observations, and are probably just as artificially unchanging in this model as in central place theory.

Although the techniques for fitting and using this model are in a sense quite sophisticated, it really rests on very primitive assumptions and has a primitive structure. There would be a great deal of room for further experiment and modification of the model and for a careful examination of the relations between its theory and other theories of retail trade location.

References

Harris, Britton, "A Model of Location Equilibrium for Retail Trade," paper presented at a Seminar on Models of Land Use Development, Institute for Urban Studies, University of Pennsylvania, October, 1964. Mimeo.

_______, "A Note on the Probability of Interaction at a Distance," Journal of Regional Science, V, 2. (In press)

Lakshmanan, T. R., and Hansen, Walter G., "A Retail Market Potential Model," Journal of the American Institute of Planners, Special Issue, XXXI, 2 (May, 1965), 134-43.

IV. Some Notes on Land Use Models

The two summaries reproduced below are drawn from Committee records. Several other models were discussed in the same sessions in November 1964. Some of these have been written up in the special issue of the Journal of the American Institute of Planners, May 1965, devoted to land use models. For example, Kenneth J. Schlager's presentation on "A Land Use Plan Design Model" appears in that publication, as does a more complete presentation of John R. Hamburg's discussion of "An Opportunity-Accessibility Model." Also appearing in the same issue is William L. Garrison's "Urban Transportation Planning Models in 1975" which he outlined in Committee sessions in November 1964.

A. The Penn-Jersey System of Models

Britton Harris, University of Pennsylvania

I am currently a part-time consultant to the Penn-Jersey study. It is my feeling that the influence which the Penn-Jersey study has had in the field of transportation planning is somewhat out of proportion to its recorded accomplishments, if you neglect influence as an accomplishment.

The P-J study was organized in 1958-59 by the highway departments of New Jersey and Pennsylvania in **response** to certain key planning issues in the Philadelphia area and a general dissatisfaction on behalf of many to the attention given to transit planning. At this time there was very little attention given to the use of EDP in the transportation planning field. The 7090 did not yet exist.

Four years ago, some felt both admiration and alarm that P-J was going to "go for broke" on difficult models; however, P-J never really went all the way. EDP was installed, but at too late a date and at too small a scale. The organization of the study also accounted for a great deal of slippage. There were difficult problems of communications between the data managers, the programing staff, the analyst, and the model builders. There was never a sufficiently strong focus of effort upon the things the staff publicized it was going to do - namely the development of growth models.

The total model building efforts of P-J fall into three general areas:

1. Models which have been completed and are in use; these are mainly very conventional "handicraft" models.

2. Models which are currently being brought into operational status; these I will describe briefly below.

3. Models set aside for future attention; these include some of the more difficult aspects of the original "regional growth models."

Current land development models have not been able to successfully answer the question of land development patterns resultant from alternative transportation systems. The current modeling efforts at P-J are committed to consideration of this, based on minimum land use plan variation and maximum variation of transportation policy. Major emphasis is therefore placed upon variables related to accessibility.

There has been a decoupling of the transportation and land use models. Rather than specifying a transportation network for each run, levels of service are input. The output of the run is the transportation systems requirements which can then be translated into system details, which are usually inputs to most transportation models. This process can be run in 5-year iterations without running the package of transportation models (trip generation, distribution, assignment). It is possible to get a transportation cost matrix for several alternative policies for input to the land use models, and afterwards run the total transportation model package for transportation evaluation of selected alternatives.

Penn-Jersey has developed a method of abstract system coding which allows, by means of parameter cards, the specification at the outset of a run the existence of major transportation links, and parameters such as freeway spacing, added rapid transit links, waiting times, etc.

Our models are run recursively over time in 5-year increments. Each activity location model is run separately from the others, talking to each other only to the extent that the locations forecast for any time in terval change the land utilization and accessibilities which are inputs to the following time period forecasts. Forecasts are mostly at the district (160 subareas) or superdistrict (75 subareas) levels.

A great deal of emphasis has been placed on calibration of the models- this has been neglected to some extent elsewhere. None of the models are based upon the assumptions of complete linearity which we believe is unrealistic.

