Comprehensive Metropolitan Transportation Planning

Fundamental Philosophy and Concepts

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●SEVERAL PRINCIPLES are fundamental to the Penn Jersey Transportation Study (PJ) approach to metropolitan transportation planning. These ideas are not exclusive to PJ. In one way or another each has been expressed previously. Nonetheless, it is the particular combination and the interpretation given to these principles that establishes the individual quality of the program being pursued in the nine-county Camden-Philadelphia-Trenton Metropolitan Region.

The first principle is that there are decisive relationships among all the means by which transportation takes place, and none can be determined without giving consideration to all.

The PJ Study is concerned with (a) all kinds of routes over which transportation movement takes place: paved roads, steel rails, pipe conduits, moving belts, air lanes, waterways, pedestrian paths, elevator shafts, escalators; (b) all kinds of vehicles: trains, trolleys, buses, trucks, taxis, passenger cars, bicycles, car floats, lighters, barges, ships, airplanes, helicopters, rockets, and containers, to say nothing of human legs; (c) the movement of individual things and with the movement of groups and masses and commodities in bulk; (d) private transportation and public, free as in the case of elevators or for hire as in the case of airport limousines, ferry boats, or moving vans; and (e) all kinds of things moved: people of specific ages, capacities, and resources as well as products that are solid or liquid, large or small, heavy or light, perishable or inert.

The Study is also aware of some things now figuring in the demand for transportation that may substitute electronic communication for actual movement. Persons traveling to a face-to-face meeting may substitute closed TV and stay physically separated. A telephone or facsimile copy may substitute for the sending of a letter.

Concern with all these aspects of transportation movement is basically most uneven. Some, at the center of focus will be studied intensively; others, near the periphery of attention, will be handled more casually in the current work. Nevertheless, PJ is aware that any element now apparently insignificant may in future years become crucial, or may seem vital to some substantial group in the community. Above all, PJ recognizes the need to look for combinations of routes and vehicles to serve a wide variety of movement demands, to seek the economies inherent in multiple and synchronized use of the facilities and services provided.

PJ's second principle is that areas of continuous urbanization require regionwide transportation planning. This is so whether the region comprises a city, county, or state or several of each or parts of each. PJ recognizes, of course, that there also are local aspects of transportation, to be handled at the municipal and county levels, as well as interregional aspects that must be handled at the state and Federal levels. Yet, PJ realizes that a tremendous amount of transportation activity has its daily ebbs and flows throughout all parts of its nine-county metropolitan region, and that certain aspects of this movement could neither be understood nor handled if the region was arbitrarily cut into smaller parts or dealt with on the basis only of the smaller divisions already existing within it. Moreover, PJ thinks the state capital is too remote for the regional aspects of its transportation needs—not merely remote in a geographic sense but also in terms of attention and a sense of urgency. PJ is a regional study. The programs it will recommend will have their regional aspects as well as local, county, and state aspects.

PJ's third principle is that transportation not only serves but shapes the region. When transportation policy is aligned with other public policy affecting the flow of land development in a growing and changing urban region, the combination can exert powerful leverage, channeling to some degree the forces of the real estate market. In addition to achieving the intended improvement of transportation service, PJ observes that major transportation measures taken in the past sometimes have been influential in bringing about unintended consequences. Indeed, it appears that the harm done by unanticipated adverse effects on general community development of a specific transportation program sometimes more than offsets the direct benefits derived in the way of improved transportation service. PJ therefore will weigh alternative transportation measures not only in terms of their respective promise of transportation service but also in terms of their prospective impact on the character of regional development. Hence, in addition to the traditional engineering criteria, applied to each transportation alternative, PJ asks: Is the region it will tend to generate socially desirable? Is this region economically productive? Is it politically attainable? Is it aesthetically attractive? Is it realistic in an evolutionary sense—that is, can the forces at work, tempered by the policies and programs at the command of the region, be channeled to bring the comtemplated future about? And finally back to the beginning, will the kind of region actually generated be so arranged and interrelated that the transportation provided will serve the region's functioning in the manner planned?

