NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE **15**

STATEWIDE TRANSPORTATION PLANNING

NEEDS AND REQUIREMENTS

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RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION
OF STATE HIGHWAY OFFICIALS IN COOPERATION
WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
- TRANSPORTATION ADMINISTRATION
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectvity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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The study reported herein was undertaken under the aegis of the National Academy of Sciences—National Research Council. The National Cooperative Highway Research Program, under which this study was made, is conducted by the Highway Research Board with the express approval of the Governing Board of the NRC. Such approval indicated that the Board considered that the problems studied in this program are of national significance; that solution of the problems requires scientific or technical competence, and that the resources of NRC are particularly suitable for the oversight of these studies. The institutional responsibilities of the NRC are discharged in the following manner: each specific problem, before it is accepted for study in the program, is approved as appropriate for the NRC by the NCHRP Program Advisory Committee and the Chairman of the Division of Engineering of the National Research Council.

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PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bringing such useful information together and making it available to the entire highway fraternity, the American Association of State Highway Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Highway Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices without in fact making specific recommendations as would be found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available concerning those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

FOREWORD

By Staff
Highway Research Board

This report should be of special interest to administrators of state highway departments, to those responsible for highway planning, and to other transportation agencies. The report offers information on data and management requirements, travel analysis, forecasting procedures, and plan generation and evaluation.

Administrators, engineers, and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. In an effort to resolve this situation, a continuing NCHRP project, carried out by the Highway Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems—a synthesis being identified as a composition or combination of separate parts or elements so as to form a whole greater than the sum of the separate parts. Reports from this endeavor constitute an NCHRP report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems. This is the fifteenth report in the series.

With the creation of a Department of Transportation in the State of Hawaii in 1959 as the precedent, 16 other states had followed suit by 1971 in the attempt at multimodal statewide transportation planning. This concentration of effort to construct, operate and maintain transportation facilities is a response to public awareness of the need for comprehensive plans and programs in transportation development.

The inception of the Interstate Highway System led to the recognition of the need to coordinate and utilize the relationship between transportation services and other activities such as economic development, education, housing, land development, etc., as a prime requirement of transportation planning. With the responsibility for the planning and implementation of the highway program located in one agency while the planning for other functional areas was housed in separate agencies, joint planning was difficult and coordination required real effort. To attain consistent policy development as well as greater effectiveness in providing and coordinating transportation improvements, some states have brought modal agencies into a unified state transportation agency.

Statewide transportation planning and development must be organized in recognition of the variety of problems that result from differences in size, location, natural resources, and human settlement. Each state's transportation program should be defined in recognition of local differences in the emphasis and answers given to a particular mode or type of travel. The Highway Research Board has attempted in this report to set down those statewide transportation planning efforts that have been instituted. The report discusses these state programs from the standpoints of organization, planning methods, and performance criteria.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from many agencies responsible for statewide highway and transportation planning, design, construction, operations, and maintenance. A topic advisory panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report.

As a follow-up, the Board will attempt to evaluate the effectiveness of this synthesis after it has been in the hands of its users for a period of time. Meanwhile, the search for better methods is a continuing activity and should not be diminished. An updating of this document is ultimately intended so as to reflect improvements that may be discovered through research and practice.

CONTENTS

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K. E. Cook, Highway Economist, and J. A. Scott, Urban Transportation Planning Specialist, both of the Highway Research Board, assisted the Special Projects staff and the Advisory Panel.

Information on current practice was provided by many highway agencies. Their cooperation and assistance were most helpful.

STATEWIDE TRANSPORTATION PLANNING
NEEDS AND REQUIREMENTS

SUMMARY

Statewide transportation planning is concerned with determining the impacts of proposed transportation and nontransportation actions on the full range of human aspirations. These actions may be physical additions and improvements, or policies and regulations, affecting the transport of goods and people by public or private facilities.

Statewide transportation planning should provide direction to legislators, administrators, and other public and private officials. This planning should include sufficient detail to enable timely decisions to be reached and the subsequent preparation and revision of long-, intermediate-, and short-range plans. All available and potential modes should be evaluated.

Long-range planning is conducted for a period 15 to 30 years in the future. The level of consideration with regard to land use, type of facilities, and other factors tends to be generalized.

Intermediate-range planning is proposed as a level of planning concerned with sectors, regions, subareas, and broad corridors for a period 5 to 15 years in the future and builds upon and refines the elements contained in the long-range plan. Major facility characteristics and developmental impacts, including environmental impacts to the extent feasible, are considered.

Short-range planning involves specific projects and policies to be implemented in a period 5 to 8 years ahead. Plans for individual projects and/or policies are developed.

Reappraisal of long-range plans is an essential part of intermediate- and short-range planning. However, the mechanics of reappraisal have yet to be established.

Transportation planning for the nonhighway modes introduces additional problems. First, one must have the know-how to plan for each mode as if it were independent of the other modes. Second, the effects of the interaction of the different modes and the requirements for coordinated planning must be integrated into the planning process.

Although there is interest in multimodal statewide transportation planning, much of the past and present effort has been directed toward highways and airport facilities, with the other modes receiving little or no attention. The movement of goods has received little or no attention. Private transportation facilities are necessary. It is also important to reach decisions on the appropriate level and responsibility for planning specific facilities.

Monitoring of system performance is necessary to statewide transportation planning. This effort should include all modes for travel for both goods and people. Any analysis of monitoring data should include an evaluation of the performance and the impact of any system on the environment and other systems.

Regulatory functions that affect transportation are rarely housed in the branch of state government responsible for transportation planning. Planners need to

become more familiar with regulatory matters that have a bearing on the use of the various transportation facilities and the land development and use.

Data flow should be a two-way process. It is important that planners recognize the need for sharing or making data available and, whenever possible, providing data services requested by other planning units or agencies. It is particularly important that data be made available to other agencies within state government and to the private sector to the maximum extent practicable.

Planning for all transportation modes requires coordination with other state objectives, including land development, industrial growth, recreation, and private investment in transportation facilities.

The performance of a transportation system should be measurable in terms of a predefined goal. Standards and level of service requirements should not be confused with goals or objectives. Transportation agencies are beginning to include the planning of multimodal systems as their basic responsibility.

Most state departments of transportation are relatively new and are highway-oriented. Although most of them have some provision for the other modes, the majority of the available funding is dedicated to highways.

Long-range, multimodal transportation plans should be the responsibility of a single office with sufficient authority to obtain the desired level of cooperation and coordination from other agencies or organizations, including local and regional groups.

