The Urban Transportation Planning Process: In Search of Improved Strategy

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•IN FEBRUARY 1969, the OECD Consultative Group on Transportation Research endorsed a proposal to convene an exploratory meeting to examine and assess the state of the art of the urban transportation planning process. The intent was to lay foundations for a concerted effort to provide OECD member governments with an improved capacity for making sound and sensitive transportation decisions. Depending on the skill with which we exploit its potential, transportation can be either an instrument of desirable social change or a disruptive force against human development. It can both enhance and damage the quality of the environment. It can act either as a stimulus or as a brake on urban growth and development. Thus, the ability to make enlightened transportation decisions may, to a large extent, determine government's success in achieving wider policy objectives.

Two premises served as the basis for the meeting. The first premise was that a new conceptual approach to urban transportation planning is emerging, giving increased emphasis to human values and to the social and economic goals of urban development. In this approach economic and engineering efficiency, demand for transportation, and profitability no longer serve as the only guiding principles for investment decisions. These conventional criteria are weighed against the social, economic, environmental, and aesthetic needs of urban residents, including personal mobility, accessibility to urban opportunities, comfort and convenience, clean air, open spaces, pleasing surroundings, and preservation of neighborhoods and of urban diversity. Underlying this shifting emphasis is the growing conviction (a) that transportation is not an end in itself but a tool for bettering the total condition of urban life; (b) that its objective is not just to move people but to enhance the quality of the cities and to improve the social well-being of their residents; and (c) that planning concerned only with the effects on transportation itself has too often resulted in transportation systems that have failed to contribute effectively to these objectives.

A concomitant premise was that there is a need for a methodology that is more sensitive to the important issues facing urban society and more effective in helping to reach socially responsive decisions. In particular, more sophisticated tools of analysis are required (a) to perceive individual and community preferences and formulate goals and program objectives in the light of evolving technology and changing habits and values; (b) to search for and generate alternative approaches to meet given objectives; (c) to predict, evaluate, and rank the impacts of alternative proposals; and (d) to give adequate recognition to the element of uncertainty in decision-making.

The aim of the meeting was as much to open up new perspectives as to review current work. Particular emphasis was placed on exploring the implications that the convergence of the new techniques of analysis into a continuous and structured systems planning process might have for improving decision-making in the context of the larger urban social system.

The meeting, held on June 30-July 2, 1969, consisted of three one-day sessions. The first was devoted to the presentation of a paper on strategies for transport planning and to discussion of the general subject of the normative principles that should guide transportation policy. The second session heard a paper on maximizing urban transportation

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potentials and a subsequent discussion on the gaps between the requirements of rational decision-making and the capabilities of existing methodology. The third and final session provided an opportunity to develop further some of the important themes raised during the first 2 days and to explore the present deficiencies and needed directions for improving the process of planning for urban transportation. This report is based principally on the discussion that took place during that final session.

It should be noted that this report contains the conclusions of a panel of experts. Its contents do not necessarily represent the views or policy of OECD or its Consultative Group on Transportation Research.

In the brief space of 3 days it obviously would have been impossible to explore in depth a subject fraught with so many complexities. The report thus lays no claim to being exhaustive, and the panel should be forgiven if in its treatment of the subject it has been somewhat selective. Also, this report is not a guide to specific improvements in the planning methods. Such improvements are going to be a matter of slow evolution. They must proceed against the background of more profound knowledge of the changing requirements imposed on transportation planning. It is this challenge—a better understanding of the new environment in which the planning process must take place—that motivated the panel's discussions.

THE SOCIAL CONTEXT OF TRANSPORTATION POLICY

Traditionally, public investment decisions about transportation have differed little in approach from those of any private enterprise. Many government agencies still tend to assess the available options and select the best among them in terms of transportation-specific criteria such as capital costs, satisfaction of observed demand, net user benefits, profitability, engineering efficiency, and reduction of traffic bottlenecks. In so doing, they measure transportation system performance with criteria relevant to the workings of the transportation system itself.

