Long-Range Strategic Planning and Forecasting Techniques: The State of the Art

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The charge of this paper is to discuss methods and techniques for long-range strategic planning and forecasting--methods and techniques that are at the frontier of current knowledge and that will give us clues to the direction in which transportation planning will proceed in the future.

At the Conference on Urban Transportation Planning in the 1980s, held at Airlie House in 1981, it was declared that there would continue to be a need for systemwide transportation facilities planning. That need stems first from the long lead times that it takes to plan and build new transportation facilities but also from the need to have a sound framework within which short-range project plans can be evaluated.

However, in the program for this conference, this workshop was asked to be strategic rather than facilities oriented, and hence it seemed reasonable to downplay the idea of systems. We shall not get totally away from systems, however, because some strategic-planning techniques are inherently systems oriented and because we have also been asked to look at the relationships between strategic and facilities planning methods--in effect, to build linkages between the two activities.

In this paper I will concentrate on strategic planning and forecasting at the state level. Darwin Stuart, in the companion paper on the state of the practice, concentrates on planning at the regional and metropolitan levels.

As we go up the scale into longer time frames and become concerned with larger regions (both of these are essential characteristics of strategy as opposed to tactics), travel behavior becomes of interest primarily as an aggregate phenomenon. In effect, we must focus not on individual trips or origin-destination patterns or temporal patterns, but on vehicle miles of travel, person miles of travel by public transportation, and ton miles of freight. In strategic planning and forecasting, travel is only one of a number of large and important factors such as the condition of physical facilities, the availability of financial resources, the state of the economy, the price of energy, the prosperity of private transportation companies, the application of new technology, the quality of the environment, and the quality of life. In this kind of setting, travel behavior and its forecasting are only important in aggregate terms.

The evidence on which this paper is based is drawn almost exclusively from my research work on NCHRP Project 20-5, which was the development of a synthesis report, Statewide Transportation Planning (1).

CONTEXT

Methods and techniques play their proper roles in the context of large work programs and government organizations. Without the support of a dynamic departmental program that assigns problems to transportation planners and uses their forecasts, evaluations, and plans for actual decisionmaking, the methods and techniques may become only toys.

To develop a dynamic program, any department needs an appraisal of where it stands. As an example of such an appraisal and its impact on a statewide planning program, an inspection of Figure 1 (1) is suggested. The last column in that figure is particularly relevant.

The following conclusions may be drawn regarding strategic transportation planning at the state level (1). Many of the same conclusions apply at the regional or metropolitan level, except that in those areas the structure of government is less unified and the needs for freight transportation planning are generally less.

1. There will be a need for more staff work in financial policy planning, programming, and critical examination of year-to-year performance of all modes.
2. Less attention will be paid to system planning, at least in the classical comprehensive, continuing, and cooperative (3C) approach.
3. Planning will become more multimodal rather than being restricted to traditional modes.
4. There is a need for better, more responsive tools in most of the modal planning areas.
5. Work with private transportation systems will continue, both for person and goods movement. This will require greater understanding of these modes and of the way they affect the economy of a state. Public investments will continue to be needed to cushion the impacts of changes and to improve or coordinate the operations of all systems, but these investments will have to be made with more careful attention to their economic worth. This planning will continue to be an intermodal activity; engineering economics will play a major role.
6. Planning will become more sensitive to the impact of transportation (all modes) on the economy of each state.

Clearly, we must look for methods and techniques that will address critical issues and respond to the requirements that top management in a transportation agency will place on its planning staff.

In this regard, it is helpful to look at the framework for statewide transportation planning that was proposed in the NCHRP synthesis report. This framework is responsive to the increasing management orientation of transportation planning and organizes statewide transportation planning into two parts:

1. The substantive part, that which is concerned with the substance of transportation: the different modes, their physical and service properties, and travel behavior (persons and goods). Substance involves systems planning, corridor planning, and project planning.
2. The management part, that which deals broadly with all implementation procedures from decisions on policy and strategy to communications with legislature and the public, programming, and the monitoring of system performance.

This recommended framework is shown in Table 1. Note that strategic planning or policy analysis has a key place at the top of the management column. Such a position, however, does not make strategic planning independent of systems planning or modal planning in the substantive column or of communications, programming, or performance monitoring in the management column. All of these activities are interdependent.

TECHNIQUES

Given this background and context, what techniques are available? What is the state of the art? In what direction is transportation planning going?

As it turns out, there are a large number of methods and techniques that are new, exciting, and worthy of being labeled state of the art.