How and when to engage citizen participation in long-range statewide transportation planning is not clear. However, the citizen role in any implementation effort is widely recognized. The public hearing process, supplemented with advance notice, is at present the path being followed. However, many states believe that citizen involvement must cover all phases of planning, from goal setting to route location hearings.

Statewide transportation planning typically relies on information developed for a base year and then used as a basis for estimating future demand. The basic transportation dimensions are:

- The actual movement of people, vehicles, and goods.
- Facilities.
- The spatial arrangement of human activities and natural resources.

Simulation models have been widely used to estimate the traffic that could be expected on a new highway facility. The basis for this estimate rests with the origin-destination studies that attempted to measure present traffic demands. Models that have been or are being used include trip generation, trip distribution, modal split, and traffic assignment. Simulation on a statewide basis has typically used larger zones and coarser transportation networks than are used in urban studies. Possible direction for future work includes (a) an attempt to improve present highway assignment simulation procedures, (b) extension of the simulation process to other modes, and (c) an attempt to integrate the simulation model into a larger, more comprehensive frame.

The simulation of goods movement at the state level is virtually unexplored. This is due largely to the fact that the major part of freight movement is made by private carriers that are regulated by a multiplicity of federal and state agencies, and to the relative newness of transportation planning at the state level.

The magnitude of investment for transportation facilities and their relatively long life impose a requirement that the future demand for travel be included in the transportation planning process. Some of the questions this requirement raises are:

Who has the responsibility for preparing estimates? Are estimates based on plans or forecasts? What form shall these estimates take in terms of specific items such as population, employment, income, and location? Are present methods adequate to obtain such estimates?

What is the ideal format for a statewide transportation plan? Would it be land use and system network map sheets, recommendations to legislators and officials? A list of goals supported by policy statements? Or some combination of all of these possibilities? There is not a single obvious solution for this question. However, whatever the form in which the plan is presented, it should be evaluated carefully from two viewpoints: First, what will be the transportation consequences if the plan is implemented? Second, what will be the impact on areas affected by transportation?

Differences in size, location, natural resources, and land uses make it mandatory that each state define its own statewide transportation planning program. Efforts should be exerted, however, to attain as much uniformity in treatment as is feasible. Each state should specify modes of transportation to be planned, the areas to be covered, the level of detail in plans, and the basic techniques to be used.

- The vital importance of positive action on the part of both transportation planners and other planners to coordinate their plans cannot be overemphasized.
- To assure consistent policy development, greater effectiveness in providing and coordinating transportation improvements, administrative efficiency, and basic economy, all modal agencies should be unified, whether it be in a department of transportation or in some other omnibus agency.
- The transportation planning function should be multimodal and should report directly to the head of the department.
- Definite, regular lines of coordination should be established between transportation planning and other related agencies, *both public and private.*
- Data should be obtained and performance evaluated on factual bases, and data should be made public in an understandable form.
- The definition of what constitutes a goal and the development of measures of performance should be the first order of business in statewide transportation planning.
- It is recommended that statewide transportation planning move in the direction of measuring performance of modal systems in relation to a set of user, community, economic supplier, and environmental goals, and in calculating the net returns on the investment.
- Limited funding will delay improvements in statewide transportation planning. Early priority should be given to:

1. Developing techniques for measuring performance of all the major modes of transportation.
2. Improving data collection for travel of persons and transport of goods on the represented systems.
3. Improving simulation models for all modes.
4. Developing better methods of simulating the mutual impact of transportation facilities and land use.
5. Assisting in developing better means of estimating costs and social benefits of alternative land development systems and the supporting transportation systems.

- Careful study should be given, at both the federal and state levels, to the allocation of funds for all transportation modes, with each mode required to meet performance criteria.

- There is a need for the generation and testing of alternative transportation plans to assess their ability to satisfy over-all development objectives.
- The transportation planner should work with other statewide planning programs to estimate future locations of population.

There are many unanswered questions regarding the most effective use of the existing rail system and the direction of future facility investments. Multistate or national studies are needed to provide dependable answers.

Although the airlines do share some facilities, studies are needed to determine whether better service could be provided at less cost through the elimination of duplicate or overlapping services.

CHAPTER ONE

DEFINITION OF STATEWIDE TRANSPORTATION PLANNING

The objective of this chapter is to frame the purposes and products of statewide transportation planning. Obviously, the purpose of such planning is to prepare an implementable statewide transportation plan. However, there are at least two schools of thought on what constitutes a plan. One is that a plan is like a blueprint—it is a document that specifies where physical facilities are to be located. At the other extreme, planning is considered to be a process that does not produce plans for facilities, but provides a basis for decisions concerning facilities.

Both elements are necessary. How can one prepare a detailed plan without a process that is capable of measuring and evaluating differences between plans? Yet in a dynamic society it is clear that conditions are constantly changing in ways that are neither easily nor certainly predictable. Therefore, plans that are designed to meet future conditions must constantly be reevaluated in the light of new developments.

Then there is the question of the audience or clientele to which the plan is addressed. Ultimately, the plan must be accepted, modified, funded, and implemented or rejected in part or in whole by the people through their elected governments, with varying degrees of actual public participation. The planner must provide to the decision makers not only plans and recommendations but also information on the costs of the proposals financing considerations, and the impact of the plan on the economy, the environment, the development of the state, and the people and businesses within the state.

An attempt is made at the conclusion of this chapter to define transportation planning.

The functions of statewide transportation planning are broader than plan preparation. Statewide transportation planning should be concerned with monitoring the existing transport and related systems, the role of regulatory functions, service, and mode of transportation.

These dimensions are given in matrix form in Table 1. Functions that are not specifically identified in the table are program management, legislative counseling, financial projections, and project planning.

PLANNING

Planning has been subdivided into four categories, as follows:

1. Long range.
2. Intermediate range.
3. Short range.
4. Plan reappraisal.

Long-range planning is typically conducted for a period some 15 to 30 years into the future. In the case of highways, for example, a long-range plan would consist of an over-all system of major corridors designed to best serve the state or region as it is expected to exist some 15 to 30 years in the future. Typically, the level of detail with regard to land development is generalized, as is the geographic detail (zone size) of the area served and/or impacted by each facility. Descriptions of the transportation facilities themselves in the long-range plan tend to be generalized. Expressways are described as corridors; lower-level facilities are described in generalized form. Rarely, if ever, are traffic engineering improvements to the existing

TABLE 1

ELEMENTS OF STATEWIDE MULTIMODAL TRANSPORTATION PLANNING

PLANNING FUNCTION	TRANSPORT MODE - PERSONS				TRANSPORT MODE - GOODS				
	Auto	Bus	Rail	Air	Truck	Rail	Water	Pipeline	Air
Plan Preparation A. Short Range - Improvement Program B. Intermediate Range C. Long Range - Statewide Systems D. Reappraisal									
Monitoring A. Transport Systems B. Other Systems									
Evaluation of Regulatory Impacts A. Rate Setting B. Franchise Control									
Service A. Agency Staff B. Other Agencies C. Private Agencies and the Public									
Coordination - Other Agencies and/or Functional Areas A. Local B. Regional C. Interstate D. National E. Private F. State									

system incorporated into and evaluated in the long-range plan.

