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Author

Webber, Melvin M.

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MELVIN M. WEBBER



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Transportation Planning for the Metropolis

MELVIN M. WEBBER

□ IT IS BUT FIFTY YEARS SINCE THE Congress recognized the automobile as something more than a pleasure vehicle and enacted the Highway Act of 1916. Following the growth curve typical also of other fields, conceptual developments in transportation planning were sparse during the 1920s, increased slowly during the 1930s and 1940s, and then, following some major empirical discoveries and conceptual clarifications during the mid-1950s, began to accelerate rapidly. Now, in the mid-1960s, the pace of developments is extremely rapid; and we may be on the verge of a golden age of discovery and creative thought in metropolitan transportation planning.

Of course, the so-called metropolitan problem, or even the metropolitan transportation problem, is not about to be "solved." Paul Ylvisaker stated this clearly when he spoke to the World Traffic Engineering Conference.

... The art of planning in the Twentieth Century is admittedly about where the art of medicine was in the Sixteenth. If there is a difference, it is that we are much less naive than the medical scientists who began their rational assault on disease four centuries ago; we know about the intricate web of cause and effect and the subtle process of balance by which nature resists what in man's self-centered view is a total solution.

We can use this sophistication to speed the development of the planning art. Not least by perfecting and exploiting nature's process of balance, and playing down the childish notion of total solutions. There

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will never be total solutions to urban problems for the simple reason that the future is never finished . . .

We ought to be talking about resolving urban problems, not about solving them . . .

Perhaps the most significant event in the recent history of transportation planning is a shift from a way of thinking that would seek a total designed solution to the transportation problems to a fresh way of thinking that sees transportation planning as but one of the ways of grappling with the evolving problems of urban life. Once an isolated, road-building effort, transportation planning is now becoming an integrated part of a larger effort to lead metropolitan development into desired directions — to accommodate the metropolitanization of the nation to the newly emerging social and economic processes that mark a society at the high-scale of development.

THE EARLY STAGES

GETTING THE FARMERS OUT OF THE MUD

Following upon nineteenth century traditions of transport-facilities planning, which had located and then built a network of canals, railroads, streetcar lines, and subways, the early twentieth century efforts were directed to locating specific routes. The major shift that came with the turn of the century was a redirection from rail facilities to roadways for individual vehicles. Indeed, transit planning in the first half of this century was almost exclusively aimed at improving operating characteristics of then-existing facilities. The new routes to be located were to serve cars and trucks.

The initial motivations in the early 1920s were to get the farmers out of the mud and to do something about reducing traffic hazards. At a time when private auto ownership was fast becoming a fact to contend with, there was little need for elaborate planning methods. The task was clear, and civil engineers were clearly the men best equipped to deal with it. Hard-surfaced roads had to be built wherever the obvious traffic demands and political pressures arose, and as soon as funds could be found. Notions of highway system, even highway network, were yet to come. Certainly "systems planning" was neither known nor needed. The concept of a planned

network of roads was to come quickly, however, as the grid began to evolve and as demand arose for links between once-separate routes.

The main financial burden lay with local government, federal aid being initially limited to 7 per cent of the rural mileage of each state. Then, with the establishment of the federally numbered highway system in 1925, a major effort was begun to build paved roads connecting major cities. It took a long time for the small-scale, rural-oriented approach to highway planning to give way throughout the nation to a large-scale effort to plan for urban facilities. A major impetus, however, was supplied by the Regional Plan of New York and Its Environs, published in 1929, which boldly called for a system-wide design for all urban transport facilities. Its plan for a vast network of highway and transit lines was the first product of a "systems approach" to urban transportation planning in the United States. The effects were slow in being felt, however. During the 1930s, increased auto ownership and use, increased speeds, and a rapid rise in trucking gave impetus to studies for extension and modernization of highways of all sorts; but the focus of attention remained glued to route-location studies for specific highway links. Few transportation planners had either the time or the inclination to attempt system-wide planning.

