DEPARTMENT OF ECONOMICS, FINANCE AND ADMINISTRATION

Planning and Urban Area Transportation Studies

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● THERE ARE emerging new developments in uses of origin-destination data which hold much promise for the future of both transportation planning and city planning. To achieve maximum usefulness, these developments must be organized and integrated so as to complement one another. By this means their usefulness will increase from the almost zero utility of a series of individual pieces of information to the high utility of a planning process. This paper describes the organization of these developments into a planning process.

These new developments are a diverse group, ranging from techniques and relationships to the application of methods borrowed from other professions. The following are examples:

1. The prediction of future traffic from land use.
2. The application of statistical tools to the analysis of data, such as multiple correlation, factor analysis, and linear programming.
3. New methods of estimating future zonal interchanges.
4. Machine methods of assignment and, possibly, simulation of traffic flows.
5. Use of electronic computers in data handling.

The accumulated experience of others, particularly in origin-destination survey work in over 120 cities of the United States in the past dozen years, has been the main source of knowledge in the collection and use of origin-destination data. This experience has been gathered and disseminated throughout the planning and engineering fraternity by such organizations as the Highway Research Board.

This paper has been prepared from experience gained in both the Detroit and Chicago urban area transportation studies. The large size of these two studies and the insistence in both that data be used rather than just collected required the development of a process of organized planning. This principle of systematic analysis of O-D data has been shaped by two recent developments:

1. The creation of integrated research staffs to do the work of urban area transportation studies. The simple fact of data gathering, analysis and planning undertaken by a research team as its complete full-time work has favored the integration of these steps into an organically interdependent pattern.

2. The rapid improvement of digital computors and electric accounting machines removes many previous limitations in the manipulation of data. Several of the new developments, especially in studies of zonal interchanges and in assignment to transportation networks, could not even be contemplated without such mechanical help.

This report describes the present stage of development of the systematic approach to traffic planning.

and workable solutions to each step are within sight.

Adequate population and economic activity forecasts are needed to begin. Each should be made independently of the other, or at least should have independent checks. Reconciliation will then provide a reasonable forecast. With such population and economic forecast, the future gross land used, by category, for the metropolitan region can be deduced.

Once the gross land requirements are known, predictions must be made of the way population and land use will be distributed throughout the urban area. To a large extent this is predetermined: (1) it is fixed by existing population and land use; (2) it is controlled by terrain or topography; and (3) it is delimited by the frictions of space excepting as these can be economically modified by improved transportation and utility systems. Either plans or predictions of future land use and population distribution can be used, depending on the degree of control of the local governments over land use.

In many areas, of course, plans do not exist, and future land use must be forecast. In other areas quite firm plans for future development exist for all or parts of the region, and these can be substituted for a forecast.

Given the amount and location of future land use and population, the numbers of trips generated in each area can be calculated. The rates of trip generation were previously obtained from data in the inventories of trips and of land use. These future trips can be calculated by trip purpose, by time of day, and by land use at destination and at origin.

For computer processing, the land use pattern is best described as the land use of a series of grid squares in a regular Cartesian coordinate system. The land use within each square can be measured in acres of land in use or in square feet of floor area. This latter measure is being used in the Chicago study because it provides more precise information on intensity of use than would the acreage figures which are available from most land use studies. A measure which reflects both the demand for and the ability or capacity to receive persons and goods is required.

Given the number of person trips or goods deliveries, present or future, which originate or terminate in each traffic zone, the next step in the estimating process is to determine zonal interchanges. Previously this has been done by expanding the inventoried travel interchanges. The present proposal for the Chicago area is to estimate interchanges completely independently using only the behavioral patterns disclosed in current inventories. As yet the exact basis for such estimation is not known, but the following ideas seem pertinent:

1. Zonal interchange may be a function of opportunities for interchange between two zones; *i.e.*, numbers of jobs, square feet of floor area in shopping centers, etc.

2. Zonal interchange may be a function of competing opportunities.

3. Zonal interchange may be an inverse function of some combination of distance, speed, cost and/or convenience which, for lack of a better term, may be called "travel resistance."

4. Zonal interchange may be a function of demand, as expressed in willingness or need to travel. Obviously, research is needed to discover the extent to which other methods of communication and exchange can be used instead of person travel and goods shipments by vehicles.

Various mathematical tools are being tested to determine their usefulness in relating these functions to estimate zonal interchange. Tests will be run against actual interchange to determine accuracy of prediction.

Travel resistance between zones, which must be known or estimated in order to predict zonal interchange, is a function of mode of travel, whether automobile, bus, train, or rapid transit. For example, the time between a suburb of Chicago and the Loop may vary by 30 min, depending on whether an automobile, train, or bus is used. Since travel resistances differ by mode, then zonal interchanges will also be a function of the modes which are available to serve any pair or group of zones.

It is clear, then, that a knowledge of likely travel resistances between all zones is a requirement for solving the zonal interchange problem. At the same time, the most logical place to study modal distribution is at the point where traffic is assigned, because it is there that flows on routes most immediately affect each other and it is there that the individual considers the use of competing modes to take him from origin to destination. Knowledge gained in the assignment problem must then be fed back into the zonal interchange problem to make any necessary changes in assumed modal travel resistances.

Given present or future zonal interchanges, the next step of the estimating process is to transform these into predicted loads on each route of each major type of considered transportation.

People, although forced by the strong demands of residence and work place to travel in uneconomic concentrations, nevertheless probably choose the mode and route of their travel with considerable care, seeking to minimize some combination of time, distance, cost or inconvenience. Choice of route for any one traveler is affected by similar choices made by thousands of others. Where crowding reduces route or modal desirability below that of competing routes or modes, people will seek less congested routes or modes. It is likely that a point is reached where to most individuals it is a toss-up between two or three possibilities either as to route — or route and mode.