Intermediate-range planning would cover a period from about 5 to 15 years in the future. This planning phase is concerned with a more detailed examination of the alternatives recommended in the long-range plan and blends into the short-range planning effort. In this planning phase the facility characteristics and performance, as well as route location, would be more specific, with evaluation of alternative designs and route locations in terms of a performance analysis, including traditional benefit/cost analysis as well as environmental impacts and developmental considerations.

Short-range planning is oriented to a period of about five years and usually ends when a project is ready to contract. In the highway field, this would include traffic engineering improvements. Expressways would be described in more specific detail in terms of ramp locations, centerline location, and geometric specifics. Also, the traffic that these facilities are expected to serve can be specified in greater detail and presumably with greater precision. For a five-year period, for example, the location and size of many traffic generators (such as stores, homes, factories) will often have been planned. Data on these near-term developments may be obtained from public agency plans, a clipping file of announced or proposed projects both public and private, and a systematic canvassing of large-scale developers. This greater specification of facilities and the travel they would be required to carry should result in greater precision of traffic estimates and, consequently, greater usefulness in facility design as well as evaluation. Obviously, elements of the long- and intermediate-range plans will find their way into the short-range planning process, which serves the dual functions of testing plans against shorter-term and more precisely detailed travel demand, as well as providing data more useful to facility design.

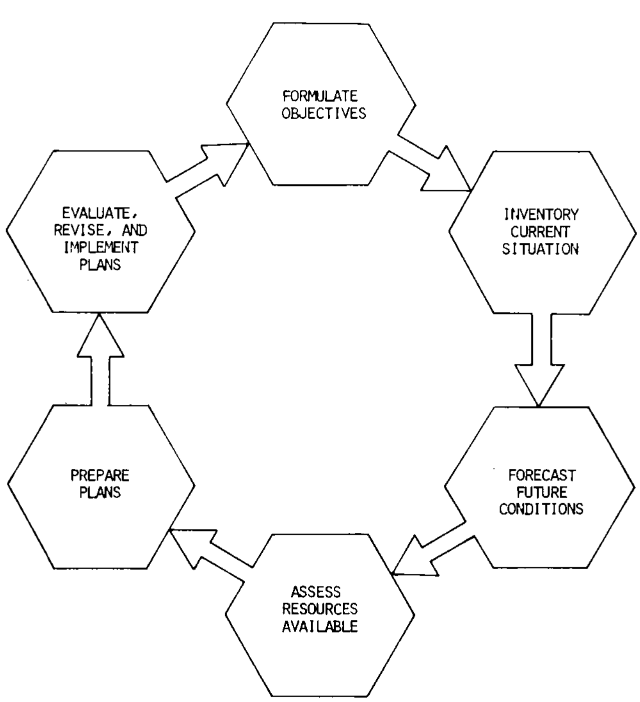

Figure 1. The planning cycle (New York).

Reappraisal of long-range plans would be accomplished in part as a natural consequence of intermediate- and short-range planning. The mechanics of reappraisal have not yet been established in the urban planning process due to the cost of repeating major studies every 8 to 12 years. It seems clear, however, that as the directions of development and population growth shift, a reappraisal of the long-range plan is required (Fig. 1).

When one turns to the planning of several modes, there are two major problems. The first is a definition of what should constitute a "plan" for each mode considered independently of the other modes. The second is the extent to which the different modes interact with each other and, consequently, require joint or simultaneous planning. This is further complicated by the fact that investment in the different modes and associated facilities varies from largely public to mixed public and private, to mostly private sources.

In terms of definition of planning responsibility, most of the states that are engaged in statewide transportation planning indicate that they were indeed interested in planning for all modes of travel. However, most of their efforts have been directed toward planning for highways and airport facilities, with the emphasis on person movement. The preparation of plans to serve goods movement has not yet received major attention, although several states have or are planning goods movement data collection programs. Also, the magnitude or importance of the goods movement modes and the potential payoff that might be associated with planned investments has not been as clearly demonstrated as have the benefits in the urban highway planning programs that can demonstrate lower total travel costs (including capital costs) than a "no build" alternative. Finally, consideration of private transportation facilities is necessary in order to properly evaluate the need for and to prepare plans for public transportation facilities.

In a report being prepared for the forthcoming *ITE* * *Handbook,* Table 2 is presented as an attempt to define both the focus of statewide transportation planning and the areas that fall outside its concern.

In general, detailed location studies, construction, maintenance, scheduling, and operation have been excluded. However, one might want to examine the relative efficiency of aircraft utilization that results from the competition of several airlines for passenger travel between cities. In the main, however, it seems that statewide transportation planning should be concerned with matters of systems designs, levels of investment, and service to users, whatever the mode being considered.

In trying to arrive at a more precise definition of

* Institute of Traffic Engineers.

TABLE 2

SUBJECT MATTER OF STATEWIDE TRANSPORTATION PLANNING

SUBJECT MATTER	STATEWIDE TRANSPORTATION PLANNING IS CONCERNED WITH:	STATEWIDE TRANSPORTATION PLANNING IS NOT DIRECTLY CONCERNED WITH:
Highway	System design *in principle* for all systems (basically spacing and configuration); corridor location for primary and Interstate routes, investment levels by type, location, and timing (both intra-urban and statewide).	Route location; engineering design; corridors of secondary highways in counties (unless owned by state); traffic engineering and control.
Bus	Systems of routes (design and interline coordination); level of service (headways); generalized terminal location; pricing; bus size.	Detailed terminal location; scheduling; internal management; operations; safety.
Air passenger	Systems of air routes and airports; generalized airport location, size, and investment; airspace use; pricing; utilization of airports by type of airplane.	Detailed airport location; scheduling; internal operations; air traffic control; safety.
General aviation	Systems of airports; generalized airport location, size and investment; airspace use; pricing; utilization of airport by type of airplane.	Detailed airport location; scheduling; internal operations; safety; air traffic control.
Rail passenger	Rail passenger systems; generalized station locations; pricing; service levels (headways); public investment; grade crossing protection.	Scheduling; operations; safety.
Rail freight	Extent and design of system; investment; terminals (especially TOFC/COFC); system speed and pick-up frequency; rail-truck coordination; pricing; grade crossing protection.	Scheduling; operations; safety.
Truck	TOFC/COFC terminal locations; expressway location; truck size and pricing.	Operations; details of TOFC/COFC location; safety.
Canals	Investment and maintenance costs; systems as related to rail and highways; recreational use.	Operations.
Ports	Investment; coordination with rail, highway; inter-port coordination and general location.	Design; management; operations.
Pipelines	Impact on rail, canals.	Safety; management; operations.
Land use	Relationship between accessibility (by mode) and the distribution and level of economic activity; population distribution.	
Environment	Preservation of natural, historical, and aesthetic resources.	

