

Criteria for Evaluating Alternative Transportation Systems

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•A CRITERION, according to Webster's Dictionary, is "a standard of judging; a rule or test by which anything is tried in forming a correct judgment respecting it." Our discussion focuses, then, on defining a set of rules or standards for evaluating proposed transportation systems, such that the "best" system will be chosen for implementation.

There is, of course, no unique set of such criteria, just as there is no undisputedly correct method of applying the various criteria to evaluate transportation systems. In a paper such as this, we can only hope to list what appear to be the most important criteria, classify them in various ways which may be useful, and discuss briefly the effects that the choice of criteria may have on transportation planning recommendations. It may then be possible to reach a few tentative conclusions as food for thought and subsequent discussion.

People seek opportunities, and in doing so they must transport themselves and their goods from place to place. A discussion of transportation planning rules and standards has far-reaching implications which stretch broadly across such fields as philosophy, economics, politics, sociology, engineering, and aesthetics. To place some bounds on this enormous topic, the following assumptions are made:

1. We are dealing with a single urbanized area, which has functionally realistic boundaries, a known political, economic and social structure, defined regional development goals, and an existing transportation system.
2. We are confronted with a set of proposed new transportation system alternatives for the area and we are reasonably sure that this set covers all reasonable alternatives, includes all modes of transportation and types of ownership, and contains the "best" system.
3. We also have at our disposal an effective method for weighing and comparing the various criteria to evaluate the proposed transportation systems.

In other words, we assume that other members of the Committee on Urban Transportation System Evaluation have successfully defined methods and criteria for developing such systems and also methods for evaluating them. Our problem then, is solely to define criteria on which the evaluating process is to be based.

BASIC QUESTIONS

Before attempting to classify and discuss the criteria in question, it is useful to list some of the more obvious questions to be asked in evaluating an array of proposed transportation systems.

1. Which system would serve most people, both in peak hours and during the entire day and week?
2. Which system would be most convenient to most people in terms of travel time, reliability, walking, waiting, transferring, and comfort?
3. Which system will have the smallest out-of-pocket costs for its users?
4. Which system is safest?

5. Which system will be least expensive in terms of capital cost, operating cost, land requirements, and effects on the amenity of adjacent areas?
6. Which system will foster the most desirable social and economic development of the area?
7. Which system will produce the greatest direct revenue from taxes, tolls and/or fares?
8. Which system will have the greatest versatility for other uses, such as transportation of goods?
9. Which system will have the greatest flexibility to deal with sharp travel demand peaks, and to adapt to changing land uses, technology and travel habits?

Many other questions could be asked, and the picture is complicated by the need to consider the various factors in combination, to produce an optimum benefit-cost solution, a least-cost solution. or some other best solution.

One point that emerges in considering these questions is that an attempt must be made to reconcile the requirements of the individual (for example, the first four factors) with the needs of society (as illustrated by the last five factors). It is understood, of course, that "society" in this context comprises many diverse elements including those who operate the system, those who are affected (for better or worse) directly by the system, and those who are affected only indirectly by it.

Decision makers must try to determine what proportion of the city's total resources, in terms of money, land, employment force, and pleasant surroundings, should be allocated to transportation facilities. Should an attempt be made to allow everyone a door-to-door, high speed vehicular travel means always available for instant use, or must this level of service be reserved for those to whom it is essential or those who can afford to pay a sufficiently high price for it? Can and should we design transportation systems with sufficient capacity to allow high speed, uncrowded travel during peak travel periods, or must we allow pricing and/or crowding and congestion to discourage unnecessary travel during peak periods?

Perhaps a closer look at some of the criteria implicit in these questions will provide a useful framework for studying possible answers.

CLASSES OF CRITERIA

In reviewing some of the questions, it is apparent that criteria for evaluating alternative transportation systems can be classified in a number of ways.

Urban Budget Allocation Criteria

Criteria in this class would provide rules and standards for determining what proportion of a city's budget should be expended on transportation improvements, as opposed to the many competing demands for urban budget expenditures in the areas of education, urban renewal, crime control, welfare, etc. Unfortunately in this area, where the range of choice is perhaps widest, usable criteria appear to be scarcest.