There are three basic location models. So-called unique locations are distributed via hand methods. Such activities as steel mills, city hall activities, universities, and hospitals could be located via a computerized model; however, it is easier to handle these locators by hand.

The residential and manufacturing activity models are based upon the non-linear migration model developed for Boston (POLIMETRIC) and their EMPERIC model which utilizes a system of regression equations. Analysis by the Boston study has indicated that at least the following four groups of variables are significant in describing residential location:

a. Accessibility to various activities
b. Vacant available land
c. Residential densities
d. Existence of certain services

Our model weights each of these factors differently for different sectors of the locating populations.

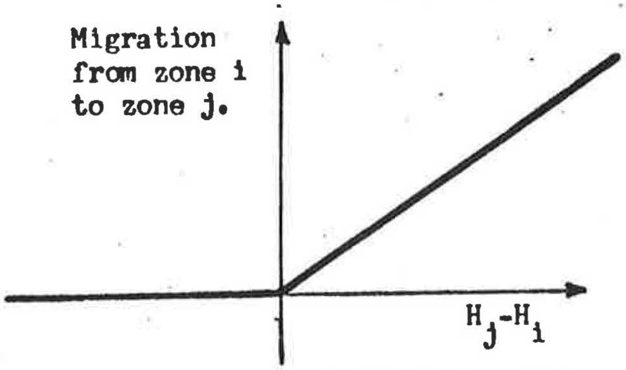
Migration between zones is related to the differential in attractiveness between the zones.

$$H_k = \sum_h A_h X_{hk}$$

where: H_k = Attractiveness measure of zone K

A_h = Weighting factor for variable h

X_{hk} = Point or intensive variable such as accessibility, density, amenity level, etc., for zone K



As indicated in the sketch, migration between areas is hypothesized to be linearly associated with positive differences in attractiveness, and zero for negative differences in attractiveness.

Preliminary tests indicated a high level of correlation for the calibration period. Experience with Boston data shows that this model tends toward achieving a steadystate with a realistic balance between city and subrub when run recursively over the long range.

The residential and manufacturing models are both similar in form.

We feel that a regression approach to a retail location model is inappropriate unless the commerical activity is stratified. Our retail model is an equilibrium model which has shown an bility to develop new commerical clusters. It is run after the residential location model and is dependent only upon the distribution of demand and the accessibility matrix. The model is run interatively until a balance is achieved between demand and opportunities. Output of the model has reproduced the puckered tent of retail concentrations which we observe in the real world.

We also have three basic space consumption models. The residential space model says that residential density depends upon the extent of the region, income, space preference of income groups, and transportation costs. The commerical and industrial space consumption models are dependent upon the residential density in surrounding areas, simulating land market competition which is observed to result in the crowding of commerical activity by the demands for residential space. Space for roads and some other public services are determined by a third model.

The use of regression in many cases is a step backwards from the original model designs developed by P-J. Most models do not treat densities endogenously to the model system. Our treatment of density is not satisfying in many respects. No one has yet been able to explain the mechanism behind the withholding of large amounts of fringe land for long periods of time which results in the spottiness of development, and this has a substantial impact on densities. Another major factor in density patterns is the multi-family dwelling, which can produce tremendous changes in residential densities.

I have doubt as to the value of overall optimizing models unless various user costs, including housing utilities (preferences) and transportation costs are included in the criterion function. When we do specify such a model, I fear that the size of the matrix gets out of hand, at least with presently available computers. We would still be optimizing within a single strategy - of which there can be many and we would have to test between alternative strategies as we are now testing between alternative transportation policies.

B. The UNYTS Opportunity - Accessibility Model

John R. Hamburg, Director of Bureau of Planning,
New York State Department of Public Works

The question of scale is of prime importance to both the theoretical and practical aspects of constructing locational models. Is the relevant unit of study the inhabitants of a specified set of geographical areas, homogenous (with respect to some phenomenon or class of phenomena) set of households within a geographical set, individual families, or simply individuals? Without a clear statement of the class of activity to be explained and rigorous tests to measure the relative explanation afforded by alternate factors and geographic levels, the chances for significant results are indeed slim. In the absence of such tests, the tendency is to disaggregate into smaller and smaller units in the hope of finding the elementary behavioral unit. This is not sound theoretically and is completely impractical from a data management point of view.