In 1934, the Highway Act provided that 1½ per cent of the federal funds be used for surveys, plans, and engineering and economic investigations for future highways. From then on the Bureau of Public Roads (BPR) acquired a decisive leadership role in promoting highway studies. The level of sophistication has steadily risen since that date, with the Bureau offering technical and intellectual leadership in a great deal of the work that followed.

The Highway Planning Surveys, jointly sponsored by the BPR and the states during the 1930s, were designed to inventory existing facilities and to measure existing volumes of traffic. Although the surveys were primarily devoted to rural roads, they accumulated a great deal of factual information on the characteristics of all road users. Perhaps the most striking finding was that most motorists were urbanites and that most people traveling on rural roads were destined for urban areas. There was thus no escaping the fact that the rural-road system was inseparable from the urban system, and that rural roads could not be planned in isolation.

O AND D AND THE SHIFT TO AN URBAN ORIENTATION

During the 1930s, seeking a more sensitive method of identifying travel habits than gross roadside counts, the BPR undertook research on sampling methods for estimating traffic volumes. Initiation of the origin and destination survey, now a standard traffic-inventory method widely referred to as "O and D," marked a major increase in the level of refinement in traffic analysis. The O and D survey called for the construction of representative samples of households, home-interviews concerning travel on a representative day, roadside checks, and refined statistical verification. Going beyond the mere recording of travel volumes at points on the roads, the O and D survey was able to produce estimates of travel-desire patterns in which the surveyors could place high confidence. The new information told how many trips were being made from place to place. In turn, it was hoped that a knowledge of travel desires would supply a firm basis for planning new transportation facilities that, in turn, would effectively satisfy the surveyed demand. When the O and D studies were initiated, the preoccupation of road planners was with the overwhelming backlog of highway-construction needs. Future highway needs were not considered of immediate concern; and designs that were fitted even to existing travel desires represented a major step forward.

The widespread application of the new and sophisticated O and D survey method had to await the end of the war, although the urban-travel studies were begun in earnest in 1944. The universally accepted need for a vast postwar highway construction program was punctuated by the phenomenal increase in auto ownership during the late 1940s and the 1950s. A firm warrant was needed to support the large expenditures that were entailed, and the O and D survey had all the marks of scientifically derived certainty.

Explicitly oriented to urban transportation, the surveys marked a major shift in emphasis from the initial rural orientation of highway planners. The surveys were intended to furnish a basis for the design of urban *highway* facilities, for neither the Bureau of Public Roads nor any state highway department was charged with transit planning. Nevertheless, the survey method itself obligated the surveyors also to inventory urban transit usage, since persons responding to the questionnaires reported their transit as well as

highway trips so as to yield a controllable total. The findings of these and related studies confirmed what everyone already knew about transit patronage, of course. The curves showing trends in transit riding were all heading downward, threatening to go off the bottom of the charts, as they do in the cartoons. And, of course, the curves were interpreted to support the highway-construction programs, on the theory that fewer and fewer persons wanted public transportation.

There were some built-in shortcomings in the O and D survey and in related methods of inventorying travel habits, volumes, and spatial patterns. A survey made in 1947 may, with care, be made to yield a reasonably accurate description of travel in 1947, but it doesn't necessarily say anything about future travel. Moreover, any inventory method, however elaborate, can yield only a description of *what* goes on at the time of the inventory; it says nothing about *why* it goes on as it does. Descriptions of transit patronage, for example, were telling; but they didn't tell why patronage was dropping as it was. To be sure, a body of descriptive data in the hands of an imaginative analyst can be enriched by combination with other sorts of information. Correlation analysis can identify other variables with which the data are associated; and such correlation studies have revealed some very enlightening associations of income, family size, occupation, race, and other demographic characteristics with certain variations in travel patterns. But, still, these are descriptions rather than explanations of phenomena observed today, and highways are intended also to serve populations that will use them in the future. Reliable projection must be based on explanation, not mere description.

