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The Long Range Transportation Planning Process: Complex Answers to the Wrong Questions

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Abstract

The long range transportation planning process is examined, with explicit consideration of the real uncertainties. Examples of the performance of transportation planning models are presented. Errors in input data, as well as socio-political bias are presented. Finally, a series of principles and methods for better reflecting the real uncertainties into transportation planning are presented.

Introduction

Fifteen years ago Marvin Manheim noted that we live in a world of rapid change, citing three dimensions of change relevant to transportation systems: change in demand, in technology and in values (Manheim, 1979). We might also note a world of uncertainty; not only is change occurring, it is occurring in ways we cannot anticipate. In spite of the uncertainty we need to plan for the future. We need to recognize uncertainty, yet not be paralyzed by it, to plan for various contingencies that may derail the attainment of valued goals of society.

The Urban Transportation Planning Process

Metropolitan Planning Organizations (MPOs) are responsible for carrying out long range transportation planning,

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covering a period of at least twenty years, and for setting transportation priorities for urbanized areas. MPOs make use of a transportation planning process comprised of a series of sequential models to describe the interactions between land use, the transportation system, and travel.

The process begins by dividing the planning area into traffic analysis zones (TAZs) and estimating various socio-economic activity measures, such as population and employment, for each zone. The number of zones can vary from 50 for a small urbanized area, to over a thousand for a large metropolitan area. Population and employment totals are first forecasted for a study area or region; then allocated to each of the TAZs in the study area.

Based on demographic and economic characteristics, the trip generation model estimates the number of trips produced or attracted by each zone. Subsequently, the trip distribution model estimates the number of trips from each zone to all other zones and the modal split model divides the trips into transit and auto modes. The traffic assignment model specifies the particular transportation links utilized between each set of zones and the total number of trips on each link.

After models have been calibrated with base year data, they are applied with forecast year land use and transportation system characteristics to derive forecast year performance. This basic process is used by MPOs across the nation. Based on economic and land use characteristics forecasted for the study area in some future year (generally twenty years), a long range transportation plan is produced. The plan is then staged, so that early implementation projects are timed for consistency with the long range plan.

The Reality: Change Cannot be Predicted with Certainty

An underlying premise is that we can forecast twenty years into the future. We then develop a master plan that would optimally serve the forecasted future conditions. The reality is that the models are not very precise, and the inputs to the models are fraught with uncertainty.

How precise can we be in forecasting social and economic factors twenty years into the future? Consider the state of the national economy twenty years from now; specifically population and employment. We need to make assumptions about a myriad of factors--the possibility of war, major recessions, petroleum production, and immigration policy.

Consider then an individual state's share of the national growth. For Florida we need to consider the future of Cuba and Haiti, tourist preferences, potential natural disasters, and availability of potable water. Beyond the state level estimates, we need to forecast growth increments in individual counties, which can be influenced by many factors unique to each county. Finally, we need to disaggregate the growth estimates into hundreds of traffic analysis zones in a given county. Seems like a pretty hopeless exercise, doesn't it? Yet, this is exactly what we do every time we prepare a long range plan for an urbanized area. We plan for an optimal response to a set of forecasts that will almost certainly not materialize.

Examples of Forecast Performance

It can be instructive to review just a few examples of the past performance of transportation forecasts.

Tampa Urban Area Transportation Study - In 1970, a comprehensive urban area transportation study undertaken for Tampa, Florida developed traffic forecasts for the year 1985. Comparing the actual 1985 traffic volumes with the forecasts made in 1970 reveals that, of 87 different links for which it was possible to compare actual 1985 traffic counts with those forecasted in 1970, the errors ranged from -78 percent to +281 percent. The average absolute link error was 57 percent--hardly the kind of estimates we would like to be using for major capital planning purposes.

Tampa CBD Employment Forecasts - During the early 1980s several forecasts were prepared of employment in the Tampa central business district (CBD). Forecasts projected CBD employment to be at 75,000 to 80,000 by the year 2000. In the mid-1980s new forecasts were made. By then, it was clear CBD employment was not on track to 80,000 by the year 2000; instead it was forecasted that employment would be in the 55,000 range by the year 2000, and would approach 90,000 by the year 2010. The reality has been that in the years since 1980, CBD employment has been very flat, falling in the 26,000-28,000 range in 1994. Unfortunately, these forecasts were the basis for major capital facility planning in the City for a decade.