PJ's fourth principle is that the process of testing and reaching agreement is an integral part of a planning program. The PJ staff is not trying to design a transportation system that would win first prize in a national contest judged by city planners or engineers or economists. PJ's job is to design a professionally competent system that has the capacity to enlist the support and commitment of all the agencies and groups whose agreement is essential if anything is to happen. To achieve results from a comprehensive transportation program, there needs to be an unbroken series of yeses by many parties whose cooperation is vital and whose opposition would be fatal.

In recognition of this need, PJ was designed to assemble into a single government agency all the major governments whose combined transportation activities determine the regional transportation system. Important subcommittees bring the private transportation agencies into the program. Moreover, because agreement is needed regarding the interaction between the regional transportation program and other programs affecting the general development of the area, the PJ organizational structure brings together representatives of general government in the region—that is, the counties—and representatives of the state and Federal highway and transportation agencies. PJ's Policy Committee is the place where agreement is sought among eight suburban counties, the City of Philadelphia, two states, and the United States Government. The function of the staff is to provide the Policy Committee with the knowledge necessary for it to reach agreement on a best plan and program for the region.

PJ's fifth principle is that there are important continuing aspects of the work in which it is engaged. One vital clause of the 12-government contract under which PJ is jointly financed and directed, calls for the establishment of some type of continuing process for carrying on the work necessary to keep the program current.

Up to this point certain fundamentals of PJ that were more or less explicit in the written agreement that initiated the program have been described. All the foregoing ideas have been elaborated in the Policy Committee's discussions and decisions that gradually shaped the specifics of the program of data collection and analysis and transportation systems planning.

To develop further the idea of a continuous process, and to proceed beyond the point to which the Policy Committee has presently arrived, the author believes it is necessary to begin thinking about the needed continuing process by considering the several objectives of the present ongoing program. First, PJ is creating a plan for an evolving regional transportation system needed both to serve and to help shape a desired pattern of regional development associated with the transportation plan. It is intended for this plan, as adopted and subsequently modified, to serve as a guide to all specific transportation measures taken by governmental or private agencies. Second, PJ is preparing a program for the staged development of the regional transportation system over

a period of years. And third, PJ is determining what provision should be made for keeping the results of PJ up-to-date and what sorts of continuing agency may be necessary in the future.

The first thing to notice is that none of these three objectives can be made final and complete in any ultimate sense within the three-year period of PJ's existence—nor for that matter at any other date in the future. A region is nothing like a building. In the case of a building, it is necessary to design the ultimate form in a relatively short space of time. The blueprints and the specifications are the means of organizing a burst of activity by an assembly of construction workers. Within a brief, finite period the construction is undertaken and completed. The building is finished and ready to be occupied. With a city or a region the process is very different. It is at least partially occupied to begin with. There is no such thing as an ultimate design—a region continues to change as long as human beings occupy it. Moreover, people are loath to burn their bridges ahead of them, as one planner has put it. They wisely like to keep the options open for as long as it is possible, until faced with the immediate need for action.

The urban planning process is like an endless journey into the future. At each step of the way certain decisions may have to be made on where to go next. Sometimes the next step has no special significance; sometimes, at the fork in the road so to speak, it is a commitment to a particular path for a long time to come. The nearer steps in the future can be seen most clearly; the places to be traversed later are grasped more vaguely. Beyond the present horizon, the journey is pure conjecture.

What is needed at each stage is a capacity to know what the situation is and what new possibilities have opened up. Given the fundamental inseparability of general transportation considerations and general regional developmental considerations, one element of the array of continuing needs is likely to be an agency of the region with the capacity to do continuously the same kind of basic policy and program development the PJ now has initiated. At this level of generality, transportation demand needs to be related to other demands in the region. Therefore, the required agency must have the capacity to look at region-shaping policies across-the-board. It must be the meeting place of all the governments whose activities combine to determine the form and functioning of the region. In brief, an agency akin to PJ's Policy Committee is likely to be a permanent need.

But policy in itself, important though it may be, does not serve regional demands. In terms of transportation, from time to time new facilities must be constructed and new services initiated. Elements in the general program advance from the category of possible future works to the status of projects to be constructed. They become like needed buildings—structures to be designed in full detail, to be described carefully in working drawings and specifications, to be built and completed and put into use. At this stage, the projects no longer are appropriate to a general policy and program development agency. They require the full attention of an action agency equipped to take action, to contract, to acquire, to build. Depending on the character of the particular project, it becomes the proper responsibility of a local, county, or state transportation department—or a railroad or a bus company. Or if the particular policy is to be expressed not as a constructed facility but as a regulation or a fiscal change, it may become the responsibility of a legislative or regulatory body.