During the 1940s and the 1950s most transportation planners easily bypassed both the problems of futurity and the absence of explanatory theory. Those who had grown up in the conceptual traditions of civil engineering were well prepared to make professional decisions despite the absence of theory, since they were well acquainted with the stability of certain empirically observed characteristics. Structural engineers have successfully designed many complex structures relying upon the empirical measurements of the strengths of materials; a theory that would purport to explain why concrete behaves as it does is not really essential, so long as the designer can be sure how it will behave under given circumstances of loading and stress. He can be confident that, if the

chemical composition and preparation conditions of two batches of concrete are the same, the performance will also be the same, whatever the time interval between the batches.

It was no surprise to the empiricist, then, when the O and D surveys revealed similar travel patterns in the various metropolitan areas. And then, when the refined descriptive measurements and comparative analyses showed that even the modal, temporal, demographic, and other specific variations were also similar from place to place at any particular time, it seemed wholly reasonable to assume that future traffic would follow the same patterns. It remained then to develop "expansion factors" that would take account of population growth and, hence, traffic growth.

In the early days, traffic was "factored up" as a direct function of population size in any two interchanging zones within a metropolis. With the later introduction of "gravity" models, distance was introduced as an added determinant of traffic interchange. Traffic was then calculated from land-use data, varying directly with the intensity of land use and inversely with the distance between zones.

Given empirically observed regularities in traffic patterns, it was assumed that these would hold into the future. Highways could therefore be properly designed, given only an O and D survey and a basis for factoring it up to some future date. For a short period of time, then, all the transportation planning pieces appeared to be in place, since the planning task was seen as no more than an assignment to install sufficient capacity to handle forecasted traffic.

EMERGENCE OF METROPOLITAN STUDIES

As the findings of the O and D surveys in the various metropolitan areas began to accumulate, a vast amount of new empirical information became available. At the same time, a wide variety of different kinds of people became involved in metropolitan studies. There had been a long and traditional interest among certain sociologists and geographers in the spatial patterns of metropolitan development, but in neither of these fields had this research remained quite respectable. Now, however, when metropolitan expansion was becoming so dominant an event in contemporary society, and

when the complexity of the policy issues was becoming so apparent, more and more social scientists and behavioral scientists were attracted to the intriguing puzzles that were being posed. In the 1960s it is becoming quite respectable, if not fashionable, for men from a great many fields of inquiry to participate in "the attack on the metropolitan problem." As dual effects, we are coming to recognize the complexities of the problem and we are beginning to learn how to deal with those complexities.

Of course there had been a long-standing interest among city planners in the development patterns of metropolitan communities, but up until the beginning of the 1950s there had really been very little planning activity in the United States at this scale. To be sure, there had been New York's Tri-State Regional Plan in the late 1920s, and there had been the short-lived New York State Commission on Housing and Regional Planning that prepared a plan at about the same time for the state; and these two efforts had in turn generated numerous analogous efforts elsewhere. Metropolitan planning remained an objective of planners through the Depression, the war years, and beyond into the 1960s. By now, indeed, a few metropolitan areas have made small steps toward establishing permanently continuing metropolitan planning and governing activities. As we shall see later, however, most of the metropolitan planning remained an objective of planners through the Depression, 1960s has been tied to the metropolitan transportation studies.

Well financed, well staffed, and empirically oriented, the recent transportation studies produced much more information about metropolitan development than ever had been available; and this new information proved to be very valuable to all sorts of students of the metropolis. Immediately, the new data made possible detailed comparative studies of automobile versus transit usage, travel times, trip lengths, trip "purposes," directional and temporal variations in travel patterns, and so on. Now, students of urban life and urban spatial structure had some new and rich data to supplement the United States census and their own survey findings. The spate of research that followed led to a revolution in metropolitan transportation planning and in general metropolitan planning as well. No longer were we tied to personal intuitive judgments alone; the careful observations and measurements gave us a bench mark against which our preferences had now to be tested.