In theory, it is possible for an urban government to accept the existing transportation system as adequate, spending nothing on system improvements, or, at the other extreme, to spend the lion's share of their available funds on improved transportation at the expense of other urban requirements. Criteria are urgently required which will allow benefits from improved transportation to be measured against benefits from other types of expenditures, so that benefit thresholds and/or marginal returns on various proposed expenditures can be compared. Such criteria would imply methods of equating per capita gains from transportation improvements with those from, say, improved education, presumably in terms of common units of value such as dollars. They would include also standards for comparing communications improvements, such as videophone, with transportation improvements as a means of increasing opportunities for interaction.

The pitfalls of estimating dollar values of what are often rather intangible benefits to persons living and as yet unborn place criteria of this type very much in the yet-to-be-developed category. Until they exist, decision-makers will be forced to rely on the

traditional method of estimating "minimum" requirements in each area of need and allocating the budget accordingly, with due regard for political pressures, matching funds in some areas from outside budget sources, special interests, etc.

Transportation Budget Allocation Criteria

Criteria in this class provide a basis for deciding how best to improve existing transportation facilities, given a specified amount or range of budget moneys and/or other resources available for this purpose. It is criteria of this nature which are usually applied, implicitly or explicitly, in urban transportation planning studies. They include all the value judgments implied in current controversies over "balanced transportation," the needs of one segment of society or sector of a city versus those of other segments or sectors, the need for a reasonable choice of travel mode alternatives, the questions previously raised, and the comments and complaints of all who move from place to place in cities.

Among broad standards to be applied in this area are the effectiveness of proposed systems in dealing with peak-hour journey-to-work travel problems, weekend recreational travel problems, downtown conflicts between pedestrians, automobiles, buses, and trucks, downtown vehicle storage problems, and problems of downtown freight collection and delivery.

Criteria Classification According to Subject Area

Some classifications of this type are as follows:

1. Social: such as air pollution levels, possible disruption of neighborhoods, and increased well being due to greater opportunities for interaction.
2. Economic: such as effects on regional employment, development patterns, distribution costs, property values, and real estate taxes.
3. Physical: such as capacity for moving people and goods, convenience to users, flexibility to meet peak loads and adapt to changing urban development patterns, reliability, and safety.
4. Fiscal: such as capital costs, operating costs, and revenues.
5. Aesthetic: such as noise levels, effects on the urban landscape, and effects on parks and open spaces.

Absolute and Relative Criteria

An example of an absolute criterion would be all trips, whether made during peak or off-peak conditions, are to be possible at a door-to-door average speed of at least 35 mph. An example of a relative criterion would be that transportation system improvement will be selected which produces the greatest increase in average travel speed per dollar spent.

Other means of classifying and expressing various criteria will undoubtedly suggest themselves. The entire question of criteria to be used and the manner in which they are expressed is, of course, intimately connected with the method of applying them to evaluate transportation systems, and those methods are not within the scope of this paper. Accepting this limitation, it is still useful to postulate what may be the most useful types of criteria.

SUGGESTED TYPES OF CRITERIA

As a general dictum, it is suggested that absolute criteria be applied primarily to insure that given sectors of an urban area and segments of its population are supplied with at least minimum levels of service. Absolute criteria could also be applied to meet minimum standards in certain social, physical and aesthetic areas to which dollar values may not be readily applied. Finally, having weeded out any proposed transportation systems which do not meet these minimum levels, relative criteria could be applied in the economic, physical and fiscal areas, to provide a basis for selecting the system which produces the most benefits per unit cost.

In practice, this might work out in the following manner. First, define acceptable criteria levels such as the following: (a) accidents per million passenger miles; (b) on-time performance (travel time reliability) as measured by allowable variance from average speeds or travel times per mile; (c) maximum allowable noise levels (different for residential, commercial and industrial areas) due to transportation facilities; (d) maximum allowable air pollution contribution rates from transportation facilities; (e) maximum allowable encroachment on existing or planned parks and open spaces; (f) minimum allowable levels of public transportation seats per hour per square mile as a function of population density and employment density; (g) minimum allowable levels of capacity for passengers and goods in heavily traveled corridors expressed as a percentage of estimated design year peak period flows; and (h) minimum allowable levels of off-street parking facilities per square mile as a function of population density.