In order to make this process workable in the estimating process, two things must be achieved. The transportation system itself must be described and stored in computer language, just as the land use pattern was described by a grid coordinate system. This description is based on the inventory of transportation facilities. A method of assigning trips to each route on the transportation system must be developed, a method which will record the decreasing desirability concomitant with increasing use. From these two parts, estimates of flows on each route can be made.

Feedbacks during the estimating process are essential for reasonable solutions. One of the most important is the effect which traffic flow has on zonal interchange. If the method of estimating zonal interchange predicts so many trips between two zones that the speed of travel is reduced, then the amount of travel between the two will decline and other zones, now relatively more advantageously located with respect to one another, may increase travel linkages until a status of equilibrium is achieved consistent with the new routes and the travel demands (Figure 4).

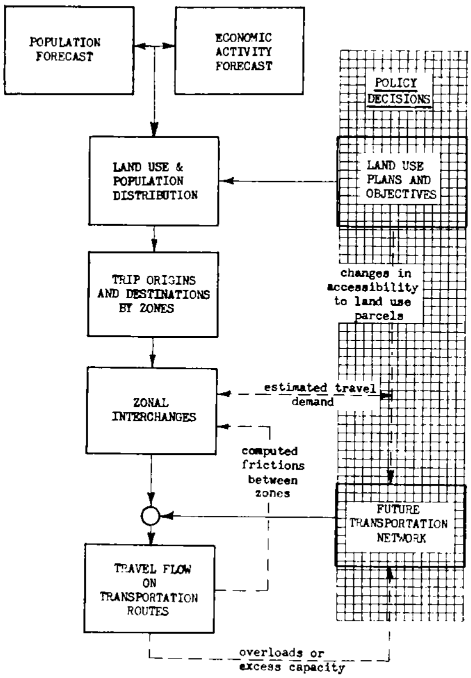

Figure 4. The integrated planning process: the estimating process as an essential part of policy formation.

The preceding section has described how the estimating process can derive traffic flows from land use information. In this process, two parts of an urban area had to be described and stored in computer language: the land use and population distribution pattern, and the transportation system. Each of these two parts may be modified by plans and policy decisions.

THE PLANNING PROCESS

The estimating process (Figure 4) is so closely tied in with the policy decisions as almost to constitute a larger planning process. In this particular study design, the two types of policy decisions involve controls on future land use and also on the development of new or improved transportation routes.

Land use plans and objectives may be obtained from any source, official or private. As noted before, there may be an absence of adequate plans and enforcement machinery. Whatever the situation, however, a policy will have been made (of purposeful public action or of *laissez faire*) which will affect the area's future land use distribution. These facts are then inserted in the model and a new set of trip generation figures produced.

Transportation plans may also be obtained from any source — from official agencies, citizen groups, thinkers, or crackpots. Like the land use distribution of the future, they are inserted into the estimating process. The future land use pattern produces a new set of trips, these are used to predict future zonal interchanges, and these zonal interchanges are assigned to the proposed transportation network to determine future traffic flows.

Already, however, facts have become apparent within the estimating process which may alter the proposed transportation plan. The future land use pattern may generate zonal interchanges clearly not in line with the transportation plan. For example, a low density land use plan will not generate trips suitable to a transportation plan with heavy emphasis on mass transportation. This may cause the planner to alter the plan even before testing by assignment.

Transportation plans may change the accessibility of some parts of an urban area. This change may shift the distribution of new growth, in turn changing trip generation, zonal interchange, and traffic flow! This is the feedback which affects land use plans or projections, and illustrates the balance of the urban system — a balance which must be accounted for in the estimating and planning process .

FUTURE IMPLICATIONS

This paper has described the framework within which new developments in the uses of origin-destination data can operate at their greatest usefulness. What are the implications of these things for the future of transportation planning and city planning?

1. A unified study design with emphasis on the creation of a sound planning process will provide the organizational framework within which future developments in transportation planning can be accumulated, integrated and applied. Without such organization, advances will tend to be separate, individualistic and without the leverage which purpose and utility provide. Within such an orderly framework each additional piece of knowledge, if of any value, can increase the accuracy of estimating and planning.

2. This paper has implied throughout, the existence of an urban area as a system in balance. Land use generates trips to satisfy human needs; these trips flow through a network; their presence in the network shifts the relative accessibility of different parts of the urban area, in turn influencing the location of new growth, in turn forcing new transportation facilities to be built. Unless all these inter-relationships are considered, the planner is dealing with only a part of the whole, and his answers will be partial answers.

3. High-speed computers with great storage capacity are coming into increasingly common use across the country. Their ability to manipulate complex systems should increasingly be harnessed to planning operations and research, particularly for problems of metropolitan scale. Only with these computers can the new ideas of testing a complex system tending toward balance or equilibrium

be accomplished, and only when the entire system is considered can new ideas and hypotheses be tested fairly. Actually, these ideas and hypotheses are likely to come into being only when they *can* be tested! These new computers, therefore, represent a potentially powerful tool for future research and planning.

4. The need for closer relationships between transportation planners and city planners is pointed out. Transportation is so vital to land use that it may be considered an instrument for effectuating a land-use policy. Conversely, land use so affects transportation systems that land use controls may have to be applied more rigorously to safeguard public investment in transportation facilities.

Much hard work remains to be done before the integrated planning process can be perfected. This unquestionably will be accomplished in time. The authors are deeply convinced that such integrated processes, which permit the accumulation of research, which fit the parts together, and which put the results to work, are the form of future planning and research. These processes can be applied to all types of planning. They will permit the affairs of large metropolitan areas to be arranged in the future with much greater certainty.