planning, one must also consider, for each mode, the facilities, if any, that should be planned for at the state level. In the ITE report on statewide transportation planning, suggestions for the "optimum" planning area are made. These are summarized in Table 3, which suggests that certain modes (air passenger, rail passenger, rail freight, and canals) be planned at multistate, regional, or national levels. It appears that some facilities need to be planned at scales smaller than statewide. Deciding at which level specific facilities are to be planned is clearly in part a recognition of legislative, administrative, and fiscal responsibility and a determination of who, in fact, uses the facilities. In any case, whatever area or unit of government or private enterprise has the responsibility for a given class of facilities, it is clear that the state can play a major role in coordination and in some measure provide a centralized source of data and professional expertise.

MONITORING

Monitoring of system performance is a task that the statewide transportation planning process should probably undertake. By monitoring performance is meant the taking of continuous measurements that permit a determination of how a transportation system is actually performing. These measurements or observations should consider the level of service being provided. In a sense, the continuous traffic counting programs operated by many states and serving as the basis for preparation of annual traffic flow maps are examples of the monitoring of traffic on highways. A flow map, although suggesting congestion or potential congestion points, does not constitute a performance evaluation. Also needed would be data on average speed, travel distances or passenger- and vehicle-miles of travel, and associated costs. One might then look at performance on an annual basis not only to demonstrate

TABLE 3

SUGGESTED OPTIMUM PLANNING AREAS FOR DIFFERENT MODES OF TRANSPORTATION

MODE	SUGGESTED OPTIMUM PLANNING AREA	REASON FOR SUGGESTING THE OPTIMUM PLANNING AREA
Highway	State	State ownership
Bus	State	State franchising powers: use of state highways
Air passenger	Multistate region or nation	The air passenger system is bigger than a single state
General aviation	State	State general aviation improvement programs
Rail passenger	Nation; multistate	National operation (as of 1971)
Rail freight	Multistate region	The system is bigger than a single state
Truck	State	State regulation; use of state highways
Canal	Nation	National ownership
Port	State; regional	Ownership by state and local authorities
Pipeline	State	Franchise powers; safety regulation

the way the transportation system is currently performing, but also to measure trends in performance over time.

There appears to be general agreement that the monitoring of transportation system performance would be a useful undertaking for statewide planning. It would also provide data useful in evaluating both plans and the simulation processes used in evaluating plans. At present, however, the only modes that are being monitored to any extent are highway and commercial air passenger travel—and even these programs do not permit comparative analysis of performance from year to year. Statistics on bus passenger movement and goods movement by other modes of travel are difficult to obtain, and a monitoring function for those modes would have to be defined, sources of data would have to be evaluated, and a program of collection and monitoring would have to be set up. Some of the data collected for monitoring purposes would also be useful in the short-range planning process.

There is another aspect to monitoring transport system performance—namely, the monitoring or surveillance of the impact of a transportation system on the other systems it serves. There are environmental impacts that need to be measured if we are to evaluate performance and improve plans. What are air pollution levels within the state and what role do the various transport modes play in this problem? Two other critical areas are economic development and land development. What is happening in economic development and land development across the state, and how, if at all, have the various transport systems contributed to this development?

Some of this work might seem to be beyond the concern of statewide transportation planning, yet it will be necessary to look to this area if we expect to use the planning of transport facilities to shape and reinforce plans for the environment. Furthermore, the work program required in the 1972 National Needs Study, as well as the likely requirements for future needs studies, underscores the activity necessary for states to be able to provide data on system performance on a continuing basis.

EVALUATION OF REGULATORY IMPACTS

Most commonly, the regulatory functions are housed in a public service commission rather than in the state department of transportation.* Questions of freight rates, awarding of a franchise, service discontinuance, and so on, are not answered by the transportation planner. However, when one considers the question of how to simulate the movement of freight within and between the states, one must become thoroughly familiar with the regulations and rates governing those movements. Typical of the problems that occur when the regulatory and planning functions are conducted independently are those in which one agency of the state is attempting to foster industrial development in a particular region, while at the same time a different agency is weighing a petition for abandonment of rail service to that region.

This concern with the regulatory function is not intended to suggest that the planner be responsible for rate setting. However, he must be thoroughly acquainted with the rates, the mechanism for establishing the rates, and, most importantly, the impact that these rates have on the volume of passengers or goods moved by a particular mode of travel and the impact on land development and use. Only with this kind of knowledge can he begin to deal with the problems of intermodal coordination and private and public investments in the different transport modes. The consensus of the states visited during the course of this survey was that the definition of statewide transportation planning should include recognition of the importance of the regulatory function in transportation planning. Several states indicated that they felt handicapped in dealing with modes other than highways because of their lack of control over the regulatory function.

It seems both appropriate and necessary that a relationship (preferably a formal one) be established between the regulatory functions, typically located in a public service commission, and the transportation planning agency. Significant regulatory decisions should be cleared through the planning agency for comment as to their potential effect on existing plans for investment in facilities.

* New York is one state that has the regulatory function housed within the DOT.

SERVICE

Provision of services to fulfill a variety of demands is another activity that statewide transportation planning should consider. For example, the planning bureau or division may require special tables of data that were not anticipated at the time of laying out the work program. Or perhaps the research unit, attempting to improve simulation techniques, may make greater demands for data or computer services than initially were requested. The need for some accommodation of these requests seems obvious, although such accommodation is not always forthcoming.

A more difficult problem in this regard is requests from other agencies of government for data, or even problem solving services, in the area of transportation. Deviating from a planning program to fill such requests may delay the completion of plans. Failure to provide this assistance, however, may cause the disappointed supplicants to question usefulness of the statewide transportation planning agency.

Finally, there are requests for data or services from private groups and citizen groups. A group considering the optimum location of a major new health facility may request data on medical travel and/or assistance in evaluation of transportation aspects of selecting a location. A citizens' group may want information on the environmental impacts of a proposed facility. The extent to which such requests can and should be met is an integral part of defining the statewide planning program.