Finally, there is the element of feedback. The actual experience with the operation of the transportation system and its parts generates new information about transportation demand and, equally important, about the functioning of the region as a whole. Part of this feedback remains within the operating agency, suggesting operational adjustments and the possible need for further modification of the system of facilities. But part of the feedback represents new basic information needed for the adjustment, modification, and further development of the broad, general regional development policies.

The author's guess, then, at this stage of PJ's program, is that this study may assist in launching into permanent orbit not just one but an array of activities, when the work is completed. Some of these are likely to require an agency patterned somewhat after the PJ Policy Committee; others are most likely to occur as functions of existing governmental and private transportation agencies or regulatory bodies; and perhaps some small number may warrant the eventual creation of one or more entirely new agencies not yet visualized at all.

The author has purposely restricted these remarks to the general philosophy that underlies the current program of PJ. How PJ is going about this program is the subject of the following paper.

Methodology of Planning

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●THE first of the two papers explaining the Penn Jersey Transportation Study presented the general philosophy that guides the Study's activities. The author has shown how the program is related to the social, economic, political, and physical environment of the nine-county region, a bi-state urban complex radiating outward from Camden, Philadelphia, and Trenton. This paper deals more specifically with the methodology of the Penn Jersey Study (PJ).

All of the research at PJ is disciplined by a single unifying concept, linking urban development, transportation movement, and growth of a metropolitan region. This theory suggests that there is a vital relationship between the activities that occur within parcels of land and the interchange of persons and goods as represented by transportation movements. If the opportunities for transfer among them are changed, a change in the activities on the land is brought about. Conversely, if the activities on the land are changed, the movements back and forth among them are changed.

Although this theory was stated many years ago—by the British planner, Sir Raymond Unwin, among others—it has become operationally significant for transportation planning only in the relatively recent past. Three sources have contributed especially to PJ's research methodology.

The first of these was the invaluable development of a technique for conducting origin-destination surveys through household sampling by a group of officials at the Bureau of Public Roads. Second was the theory expressed in the book, "Urban Traffic and Transportation," by Mitchell and Rapkin, which provided a synthesis of earlier thinking relating transportation and land use. And third was the significant pioneering work of J. Douglas Carroll, Jr., who made this synthesis operationally workable by demonstrating the feasibility of relating travel to land use in his transportation studies of Detroit and Chicago.

This paper shows how PJ research is oriented toward applying its unifying concept to the specifics of the particular metropolitan region it is studying. The Penn Jersey region covers approximately 4,600 sq mi and has about 4⅕ million inhabitants.

The agreement creating PJ involves 12 governmental agencies. This agreement calls for the development and examination of several different plans and programs of transportation improvements for the nine-county area. PJ is asked to identify the patterns of regional growth and change that tend to be associated with alternative sets of transportation proposals.

PJ wants to know how the region might change over a period of time in response to public improvements applied in staged sequence. Each group of proposals will represent a different development pattern and will be expressive of a basically different transportation system. A particular program will express one possible combination of transportation, industrial development, and land development patterns that are consistent with each other as to over-all region-shaping purpose and effect.

What shall be done is to simulate the development of PJ's region as it might take place during a long period of time in response to each of several alternative combinations of public policy—transportation policy being especially prominent among these. The central instrument is a projection methodology which is referred to as the "PJ regional growth model."

Regional growth model is PJ's short name for an interrelated array of sub-models,

procedures, and routines which will describe the changes that might occur in land use and in travel patterns over time in response to the interaction of various programs, given the social, economic, and political forces and trends operating in and on the PJ region. The model is being designed to simulate both the growth and change of urban development and the patterns of movement that would occur in a given type of region at any particular stage in its evolution.

The PJ model incorporates new versions of various models that already have been used successfully in other places as well as some original models. PJ stresses, however, the feed-back that must occur throughout the complex system of sub-models if changes are introduced in any one of them. Thus, for example, if new highways, adding capacity to the highway network, are introduced and the relative accessibility of land is improved in various locations, PJ shall investigate corresponding changes in the real estate market to determine whether the magnitude of change is significant, and if so, how land development may be affected.