Although this approach allows for the satisfaction of internal, system-specific demands, it ignores the wider, external effects of transportation. Yet transportation is only a part of a larger urban or regional complex, and every change within the transportation system reverberates throughout the larger complex, producing multiple impacts that reach out far beyond the confines of the transportation system.

Today the external impacts are playing an increasingly dominant role in the calculations of the policy-maker. When considering an investment decision to build a new airport from the traditional technoeconomic standpoint, for example, it is sufficient to evaluate the various location options in terms of benefits that the projected investment may be expected to bring to the users of the airport, including additional passenger and freight capacity, reduction in travel and shipping time, and relief of congestion. In this approach, the airport is appraised only against its own internal criteria for success.

We have come to realize that this is an incomplete way to view a public investment; equally as important as the internal effects are the impacts of the proposed airport on the larger system of which the airport is a part. Hence, we try to anticipate the effects of the alternative location decisions on future land development around the airport; on the likelihood of attracting new industry and creating new demand for labor in the area; on the levels of noise, pollution, and traffic congestion in the communities neighboring the airport; on the degree of relocation assistance required; and on the desired economic development of the region.

If, in addition, we are to be sensitive to the social and political consequences of our actions, we should also attempt to trace the impacts of the secondary effects on the different groups that are affected by them and to learn how these impacts are perceived and evaluated by the individuals who make up these groups. Only by so doing can we test the decision's fairness.

In recent years a number of sophisticated studies have attempted to estimate the magnitude of costs and benefits that would be generated by a proposed government investment. A common feature of many of these studies has been the implied assumption that, if the total benefits exceed the total costs, the project is desirable from public

policy standpoint. This aggregative approach is oblivious to the redistributional effects of public decisions. Even if overall benefits of the proposed airport site did exceed its overall costs, the decision could nonetheless impose considerable hardship on a large number of people. Which publics are to pay and which are to profit from government's action is ultimately a political decision. To make a socially enlightened and politically sensitive decision, we must explicitly recognize that there is a multiplicity of competing communities of interest, each with its own set of values, preferences, and ideas as to how the benefits should be paid for and distributed. Hence the planner and the analyst should strive to trace and evaluate the incidence of the benefits and burdens of alternative decisions on each of the affected publics, rather than engage in a grand social accounting for some generalized and largely mythical community at large.

Because we have acquired a heightened awareness of the external impacts of transportation and of the social and political significance of their redistributional effects, our approach to transportation planning is changing. Today the best design for a transportation system is no longer necessarily the one that results in the lowest capital costs or in lower user costs or the one that produces the biggest reduction in travel time. Rather, it is the design that yields the highest social return on the investment and that reconciles most effectively the conflicting interests of the individuals and various groups in the community affected by the proposed project. Hence the cardinal challenge facing transportation planning today is not so much to achieve maximum functional efficiency as it is to respond most fully to society's present and future total needs.

What is the nature of those needs? On this there never will be complete agreement. Nevertheless, there is sufficient consistency in human desires and behavior for us to distill a certain workable consensus. As we draw closer to an era of near-total urbanization, a dominant social goal of public policy will be that of preserving and fostering an urban environment drawn to the human scale, with values, services, and facilities that respond fully to the needs of the various groups that make up the urban community. This means, on the one hand, a social environment that provides freedom for all to move up social and occupational ladders; promotes opportunity for all citizens to participate fully in economic, social, and political life; and offers a variety of ways of life with opportunity to choose among them. On the other hand, it means a physical environment that meets the aesthetic and psychological needs of urban residents; protects them from the excessive intrusion of the unintended side effects of changing technology; preserves the historical heritage and beauty of the urban landscape; and promotes a climate in which cities can grow as viable centers of management, commerce, information, knowledge, and culture.