For all proposed transportation systems meeting defined "entrance requirements" of this nature, calculate total costs and total benefits, reduced to present day dollar values, including the effects of such criteria as capital costs, operating costs, user costs, operating revenues, property values, taxes, goods distribution costs, and time saved by users with suitable weighting for walking, waiting and transferring times. Methods to be proposed by other members of the Committee would be applied to select the best system based on costs and benefits of this nature.

Unfortunately, the above suggested framework does not explicitly incorporate such criteria as disruption of neighborhoods, effects on regional employment and development patterns, flexibility to meet peak loads and adapt to changing development patterns, and effects on the urban landscape. Although some criteria of this nature may be incorporated either in the minimum requirements procedure or the benefit-cost measures, it is more probable that they will continue to be included, if at all, as qualitative value judgments applied as an addendum to the benefit-cost appraisal procedure.

The examples given in this section are not intended to be definitive or exhaustive, but rather to indicate an approach which would introduce into the evaluation process criteria which at our present level of knowledge cannot be easily expressed in monetary terms.

EFFECTS OF CRITERIA SELECTION ON DECISIONS REACHED

As indicated by the previous discussion, there are many problems and uncertainties in the choice and definition of transportation system evaluation criteria. In view of this, it is extremely important that decision-makers should be aware of probable effects on their decisions of the omission or inclusion of various criteria as well as the methods by which the criteria are applied in the evaluation process.

For example, elimination of some of the social, physical and/or aesthetic criteria might perhaps result in selection of a system with optimum monetary benefit-cost characteristics when an alternate system with very nearly as good benefit-cost characteristics would have met the non-monetary criteria much more satisfactorily. Similarly, different assumptions concerning such items as the monetary cost of time may result in quite different recommendations concerning the best system.

SUMMARY

In summary, two points seem to emerge from this discussion. First, the choice, definition, and application of criteria for evaluating transportation systems are fraught with uncertainty. Second, more knowledge is urgently needed concerning the effects of these uncertainties on transportation planning decisions which must be made and are being made based on whatever facts and recommendations can be put together.

It is therefore strongly recommended that research projects be set up as soon as possible to carry out systematic sensitivity studies using real city data to test the effects of alternate criteria and methods on transportation planning recommendations. Such a program, it is felt, would be one of the most direct means of developing truly effective methods for evaluating transportation systems.

Discussion

THOMAS B. DEEN, Alan M. Voorhees and Associates—Neal Irwin's paper goes a long way toward bringing order to an enormously complex subject. His classification of various criteria serves to point out the wide range of urban activities which are touched upon by transportation proposals.

Fundamentally, a transportation system, like other public improvements, should exist for the purpose of serving people, that is, individuals. To get at the relative worth of a particular transportation system proposal, it might be worthwhile to ask Mr. Citizen how he would evaluate the proposal for himself. Doubtless he would ask at least some of these questions:

Will it serve me? My family? For which trips? How much time will it save me and mine? Will it allow me a greater range of places to live while still holding the same job? Allow me to take another job without moving my home? How convenient will it be? How safe? How comfortable? How much will it cost me to use it or not to use it? How will it affect my property visually, olfactorily, audibly, physically, and socially, both now and in the future? From similar standpoints, what about the effect on my neighborhood and my city?

Each individual and each family will weigh these points in different ways, and their ordering of the questions will be in accordance with the hierarchy of their own personal value systems. In fact, the basis of individual criteria for the evaluation of anything must be these personal goals or values. All individuals have goals, whether stated or otherwise. A complete list would be long and extremely diverse, but some common ones are personal security, freedom to choose values and pursue goals, physical and mental development, accumulation of knowledge, physical comfort, serenity, physical pleasure, meaningful relationships, acquisition of material goods, and sense of worth.

The existence of society provides both opportunities for the fulfillment of, and necessary constraints on, personal aspirations. An ideal society would provide an environment encouraging the maximum fulfillment of personal goals, and the public agencies of such a society would establish collective goals which tended to maximize that fulfillment. These goals might be aggregated at various levels, starting with the individual and moving to neighborhood, subregional, regional, state, and national goals. Since, at each larger scale, the amount of diversity to be accommodated would increase, the common elements would decrease and the items included would change according to the scale of the function at each level. Thus, collective goals at any level are a reflection of personal goals; and they are essentially arrays on hierarchies of values, only a part of which can be measured in objective or numerical terms. Monetary or economic items constitute only a part of the total list. Criteria for the evaluation of any public improvement, then, can only be established by reference to the goals of the level of society undertaking that improvement.