The unifying concept considers the effect of a new highway or rail facility on undeveloped land, where extensive development may take place soon after the facility is built, without losing sight of the highway needs that are created by residential or industrial growth. To use this concept, PJ's simulation of regional change and the resulting travel patterns must approximate continuous change, and, therefore, will not operate as a continuous process, but will be iterated by 5-yr periods.

At the end of each 5-yr projection, PJ will describe and introduce hypothetical improvements in the transportation system, feed in the anticipated growth factors, and develop the resulting interchange of persons and trips that would occur as the result of regional growth in the interim. This step-by-step procedure will enable PJ to take a close look at the results of the research periodically, so as to determine whether the end product of each step is acceptable as an input to the following iteration.

The following is a brief description of each of the components of the regional growth model. This model has grown out of the cooperative activities of people associated with the Study. The transportation portion of it will represent improved applications of well-known approaches. It is believed that new findings will be available regarding social, economic, and trip-making behavior. The design of an over-all model combining these diverse parts has been under the direction of Britton Harris, Research Coordinator for the Study. The model is essentially a means of combining procedures and subroutines, some of which were previously used by other study groups and some of which are being developed by the PJ staff.

The first principal component of the model is the transportation network. To describe the main patterns of movement and the interchange of both persons and goods which take place between the various types of land use, PJ divided the nine-county area into approximately 175 districts, varying in size as the concentration of population, commercial activity, or industrial use changes. The districts were designed so that principal areas of activity can be distinguished from those of less importance with a minimum of data processing. The largest traffic generating areas, including business districts and industrial zones, can be selected rapidly for analysis of area characteristics.

District maps were prepared in such a way that the principal traffic corridors are described by combinations of districts. Expressways, railroad lines, and primary highways pass through the district centroids as closely as could be determined by inspection of present route intersections and centers of urban activity.

The transportation network produces accessibility, without which an area of land could not sustain urban development. Access either must exist or be attainable through new construction. The most attractive districts are those having convenient access; that is, a capacity for interchange with other districts with a minimum loss of time. Time values for links in the transportation network are being obtained by field studies, both peak and off-peak, on all of the rail and highway links of the major transportation network.

The conversion of toll charges to time equivalents presents a problem. The Study area is comprised of counties located in Pennsylvania and New Jersey, and interstate travel takes place on toll bridges, located at various points along the Delaware River.

There also are turnpikes in both states on which tolls are collected. Toll charges vary on the bridges in some relation to the degree of convenience afforded to the public. It is recognized that toll payments affect the volumes of travel on turnpikes as well as on bridges. The effect of toll payments will be counter-balanced in the transportation network by assigning restrictions in the form of additional hypothetical travel time to the time values selected for each of the links.

The second component of the regional growth model includes the existing use of land and the land development potentials. Certain land development depends just on the sheer growth of the population; other development depends on the economic growth of the region, the expansion of commerce and industry. Moreover, new commerce and industry will be required to serve the growing population, and conversely, newcomers will be attracted to the region to man new jobs. A new housing development needs shopping facilities and other services. A new steel mill or new manufacturing plant may bring about a shifting of the labor market inasmuch as workers and their places of residence follow the availability of employment.

Industry, for purposes of present analysis and future projection, is divided into two classifications; that which is fixed because of present location and resistance to making a change, and that which is new or inclined to move. Numerous large industrial installations are considered to be at least semi-permanent inasmuch as change of location is not likely within the foreseeable future. Many plants already are located where conditions are ideal for the interchange of goods and movement of people; others are not so favorably located, but the investment in plant and equipment, the availability of skilled labor, or the cost of relocating, limit the economic advantages of seeking new locations.

New industries and those that are in a state of flux, moving or subject to change in location, present a real challenge to the regional growth model. Many small plants and business establishments requiring parking facilities and convenient highway access are moving to suburban areas where their requirements are fulfilled without loss of trade.

Light industry enjoys considerable flexibility in the selection of accessible plant locations, but other influences, including the availability of utilities and public services, as well as comparative tax rates, affect the choice of location. These factors have an important bearing on the potential of land for development.

A third type of industry serves residential demand. The construction of new homes promotes the building of shopping centers, office buildings, and small plants to satisfy the home owner's needs. Schools, churches, and public buildings become necessities that must be provided locally.