For the analyst and planner the challenge has become that of developing a capacity to assess the effectiveness and productivity of proposed transportation investment in terms of its contribution to these broad societal goals. This, in turn, calls for the development of new, more sensitive measures of transport output. Four such measures have particular significance in present-day transportation analysis and plan evaluation.

Accessibility to Opportunities

Except for such activities as ship cruises and Sunday driving, transportation has value only insofar as it helps to overcome the friction of space. In so doing, transportation improves geographic accessibility. Accessibility, in turn, opens up new markets, fosters trade and commerce, increases opportunities for contact and exchange, and thereby acts as a medium for economic development. This was the motive behind the huge railroad and canal building era of the 19th century and behind the highway and airport construction programs of the first half of the 20th century. This is also why today developing nations are still investing up to a third of their gross national product in transportation.

For most of the industrialized world, the problem of inaccessibility as an obstacle to economic growth has significantly diminished. We have largely succeeded in integrating local economies into national economies, and we are well on our way to integrating national economies into one world economy. To be sure, the task of

improving transportation to foster economic growth is not quite finished. We must continue to use transportation as a means of developing remote regions and reviving economically depressed areas that are the victims of structural imbalances. We will need to enlarge the capacity of the transportation network to keep up with the demands of a growing economy and an expanding population. We will continue to strive to cut down transit time and reduce traffic bottlenecks in order to improve transport efficiency. But all this, relatively speaking, will call for marginal improvements. In urban areas of the industrial world, at least, economic development can no longer serve as the primary justification for large-scale capital investment in transportation. The future objective of urban transportation investment must increasingly be viewed as that of promoting social development and bringing the resources and opportunities of the city within the reach of all citizens.

Today, large segments of population in metropolitan areas are denied convenient access to urban services and facilities because they lack personal mobility. Their freedom to move may be impaired because of poor public transportation service, because they cannot afford an automobile, or simply because they are unable to drive. Whatever the reason, people whose personal mobility is impaired are barred from the enjoyment of what the city has to offer. Also, they are placed at a disadvantage as regards access to the more basic things in life, such as opportunities for employment, education, decent housing, medical care, and recreation. Thus, the extent to which transportation can serve to lower the barriers to urban opportunities, by offering those who are disadvantaged improved personal mobility, may well become one of the chief measures of transportation's performance.

Environmental Effects

Transportation activities have always adversely affected the environment. But until recently transportation impinged on relatively small portions of man's environment, and therefore its impact was not widely felt. Today, the ubiquity of modern means of transport has made escape from their external effects no longer feasible. All who live in metropolitan areas are the unwilling sufferers of noise and fumes emitted by automobiles. Increasing numbers of people are being exposed to noise from aircraft, and soon millions might become exposed to sonic booms from supersonic transports. More and more neighborhoods suffer disruption through urban freeway construction, and few of us are protected against the unsightliness, obtrusiveness, and ugliness of a variety of transportation-related or transportation-induced phenomena: automobile junkyards, elevated highways, parking lots, billboards, and the like.

The undesirable, unwanted side effects of transportation activities have reached a point where society can no longer ignore them. Increasingly, criteria for evaluation of transportation investment must include environmental quality considerations; increasingly the analyst will be called on to answer the question: To what extent will the transportation system impinge on the environment in terms of noise and air pollution, visual impact, land consumption, disruption to the surrounding area, and risk of accidents? In our increasingly crowded society, environmental quality will inevitably become a highly important criterion for evaluating total transportation effectiveness.

Long-Term Impacts on Land Use

Changes in accessibility and in the levels of environmental quality can, in turn, cause profound and lasting changes in the character of land use. One of the most striking examples of this phenomenon has been the effect of the construction of radial and circumferential highways in the vicinity of some of the large cities. By offering improved access these highways have triggered intense development of the adjacent land and have become a magnet for an ever-growing array of industrial parks, shopping centers, recreational facilities, and housing developments.

