Development of Transportation System Alternatives

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•AT ONE time the preparation of an urban transportation plan was approached as an engineering problem that had as its principal goal the development of a workable solution. Today, workability alone may not be enough. True, plans for urban transportation systems must be functional; but plans must also represent an efficient allocation of resources and a step toward the achievement of a better overall urban environment. These more complex demands on the urban transportation plan mean that a meaningful solution can be achieved only after a thorough search for alternative workable transportation systems that have been evaluated in terms of their various attributes.

To identify where the development of alternatives fits into the total picture, the Chicago Area Transportation Study serves as a representative example of a transportation planning process that arrived at the recommended plan after investigating a number of area-wide alternative systems. Because of this, it can show where the development or conceptualization of alternatives fits into the overall transportation planning process. Briefly, the CATS procedure was as follows:

1. Determine the objectives (criteria) that will be used to select the best transportation system.
2. Develop alternative metropolitan-wide transportation networks (these are initially in the form of sketch plans).
3. Subject each alternative to a testing process that measures the alternative in terms of travel time, cost, and other factors.
4. Select the alternative that best meets the stated objectives.
5. Refine the alternative by testing minor changes in the network in order to better meet the objectives.

Only the second step, development of alternative networks, is the subject of this discussion. This means that we are concerned with strategies and techniques for producing transportation plan alternatives which will be subjected to further testing and evaluation in another part of the transportation planning process.

Any design process is one of repetitive stages of conception, testing, compromise, and retesting; therefore, even in the process of developing or creating alternatives, a considerable amount of testing and evaluation may take place. It should also be recognized that development of alternatives and refinement of the selected alternative are closely related. Many techniques may be common to both these stages in the process of arriving at the final plan. Although we may lack a perfect conceptual framework, this should not prevent us from focusing on the need for research into how one goes about reaching out for ideas that can be developed into alternative network proposals.

The process of designing alternative systems for further evaluation has been the subject of little research. Last year each member of the Transportation Systems Evaluation Committee was asked to submit the five references that, in his opinion, represented the best published work dealing with the development of transportation

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system alternatives. Out of a number of references, only three appeared on more than one list:

1. Chicago Area Transportation Study, Vol. III: Transportation Plan (1962),
2. Pittsburgh Area Transportation Study, Vol. 2: Forecasts and Plans (1963),
3. Creighton, R. L., Hoch, I., Schneider, M., and Joseph, H., "Estimating Efficient Spacing for Arterials and Expressways," HRB Bulletin 253, pp. 1-43, 1960.

Even though only three references were duplicated on one or more other lists, it is significant that each reference represents a technique or strategy designed to systematize the art of conceiving transportation systems. The need for systematic and replicable methods of system conceptualization should not require debate. The very absence of a consensus on how alternatives should be developed underscores the desirability for further investigation in this area.

In most urban areas much of the job of developing alternative systems is already done. The existing system is in place, and something called the committed system is usually taken as a given factor. Also, there are often proposed projects of merit which have been put forth by individuals or agencies and which have not been implemented over the years.

The process by which plans are first conceived is well known. It usually involves plotting existing facilities and proposals on a map, followed by attempts to weave the best of these into alternatives that will have system continuity. Sometimes this process will result in a wide range of alternative designs; but often the existing and committed system, along with topographical or other constraints, will appear to limit the alternatives to be tested to a single theme with a few minor variations.

At this point, a few questions may arise. Are we sure that the best alternative has been included within those we are proposing? Can another transportation planner come along in a few years and, by widening the accounts, propose a system that is better but that was not included within our set? Can we explain or demonstrate to others that, in developing the plan, we have given full consideration to all reasonable alternative means of moving people and goods? In short, have we followed some methodology which assures us that the best possible transportation system has at least been proposed?

To begin to develop some sort of systematic process for conceptualizing alternatives, we must first know the criteria that define what we mean by "best." Such criteria may be simple cost criteria or complex criteria related to regional goals and policies; but, regardless of what they may be, they need to be known. A knowledge of the criteria by which systems will be evaluated is essential to the development of any systematic method of generating alternatives.

The "efficient spacing formula" (one of our recurring references) represents an example of a technique used in developing an alternative that is directly related to a criterion. The criterion or objective is to determine the spacing which will minimize the sum of all transportation costs. This formula relates the spacing of expressways to trip end density, the cost per mile of expressways, the cost of travel on expressways and arterials, and the proportion of all trips that will use expressways. The formula makes a number of simplifying assumptions, but it "does much to eliminate wild guessing and inefficient testing of plans. It allows the planner to define more narrowly the territory within which an optimal plan can be found."[1]

Since this formula determines spacing and, also, since it does not explicitly consider the existing expressway system when determining efficient expressway spacing, it is most useful for indicating what kind of ideal or schematic system configuration would provide least cost transportation for a given pattern of trip ends. This ideal form—ideal if one accepts the criterion—can be compared visually to the existing system so that the existing system can be added to in such a way that, hopefully, the plan resembles the ideal form as much as possible.