THE LAND-USE BOOM OF THE 1950s

PIONEERING EFFORTS

Unquestionably, the major event in metropolitan transportation planning in the 1950s was the rediscovery that land-use patterns and travel patterns are intimately related, a fact discussed in the early 1920s, but largely neglected since. In 1954, Robert B. Mitchell and Chester Rapkin published *Urban Traffic: A Function of Land Use*, the first major clarification of this important idea (Mitchell and Rapkin, 1954). At the same time, the Detroit Metropolitan Area Transportation Study, directed by Dr. J. Douglas Carroll, Jr., was successfully applying land-use data including estimates of future land-use patterns as effective determinants of urban-travel patterns. In the same year, the San Francisco Bay Area Rapid Transit Study was independently seeking to derive travel patterns from land-use patterns. A year later Alan M. Voorhees published his prize-winning essay entitled, "The General Theory of Traffic Movement," in which he too was demonstrating that traffic patterns are consequences of land-use patterns, and that the gravity formula can be adapted for relating the two. Then, in 1956 a year later, John Rannells published his perceptive book, *The Core of the City*, in which some important conceptual clarifications were made (Rannells, 1956). This was followed in the latter years of the decade by the Chicago Area Transportation Study, where some of the most refined analyses of urban phenomena ever made were conducted.

These were primarily the contributions of city planners, who understood that transportation planning cannot be done in isolation from land-use planning and who therefore became transportation planners themselves. All of them were saying, as the Mitchell-Rapkin title had contended, that traffic is a function of land use — that traffic can be better understood and projected as a derivative of activity location-patterns. Underlying this proposition is the more general idea that urbanites, being specialists, are dependent upon other urbanites with whom they communicate. One mode of communication is travel — travel to work or to shop or to school or elsewhere. Another mode of communication is goods shipment, expressed primarily as truck and rail movements. Another mode is message-sending, through telephone, newspaper, broadcasting, and other message-handling channels. The metropolis in this context

is seen as a vast communications system within which thousands of interdependent establishments — whether business firms or households or governmental agencies — interact with other establishments. Land use, then, is simply a short-hand way of identifying different kinds of establishments and, hence, different kinds of relationships — linkages — that each has with other establishments.

The effect of the Mitchell-Rapkin and the Detroit studies, particularly, was to precipitate a new approach to transportation planning. Land use was quickly recognized to be a more sensitive indicator of traffic generation than anything that had been available before. Almost overnight, transportation planners became land-use analysts as well, and land-use planners were welcomed as collaborators by transportation engineers.

LIMITATIONS OF LAND-USE INVENTORIES

The built-in dilemma of land-use inventories is of course the same as that which we noted with O and D surveys: an inventory of today's land use does not necessarily tell us anything about tomorrow's, nor does it offer any direct clues about the causes of potential change. The response to these bothersome facts has been identical to the response to the O and D inventory's "nowness." With the completion of a fairly large number of quantified land-use inventories, marked regularities among the patterns in different areas were discovered. Again it did not surprise those who were familiar with empirical regularities in structural materials and, by now, with the empirical regularities in traffic patterns, that land-use patterns in one metropolis turned out to be quite similar to land-use patterns in another. More than that, even with the little information that was available about prior patterns, it became possible to detect certain regularities in land-use pattern changes through time, however coarse the early analyses had to be. It became clear that land use, like traffic, is not capricious. Indeed, it began to appear that land-use patterns might be the consequences of the workings of something akin to natural laws. And, again, as with the natural laws governing the behavior of materials, for certain purposes it is not necessary to ask why the laws govern as they do. To apply the findings, it is only necessary to know what the consequences are; and if the consequences of the natural laws are indeed consistent, as the effects of natural law by nature are,

then future land use should be readily predictable. To see what the future patterns will be, then, one need only to look at present, empirically observable patterns.

THE NEW FORMULA FOR TRANSPORTATION PLANNING

With the fortuitous development of high-speed computers at this very same time, we thus entered a period of lively investigation of land-use and traffic patterns in urban areas. In the hands of some creative and able analysts, the findings of the studies were reducible to fairly simple mathematical formulations. Now, in the mid-1960s, land-use and traffic forecasting and highway planning are becoming standardized procedures that most transportation engineers can readily learn. They call for (1) an O and D survey (or desire-line patterns synthesized via computer-based simulation models, without the expensive home-interview); (2) a quantified land-use inventory; (3) computations of the traffic-generation rates of the various land-use classes; (4) forecasts of area-wide population and employment to some future date; (5) spatial allocations of future population and employment in accordance with the empirically discovered present patterns — in effect, factoring up land use to a future date; (6) application of the traffic-generation rates to the forecasted land use, thus synthesizing future O and D travel patterns; (7) assignment of the traffic to a hypothetical highway network and testing of the ability of the net to handle the forecasted traffic volumes; (8) adjusting the net to fit the projected traffic; and then, finally, (9) constructing the network.