To be sure, the need for large parcels of land—induced by exogenous factors such as technological change in manufacturing processes, the shift from vertical to horizontal integration of production lines, and changes in merchandising methods—may have been at the source of the massive shift to the outlying areas. But without the improved access

offered by the new highways, this shift would at best have required a much longer period of time; often it could never in fact have occurred.

Similarly, there are numerous examples where transportation facilities have been responsible for depressing the character of land use. The effect of urban freeways, for example, has often been to condemn a formerly viable and attractive area to the status of a second-class neighborhood because of the adverse environmental effects associated with their use.

In the past, transportation planners have all too often been oblivious to the external impacts that their decisions produce on the surrounding land. Increasingly, however, transportation investment is viewed as a conscious instrument for promoting orderly land use development and desirable urban form and growth patterns. Increasingly, too, the test for transport effectiveness will include a test of its influence to preserve and shape the character of the neighborhoods and regions that it is supposed to serve in a way that satisfies the community's sense of basic values and aspirations.

Quality of Service

For a long time the amenities of urban travel played a subordinate role in the planning and design of public transportation. The result has been that the quality of urban transportation service often falls far short of that expected by the transport user. The city bus is an example of unmet aspirations of the urban dweller. Although the bus is a model of engineering reliability and economic efficiency, it has fallen into public disfavor (as witnessed by falling patronage) because it fails to provide the kind of service that the riding public demands. Although the bus loses part of its appeal because it gets caught in traffic jams, much of the reason the bus projects a poor image stems not from its slow speed but from poor service: infrequent and irregular runs, unreliable schedules, poor riding comfort, uncertain arrival times, long waits at bus stops, crowded vehicles, and inadequate shelters.

As improvements in the amenity of other forms of travel and rising living standards push the expectations of the urban traveler even higher, the qualitative aspects of urban transportation will assume increasing importance. Factors such as comfort, convenience, frequency of service, and reliability will take on new significance and will figure importantly in the evaluation of overall transportation systems performance.

These four elements—accessibility to opportunities, environmental effects, the resulting long-term impacts on land use, and quality of service—have joined the more traditional criteria in the evaluation of transportation investment. If the basic assumptions are valid that transportation has value only insofar as it satisfies the broader social purposes, and that the test for transport effectiveness, therefore, must be a test of its external, social effects, then these four measures may emerge as the principal factors that will shape future public decisions about urban transportation.

THE PROCESS OF GOAL FORMULATION

Fundamental to the planning process is the initial step of setting goals. Goals provide the necessary direction for the planning effort and furnish a means by which the effectiveness of the effort can be measured. However, in a society dominated by rapidly evolving knowledge, technology, and culture, goals will need to be revised and replaced as new needs and opportunities present themselves. Whether the goals are arrived at by the reflection of the planner, by surveying the opinions and attitudes of the local citizens, or by the dictates of the political decision-maker, they are likely to be abstractions or broad generalities. Strategies must be developed to translate such goals into statements about specific objectives that are truly attainable, if goal-oriented planning and evaluation methods are to be effectively introduced.

As in all areas of broad public interest, setting goals for transportation involves choices between competing and conflicting interests and scales of values, and must be viewed in terms of a comprehensive policy in which all the pertinent considerations—social, legal, aesthetic, and political, as well as economic and technical—are weighed, evaluated, and reconciled.

Some innovations in the policy-making apparatus may be required to achieve these purposes. Present governmental structures are not designed to deal with broad issues of social development and environmental quality in a comprehensive manner. Although decisions can be made on the basis of arguments and considerations formulated by agencies with specific goals and missions, there often is no mechanism for trading off the benefits against the disadvantages and for taking distributional effects into account.

New institutions may have to be created that cut across the jurisdictional lines of existing agencies in order to provide a forum in which goals for transportation development can be brought forward, argued, weighed, and decided on with the widest possible interplay of interests and values and in light of the total needs of society.