NCHRP 20-5 identified 27 techniques that were called examples of good practice. Clearly, we can only present a few here and then only briefly. These are of two types: (a) individual techniques, which repond to specific problems; and (b) integrative techniques, which help to coordinate results.

The presentations describe the problem or problems faced, the method in brief, and then attempt to identify the key characteristics that make each technique worthy of being called the state of the art. At the conclusion, I shall try to pull these characteristics together to see whether they give any clues as to the future of transportation planning.

Individual Techniques

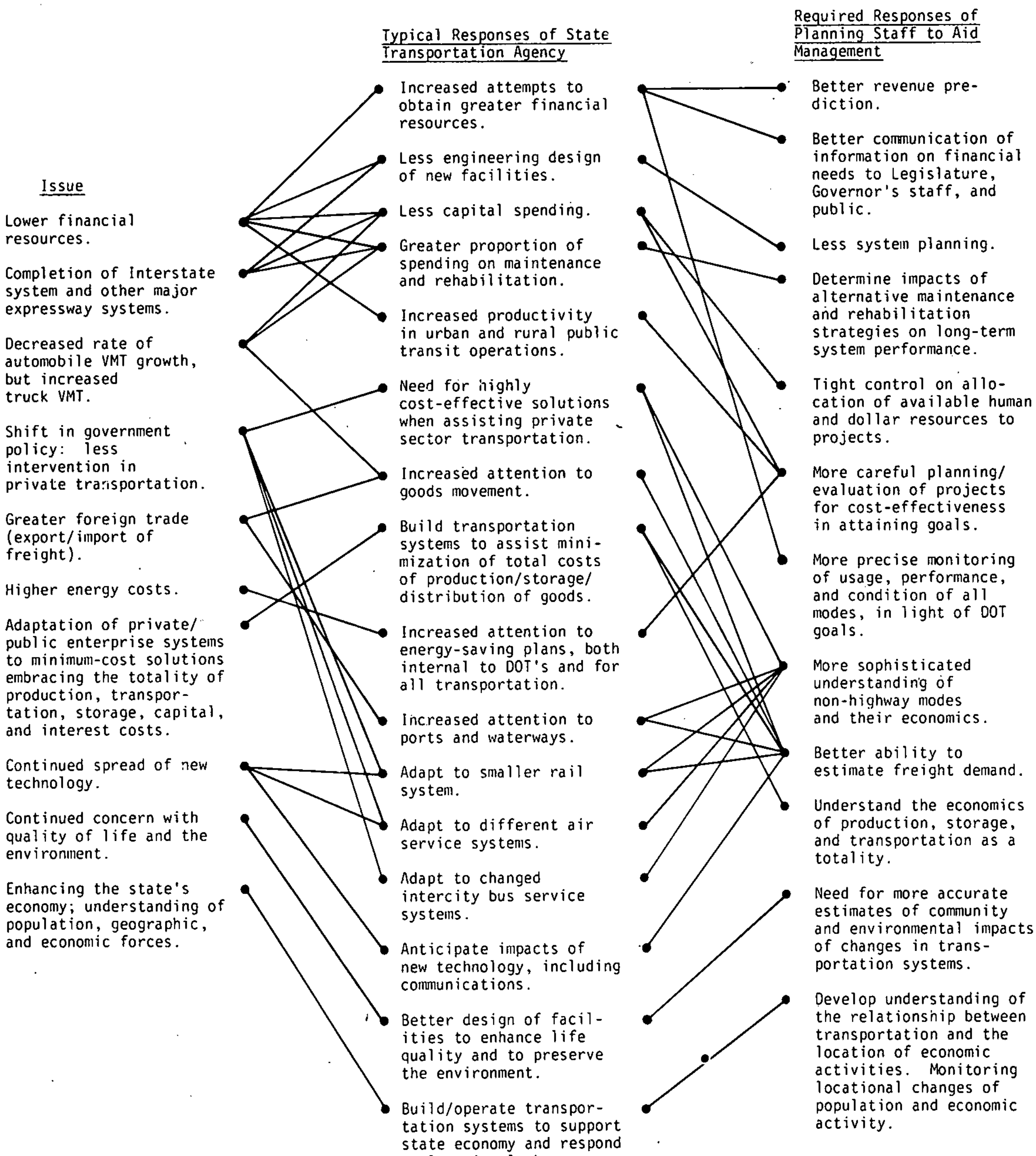
Group A: Estimation of Financial Resources

Estimation of financial resources is one of the critical elements in long-range strategic forecasting for the simple reason that financial resources establish the boundaries of the capital and operating plans and programs of a transportation agency.