This strategy for metropolitan transportation planning is highly compatible with good civil engineering practice. Engineers are well equipped to handle the large volumes of data; the modes of analysis are similar to those in civil engineering; and the empiricism is of the same sort, as we have noted before, as is traditional in testing strengths of materials and designing engineering structures.

The metropolitan transportation planning task clearly calls for a high level of sophistication in data handling and in the treatment of large and complex problems. These are, of course, the traditional skills of the engineer, and he has not hesitated to take on this difficult and intricate task. Highway planning also, of course, has been one of the traditional professional assignments of civil engi-

neering and, more recently, traffic engineering; and most of the staff in the state highway departments and in the Bureau of Public Roads are trained as engineers.

With the discovery of the vital importance of land-use projections, during the past few years, the engineers have not hesitated to invite other kinds of specialists to assist them; and it is now no longer a rarity to find urban planners, economists, geographers, sociologists, and others participating in the large metropolitan transportation studies. Because of their long-standing concern with urban land-use patterns, the urban planners in many of the metropolitan areas are called upon to prepare inventories and extrapolations of existing land use and to help evaluate the realism of land-use forecasts.

But a few urban planners have had a far more central role than that. The pioneering Detroit Area Transportation Study was directed by a group of social-science trained planners who later conducted the large-scale Chicago Area Transportation Study where the forecasting techniques were refined and made fully operational. The most advanced state of the art along this important line of development is now to be found at the seat of the earlier metropolitan and state planning efforts of the 1920s, having been transported from Chicago to New York. The up-state New York transportation studies, directed by Roger Creighton, and the Tri-State Transportation Study for the metropolitan region centered on New York City, directed by Dr. J. Douglas Carroll, Jr., have carried the techniques to a high level of technical proficiency and sophistication.

Under the impact of these and the numerous other metropolitan transportation studies that have been undertaken during the early 1960s, route planning has almost universally given way to transportation-system planning. Indeed, federal highway legislation now makes this mandatory on a "comprehensive, continuing, and cooperative" basis. The contemporary effort is to lay out coherent networks of routes interlacing the entire metropolitan territory. The exclusive focus on the highway, that dominated transportation-planning efforts throughout the first half of the century, is by now yielding fast to the conception of a "balanced transportation system," comprising some rationalized mix of auto and transit facilities. Rarely, however, is the boundary of the system under design stretched much beyond the physical transport facilities themselves. Metropolitan transportation planning has gone through a rapid and

revolutionary development during the past twenty years; but it is still transportation planning, not metropolitan planning.

THE GROWING DISENCHANTMENT

METROPOLIS: MACHINE OR SOCIAL SYSTEM?

The approach to metropolitan transportation planning that is briefly outlined here and that is now becoming codified in transportation planning practice throughout the nation seems to derive from the conception of the metropolitan area as a closed mechanical system. It is assumed that if we can predict land-use patterns and hence, future travel patterns for some specified future date, we can then install sufficient transportation capacity in the appropriate places to satisfy future travel demand. This is akin to designing a part of a machine in such a way that the operations and capacities of the part will match the machine's requirements — say, to take a simple example, the design of an automobile's carburetor, with fuel-handling capacities matched to the fuel intake of the cylinders. The idea is, of course, a very familiar one in many branches of engineering, architecture, and urban planning; and it is familiar to all of us who have grown up in an industrial society.