PARTICIPATION

Now that we have come to view transportation as an activity that produces multiple external impacts that fall unevenly on the various groups in society, we want to know what trade-offs among the alternatives and impacts are necessary to reach socially desirable decisions. To gain this knowledge we need to consult the affected groups in the community and to allow them a voice in the formulation of decisions. All too often planning efforts have been characterized by inadequate contact between the planner and the public and between the planner and the politician, leading to the criticism that planning has insulated itself too much from the political process.

One of the important roles of transportation planning is to help clarify in the minds of political decision-makers, as well as the community, the range of options open to them, as well as the implications of these options. There are a number of fruitful directions for development of more effective interaction between the technical process of transportation planning and the real-world political process.

Within the technical process itself, there should be continuous attention given to identifying each of the different interest groups that might be affected by the alternatives being studied. The technical team should spend considerable effort evaluating how these effects might be perceived by the groups, and should search for technical means of minimizing negative effects—redesigning alternatives, providing adequate compensation, and searching for more equitable solutions.

The technical process itself should be open to the public. Considerable effort should be devoted to communicating with a variety of interest groups not only when presenting the final technical recommendation, but also at the beginning of the project. It is very important, therefore, that the technical team, from the earliest stages, seek out groups that may be affected, learn about these groups and their desires and attitudes, build effective communication, and present to them through the planning process technical information on the alternatives and their impacts. To get all points of view fully and adequately expressed, it may be desirable in some circumstances to provide resources to particular community groups to enable them to obtain technical assistance for a thorough evaluation and for articulate support of their position.

Effective communication presumes not only a thorough understanding of the plan on the part of the planner, but also an ability to convey its meaning and explain its consequences to the public. The development of more effective methods of presentation, as well as intelligent and persuasive advocacy of desirable planning alternatives, is essential for establishing a meaningful interaction between the planner and those for whom he plans.

It is inevitable that transportation plans will raise controversy; some interest groups will always be hurt. Every effort must be made to confront clearly the social choices that are called for and to involve those affected in the decision-making process. The planning process may cost more and take longer as a result, but the final product is more likely to reflect the overall interests of the metropolitan area.

INNOVATION, UNCERTAINTY, AND EXPERIMENTATION

If transportation is to continue to serve effectively the needs of urban residents, it must be alert to changing urban conditions and have the capacity to respond rapidly to the resulting changes in the nature of travel demand. Existing modes have shown them-

selves unable at times to cope with the multiple requirements of urban travelers. As cities and urban population continue to expand, traditional transportation systems will find themselves less and less capable of accommodating the increasingly dispersed patterns of movement in the suburbs and the growing concentration of trips in downtown areas, while maintaining levels of personal mobility, accessibility, service, and comfort that meet the expectations of modern urban dwellers.

Although a temporary solution may be obtained from incremental improvements and from a more efficient use of available facilities and technologies, entirely new transportation solutions may be required in the long run to satisfy urban travel needs and to save urban areas from total strangulation. A necessary condition for the emergence of such solutions is a vigorous and sustained level of technical innovation.

Unfortunately, quite the opposite has been the case to date; the level of innovation in urban transportation has been generally quite modest. The explanation for this poor performance can be found in a number of legal, financial, institutional, organizational, and planning constraints. Foremost among the obstacles to orderly innovation, however, has been the element of uncertainty and risk that surrounds the introduction of major changes in transportation systems.

Risk is always present when ushering in innovative ideas, but this is particularly true in the field of transportation. Massive resources will be required for research and development to carry new transportation systems from concepts to operational prototypes, to test them, to refine their design, and to produce working operational systems. As with any untried technology, there will be uncertainty about actual construction and operating costs and engineering performance. There will be uncertainties about the new systems' environmental side effects, their effects on property values, and their compatibility with existing transportation networks. Most importantly, there will be uncertainties about the degree of public acceptance, passenger response, and the resulting magnitude of the market for the new transportation service.