Unfortunately, as we all know, society is not so ideal. Collective goals are difficult to establish at any level with any degree of consensus. There is no arm of society which has the authority or competence to establish collective goals; and thus, there normally exist no community goals within which to establish criteria for urban transportation systems evaluation. Nevertheless, such criteria must either explicitly or implicitly be developed by reference to what are thought to be community goals.

As technicians, we long for the simplicity and objectivity of a procedure which would combine all the diverse elements that must be considered in evaluating a set of transportation systems into a single weighted index and thus provide the answer as to which is the best system. There is danger perhaps that we go so far in this direction, that we overemphasize those elements which are measurable and which do fit into the equations, or that we substitute our own subjective ideas as to how society weights its values. The result is that our recommendations and their underlying rationales are sometimes dismissed as technical exercises. It is apparent that, of the list of personal goals mentioned, only a few can be labeled as monetary or economic goals. In the future, as the debate over where to channel our affluence increases, the problem of attempting to reduce our criteria to strictly economic or monetary terms is likely to become even more troublesome. In the past, when man's primary concern was with

the acquisition of food, shelter, and clothing (all terms easily reducible to monetary terms), it was much easier to find the consensus that economic considerations should prevail. Today, we are seeing society show an increasing interest in, and responsiveness to, such non-economic values as the arts, environmental aesthetics, recreational facilities, and getting to the moon.

The relevance of our economic criteria is not enhanced by present fiscal policies. Funds for various system components come from such varying sources as state and federal gasoline taxes, local fare box revenues, local real estate taxes, state sales taxes, and federal income taxes. It is apparent that two otherwise equally desirable systems might look quite different from the standpoint of local costs, since one system may well have a higher portion of its costs eligible for external (i. e., non-local) financing. As long as this situation prevails, it is unlikely that local officials will be as much impressed by the most economic system as they would be by that which can be obtained with the least local financing. The search for relevant criteria requires recognition of this situation. The need for more rational criteria requires more control of transportation fiscal policy at the local level.

Choices among alternative transportation systems often involve trade-offs between conflicting goals. It is difficult for an individual, as for a community, to know which group of his personal goals are the most important when decisions among a limited number of alternatives require that he sacrifice some goals for others. For example, the construction of an urban highway immediately raises the goals of reduced travel time and increased travel opportunities, and in opposition, those concepts of a better urban environment that consider noise, visual aesthetics, and air pollution. Perhaps only when faced with a specific decision, where the consequences of each alternative are drawn in explicit terms, can one make such a trade-off. Criteria for evaluation must, then, be flexible and may sometimes be "weighted" only at the time of decision.

Such considerations maximize the need to measure all those elements which are subject to quantification, to improve techniques for describing, picturing, and projecting those elements which involve more subjective considerations, and to present the entire array of considerations to political decision-makers and to the public.

Final decisions should be made at the political level and must of necessity involve some debate, since the decision involves trade-offs between conflicting values of each individual, as well as between individuals and between groups. Our job is to see that the facts (that is, the consequences of alternative decisions) are available and are so understandable as to greatly enhance the possibilities of informed constructive debate.

JOSEPH McC. LEIPER, Director of Transportation Planning, New York City Planning Commission—Neal Irwin's paper does a good job of identifying the issues involved in evaluating alternative transportation systems and the lack of knowledge available with which to make these evaluations.

My remarks stem primarily from 15 years of experience in the New York area—years which have afforded little opportunity to step back and take a really reflective look at our decision-making tools and mechanisms. New York is, no doubt, unique in the intensity and complexity of its on-going action. On the one hand, we have a mature city with highly developed activities, facilities, and institutions—all resistant to change. But New York's role as the nation's business headquarters and other forces are bringing about profound changes within the social, economic, and physical structure of the city.