But metropolitan areas seem not to be systems of this kind. Rather, they seem to be more like self-regulating biological systems than like mechanical systems. They maintain themselves, they grow, they sometimes reproduce, they respond to stresses, they age, and they may even die and enter the hereafter as ghost towns. Unlike the workings of a mechanical system, the inputs into the metropolitan system contribute to the system's growth and change. More than that, a change in any one of the subsystems induces changes in other subsystems, such that the characteristics of any part depend upon those of all the other parts. To add a part to the system is to change the characteristics of all other parts and indeed to change the characteristics of the new part itself.

New population arriving in a metropolis is not simply added on to previous populations; it influences the preexisting populations, itself changes, and in turn influences later development of the metropolitan area, possibly in quite different ways than did earlier immigrant populations. Similarly, the construction of a major public

work, such as a new freeway or transit line, is not simply added to the existing stock of facilities. Rather, it becomes a causal input that influences all prior and later developments, possibly in quite different ways than did previously constructed facilities.

METROPOLIS AND THE TRANSPORTATION SYSTEM — AN INTERACTING PROCESS

And yet metropolitan areas are different from both mechanical and biological systems, being in some degree susceptible to willful modification through the actions of organized communities of men. Inputs to the system — new populations, new public works, new business activities, new social services, new governmental fiscal arrangements, changes in the locational preferences of establishments resulting from technological or cultural changes, and so on — can modify the patterns of future metropolitan development. Some of these influences can be deliberately controlled, most notably of course, the very transportation facilities which the planning studies are typically intended to design.

It is thus becoming clear that transportation facilities are considerably more than cogs in a metropolitan machine. They not only serve transportation demand, they also shape it. And the ways in which they do so are devious and complex, finding expression through the millions of decisions made daily by individuals and groups who deal with each other within the metropolitan setting.

Although it had apparently escaped the attention of many practitioners and theorists concerned with the metropolitan transport, over a long period of time a body of theory has been accumulating in economics, seeking to account for the locational decisions of urban establishments. Currently that theory is being actively re-examined, and important refinements and elaborations are now coming forth. But, at least to our knowledge, none of these theorists has yet challenged the long-standing proposition that locational decisions of households and firms are fundamentally shaped by the costs of overcoming distance. Other variables — including the costs of density, incomes, and space and amenity preferences — are also directly at play; but the theorists are agreed that distance costs are among the major variables accounted in the locators' calculus. Because distance costs depend upon the transportation facilities and services that are available, transportation, in turn, is itself a major influence upon the spatial patterns in which

urban establishments distribute themselves. This being so, it is patently clear that a change in the transportation system is tantamount to a change in the locations of activities — that is, to a change in the land-use pattern — and to a change in the pattern of social and economic intercourse. In turn, a change in interaction patterns probably leads to more fundamental changes in the social and economic structure of the metropolitan community.

It is thus becoming apparent that transportation facilities are not only shaped by land-use patterns but that they are also shapers of land-use patterns. And, perhaps of even greater significance to the long-run evolution of transportation planning thought, we are now beginning to see that traffic, which is a reflection of social and economic intercourse, in turn influences and shapes patterns of social and economic intercourse. And if these propositions be valid, it then becomes clear that transportation planners are involved with a great deal more than highways and transit lines.

THE INSIGHTS IN THE EARLY 1960s

THE METROPOLITAN COMMUNITY AS A SOCIAL PROCESS

The urban planners' discomfort with the mechanistic character of transportation planning has been spreading within the engineering profession as well. Five or ten years ago, the engineer's response was one of despair; the more he planned and built, the more traffic was generated, the more congestion showed up on the counters, the more facilities were needed. The metropolitan machine seemed to have a mind of its own and, like Pinocchio, it seemed determined to break the rules that good mechanical systems are supposed to obey.

The problem is, of course, that metropolitanites do have minds of their own; and given new highways, they seem determined to use them. Unlike Pinocchio, though, they are not being mischievous. A new freeway that reduces the travel time between the central district and a suburban locale may, for the first time, make it economically feasible for a family or a business firm to move to an outlying location. Newly created ease of access within an urban area may open up opportunities for visiting friends, shops, or parks that were previously too hard to get to. Improved highway

networks make trucking more competitive with the railroads. And, of course, the increasing attractiveness of the large metropolitan areas to families and firms in some measure reflects the effectiveness of the transportation system in serving the economic and social processes of the metropolitan community. New urban highways become congested because social and economic interaction is the very stuff of urban life; and, because highways are an important means of maintaining interactions, people locate themselves in places where they can take advantage of the accessibilities that the highways create.