In the face of the large uncertainties and capital investment requirements, municipalities and transport companies have been hesitant to innovate because the risk of loss is high in relation to potential pay-offs and because failure of a new system or policy might involve political repercussions as well as loss of money. The financial and political risks, in fact, may be so unacceptable that transportation authorities will forego the introduction of major system changes unless they involve fully developed and tested technology. Private industry, however, in the absence of clearly identifiable markets for such technology, is not likely to risk its own capital to develop "off the shelf" operational systems.

To some degree, uncertainties can be reduced through the application of analysis. Thus, because of steady improvements in simulation methodology, the innovator is obtaining increasingly reliable estimates of the probable technical and economic performance of new systems. However, even the best models and predictive techniques cannot overcome all of the uncertainties associated with new technology, particularly the crucial uncertainties concerning response of the consumer and the resulting demand for the new service. The most effective and perhaps the only sure way to dispel these uncertainties—and hence to provide greater confidence in critical decisions—is to test the innovation in a real-world situation before beginning detailed design and construction of the full system.

Increasingly, the concept of large-scale experimentation is recognized by governments as a powerful device for reducing the risk of loss and for lessening the constraints that inhibit successful development and implementation of new systems of urban transportation. Until now the concept of the transportation demonstration has been associated principally with testing and evaluating new technology. Nothing in its nature, however, prevents the demonstration from being used as a vehicle for evaluating a variety of nontechnological innovations: improvements in service, in operating and promotional techniques, in design, in pricing policies and financing arrangements, and in organizations and institutions.

The art of design and conduct of transportation demonstrations is still in its infancy. A concerted effort should be made to refine the methodology so that the transportation demonstration can assume the role it rightfully deserves in the managerial decision-making process.

ADAPTIVE PLANNING

Transportation planning takes place in a context of continuous evolution in demand, technology, people's preferences, and objectives. Because there are significant time lags in the implementation of transportation systems, the planner must build into his plan an opportunity to review and revise his strategy in order to accommodate the changing conditions.

In considering a comprehensive long-range transportation development plan for a metropolitan region, we can expect that even by the end of the first 5 years things will have changed. Demand patterns will have evolved as a result of urban growth; new technologies and new ways of using existing technologies will have been developed as a result of research and development efforts; behavioral research and data collection activities will have produced new insights into people's needs and wants, which in turn will have altered the planner's view of community goals and objectives. The conditions would no longer correspond to the planner's initial set of assumptions and, therefore, would call for a modified plan of action. If changes have been relatively minor, the actions to be implemented in the subsequent stages of the planning strategy may stay the same; more likely, however, the later stages of the plan will likewise have to be revised because of further changes in critical conditions.

The planning process described involves an iterative or sequential approach. The transportation plan is conceived as a sequence of staged actions; at the conclusion of each stage, the planning strategy is reviewed and possibly modified in the light of fresh data acquired through observation and appropriate demonstrations.

An even more general formulation is that of the "open-ended" planning process. Here the process is one of constant iteration and feedback, with the goals and objectives being redefined and modified as new alternatives and strategies are conceived. These are tested and compared against the background of advancing technology, changing human needs and habits, and evolving community aspirations and values. The result is a dynamic process of continuous assessment of future conditions and continuous search, evaluation, and refinement of alternative solutions.

ALTERNATIVES AND INNOVATIONS

One major reason why urban transportation investment and management policies are not always fully effective is that the alternatives considered for analysis and evaluation are often severely and prematurely limited. This premature restriction of potential options arises from inadequacies in both the institutional setting within which urban transportation studies are conducted and the planning methodology that is used.

Most transportation studies are conducted within an institutional context that tends to emphasize a single mode and that almost invariably excludes serious consideration of truly innovative technologies or practices. Furthermore, present transportation planning models and procedures are designed to analyze a limited number of alternatives in great detail. The expense and time required to acquire the necessary data and to simulate large and complex networks often preclude evaluation of more than a few candidate systems.