Travel forecasting in turn is an important component of financial forecasting because fuel, vehicle ownership, and other travel-related items are major components of the tax base that is traditionally available for or dedicated to transportation improvements.

There are a number of financial forecasting models that states are using (2,3). However, the California package of models, including FINPLAN (4),

Figure 1. Potential impact of current issues on state transportation programs and on requirements for planning.



seems to me to be at the leading edge. FINPLAN is a multiyear computerized model that estimates financial resources for highways; it takes into account all the factors that contribute resources (taxes, fees, and miscellaneous sources) and also that subtract from resources (apportionments and transfers). FINPLAN is a highly disaggregated model, with eight main modules (see Figure 2).

What particularly about the California package makes it so timely? There are, I suggest, several reasons.

Table 1. Framework for statewide transportation planning.

Substantive Content	Management Content
Mode	Strategic planning or policy analysis
Highway (automobile or truck)	Financial
Rail	Regulation
Air	Shared policies (e.g., with land use, energy, and the environment)
Port or waterway	Communications
Pipeline	With state administration
Bicycle or moped	With legislature
Bus (intercity, rural)	With public
Urban transit[a]	With regional transportation planing agencies
Level of planning	With local governments
Systems planning	Programming
Corridor planning	Projects
Project planning	Resources (including staff time)
Preliminary engineering[b]	Performance monitoring
Engineering design[b]	Of systems and services
Planning for operations of existing systems or services[b]	Evaluated in terms of goods and standards)
Assistance to local, county, or regional transportation planners	Miscellaneous
As a process	Operations management studies
Data collection	
Forecasts	
Goal specification	
Preparation of alternative plans	
Testing	
Evaluation	
Decision	

[a]In some states, urban transit may be a function of a statewide transportation planning staff, but in most states only the funding levels are critical issues in statewide transportation planning.
[b]Not functions of transportation agency's planning staff, but part of the total process leading to construction or project implementation.

1. The components of the package are regularly run and rerun. This can be done because they are programmed for computer operation. Thus analysts can concentrate on a critical analysis of the input variables and use alternative inputs. Most of us are skeptical about long-range forecasts (which, however, are essential to strategic planning), and it is only when we can see how the future will look under a range of alternative assumptions that we believe the results.

2. FINPLAN is comprehensive; that is, it is internally structured so that it not only estimates revenue but predicts where the funds will be allocated through the various fund accounts and apportionment to local government.

3. A related California model estimates escalation of capital costs as a result of inflation (5). What makes that model interesting from the point of view of the state of the art is that it has a tie-in to an external forecasting source on a regular basis. In this case, the source is Chase Econometrics. The strategic forecasting operation benefits from this linkage to an external forecast that deals with the national economy.