British Case Studies - The Transport and Road Research Laboratory published a study in which forecasts from 44 British urban transportation studies undertaken between 1962 and 1971 were compared with actual occurrences (Mackinder and Evans, 1981). Even at an aggregate level, it was found that nearly all of the forecast items considered were significantly overestimated. On average, population was overestimated by 20 percent, and highway and public transit trips by 30 to 35 percent. If one were to measure the errors in forecasting the incremental change in various parameters, the results would be much worse. Average forecasted population growth was three times the observed growth, while forecasts of the growth in total person trips were over six times the observed growth.

Guideway Transit Case Studies - A number of studies have examined the forecasting accuracy of the urban transportation planning models as applied to fixed guideway transit projects. A comparison of predicted and observed modal split values in Baltimore, San Francisco, and the Twin Cities noted that the total prediction error was between 25 and 65% of the predicted value. It was also noted that purposeful misuse of the models is clearly possible; that the results can be easily biased toward a desired "policy" direction (Talvitie, et.al., 1982).

One of the most controversial recent transportation research works reported on eight U.S. cities that have invested in rail transit projects (Pickrell, 1990). It was reported that ridership was consistently overestimated and costs consistently underestimated. It was noted that decisions to implement these major investments have been made based on very small forecasted differences in performance between alternatives, whereas the actual performance of the selected alternatives has been substantially different than the forecasts. If forecasting errors are large in comparison to the differences in alternatives, the planning process cannot be relied upon to guide decision makers toward sensible decisions.

Technological Forecasting - Ascher notes the susceptibility of transportation forecasts to technological factors. He cites a Lockheed executive who predicted in 1956 that a family type convertiplane would be developed within 15 years and that the family automobile would largely be replaced by it (Ascher, 1978). Evans reinforces this skepticism, noting the recent preoccupation and massive investment in IVHS research based on predictions of vehicles travelling at enormous speeds a few feet apart on automated highways. He notes that such a system would need to have the reliability of the Challenger-7 spacecraft, while being priced as a consumer item and maintained by members of the general public. Those focussing on basics are dismissed by enthusiasts as purveyors of negativism and opponents of technology (Evans, 1993).

Socio-Political Bias in Decision Making

When we reflect on a historical occurrence, we search for reasons why it was entirely predictable, even though beforehand the evidence was very confusing and mixed and some very intelligent people made very confident, but incorrect predictions (Behn and Vaupel, 1982). We perceive a past which held few surprises and predict a future with little appreciation for the many surprises that it will hold.

As difficult as it is for individuals to think clearly, can it be any wonder that group decisions are even more confounding? Moreover, government decision making, which is answerable to diverse political constituencies, greatly increases the complexity.

Media Bias Toward Dramatic Forecasts - Popular media can bias our perceptions of current trends. Evans notes that forecasts we read and hear about are systematically biased due to a strong market for the dramatic. A prediction that some factor will remain largely the same as it is today generates no news and little interest, no matter how accurate it may be (Evans, 1993).

Correlation Among Forecasters - Schnaars suggests that forecasters read the results of each others' forecasts, yielding a high level of correlation (Schnaars, 1989). Most of us have observed this in everyday life. How often have we glibly repeated some "factual" account, only to find that the fact was nothing more than a rumor that had gained credibility from repetition?

Forecasting What We Desire - One of the most difficult biases to correct is the pressure to forecast what we desire, rather than what is most likely. As noted in a recent USDOT and EPA report, the forecasted distributions of regional population and employment are often an erroneous input to the transportation planning models because of political compromise, rather than technical expertise. Local officials want forecasts to reflect the successful implementation of land use policies that prove to be difficult to enforce (U.S. DOT and EPA, 1993). Human nature being what it is, most of us are far more willing to entertain evidence that supports our view of the world, and resistant to accept contrary evidence.

Forecasting Ethics: The Bias of Advocacy - Wachs deals with the issue of ethics in forecasting, asserting that, "The complexity of the mathematical models obscures the fact that the forecasts are more critically dependent on assumptions than they are on mathematical manipulations and that assumptions and parameters are continually adjusted until the intended choice is justified by the forecasts" (Wachs, 1986).

Planners Unwilling to Admit Uncertainty - Richard de Neufville, one of the most effective proponents of the need to deal with uncertainty, notes that a major obstacle will be overcoming the objections of a professional staff who make their living preparing forecasts. They can hardly be expected to admit that their expensive efforts and staff cannot make accurate predictions (de Neufville, 1990).

Other Observations about Forecasting and Decision Making

A number of additional insightful observations have been made about current forecasting methods and the way we use forecasts in political decision making.