To broaden the spectrum of transportation alternatives that can be analyzed and evaluated for potential implementation in urban communities, the following principles should be observed:

1. Transportation planning and investment studies should not be tied to any single mode but should be conducted within an institutional setting that encourages the comprehensive analysis of several modes.
2. The potential of various forms of transportation—pedestrian, automobile, transit, and multimodal systems—to provide a broader range of integrated services should be more systematically analyzed. Particular attention should be given to the interface among the several components of urban transportation systems and between urban and intercity systems.
3. A mixed strategy should be employed in which short-run improvements based on available technology and practices are instituted within a framework of more comprehensive and longer run programs that might include unconventional technology.

4. In view of the very rapid rate of technological and social change, preference should be given to improvements that can be introduced incrementally so as to avoid "locking in" the future with massive fixed investments.

5. Systems engineering studies that explore the potentials of new technologies should be made an integral part of the urban transportation planning process so as not to base transportation plans on or continue to encourage the adoption of outdated or obsolete technologies.

6. Transportation systems analysis techniques should be developed and adopted that allow for a rapid screening of a wide range of candidate systems in terms of both level of service and community impact. These overview techniques should not rely on massive accumulations of data but should serve to suggest the most effective directions for subsequent, more intensive data collection and analyses.

7. Research should be encouraged in formal design and search techniques, including systems optimization and mathematical programming models. Both community impact criteria and transportation service objectives should be made an explicit part of the model system.

8. Because land use is part of the system, any selection of alternatives should include those that vary land use arrangements as well as transportation facilities.

EVALUATION OF TRANSPORT SYSTEM ALTERNATIVES

To make sound choices from among several transport system alternatives, a procedure must be employed to give the decision-maker information about the relative merits of each proposal in terms of the goals they are expected to fulfill. In the typical case where investments being considered are relatively small and the alternatives have much in common, the evaluation procedure is conceptually simple, and existing methodology is fully satisfactory.

Some of the major studies undertaken in recent years have attempted to extend this procedure by adding to the analysis other readily quantifiable measures of transportation system performance, such as travel time, accident incidence, and direct costs of travel incurred by the user. In some cases, the operating benefits associated with a proposed new policy have been converted to monetary equivalents and compared to the estimated capital cost in order to derive a percentage return on investment or a benefit-cost ratio.

Although this procedure can be illuminating if knowledgeably applied, the decision-maker should be made aware of the important considerations ignored in the analysis and of the tenuous assumptions employed. Arbitrary values of time are often used and distinctions are seldom made in this regard among different categories of travelers. Major systems costs such as traffic control, emergency services, and facility maintenance are often not included in the analysis, a practice that can be justified if alternatives considered are basically similar, but one that becomes a significant deficiency if multimodal alternatives are being considered or if the scale of alternative investments is very different. Many performance characteristics important to the user are not considered explicitly (e.g., security, privacy, reliability, and comfort), thus severely limiting the application of existing methodology to the comparison of alternatives employing different mixes of modes.

It is particularly important for the decision-maker to recognize that analysis techniques now in use do not take into consideration a broad range of important environmental impacts that fall on nonusers or on the community as a whole. Therefore, the rate of return or benefit-cost ratio associated with each proposal must be only one of several factors weighed by the decision-maker in the process of selection. Other factors to be considered include noise, pollution, aesthetic intrusion, land consumption, economic impact, social disruption, and relocation.

Analytical procedures can be modified to throw additional light on many of the system characteristics mentioned so as to assist the decision-maker in the comparison of alternatives. The nature of this analysis must be influenced by the political realities in each situation, so that those system impacts considered most important by the community will receive attention by the system designer and the analyst. For example, it should be possible in many instances to determine the degree to which target populations

in a community—such as the young, the old, or the poor—would be affected by any proposed transportation investment.