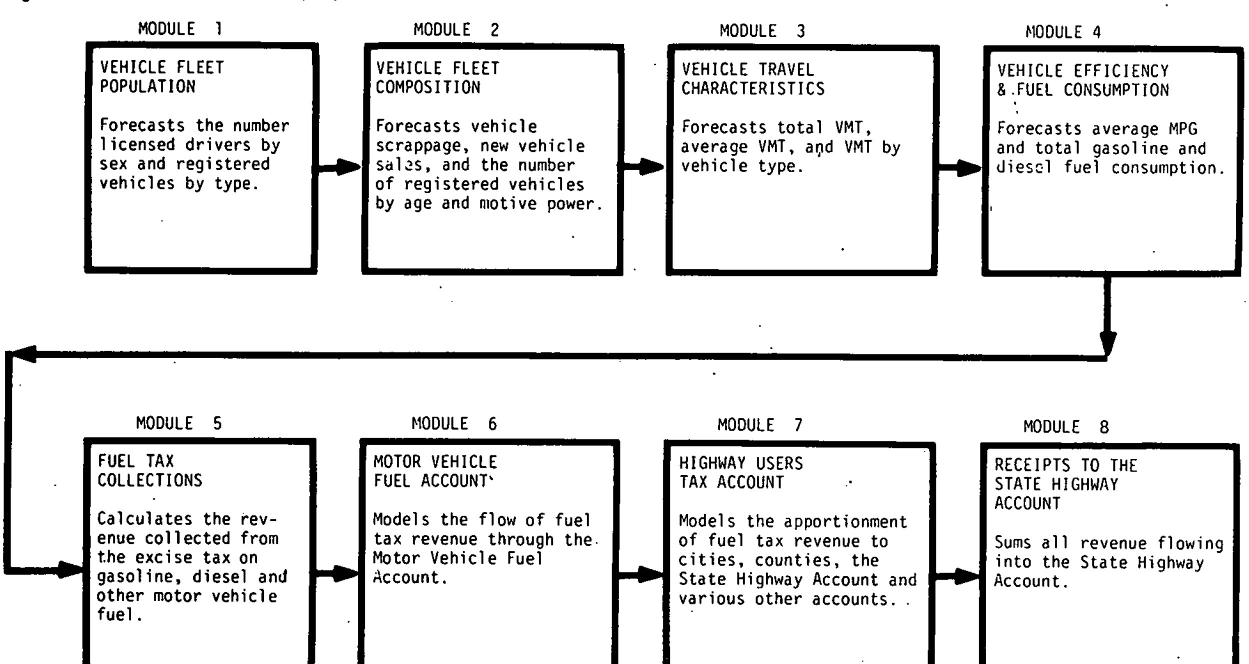
Group B: Freight Modal Study

Strategic planning at the state level (or at the multistate or regional level) must, from time to time, deal with a variety of modes, and for each mode (or modal problem) a different technique may have to be applied or developed. Here an analytical technique is described.

Proposals had been advanced to build an all-American canal linking the Great Lakes with the Atlantic Seaboard. Twelve improvement plans were to be evaluated, consisting of different route locations and channel sizes. The problem was to estimate the economic benefits that would accrue to shippers if each of the proposed navigation systems was built.

The technical problem required estimation of commodity flows by major commodity type for origin-destination pairs that included the 19-state Great

Figure 2. Schematic of FINPLAN model.



Lakes region plus other domestic, Canadian, and foreign origins and destination. Transportation costs had to be calculated for alternative combinations of modes and routes, including rail and truck routings. Costs included transshipment costs and costs as a function of barge and vessel sizes. An accounting model [Transport Cost Calculation System (TCCS)] was developed to summarize costs and thereby savings over present routings (6).

What is unusual about this procedure is that it employed the computer not as a travel-forecasting tool, but as an accounting tool. In the realm of freight transportation, we must deal with extremely disaggregated conditions--different commodity types, different vehicle requirements, different transshipment costs, different perishability rates, and different origin-destination types. To handle these successfully over the range of commodity types and other conditions that exist the computer has to be employed as a clever adding machine, given a large number of rules to work with. The strategic plan is developed not so much as a response to forecast conditions (which are so hard to predict) but as an evaluation of how alternatives will perform under present travel demands.

Group C: Highway Pavement Management

A number of states (California, Arizona, Washington, and North Dakota, for example) have developed pavement-management systems (7-11). These systems have been brought into being at a time when diminished fiscal resources and inflation have reduced states' abilities to build and maintain highways and when, therefore, greater care has had to be taken in the allocation of funds to pavement management.

The essence of these systems is contained in three elements:

1. A complete inventory or an adequate sample of all miles (or preferably lane miles) of a state's highway system, containing condition indicators that are regularly updated;
2. A set of criteria that define the conditions when lanes need maintenance or rehabilitation; and
3. Equations based on historical data that will estimate the need for, and cost of, maintenance and rehabilitation under alternative investment strategies. These equations should take traffic volume data into account.

What is it that makes such techniques timely and that will lead other states to use them? Basically, there are two characteristics that count:

1. The ability to predict the rate of deterioration of pavements, and hence physical maintenance or rehabilitation needs and their costs, is important to the development of long-term strategies for state transportation agencies; and
2. The technique requires a good data base and that data base needs to be stored in a computer in a fashion so that updating can be done inexpensively.

Integrative Techniques

One of the problems with long-range analysis and forecasting techniques is that they tend to become highly specialized. Inevitably, the more advanced they become, the more specialized they will be. Therefore, some integrative techniques are needed.

What are the state-of-the-art integrative techniques? There are two that I would like to discuss briefly.

Group D: Published Master Plan

At least 13 states have published statewide transportation plans since 1975, according to data received during NCHRP Project 20-5 research work, and most of these plans were actually published in the period 1978-1981.

One of the reasons for preparing a statewide multimodal transportation plan is to force coordination between (or integration of) separate modal plans; decisions made on finances; regulation; and relationships with the nontransportation dimensions or sectors of a state or region. Requiring statewide transportation plans to be prepared is, in many cases, part of the directive given to state departments of transportation by their legislatures, and this makes sense because a lack of coordination between the modes has often been one of the prime reasons justifying creation of state departments of transportation.

