of an urban renewal project area. The results are very tentative, but they suggest the existence of a class of entrepreneurs who knowingly invest in substandard housing. I would also suggest that the racial factor ought to be important in studies like this, in which the planner aggregates and disaggregates data for purposes of understanding urban processes. There is a very simple reason: the Constitution demands equal protection of the law and, consequently, the law will respond in a legally significant way towards different racial groups. There-

fore, I would suggest that in most of the models you build you should be very interested in the spatial implications of the treatment of different racial groups. Racial stratifications should become very important to anyone who deals with models of the urban system.

GEORGE T. LATHROP, *University of North Carolina at Chapel Hill*

I would like to speak about two points that grow primarily out of my experiences in New York with John Hamburg and our efforts to build a crude land use model for our work in transportation planning. Both pertain to the question of disaggregation. Stu Chapin's paper brings out the issue fairly clearly, and to me the paper illustrates a context in which I agree that disaggregation is useful. However, I would like to express some concern about it.

The first of these two points concerns the nature of the "search for understanding." The examination of the motives, preferences, and behavior of individual actors or family groups in the urban area certainly provides a strong basis for understanding and for returning to a more aggregative approach. I think this obviously is one of the strong intentions in Chapin's work. This re-aggregation may not take the form of mathematical modeling or "social physics," but it is aggregation based on a grouping with a purpose in mind. I would like to emphasize, although it should be obvious, that the purpose of the modeling effort must determine the level of aggregation or disaggregation. This implicitly assumes that modeling is the end sought, or that it is the vehicle which serves as a way-station in the "search for understanding."

That brings me to the second point which also is involved closely with this question of purpose—and that is a question of scale. We talk both of temporal and spatial dimensions and Chapin includes these dimensions in his discussion of activities. I think they are appropriate, too, to a panel of discussion of modeling. In transportation, to borrow an example from my own experience, we may plan for five or for twenty-five years, or even perhaps for forty or fifty years. Ignoring, for the present, other issues that are raised by that statement, we also plan for regional transportation facilities, and we plan for very localized transportation facilities. It almost goes without saying that the sort of information we need for these different scales is very different in terms of detail and in terms of aggregation. These changes in scale lead to different types and degrees of uncertainty, to different degrees of likelihood of fluctuation—in short, they present completely different contexts. They require different levels of aggregation and different kinds of modeling. Chapin explicitly makes a point of the difficulties of moving back toward aggregation for modeling and of the necessity for doing so. My point here is to emphasize the necessity for choosing an appropriate scale, and to express my concern about the number of variables that sometimes appear in disaggregative models and about the uncertainties of data handling, which compound the probabilities of error to which Alonso refers in his paper. Substituting four variables, which are difficult to predict, for a single variable which is very little more difficult seems

self-defeating and laborious unless there is a substantial gain in understanding or a specific need in terms of scale.

As long as purpose and scale, both physical and temporal, are kept clearly in mind, I think the issue of aggregation will take care of itself