In some cases it may be possible to simplify the comparison of alternatives by determining the cost to society of compensation for certain undesirable aspects of each transportation system. By utilizing the insight of social scientists, engineers, and analysts, we could introduce the cost of correction, abatement, or compensation as a bona fide system cost and adjust the rate of return calculation accordingly for each alternative. However, it should not be assumed that this process can in all cases be safely applied in a comprehensive manner to convert all system characteristics and impacts to a monetary equivalent. Such an effort, leading to the creation of a single performance index for each transportation alternative, probably is an impossible goal for the analyst and could pose a danger for the decision-maker by obscuring critical assumptions.

Existing methodology has an important role in evaluation of transport plans in spite of obvious weaknesses and shortcomings. However, the decision-maker must understand the limitations of what the analyst has to offer and recognize the critical gaps in analysis that must be compensated for by astute, politically informed judgment.

THE SYSTEM OF MODELS USED FOR ANALYSIS

A repertory of models has been developed for use in analyzing alternative transportation systems. This system of models has been utilized by many urban transportation studies. The development of this system represents a major achievement in placing transportation analysis on more rational grounds. However, the system suffers from the following significant limitations:

1. In theory, analysis of transportation systems should predict the flows in the networks by finding equilibrium between supply and demand. In practice, the existing system of models makes a number of simplifications, resulting in a segmented series of computations with internal inconsistencies.
2. There may be certain biases introduced by the simplifications that have hitherto been found necessary. For example, the technique called "all-or-nothing assignment without capacity restraint" may significantly overestimate the demand for private automobile transport, as also may the assumption that the total number of trips originating in a zone is independent of the level of congestion in the network.
3. No wholly satisfactory system of models exists that (a) analyzes multimodal systems (particularly with new technologies); (b) tests a wide range of operating, financing, and pricing policies as well as network alternatives; (c) takes into account the influence on consumer choice of transportation mode and route attributes other than total trip time and cost (such as reliability, number of transfers, privacy, flexibility, and other difficult-to-measure aspects of quality of service); or (d) considers explicitly alternative time sequences of investment and uncertainty.
4. Many significant nonuser impacts are difficult to predict and are not included effectively in present model systems (e.g., the effects of relocation of residents and businesses and air and noise pollution). Prediction of land use changes arising from alternative transport systems, although the subject of some study, is highly uncertain, partly because of the lack of detailed land use data at several different time periods. As urban development decisions become concentrated in fewer hands, the use of urban development models as a tool of prediction may become even more open to doubt.
5. The system of models and the whole process in which the models are developed, tested, and used in a particular metropolitan area may be out of proportion. It is important to achieve a basic level of planning capacity through initial data collection and model construction efforts. However, achievement of this capability is only the first step, not the final target; the data and models must be used to analyze a wide range of alternatives. Sufficient time and resources must be budgeted to allow this analysis after data collection and model construction. The present system of models may be more detailed and thus more expensive and difficult to use than necessary; the degree of precision in the numbers produced may be more than is justified by the underlying population, employment, and trip-making behavior assumptions. Many more alterna-

tive systems and policies should be analyzed than most present studies have been able to do. This may require development of new model systems that are less detailed, easier to use, and more relevant to the issues to be studied.

6. There is a strong concern about behavioral changes over time and their effect on the accuracy of long-term forecasts and forecasts of consumer response to new types of systems and services not previously experienced. The present model systems generally forecast travel patterns based on simple extrapolations of present trip-making behavior. What is required is a more behavior-oriented approach to demand modeling and a change in emphasis in data collection. For example, there should be continuing collection and analysis of demand data with a more varied mix of survey approaches. In addition to the typical cross section studies (such as an origin-destination survey), there should also be periodic selective sampling of particular market segments and travel groups (e.g., airport-user and transit-rider surveys), consumer panels, and a variety of other means of continuously observing and sampling the travel market.

Thus, the system of urban transportation models developed to date should be seen as a starting point for further work, and not accepted without questioning. Building on this base, second-generation analysis models must be progressively developed that are more appropriate for the problems facing OECD member countries.