The problem of planning for transportation, or any other function, is one of adapting the existing urban structure over a period of time to changes that cannot be precisely measured. These forces of change include the distribution of population and economic activity, income and education levels, availability of fiscal resources, technology, and institutional evolution.

The standard procedure of transportation studies, faced with the responsibility for system planning, has typically been to extrapolate trends of urban development 20 years

into the future and design a balanced system of modern rail rapid transit and free-flowing expressways.

While we have learned a great deal in following these best available procedures, our methods have left us with great uncertainties:

1. We really do not know how the city of the future will develop—to what extent, for example, will the exodus of blue collar jobs from the urban cores continue or accelerate?
2. We cannot yet measure the impact that transportation access, or the lack of it, will have on urban development and redevelopment.
3. We cannot even be sure, at least in some of our major cities, that the systems we are planning will be the best transportation solution for the 40 or more years of their existence. Perhaps a technological breakthrough is possible, if not imperative, to combine the flexibility of auto transportation with the space efficiency of mass transit.
4. We have difficulty in finding convincing ways of persuading people, businesses, and politicians that they should allow urban activities to be relocated in order to build new transportation facilities.

Because of these limitations of knowledge, I would tend to accept Neal's thesis of using minimum explicit criteria for evaluation of transportation systems. This, however, should not be interpreted as inhibiting the range of planning and evaluations—far from it. We should go ahead and project into the future and lay out a maximum range of possible courses of action. But we should not be afraid to keep our thinking flexible and use judgment freely to evaluate alternatives and set priorities when more explicit criteria are lacking.

I would point up four general criteria that I think are particularly significant in the evaluations which we are considering here today:

1. Efficiency of investment and conservation of resources must be a prime consideration in planning major urban areas. While national economic productivity is expanding at a rapid rate, needs and expectations are also growing in all areas of human activity, and barring a revolutionary reallocation of resources, older cities will continue to be financially strapped for the foreseeable future.
2. Quality transportation is essential. Rising incomes will inevitably generate demands for improved transportation, and while investment may be limited, it should be put into facilities that will have maximum utility in changing times. Older cities, however, must not lose sight of special transportation needs for lower income residents.
3. Flexibility is the key to a sound transportation development strategy. While transportation system decisions inherently tend to commit major expenditures in facilities that will be fixed over a long period of years, it should be possible to stage transportation programs so that a change in policy as to facilities and services may be effectuated at some time in the future as new conditions may dictate. Otherwise, we may become committed to massive transportation programs that will be obsolete by the time they are completed.
4. Feasibility must be uppermost in setting urban transport development priorities. While broad planning and promotion can stimulate public acceptance of new ideas, effective transportation programming must concentrate on policies and projects which can be effectuated in the relatively near future. These programs, however, can and should be consistent with longer range thinking that is being evolved over a period of time.

These criteria may sound conservative and myopic. In the long run, however, I think they may prove dynamic and realistic in making maximum progress toward improved access in some of our larger metropolitan areas.

S. M. BREUNING, Massachusetts Institute of Technology—It must be recognized at the outset that this discussion is intended to provoke thoughts and deliberation on an issue about which much current concern exists without adequate methodology or data to handle its problems. After recognizing that Mr. Irwin's paper points up crisply the major ideas and capabilities which we have today to deal with the problem, I should like to

stress the limitation in his approach and the resulting problem to which we must address our research for the future. He is presenting an adequate and well-outlined case for a practical approach to today's problems, but does not provide the broad basis needed to plan research to deal with future problems.

The Academic Point of View

Some other participants in the discussion deal with similar questions of breadth of basis for the decision process. Therefore, I shall not belabor the basic question but rather will discuss the reason why I, as an academician, must concern myself with this breadth, even if it involves vague statements and Utopian suggestions. We academicians teach students, and if we do our job right, we will teach them about those things with which they will have to cope early in their professional careers. In other words, we have to teach them about the questions that will face them five or ten years from the time that we speak to them in the classroom. This is the time that will have elapsed before they attain positions in their professions in which they will be concerned with questions of sufficient depth and significance that they fully require the background of their educational framework and policies. Before this time, these engineers are in relatively subordinate positions where their contributions are not on the policy level. In the longer range, we can expect that the experience in their professional careers will gradually build upon and supplant the background they have obtained at the university. Thus, we must look at the problems for the student in a futuristic framework and must ask ourselves what questions will they have to resolve ten years from today.