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[1]Chicago Area Transportation Study, Volume III: Transportation Plan, p. 44 (1962).

Techniques similar to the efficient spacing formula can help to assure that system alternatives are near the optimum in terms of some broad, single objective. In this way such techniques can aid in answering such questions as, "Are we sure that the best plan has at least been proposed?" The efficient spacing formula is used here as one of the few examples of a technique specifically designed to aid in the conceptualization of alternatives. It cannot do the whole job. There are still potential alternatives that might involve other transportation modes or new kinds of transportation hardware. But, it is a start.

Up to now this discussion has viewed the development of alternatives as though the alternatives themselves were entire area-wide systems. It is assumed that these area-wide alternatives then will be subjected to some process of testing or measurement which will permit the selection of the alternative that best meets some criterion. In a sense, then, this entire process is a search for the ideal plan or end state.

If one is inclined toward a deductive strategy of plan development that moves from the general to the particular, such a process may have appeal. There is, however, no reason to assume that it is necessary for plans to be made in this way. Perhaps some process which incrementally adds facilities to the existing system in some optimal fashion would be better.

The question of whether the planning process should have as its objective the production of a plan representing an end state or whether it should have as its objective the development of a mechanism for incrementally programming optimal improvements is one that should receive some attention from transportation planners. Other planners are becoming concerned with this question.[2]

Suppose that, instead of being concerned with an ideal end state, a planning strategy is used which first programs in the improvement most needed by the existing system. Then, with this as a base, the next most needed improvement is added. On the assumption that we would have some way to allow for changes in transportation demand caused by urban growth, where would this kind of process take us?

One of the problems with this approach is that when each project is added it may divert traffic or patronage, thereby absorbing some of the benefit of prior projects; so theoretically, at least, negative system benefits could result even though a particular project had seemed to be warranted. Thus, the specific rules for determining which project is best and should be added become very important. Furthermore, they are reflected in a chain of decisions that may or may not result in a good plan. As long as some of these problems are considered, it may be possible to develop incremental programming techniques that will, for all practical purposes, yield a solution as valid as the conventional and state approach. In addition, there are some obvious side benefits of incremental programming that make it attractive.

This discussion presents no brief for either approach, nor does it attempt to advocate any particular technique. Rather, its purpose has been to underscore some of the work and thinking that has been done to develop transportation system alternatives. Conceivably, there could be many ways to approach the problem. Certainly, there is no book solution. Hopefully, future research in this area will lead to replicable methods that will aid in the development of effective transportation systems.

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[2]See Webber, Melvin M., The Policy Sciences and the Role of Information in Urban Systems Planning, pp. 1-21, and specifically pp. 10-16, of Urban Information and Policy Decisions, a publication derived from the Conference on Urban Planning Information Systems and Programs and published by The Institute of Local Government, University of Pittsburgh (1964), Editor, Clark D. Rogers.

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Discussion

JOHN HAMBURG, New York State Department of Public Works—First of all, an activity system refers to that collection of land, enterprise, and people (otherwise called "the city") which exists at some point in time as a function of history and utilized technology.

A transportation system (a) serves as the connector to all the spatially separated activities in an area and (b) to an unknown degree shapes the emerging activity system.

The notion of alternative transportation systems has a double meaning: (a) as alternative transportation systems for a given activity system, or (b) alternative transportation systems for alternative activity systems. For us, the alternative activity systems are hypothetical . . . being the alternative future activity systems which are to be considered.

If we consider the problem of transportation system alternatives for a given activity system, our quest is to find a transportation system that is better than any other that we consider; in other words, the optimum system.

Now in order to arrive at alternative transportation systems from which to select the best one, we must somehow generate a series of systems. Choice, after all, implies the existence of at least one other system. Usually, highway and transit elements will be necessary subsystems in these alternatives.

A time honored technique is to get out the grease pencils and the aerial photo mosaic and begin drawing routes and systems.

An autocratic way is to have the boss do this over a weekend when everyone else is out mowing their lawns or playing golf. Another way is to have the multi-discipline, mission oriented research team prepare alternative systems. As an aside, over and above any useful ideas that may evolve from this process, it represents a gaming technique which management can use in personnel evaluation. The contrast between system sketches prepared by mathematicians, design engineers, planners, and sociologists is a lesson in itself.

Still another technique, one which is used extensively in Upstate New York, is to have local agency planners and the district engineer submit their system ideas for the study through the planning committee.

All of these system development techniques work in the sense that they generate an abundance of plans to consider. But how do we choose the best one? Also, how can we avoid the lingering doubt that the best transportation system may not have been among the alternatives and therefore had no chance of being selected.