The PJ Economic Establishment Survey will provide valuable information essential for determining whether the locations of particular industries should be considered fixed or flexible.

Another key element in the projection of land development is the growth of population. Fortunately, the 1960 census data becomes available just at the time when population trends are being analyzed. The census data will be correlated with information being obtained from a new kind of household survey supplementary to PJ's standard origin-and-destination home interviews. The supplemental household survey, designed and supervised by Henry Bruck of the PJ staff, will yield detailed knowledge of family characteristics and factors influencing choice of residence. Field crews conducted 6,600 supplemental interviews to obtain sociological information from a subsample of the home interviews. The resulting data will provide important and essential input factors for the regional growth analysis.

The third component provides trip generation rates and the distribution of trip ends for the model. Trip generation rates are being studied in two ways: first with respect to knowledge of 1960 land use and trips, as reported in the 1960 interviews; and second with respect to knowledge that can be gained by reviewing and reprocessing 1947 trip data. Land-use information is also available for correlation with 1947 trips. The mathematical relationships between the number of vehicular or person-trips generated in an areal unit and the type of land use provide a means for expressing the observed phenomena in a manner which will indicate whether data obtained from surveys made

13 years apart can be related. Comparisons and tests of various mathematical models will lead to a refinement of the equations that will be used for estimating trip generation rates at future dates. The analysis of trip generation and trip-end distribution is being made by George Wickstrom and Anthony Tomazinis of the PJ staff.

The analysis of trip-end distribution involves the patterns of movement between interzonal origins and destinations when trips are distributed, first in accordance with the observed phenomenon, and second when they are projected in accordance with the anticipated termini corresponding to the effects of land-use changes. Trip-end distribution is influenced by the inclination of an areal unit to attract trips. The characteristics of trip patterns are being considered on the basis of two assumptions: first, that the propensity of an area for attracting trips is related to the character and density of activity which take place within the area; second, that the probability of a trip finding a specific terminus is determined both by the number of intervening trip opportunities of a similar nature and by travel time or distance. It is believed that a combination of these two theories will produce reliable results. To put this in terms of a familiar example, a large suburban shopping center attracts many patrons, but the residents of a particular area will select the shopping center that is closest, providing the nearest one satisfies their needs. Tests will be made to determine how these relationships operate in PJ's region.

The PJ Study carefully inventoried land use, parcel by parcel, in all nine counties prior to the survey of trips. The home-interview sample was selected from the field listing of residential addresses. Therefore, complete information is available for analysis of trip generation and trip-end distribution.

A separate analysis is being made of the factors that influence choice of mode, using additional data from a field survey of rail passenger trips. Person trips using transit will be related by mathematical expressions to the significant regional characteristics of particular districts or corridors. This type of analysis will produce insights for the determination of the essential factors that will be used for identifying potential transit volumes in the assignment of persons trips to the transportation network—a network that will combine both highway and rail links.

The final component of the regional growth model is the evaluation of traffic volumes and determination of the probable flow patterns between districts, thereby testing the results of our traffic simulation procedures. Having started with relatively large districts, connected by major highway and rail routes, population, land use, and other factors obtained from the analysis of PJ's regional data are added. Then, from an analysis of traffic-generating characteristics of various activities and the distribution of trip ends, mathematical expressions relating trips to land use are obtained. Now, PJ returns to the physical description of the area, in terms of districts, to compute the travel patterns and the volumes of interchange between districts.

Initially, by simulating the flow of persons and goods by different modes, the reliability of the methodology will be tested using only 1960 data. Having modified the procedures until they are reasonable, PJ will then use the initial output as the input to the next iteration after adding newly constructed, committed, or proposed segments of the major transportation network. These steps will be repeated to represent 5-yr intervals to the year 1985.

At the end of each iteration, a sufficiency analysis will be made of highway capacity, considering only the inter-district movements and major highway and rail links. This analysis will aid in checking a program for scheduling the construction of improvements and in estimating costs of new facilities on a 5-yr basis.

The end product of PJ's research will be a transportation plan and a recommended development program. Recommendations are being formulated to provide for a continuing transportation planning process, whereby the plans and programs described herein will be kept current and periodically updated. This continuing process will provide assurance that planning can precede the demands of the public for better transportation.