Actually, there are few better ways of finding inconsistencies between single-mode plans or between plans and financial policies than through combining them in a report with its maps, text, and tables and then critically reviewing the results within the transportation agency and with the public. All kinds of problems can remain undiscovered when different plan elements are lying around in different bureaus or offices. Forcing them together in a report will reveal most of these inconsistencies.

Group E: Performance Monitoring

Performance monitoring is the regular measurement and evaluation of the use and quality of service provided by all the transportation systems of a state or an urban or metropolitan area. The concept of monitoring transportation systems has been around for many years and is implicit in activities such as highway sufficiency ratings and the monitoring of activities on rehabilitated railroad branch lines (12).

In what way is performance monitoring relevant to long-range strategic forecasting or to travel behavior? Or in what way is it an integrative technique?

The answer to these questions lies in the fact that long-range forecasts are notoriously prone to error because travel, among other subjects (such as the economy, population, technology, and energy supplies or prices), is subject to so many external forces. Given this condition but still accepting the necessity of very careful forecasting of future conditions, it is important to obtain regular indicators of changes that are taking place now. Transportation needs indicators just as much as economists, businessman, and governors need data on unemployment, money supply, prices, and bankruptcies.

At present the state of the art of monitoring is not highly developed, although in certain subject areas [e.g., pavement management systems (7,13,14)] it has galloped ahead. I expect that this trend will continue strongly in the future.

ESTABLISHING LINKAGES BETWEEN STRATEGIC TECHNIQUES AND FACILITIES PLANNING

As suggested in the workshop directive, relationships between strategic and facilities planning methods are to be discussed. We do need to build linkages between strategic planning and the world of physical systems and project plans. This is important because without adequate relationships, strategic planning can become irrelevant to decision-making, whereas, on the other hand, facilities planning can become detached from the future unless it is based on a sound, long-range strategy.

As it turns out, there are a number of linkages that can be quite effective:

1. Where the strategic plans are modal, as in the case of the all-American navigation system cited earlier, the strategic plan is the facilities plan.
2. Where a modal planning operation predicts future conditions and the needs that derive from those conditions, as in the case of a highway pavement management system, strategy can be developed by means of an upward link from the modal plan to the strategic plan.
3. The fiscal constraints imposed by estimates of financial resources provide an important linkage, which should be administered through the programming process.
4. Monitoring of travel and transportation facilities and services provides a regular means for evaluating whether system performance at particular places in a state or urban area is actually improving toward strategic goals or is declining in quality.

DIRECTION OF FUTURE TECHNIQUES

In the long run, our work in transportation must be directed toward a vision of a desired future condition. That vision will be expressed both in qualitative terms (such as low accident rates, reduced noise, and low-cost travel) and in physical terms. The physical terms will be important because so much of what will be in fact exists today.

Strategy is the means by which the vision is achieved. Developing that vision, which realistically is an adaptive target, calls for multiple planning and forecasting techniques. There is no single, preferred technique nor any likelihood that an all-embracing technique will be developed. The bigger the planning area and the longer the range, the more techniques there will be. The fact that we must employ a flock of them does not, however, diminish their individual importance. Each technique is just as important to planning as a technological improvement (like the wide-bodied jet or the container ship) is to transportation itself.

If we look at the state-of-the-art example given in this paper, we can discern certain qualities that indicate the direction future techniques will take. There are six of these qualities:

1. Repetitive computer operation: The techniques will be repeated year after year or even more frequently as integral parts of a transportation agency's planning, forecasting, and evaluation program.
2. Internally comprehensive: The techniques will deal with a variety of closely related phenomena in the general subject area of concern.
3. Externally linked: The techniques will have, where appropriate, one or more links to the non-transportation world as a means of verification or to study impacts.
4. Process orientation: The new forecasting and planning techniques will be more process or accounting oriented than theoretically oriented. Theories and models will be employed, but they will play secondary rather than primary roles.
5. Data base: The techniques will depend on data bases that are much more extensive, well maintained, and accessible than anything we now know. Michigan's data base is a forerunner (14,15).
6. Retroactively checked: Planning and forecasting techniques will have their predictions constantly checked through programs of monitoring.

Finally, there is one dominant thought. Success, usefulness, and innovation will occur wherever there is a transportation agency that has the wit to nurture technique and the strength to submerge technique as a utilitarian part of a dynamic program.

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