In general, most planners and administrators engaged in statewide transportation planning believed that such service was essential. Most also believed that they should be providing more rather than less service.

One state official suggests that the first priority for transportation planning data service should be the provision of inputs to the legislative process. This would include inputs to both local and state governing bodies.

COORDINATION

Coordination is an obvious task that should be part of statewide transportation planning. However, several different kinds of coordination are required.

A major coordinative effort is required between planning of the transportation modes and the activities they serve. First and foremost, of course, would be coordination of transportation facilities with the plans for economic and land development across the state. Is the state attempting to stimulate or reinforce economic and population growth for selected areas of the state? If so, how can transportation be used to assist in this policy? The same kind of coordination needs to be accomplished between transportation planning and other functional areas such as recreation planning, industrial development, and educational planning.

Another kind of planning coordination concerns that between areas and between different levels of government. Statewide planning obviously must coordinate its efforts with the planning efforts of cities and regions within the state. The program must also coordinate its efforts with other states. The statewide planning program must also be coordinated with transportation planning at the national scale. The current procedural reviews required by various federal agencies are mandatory coordination steps.

Finally, there needs to be coordination with private investment in transportation facilities and services. This may be one of the most difficult areas of coordination, particularly as regards the maximizing of both profit and social benefits.

Discussions with planners concerned with statewide planning and a review of the purposes of establishing the state departments of transportation indicate that there is agreement on the need for and desirability of coordination.

DEFINITION OF STATEWIDE TRANSPORTATION PLANNING

The preceding discussion has considered the several activities that should be included in a statewide transportation planning program. Obviously, it would be difficult to formulate a definition acceptable to all professionals engaged in statewide transportation planning. Nevertheless, the attempt is made in the following summary statement:

Statewide transportation planning should be concerned with the preparation of a transportation plan. In order to both generate alternative plans and make useful comparisons between alternative plans, the planner must acquire the capability of determining the impacts of proposed transportation actions and other functional planning on the full range of human aspirations. These proposed actions, both public and private, may take the form of physical additions to the transportation systems, improvements thereto, and policies and regulations with respect to the transport of people and goods. The aspirations on which proposed actions impact are typically referred to as goals and they should be as broad and comprehensive as possible, but, to the extent feasible, the impacts should be in measurable terms. Results of the examination of proposed or alternative actions should be widely circulated in order to allow a broad review of alternatives. However, the major recipients of such information should be the administrative agencies, the legislature, and the executive offices responsible for implementation of proposed actions. A collection of a set of these proposed actions interrelated with respect to modal systems and organized with respect to a specified time frame constitutes an alternative plan. These alternative plans should include facilities as well as policies and should be submitted to the appropriate agency(s) for review, approval, and implementation. However, plans including those elements that have been approved will be subject to a continuous review and reappraisal process constituting an integral function of statewide transportation planning.

CHAPTER TWO

GOALS OF STATEWIDE PLANNING

Any discussion of goals will become enmeshed in semantic difficulties arising from the participants' different concepts as to what constitutes a goal. Although it is well beyond the scope of this report to pursue an ultimate definition of the term, it will be useful to discuss the concept of a goal as it is used in the following discussion.

A goal is conceived to be the criterion against which the performance of a facility or system of facilities is measured. An example of a goal would be the statement that a transportation system should be safe. Reduction of accidents is thus the means by which one moves toward the achievement of the goal. Complete elimination of accidents would represent complete achievement of the goal, whereas the extent to which accidents are reduced for one system in contrast to a different system becomes the measure of the superiority of the former system over the latter system with respect to that goal.

Thus, in this use, the performance of a transportation system should be measurable in terms of goal performance. If one cannot determine the extent to which transportation systems fulfill a given goal, or even whether transportation systems have any impact whatever on the goal, the goal is irrelevant.

Often, goals are stated in a compound sense. It is desired to minimize both transport costs and travel times. It seems clear that achievement of the first will work against achievement of the second.

Another problem in goal formulation is the frequent confusion of the goal itself with the action to be taken to realize the goal. Thus, provision of direct access between all cities of a given size is really a statement of a particular system of transport facilities, rather than a goal in itself.

The final point of confusion is use of standards as goals, or in place of goals. Most standards reflect in fact a given level of performance with respect to the achievement of goals. For example, specifying a level of service of a transportation system as a goal to be achieved avoids the difficult but necessary evaluation of that level of service in terms of goal performance (capital costs, travel time, operating costs, social benefits, etc.) Specifying a standard level of service in one region may result in higher total transportation costs than would a somewhat lower level of service. In another region a higher level of service might result in lower total transport costs than a predetermined standard level.

Before moving to a discussion of particular goals, a few observations are in order. Some critics of the urban transportation planning process have accused the transportation planner of measuring only those items that are easy to measure, such as travel costs, time savings, and accidents. There may be an element of validity in such criticism. Society's increasing concern with preservation of the environment and provision of accessibility without regard to social factors such as income, race, or age should be reflected in the goal statements of statewide planning. However, this does not mean the abandonment of performance goals currently in use. Rather, efforts should be increased to enlarge the lists of goals and the techniques for transportation system performance evaluation in terms of this broader listing.

Some contend that one can never expect to successfully isolate goals and develop goal measurement techniques that will be universally embraced. This is probably true. However, in the absence of any goal statements and goal evaluations, development of alternative plans and selection from among these plans becomes a chaotic and haphazard process with little assurance that resulting investments will bring any real social gains. Experience gained in gaming approaches to transportation planning reveals the essentially selfish or individual-oriented goal achievement motives of the participants. Although such gaming illustrates the difficulties inherent in achieving agreement with respect to goals, it underscores the need for moving toward agreement.

The State of Wisconsin, in its 1968 report, *Highways II: The Plan,* made a careful attempt to spell out the goals. The authors defined goals as general plan objectives that support widely supported public values and desires. Their format consists of (1) an objective, (2) a principle, and (3) the standards that are criteria or indicators used to measure the component parts of objectives. Their objectives are reproduced as follows:

OBJECTIVE No. 1: *MEET FUTURE TRAVEL DEMANDS*

- **Develop a state highway transportation system plan which will serve effectively and provide accessibility to existing and anticipated patterns of development throughout the state and travel demands generated by existing and future development.**

Principle

A well planned state highway system interconnects land use activities within and outside the state. In this manner the highway system facilitates mobility between activity areas and provides the accessibility essential for the support and development of activity areas. Through the

effect of the system on accessibility, the highway system can stimulate development in preferred locations and discourage incompatible use of land.

Standards

1. The plan should provide maximum service to existing and anticipated patterns of development, to areas of population concentration, and to activities which generate significant traffic demands throughout the state and surrounding regions.