The Parts of the Problem

Analyzing the title of our topic, we find essentially three items of information: criteria, evaluation, and transportation systems. Criteria here have been well defined by Mr. Irwin. We may circumscribe them differently as the scales by which we measure certain phenomena. The combination of such scales provides a total measurement for the transportation system under examination. By comparison, evaluation could be defined in terms of the gradations on the scales or criteria. Value is a quality determination of a measurement, and in comparison with criteria, it defines how much better or worse one measure is than another. While the definition of value is confusing enough in itself, it becomes still more so when applied to value of a transportation system. Thus, value and criteria are problematic points of discussion, with which we will have to grapple more and more as time goes on if we are to resolve such questions as those posed in our discussion. In comparison to the previous two factors, the transportation system is a rather simple one to define and discuss. It is defined as all physical facilities and their operating characteristics working together to provide transportation for an area.

The Problem

In consequence of the foregoing, it becomes our immediate problem to deal with the question of evaluation. One could perhaps argue that criteria are as important as evaluation, but from the practical point of view evaluation is the key to the answer. Let us look at two examples of the problem of evaluation.

Example 1. It is readily apparent to anyone that there is increased dissatisfaction with today's highway transportation system compared with that of ten years ago. We can nevertheless show that at least some value facets are better today than they were at that time. Time by automobile for the same distance traveled is less today in almost all cases than it was ten years ago, be it for inter-urban or intra-urban trips. Furthermore, the quality of highways is considerably better today. Why, then, are people more dissatisfied today than they were ten years ago? Obviously travel time and the quality of roads cannot be the sole measures for this dissatisfaction. Thus, if our value measure, which shows greater dissatisfaction today than ten years ago, includes time and physical highway facilities which are now better, then some other value facets which enter into the value measurement must be considerably worse today in order to offset these two positive developments.

We could next assume that this dissatisfaction is not based on individual physical factors of the system but rather on people's belief that the highway transportation system of today could be considerably better than it actually is. This assumption, which has considerable merit and support, leads to another disturbing factor gleaned from this short discussion, namely that value as a single measure is a time-dependent factor which changes not only in its composition of supporting facts such as time and comfort, but also changes as a function of human expectation.

Example 2. Next, let us compare transit and the automobile in their attractiveness to the user. In most cases, out-of-pocket costs of transit are considerably less than those for the automobile for comparable trips. But the automobile almost invariably is preferred by the users. Obviously, then, the automobile provides the user with added "values" for which he is willing to pay an additional amount. Again, this points to the basic question: What is this value of transportation for which people pay differing amounts of money? The individual user prefers the automobile even considering the basic inadequacies of and dissatisfactions with today's highway transportation system. To the public official, i. e., from the point of view of the city government or other governing bodies, the transit system is preferable because of its surmised high capacity and low real estate and operating costs. Some of these public values of transit have been extolled as of late in numerous more or less factual professional and news articles. Nevertheless, transit patronage is not increasing. This again demonstrates that value is a highly controversial and changing item for each individual user. It adds the further complication that value differs from the point of view of the individual user on the one hand and from that of the society as a whole on the other, assuming that the civic governing bodies represent society as a whole.

Mr. Irwin deals with current possibilities for criteria and values. He shows possible approaches, but to any serious reader he shows that our present value scales and criteria are woefully inadequate to represent the problem. But unfortunately we have nothing better to suggest at this time. Therefore our needs are primarily in developing research to solve these problems.

Research Needs. It becomes fairly evident that essentially three steps are needed in the research program to provide answers to our problem, we must:

1. Define value of transportation despite its ambiguity, including its many and varying facets and its changes with time.
2. Establish practicable measurements of the value or its measurable facets.
3. Integrate these measurements in some way that makes possible the comparison of different transportation systems or services.

Discussion. So far, the discussion has been rather esoteric and it can easily be argued that the ideas may be all right but their implementation would be impossible. There are, however, some suggestions as to how one may go about doing the research as suggested.