We have been accustomed to view the metropolitan area as a static pattern of land uses interlaced by a static network of transportation lines, as these might be portrayed on a map. Even when we have viewed traffic flows, we have tended to regard flow patterns as static phenomena, as traffic counts at various stations. This photographic image is now being supplanted by a view of the metropolitan community as a social process in which people deal with other people. In the complex network of individual and group relations, traffic is but one of several processes of communication by which linkages among establishments are maintained. It is these interdependencies that make land use relevant to traffic, and it is now becoming generally understood that the most sensitive understanding of traffic generation would come from studies of these linkage patterns, rather than from empirical land-use measurements and maps alone. Whereas during the 1950s, transportation planners tended to treat land-use statistics as reified "things," they are now searching behind the superficial meanings of land use for the social processes that give "land use" its important meaning and its utility. A static *form-view* of land use and transportation is now giving way to a dynamic *process-view*.

THE METROPOLITAN COMMUNITY AS A GROWING SYSTEM

At the same time a new conception is emerging that sees the metropolitan community as a *growing system*. Traditional plan-making methods in urban planning and in public-works engineering called for a portrait of the state of affairs at some future *point* in time. Desired land-use patterns or land-use forecasts were made for some single future date, typically some twenty to twenty-five years away. The planned facilities were then fitted to the anticipated

demands that would occur at the future date, in accord with the idea of a mechanical system that we have mentioned before. Even when the planners did not simply factor up existing patterns to accommodate projected trends in population and employment increase, but instead projected considerable change in the pattern, the future state of affairs was typically viewed as a static portrait at a given point in future time. Now, as we are beginning to learn something about the processes of change in metropolitan patterns, this static conception is being replaced by a view of the metropolitan area as a growing system.

THE PENN-JERSEY STUDY — OPENING A NEW FRONTIER

Simultaneously, as the theoretical work of the various groups of social scientists is being brought to the attention of transportation planners, we are learning to ask the “why” kinds of questions about urban growth, instead of the descriptive, “what, where and how much” kinds that we have traditionally dealt with. Our understanding of the complex matrix of casual relationships among the various aspects of the metropolis is increasing very rapidly now. We may already be at the stage at which we can apply multicausal models in transportation planning to replace the simple cause-and-effect models that we have used in the past. This was precisely the intent of the Penn-Jersey Transportation Study, initiated in the Philadelphia area in 1959.

There an effort was made to put our new insights to work in designing a transportation system that would best conform to a wide range of criteria. The planners sought to grapple with the metropolis as an economic, social, and political process. Traffic was understood to be an expression of the functional interdependencies among the individuals and groups living there, and the decisions to locate their establishments were seen as responses to a wide range of variables — including public actions, previously located private establishments, economic opportunity, and private preferences. Instead of projecting a future land-use pattern to some future point in time — as every previous metropolitan transportation study had done — Penn-Jersey attempted to simulate the process and the spatial patterns of growth *through* future time.

This is a decisively important step forward. Contending that the realism of a future land-use portrait can be evaluated only if

we can describe and explain the sequence of steps that would create it, Penn-Jersey attempted to trace alternative sequences of future metropolitan growth patterns that would result from different combinations of public policies and from different combinations of private opportunities and preferences.

The procedures created for deriving future land-use patterns represent a major improvement in metropolitan planning technology and thought. In 1954, both the Detroit and the San Francisco land-use plans, prepared by city planners and then adopted as the bases for traffic projection, were largely intuitive expressions of the planners' best thinking concerning the desired future state of affairs. Being essentially static in concept, they were "snapshots" of land-use patterns, each at a single point in future time. The Chicago and the 1959 Washington D.C. land-use forecasts were not presented as *desired* future states of affairs, but were conceived, rather, as the most probable state at the single future design date. Although the difference between a plan and a forecast is great — the one being normative in nature, the other positivistically predictive — all four of these land use plans in common dealt with a single future date, with no explanation of the sequence of causes between the now and the then. None of them sought to derive the future state of affairs as the resultant of sequenced events. In common, they seem to have bypassed any explanation of growth processes.