2. The plan should be based on forecasts of future demands for the movement of people and goods by highway. Forecasts of travel demands should also be related to forecasts of land use development, economic activity, and population.

3. The plan should utilize the present highway system to the fullest extent feasible in meeting projected travel demands.

4. The plan should provide for any new routes or new route locations that might be needed, in addition to the existing system, to meet anticipated travel demands.

OBJECTIVE NO. 2: *DEVELOP A FUNCTIONAL PLAN*

- Develop a functional state highway transportation system plan which will provide for appropriate types and levels of highway service commensurate with the needs of the various areas and activities in the state.

Principle

A functionally stratified state highway system, consisting of various types of highway facilities, is essential to provide an adequate level of service to all segments and concentrations of population, to properly sustain essential economic and social activities, and to achieve economy and efficiency in the provision of highway transportation services.

Standards

1. The highway plan should be based on the concept of functional classification, the aim of which is to group streets and highways into categories according to the character of service they provide and will be expected to provide.

2. The procedures and criteria used in functional classification should be related to those developed by the AASHO-NACO joint Subcommittee on Functional Classification.[1]

3. The functional system plan should provide a functionally stratified network of highways consisting of about 7 to 10 percent Arterials, 20 to 25 percent Collectors, and 65 to 75 percent Locals.

4. The arterial and collector systems should be stratified further to reflect meaningful differences in travel patterns and service needs.

OBJECTIVE NO. 3: *REDUCE TRAVEL TIME AND TRAFFIC CONGESTION*

- Alleviate traffic congestion and reduce travel time between component parts of the state.

Principle

To support the everyday activities of agriculture, industry, business, shopping, recreation, entertainment, and social activities, it is essential that the state's highway system provide for relatively fast and convenient travel service. Congestion and slow travel times result in loss of time and increase the costs of transportation. This is reflected in higher product costs which in turn adversely affect the relative market advantages of agriculture, industry, commerce, and services in the state.

Standards

1. The total vehicle-hours of travel time within the state should be minimized by providing for direct routing between major termini in the state. Emphasis should be placed on routes carrying the highest number of vehicle-miles.

2. The number of vehicle-miles of travel on the higher functional systems should be maximized.

3. The total daily vehicle-miles of travel should be minimized by directly routing highway facilities carrying the highest number of vehicle-miles to provide the shortest travel paths for the greatest number of trips.

4. The longer trips should be served by the higher functional routes by locating these routes in corridors which exhibit a significant percentage of long distance trips.

5. To further encourage long distance trips on high functional routes, these highways should be located in aesthetically attractive corridors.

6. To increase the overall traveling speed, the direct relationship between the functional systems and their appropriate operating speeds should be stressed.

7. To minimize traffic congestion, the volume-

[1] "A Guide for Functional Classification," May 1, 1964.

to-service volume ratio[2] should be equal to or less than 1.0 based on 24-hour average weekday traffic volumes.

8. Travel time between significant population, economic, recreational, and institutional centers throughout the state should be minimized.

OBJECTIVE NO. 4: *PROVIDE FOR SAFE TRAVEL*

- Reduce exposure to traffic accidents and provide for increased travel safety.

Principle

Accidents take a heavy toll in life, property damage and human suffering, contribute substantially to transportation costs, and increase public costs for police and welfare services. It follows that every attempt should be made to reduce both the incidence and severity of accidents.

Standards

1. The volume-to-service volume ratio should not be greater than 1.0 based on a level of service B in rural areas and a level of service C in urban areas.[3]

2. Travel on highway facilities which exhibit the lowest accident rates (freeway and expressway type facilities) should be maximized.

OBJECTIVE NO. 5: *PROVIDE AN ECONOMICAL AND EFFICIENT PLAN*

- Provide a plan which is both economical and efficient, satisfying all other objectives at the lowest possible cost.

Principle

The total resources of the state are limited, and any undue investment in highway transportation facilities and services would occur at the expense of other public and private investment. Total highway costs should be minimized, but not at the expense of failing to meet desired levels of service.

Standards

1. The sum of the highway transportation system's capital costs and user's operating costs should be minimized.

2. The fullest economic use should be made of existing and committed major highway facilities.

3. Additional highway facilities should be provided to serve or induce future travel demand at the desired level of service.

OBJECTIVE NO. 6: *COORDINATE HIGHWAY PLANNING WITH LAND DEVELOPMENT*

- Coordinate highway planning with land use planning for the development and preservation of resources.

Principle

The social and economic costs attendant to the disruption and dislocation of homes, business, industry, agriculture, communication, and utility facilities, as well as adverse effects on the natural resource base, can be minimized through the prudent location of highway facilities.

Standards

It should be noted that although this objective and the following standards are important in planning, they become most directly applicable at the highway design stage of the planning process. At the long-range planning stage they serve as a guide for very general system configuration and route locations. In any case, full utilization should be made of other state plans (such as recreational and institutional plans) in the development and evaluation of the State Highway Plan.

1. Major centers of economic, recreational, and institutional activity should be served by the arterial system.

2. The penetration of residential areas and of

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[2]*Volume* refers to 24-hour average weekday traffic volumes. "A *service volume* is the maximum number of vehicles that can pass over a given section of a lane or roadway in one direction on multi-lane highways (or in both directions on a two- or three-lane highway) during a specified time period while operating conditions are maintained corresponding to the selected or specified level of service." *Highway Capacity Manual*, (Washington, D. C.: Highway Research Board, 1965), p. 8.

[3]The Highway Research Board specifies six levels of service — A, B, C, D, E, and F — to describe operating conditions. Level of service A describes the best traffic operating conditions that may occur. "Level of service B is in the zone of stable flow, with operating speeds beginning to be restricted some what by traffic conditions. Drivers still have reasonable freedom to select their speed and lane of operation. Reductions in speed are not unreasonable, with a low probability of traffic flow being restricted. The lower limit (lowest speed, highest volume) of this level of service has been associated with service volumes used in the design of rural highways. Level of service C is still in the zone of stable flow, but speeds and maneuverability are more closely controlled by the higher volumes. Most of the drivers are restricted in their freedom to select their own speed, change lanes, or pass. A relatively satisfactory operating speed is still obtained, with service volumes perhaps suitable for urban design practice." *Ibid.*, p. 81.

neighborhood areas by high functional arterial routes should be avoided.

3. The dislocation of homes, businesses, and industries should be minimized in detailed facility planning.

4. Direct access via the arterial system to designated scenic routes should be maximized.

5. However, arterial highways on designated scenic routes should be minimized.

6. Highway facilities should not be located in or through environmental corridors[4] except when necessary to serve the proper utilization of these areas.