At the present time, we attempt to make our selection based on a least cost notion. That is, we select that network which has the least total cost considering both the cost of the network (the cost of building and maintaining) and the cost of traveling on that network. It seems clear that if we believe we can evaluate alternative transportation systems and choose one which is the optimum, we really should be using the criteria by which we choose between systems to develop the best system in the first place. After all, the choice criteria must exist in order to choose; we may as well use it at the outset instead of waiting to use it at the end of this part of the planning process. Why flail around subjectively and not only take a chance of missing the best one, but also spend time dreaming up plans which have no chance of being selected? The moral: design the best system using the criteria required in the evaluation process; or, the very criteria used in evaluation should be used to design.

As Mort Schneider would say, "This is a trivial problem conceptually." However, the mechanics of the solution are a great deal tougher. For example, the optimum spacing notion was one attempt to use the criteria-design idea. The assumptions of a rectilinear transportation system coupled with constant density of vehicular destinations, failed to provide a unique and continuous transportation system. It provides the planner with a useful rule of thumb with regard to spacings of routes, but not a complete system.

The choice problem is further aggravated by the fact that there is typically a fairly large plant of existing transportation facilities which may or may not conform to or be easily reconciled to a transportation system which is an optimum system for a given region ignoring the existing facilities.

Because these existing facilities represent a very substantial investment, they must be integrated into any final system plan. It is not clear, however, whether a continuation of the system configuration implicit (if any) in the present network would be a superior strategy to one of attempting to warp the present network into the ideal network.

For this reason, and in order to objectively demonstrate the inadequacies of inferior systems, which may be someone else's pet, it is clear that we will have a continuing need for an evaluation technique. It seems equally clear, that we must continue to attempt to derive an optimum transportation system for a particular activity system from the very criteria which we use to evaluate the transportation system.

Properly, the planning process should not stop with the design of a transportation system; it should extend itself to include alternative city forms. While this is a much more difficult task than "just" arriving at the optimum transportation system, the approach should be the same. That is, (a) establish the criteria, (b) unify these into a frame by which to evaluate proposals, then (c) design the optimum form (activity system) using the established criteria. It is not certain whether we can do an adequate bookkeeping job on the problem, quantify the criteria, or select the least-cost activity system. However, for each of the activity systems considered, we should include the transportation system which is optimal to it . . . and presumably the transportation system's cost will include a substantial part of the combined activity-transportation system structure.

WALTER G. HANSEN, Alan M. Voorhees and Associates, Inc., Washington, D.C. It does not seem proper to separate, even at the high conceptual level suggested by Mr. Hamburg, the effect of the transportation system on the activities system from its reverse, the effect of activities upon transportation. Alternative transportation systems that are developed by techniques based on this separation will have certain advantages. They will have in common some easily calculable criteria. Their pros and cons will be, thus, easily stated, and final determination of an "optimum" system will be clear-cut. This will come about because of the predefined nature of the factors being considered and, unfortunately, because the procedure fails to consider the real problem.

What is being missed, then, is the consideration that must be given to the "goals" of the area, in terms of both transportation and activities systems, before any alternatives can be established. The minimization of transportation cost may, or may not, be one of these goals. The reverse, the maximization of opportunities, may be one. Most likely, the regional goals will reflect some balance between the two. In any case, it is important to know in what general direction the community wants planning to go.

How to use something so imprecise to determine alternatives? The diversity of the goals of most areas would seem effectively to rule out any direct measurement of the "optimum-ness" of a system, at least in the sense of being able to calculate numbers in a systematic and regular fashion. The development of alternatives should, rather, be the function of a group of people representing as many as possible of the interest groups, political organizations, and technical disciplines present in the area. The consensus of this group would, then, determine those alternatives which approach optimization of the diverse criteria present and are, therefore, worthy of complete analysis.

There is another problem which must be faced in the development of alternatives, that of the constraint placed upon such development by the existing network and worsened by the presence of a "committed network." These two will probably constitute well over 90 percent of whatever future network is to be proposed. Although there is probably little that can be done with the existing system, it is important that those who are developing alternative systems minimize the restraint caused by the committed projects. They may, after all, be "committed" only because the highway department has commissioned the design of a bridge or an interchange. Tearing-up or altering these plans would certainly be cheaper in the long run than building the "wrong" system. The keynote of the development of alternatives must be flexibility; too often, those developing these alternatives use the existence of large "committed" networks as an artificial limit on what they may propose. They should, rather, try to minimize the constraints upon the alternatives developed.

It should be stated that, at this stage in the normal procedure, a traffic forecast has been made and the 90-odd percent of the system that exists has been inventoried. This means, in fact, that it is not a question of designing a system, but, rather, one of selecting additions to an existing system. This process, therefore, should approach the problem in the second manner, as outlined by Mr. Ferguson, that of making optimum additions to that which already exists.