A transportation user makes some rather definite decisions when he decides to buy transportation services. Appropriate analysis of this decision makes it possible to obtain some quantitative measures of values. Unfortunately, the aggregation of factors is such that a specific measurement of individual value facets is not easy. But this is exactly where good research intellect and modern technology are needed and can provide possible approaches. Society's value of transportation is somewhat more easy to determine when one considers that 20 percent of the gross national product is spent on transportation (not counting secondary inputs in transportation). In contrast to this known quantity, it might be interesting to study the amount of effort individual people spend daily on transportation. Such a study might be expanded to determine what criteria people use in their transportation choices and decisions.

The above problems are mentioned by Irwin briefly, but since he, no more than anyone else, knows of no appropriate answers nor an easy way to handle them, he moves on to other criteria to serve as substitutes for these basic items. This is appropriate when we are trying to solve today's problems. But research must be originated now to lay the groundwork for better solutions to the problems of tomorrow.

Research in these areas is practically nonexistent or, at best, confused. It is therefore necessary to under take both a conceptual development of the many interacting

factors involved as well as a research design for obtaining very specific and quantitative data for all parts of this problem. Much of the problem is in the human factors area and needs sound research approaches which take human factors principles and methodologies into account. Some of the needed information might be adapted from existing concepts, models, or data worked out for different applications.

Recommendations. In conclusion, I should like to point out again that my arguments are aimed at developing more research to provide better answers in a field involving tremendous human investment and sparse understanding of the problem. I therefore recommend the following:

1. We must recognize transportation planning as a process which can be made orderly through the application of rational methods of analysis.
2. We should initiate and support research in those areas required for the implementation and for the working of the planning process. The real need is not only to do more research, but also to aim much of it at the basic human questions of transportation demand, generation, and distribution, for the individual as well as for society.
3. In order to provide workable measures for evaluation, such procedures as Irwin's "budget allocation criteria" might be developed as a first step. Such a method can be improved step by step as research makes available better basic data and evaluation criteria for the decision process.

Utilizing an evolution process with a heavy research backup, we should be able to develop an efficient framework which exists today only in outline form. Discussions might do as much to focus attention and establish needs as they contribute to the solution of the specific problem.

NEAL A. IRWIN, Closure—The viewpoints expressed in this discussion represent, in microcosm, the type of problems and discourses observed today in many urban areas confronted with transportation planning decisions.

Speaking from planning agency and consulting experience in a number of cities, Mr. Deen emphasizes the value judgments and criteria used by individuals in evaluating a transportation system. He points up the diversity of such value judgments and the resultant difficulty of distilling from them a meaningful consensus by which planners and decision-makers can be guided. He stresses the need for planners to include non-monetary values in the plan evaluating process and their responsibility to make known the facts concerning all relevant alternative plans so that the political process of plan selection can be carried out in a sufficiently wide context.

As a transportation planner with fifteen years' experience on the New York City Planning Commission, Mr. Leiper highlights some of the practical problems experienced in the field, including difficulties in forecasting urban development, attaining transportation system flexibility, and obtaining community approval for new transportation facilities which may require some relocation of businesses or residences. As criteria for judging new plans he suggests efficiency of resource allocation, provision of a mix of both high quality and low cost transportation, system flexibility, and system feasibility.

Speaking as an academician, Dr. Breuning stresses the present lack of criteria which will be effective for long-term as well as short-term planning, and the need for research to develop such criteria and related evaluation methods. Among suggested avenues of research are analysis of decisions made by individual travelers, studies of the amount of time and resources committed to transportation by various individuals, and development of usable "budget allocation criteria" of the type outlined in the subject paper.

In summary, it is apparent that the criteria we seek are elusive. In working toward them we must follow a middle path between oversimplification on the one hand (the "single all-inclusive measure of excellence") and a know-nothing attitude, born of despair in the face of great complexity, on the other. Stated in other terms, we would be ill-advised to attempt avoiding the political decision-making process by reducing plan

evaluation to a purely numerical exercise; however we, as technicians, must assemble and explore all ramifications of the most feasible alternatives so that the community and its leaders may have the best possible basis for decision.

A number of worthwhile ideas for research into plan evaluation criteria have been suggested in the discussion. Let us proceed along these lines and all others that look promising. We are starting from a rather small base.