7. The proper use of land for, and adjacent to, highway facilities should be maximized by coordinating highway planning with land development. To minimize incidents of development which might be incompatible with highway corridor development, more use should be made of advance reservation of land for highway facilities.

8. The destruction of historic buildings and of historical, scenic, scientific, and cultural sites should be avoided.

9. The use of land for highway facilities should be minimized.

10. The penetration or disruption of existing or proposed parks, recreation lands, and wildlife refuges should be avoided.

OBJECTIVE NO. 7: *ENHANCE AESTHETICS OF HIGHWAY TRAVEL*

- Develop a plan which integrates the state highway system with the aesthetic qualities of the landscape.

Principle

Beauty along the highways and surrounding environment is conducive to pleasurable driving and to the preservation and enhancement of natural resources.

As major features of the land and cityscape, highway facilities have a significant impact on the aesthetic quality of the total environment.

Standards

The following standards become important factors at the design stage of highway planning.

1. Highway transportation facilities should be located to avoid obstructing the view of visually pleasing buildings, structures, and natural land features. Furthermore, highway facilities should be located to provide visual contact with such features.

2. Highway transportation facility design and construction plans should be developed using good geometric, structural, and landscape design standards, which consider the aesthetic quality of the transportation facilities and the environment through which they pass.

OBJECTIVE NO. 8: *INTEGRATE WITH MODES OF TRANSPORTATION AND HIGHWAY FACILITIES IN ADJACENT STATES*

- Develop a plan which is capable of being integrated with other modes of transportation and systems in adjacent states. Attention should be given to existing and planned termial locations and their expected levels of activity.

Principle

Travel is not limited by state boundaries or by mode, and a state plan must be integrated with the plans of neighboring states for maximum effectiveness, In addition, terminals of non-highway modes of transportation (water ports, airports, and railroad stations) are of particular importance in highway planning. Virtually all passengers and goods arriving and departing at these facilities use highways.

Standards

1. At least all high function arterials crossing state lines should coincide with routes of comparable levels of adjacent states.

2. Highway connections, consistent with the importance and level of activity, should be provided to terminals of non-highway modes of transportation.

The Concept of Functional Classification

This section is devoted to the general concept of functional classification — defined as the grouping of streets and highways into systems or classes, according to the character of service they provide or will be expected to provide. The central purpose is to introduce in clear fashion some fundamental relationships which are necessary to a basic understanding of this newly emphasized approach to highway planning. Functional classification provides the basic structure of the State Highway Plan.

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[4]Environmental corridors are land use areas in which concentrations of scenic, recreational, and cultural resources occur and which should be preserved and protected. See: *Recreation in Wisconsin* (Madison: State of Wisconsin, Department of Resource Development, 1962), pp. 19-26; *Inventory Findings — 1963*, SEWRPC Planning Report No. 7, Vol. 1 (Waukesha: Southeastern Wisconsin Regional Planning Commission, 1965), pp. 74-77.

As previously noted, there are differences in definitions of terms such as goals, objectives, standards, and criteria. However, the Wisconsin listing provides an illustration of the types of concerns with which they attempted to deal in preparing a highway plan.

Some of the standards are subject to a criticism made earlier. For example, under Objective 1, Standard 3, the meaning of "feasible" seems vague. Subsequently, it is asserted that all plans tested met this standard because "all present major highways were included in all networks."

The two standards given under Objective 4, Provide For Safe Travel, also deserve some comment. The first, the assertion that the volume-to-service volume ratio should not be greater than 1.0 based on a rural level of service of B and an urban level of service of C, assumes the conclusion of how to prevent accidents without actually attempting to apply accident rates to assigned traffic volumes for the tested networks. The second standard of maximizing travel on freeway- and expressway-type facilities also sidesteps the issue of attempting to actually estimate accidents. One might naturally assume that as traffic volumes decrease for any facility type, accident rates (expressed in terms of accidents per million miles of vehicle travel) would also decrease. Moreover, because freeway travel often generates additional miles of vehicle travel, there may in fact be a distribution of traffic over the system that would have a lower over-all accident performance than would the distribution in which expressway use was maximized.

Objective 3 mixes travel time, something that can be directly measured (through the traffic assignment process) with traffic congestion, something that is much more difficult to measure. One would expect that given the least cost plan with respect to total capital and operating costs, travel time costs, and accident costs, one would not need to be concerned with congestion.

An important objective in the Wisconsin goal statement is No. 6: Coordinate Highway Planning With Land Development. The report suggests that this objective is most directly applicable at the design stage of highway planning. Yet if transportation facilities have any impact on the timing, quality, and quantity of land development, different plans mean different development patterns and different traffic demands. Moreover, if the state or regions of the state have land development plans, the highway plan should be integrated with that plan to the greatest extent feasible. The Wisconsin goal statement urges this kind of coordination. In point of fact, in most states little has been done in the way of statewide economic or land development plans.

The Wisconsin report is a highway plan. Nevertheless, it acknowledges the need to integrate and coordinate the plan with other modes of transport and with highway facilities in adjacent states. Missing from the goal statements is the specification of goals for other modes of travel. Also missing is a discussion of air pollution * and noise pollution. This may be an indication of the reduced need for and concern with these goals at a statewide level, although it appears clear that for certain elements of a system these concerns would be paramount.

Finally, the question of how to deal with the trade-offs between the separate goals and, especially, how to arrive at a rational allocation of investment not only between different modes, but also between transportation in general and other areas, must be examined.

In the main, Wisconsin has done significant work in attempting to define and measure the goals of highway planning. However, the job remains essentially unimodal, and a mechanism for the trade-offs between goals other than capital costs, operating costs, time costs, and accident costs, is still to be found. In the absence of knowledge of the rate of return on investments outside the area of transportation (real information appears to be lacking) at least an interest rate should be selected that is the best estimate of the marginal rate of return in areas other than transportation planning. This at least guarantees that rate of return on any plan. Ideally the planners should be in a position to know the marginal rate of return for all modes of travel.

In a report dated July 1971, the Wisconsin Division of Planning has gone beyond the goals reproduced previously from *Highways II*. In this report an attempt is made to broaden the goal set to include all modes of travel. In addition, four objectives not previously included have been added, as follows:

- Balanced urban passenger transportation systems providing the appropriate types of service within the various urban subareas of the state at adequate levels of service.
- A balanced public intercity passenger transportation system providing the appropriate types of passenger service to all areas of the state at adequate levels of service.
- A balanced commodity transportation system providing the appropriate type of freight transportation service to the various subareas of the state and its communities at an adequate level of service.
- The minimization of internal subsidy for public transportation services while promoting full utilization of available facilities.