Satisficing Behavior - Cognitive limitations force us to construct a simplified model of the world to achieve satisficing solutions, which focus on achieving a satisfactory but not necessarily optimal solution (Dawes, 1988). When we develop a master plan, it is limited not only by the realities of uncertainty, but also by the number of alternatives we can afford to examine.

Core Assumptions - Ascher notes that core assumptions are more critical than the sophistication of the forecasting method. Further, he argues that improvement in techniques does not compensate for erroneous core assumptions (Ascher, 1978).

Error Increases with Duration - Another point made by Ascher is that the longer the forecast period, the greater chance that conditions affecting the forecast will change. Therefore, longer range forecasts are intrinsically more difficult and are likely to be less accurate. While this conclusion may seem obvious, it has enormous implications for transportation planning practices, which typically plan for twenty or more years into the future.

Requirements of a Strategic Transportation Planning Process

This paper has provided illustrations of the failures of past forecasts, the complications of social and political bias, and other characteristics of decision making error. The most significant problems with current transportation planning practice are summarized below:

1. The inability to predict the future. Uncertainty exists in future demand, technology, costs, resource availability, and values. Imponderable and unpredictable events will shape the future in ways we cannot hope to anticipate.

2. Current travel demand models are limited in their ability to replicate the present, much less forecast the future.

3. Even if travel demand models were perfect, uncertainties in the input variables are enormous, and to a large extent unpredictable.

4. Limitations in intuitive decision making often result in fallacious interpretations of information.

5. Social and political bias is a strong contributor to errors in anticipating future events and to our willingness to deal with uncertainty.

Our inability to anticipate future conditions dictates substantial changes to the way we do urban transportation planning. As observed by Schnaars, "...Asking the right questions is superior to finding elaborate answers to the wrong questions" (Schnaars, 1989). In many respects, the current urban transportation planning process does the latter--it gives elaborate answers to the wrong questions.

In contrast, the desired features of a strategic transportation planning process would include the following.

Understandable to Decision Makers and the General Public - One of the most serious indictments of the current planning process is that it is not understandable to the general public or to decision makers. Indeed, there are few professional transportation planners that understand the underlying technical assumptions. The new process needs to be practical in terms of ease of understanding by elected decision makers and the public.

Reasonable Financial Resources - Planning, although it is extremely important, cannot consume more than a small percent of the total transportation budget, or it will not be tolerated. Thus, the new process must make prudent and strategic use of financial resources.

Promote Objectivity - The new process should promote objectivity. While it cannot (and should not) remove the politics from decision making, the process should promote the separation of politics from forecasting. Political tradeoffs should be based on information that is objective and not contrived to support a predetermined political agenda.

Incorporate Ranges of Assumptions - Previous sections demonstrated the importance of assumptions, and the difficulty of guessing the right assumptions. The new process should therefore incorporate ranges of assumptions to attempt to better reflect the possible outcomes. Forecasts should reflect not just what is likely to occur, but also potential surprise outcomes.

Highlight Uncertainties - No matter what models are used and what assumptions are used, ethical considerations mandate that uncertainties be highlighted for decision makers and for the public. Uncertainties can relate to numerous factors, including demand, technology, costs, resource availability, and values.

Place a Premium on Flexibility - Manheim has argued that the only truly firm decision is how to spend next year's dollars. He notes that an important issue in choosing an action for implementation is its degree of "commitment" versus "flexibility"; if this action is implemented, which future options will be foreclosed and which will still remain open. He argues that the function of the long-range plan should be to assess the long-range consequences of near-term actions (Manheim, 1977).

Putting it all Together: A New Strategic Urban Transportation Planning Process

As noted previously, the reality of uncertainty does not imply we should abandon planning. It does demand that we explicitly recognize uncertainty and deal with it in our planning process. A number of recommendations can be made at this time to better incorporate uncertainty into the planning process. The specific steps that are recommended include:

A Strategic Vision - The process should begin with a strategic vision. Indeed, any meaningful planning process must have a vision of a desired outcome. Elected officials, as representatives of the general public, must be able to articulate a vision of what they want their community to be "when it grows up".

Because of the critical interactions of transportation and land use, the vision will need to incorporate land use, community development and transportation. For long range planning, the vision will necessarily be strategic -- it will incorporate the general desired features, but will not specify precise details, as these must be responsive to the unknowable details of the future.

Identify Uncertainties: A Classical Strategic Planning Process - Once a strategic vision has been articulated, a classical strategic planning process should be undertaken to identify strengths, weaknesses, opportunities, and threats to reaching the desired outcome. The inclusion of this activity represents a radical departure from traditional planning practice, which evaluates all available information to estimate a single expected value for each variable. A number of fundamental uncertainties should be addressed by all transportation planning efforts, including population, labor force, and employment.