The Penn-Jersey planners, deliberately assembled from a dozen disciplines, sought to attack the issues of developmental processes frontally. Tapping into the body of economic and social theory that purports to explain locational decisions of households and firms, they constructed a set of "growth models" to be used to simulate the alternative, time-sequenced processes of development that would occur under alternatively assumed market and public-policy conditions. In accord with the behavioral theories of the economists, sociologists, and political scientists, they sought to account for the effects upon individuals' locational decisions that would be generated by different hypothetical transportation systems, zoning regulations, taxation policies, and the like. They collaborated also with the City of Philadelphia in monitoring the actual impacts of experimental programs testing the reactions of daily commuters to modifications in fare structures, time schedules, and comfort levels in mass transportation services. Future land use was thus to be derived as a function of transportation and other

governmentally supplied services and facilities; simultaneously, future traffic was to be derived as a function of land use and of the changing interdependencies among establishments. The intent was systematically to predict which interacting chains of events might occur, *if* governments and private decision-makers were to act one way or another. Thus, the pattern of the analysis and prediction was to test effects of alternative government actions with respect to transport and other matters by evaluating the networks of repercussions that the actions would trigger.

The Penn-Jersey charter called for the design of a regionwide transportation system. When the formulations of the economists' location theory were introduced into that task, under the research leadership of Britton Harris and Henry W. Bruck, it became apparent that transportation-directed actions are both cause and effect of a far larger spectrum of actions. Hence it became clear that transportation cannot be dealt with as though it were a separate system, susceptible to independent management. The long-sought goal of an optimum transportation system, which a few years earlier had seemed to be nearly within grasp, suddenly vanished. Transportation services and facilities now had become intrinsically valueless, so to speak. Their value lay only in the instrumental contributions they might make to the workings of the larger metropolitan system. And, because the larger metropolitan societal system is governed by intricate and subtle economic and political processes, the task of transportation planning became inseparable from the larger and more complex task of governing metropolitan development processes. Accordingly, the transportation study officials became instrumental in the formation of improved general policy making machinery for the metropolitan region. As it had been thirty years earlier in the Regional Plan for New York, transportation planning again became one instrument, among others, with which to shape metropolitan growth. At Penn-Jersey the transportation mandate became inseparable from that larger mission. The idea, no doubt, was among the things transported from New York to Penn-Jersey by Henry Fagin when he moved from the Regional Plan Association to head the Philadelphia staff.

Currently, such transportation studies as that in southeastern Wisconsin are building further onto the structure of methodology that evolved so significantly since the first massive O and D surveys of twenty years ago. Here, water supply and sanitary and storm

sewer systems plans are, together with transportation, integral parts of one continuing regionwide set of policy development responsibilities.

SUMMARY AND PROSPECT

Thus, during the course of the past forty to fifty years, we have seen what has amounted to a major revolution in transportation planning. We have moved from a road construction, project orientation, through a period in which efforts were made to analyze empirical regularities in traffic patterns, to a concern for the land use traffic relationships, to the present time when transportation-system planning is becoming inseparable from metropolitan planning. As Robert B. Mitchell has so aptly put it, we now know enough to realize that coordination of highway planning and transit planning, or even coordination of transportation planning and land-use planning, is not enough. Nothing short of complete integration of the two efforts will suffice. Because we now understand that transport facilities have such important impacts on so many aspects of the metropolitan community, none of us in good conscience can any longer deal with transportation systems alone.

Whether we like it or not, all of us are involved in shaping the whole metropolitan environment and thus, in shaping the environmental conditions in which business firms will conduct their affairs and in which residents will live out their lives. Transportation planning has evolved to become an activity for planning the environment of urban life. And it is this broadened perspective that makes the undertaking so exciting and its results so important.