A critical element of the process should be the clear enunciation of all assumptions. This practice will require a new awareness on the part of professional staff to the importance of assumptions in the analytical process.

Plan for the Short Run, with an Eye on the Long Run - While it is not a major revelation that uncertainty increases with duration, surprisingly, it is a fact that is frequently ignored. It is recommended that the focus of transportation planning on the twenty year horizon be changed. Instead, the focus should be on current deficiencies, and on the five year horizon. Initially, alternative actions for coping with immediate deficiencies would be evaluated. The traditional transportation planning models could be run with current year traffic analysis zonal data to test alternative actions to correct current deficiencies. Following this application, forecasts would be made of conditions five years into the future. Importantly, assumptions and uncertainties would be clearly illuminated.

Subsequently, based on the outputs of the five year forecasts of socioeconomic and traffic conditions, the forecasts would be extended to a ten year horizon. Similarly, at the conclusion of the ten year forecast, an extension would be made to twenty years. Each step along the way, projects would be identified to meet transportation system deficiencies in each increment.

Only one set of input variables would be necessary for the evaluation of current improvement projects, and for the five year forecast. Even over a five year period there will be some uncertainties, but their impact on travel demand should be relatively minor. For the ten and twenty year forecasts, input variables might include three scenarios: a future believed to be the most likely to occur, a future representing a significantly lower rate of growth, and a future reflecting much stronger growth than currently anticipated.

The emphasis would be on selecting the optimal short term plan, to meet the needs of the initial five year period, but a sequence of improvements would be identified for each subsequent increment. In contrast to the current process, which is predicated on optimizing the response to a highly uncertain twenty year forecast, the recommended process is focused on optimizing responses in a shorter five year time frame, with an eye on the long term.

Incorporate Independent Peer Reviews - The preparation of regional transportation plans, major corridor analyses, and major activity center studies should include a new task, an outside peer review, similar to value engineering reviews. The principal purpose of the peer review would be to review all planning process assumptions, both explicit and implicit, and to critique the reasonableness of results. To minimize adverse impacts on the planning process, an initial peer review should be conducted at the conclusion of the development of zonal input data, prior to running the transportation models. A second peer review would be conducted following the application of the transportation models and the identification of improvement projects.

Promote Flexibility - Once we admit the reality of uncertainty, flexibility becomes paramount. In a future that holds unanticipated surprises, we need to place a high value on retaining future options. The planning process should therefore identify which options are foreclosed by a near term action.

Incremental Implementation of Major Capital Investments - For every major transportation capital investment, an incremental implementation plan should be developed that undertakes usable portions of the major investment in a sequential program.

One of the most controversial categories of transportation investments are major fixed guideway transit projects. The planning that has been applied to these systems reflects many of the identified pitfalls. Risks and uncertainties, particularly as they relate to future ridership and costs, have made it impossible to muster the political support to implement such systems. Can it be any surprise that elected officials are reluctant to commit to systems that will involve massive costs in return for uncertain future benefits? We don't give enough attention to the here and now. We might actually implement something one step at a time, whereas the likelihood of implementing a plan based on projections decades into the future seems highly unlikely.

Instead of the "one-shot" long range picture of the desired system decades into the future, an incremental approach is recommended. We might begin by offering express bus service using makeshift park and ride lots, making use of church parking lots, or of under utilized shopping center parking spaces. As demand increases, permanent park and ride facilities can be constructed. As warranted by demand, high occupancy vehicle (HOV) facilities can be implemented. Preferential bus treatments can be constructed to allow buses to circumvent specific high congestion delay points. As each of these actions is taken, based on ridership affirmation, political support for the next increment of investment will build. Ultimately, the addition of a guideway transit system can be justified, with the park and ride infrastructure already in place.

The same philosophy holds for major highway capital investments. The Tampa Interstate System Master Plan Study, for example, adopted the traditional approach of developing a master plan to serve demands forecasted to exist in 20 years. Designs are being prepared for small pieces of the future mega-highway needed to serve the 20 year demand. We will have segments constructed to meet anticipated 20 year needs, while other segments are failing to meet current needs. Only recently has there been a recognition of the need for interim improvements in advance of the "ultimate" solution. Perhaps we would have done better to adopt a time-staged approach, evaluating incremental improvements on a year to year basis.

Additional Research Needs

The measures recommended above will go a long way toward recognizing the uncertainties in the transportation planning process. However, work is continuing on integrating these methods into a more unified and replicable approach.

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