This concern with developing goals for all modes of travel is appropriate and necessary before one attempts to undertake intermodal transportation planning. The last objective, attempting to deal with pricing, profits, and public interest, is an area that all agencies concerned with intermodal transportation planning must ultimately manage.

The standards advocated to fulfill the objectives continue, by and large, to take a prescriptive rather than an analytic/evaluative approach. For example, the report suggests that the total transit route length in any urban area should be approximately 4 route-miles per square mile, or one route-mile per mile of arterial street. One would expect that the optimum spacing might vary according to such factors as population density, income, car ownership levels, and region size.

However, this work is very detailed and highlights an

* It has been suggested, however, that public concern over air pollution is of relatively recent origin and that the Wisconsin goals were based on elements considered to be of importance in the mid-1960's.

area that is of critical importance to statewide planning. Should the goals be the basis against which system performance is measured, or can standard levels of system performance be specified? The latter, in fact, assumes the conclusion and is in no sense a basis against which to measure and evaluate performance.

The State of Connecticut published a report entitled *Goals for Connecticut.* This report is interesting because of the methodology employed to isolate goals and because of the breadth or range of human activities these goals are intended to cover.

In order to determine "established goals," the General Statutes, administrative reports by state agencies, reports of special committees, town and regional plans, and platforms of political parties were examined. Sixty-four municipal development plans were studied to determine the goals toward which the plans were directed. This examination revealed the following:

1. Most municipalities wish to keep their individual and discreet identities.
2. Municipalities show no desire to change from one class to another.
3. There is a decided preference for rural rather than urban atmosphere.
4. Municipalities in all cases show little awareness of their regional role.

The study also examined the goals of regional planning agencies. Two major goals appeared. The first is to develop a region that is in balance; that is, a region where economic, social, and physical needs are balanced by opportunities to provide these needs. The second goal was that of orderly growth.

When the study turned to state goals as defined or implied in legislation, administrative reports, special commission or committee reports, and political party platforms, it found these goals deficient because they failed to give clear guidelines or to establish priorities or relative values. The study notes that such goals failed to cover all of the elements of a plan and all of the fields that the elements of a plan affect. State goals that were isolated are discussed in terms of economic goals; community development goals; transportation goals; goals for natural resources, open space, and recreation; public health goals; housing goals; and general goals.

In a section dealing with personal goals, the study notes that the rights of life, liberty, and the pursuit of happiness cover the full range of personal goals.

The state used data obtained from a sample of 4,900 households in which interviews were conducted to measure attitudes concerning the factors that make an area a desirable place in which to locate and live. Attitudes toward housing, the home town, the state, leisure time activities, and recreational activities and facilities were the chief targets of the interviews. One of the findings was that 60 percent of the people in Connecticut prefer to live in a home with a lot that has a frontage of greater than 60 ft. In contrast, four times as many people lived on lots less than 60 ft wide than people who expressed a preference for lots of less than 60 ft. The major conclusion of this section of the report is that

> . . . there is a diversity of desires in all categories and that these desires are not, or cannot always be fulfilled when decisions are made. It is obvious that families take a number of factors into account when they choose a home or a town. They may desire many things, but economic and physical realities demand that compromises be made. It is one of the purposes of planning to reduce the need for compromises so that more people can live in situations that are closer to their ideals.

The report goes on to propose "functional goals," which should be the elements of a comprehensive plan. The functional areas considered are economic goals, goals for urban form, transportation goals, goals for open space, natural resources and recreation, and housing goals. Some of the major points with regard to transportation were

> . . . the chief purpose, or goal, of transportation is to bring elements of the community closer to each other in time distance. . . . Communities of all sizes should be tied together. . . . Safety is a particularly pressing issue. . . .

Goals are then presented with respect to the purpose of the travel. For example, the primary design goal for commuting is listed as that of achieving a system of high capacity. For personal travel, safety is listed as a high-priority goal. For recreation travel, the design goal would be to "achieve a system of high enough capacity to accommodate without excessive delays all those who would desire to travel to recreation facilities."

The Connecticut approach to defining goals is noteworthy for its breadth; transportation is but one component of the full range of human activities for which goals need to be specified. The use of a wide range of source data and an attitude questionnaire in the search for appropriate goals is also to be commended.

In returning to the earlier definition of a goal as the criterion against which or in terms of which performance is measured, it is found that the Connecticut study treats goals as being unmeasurable ("objectives, unlike goals, can be measured"). The study goes on to state that objectives are obtained by applying appropriate standards. Thus, assumption of standards takes the place of goals and implicitly assumes the level of goal achievement that is appropriate. Although the use of minimum standards may be of practical use in designing a plan or plan element, one must be aware that by so doing he has assumed his conclusion. There may be established a minimum standard below which a plan is unacceptable whatever the cost savings, or a maximum standard above which benefits are superfluous. Surely, however, two plans that both meet a minimum standard need not or should not be considered equal with respect to the goal from which the standard is derived, especially if that goal were, for instance, safety.

CHAPTER THREE

ORGANIZATION FOR STATEWIDE TRANSPORTATION PLANNING

The movement of persons and goods utilizes a variety of transportation modes that interconnect to varying degrees. Furthermore, the provision of transportation facilities may influence the development and geographic distribution of the very activities that utilize the transportation system. Any attempt to prepare plans for the facilities of one travel mode independently of other modes and independently of other plans and/or actions of government or private industry is certainly not ideal. In response to the need for a single institutional setting in which the many facets of transportation could be integrated with each other and coordinated with the other related activities of government, the Federal Government and several state governments have established Departments of Transportation. The organizational character of these State Departments of Transportation is discussed in "A Status Report of State Departments of Transportation" by the Transportation Development Division, Highway Users Federation for Safety and Mobility, dated December 1970.

ACTIVITIES OF STATE DEPARTMENTS OF TRANSPORTATION

In 1959, Hawaii became the first state to establish a Department of Transportation. Since then, 16 other states have followed suit, and several more are actively considering establishment of DOT's.

Some of the more significant facts and authority of these DOT's are summarized in Table 4. The first that must be remembered is that Departments of Transportation are a relatively new phenomenon (less than five years old in 10 of the 12 states listed in the table).

A second observation is that although the powers of the State Department of Transportation vary considerably from state to state, all, without exception, have been authorized to construct and provide financial aid to highway systems. For other modes, however, this power more often than not has been withheld. In the case of pipelines, this power has not been granted to any of the state DOT's.

The power to give financial aid is a strong one, but in terms of implementation is influential rather than direct. The several modes—highway, air, water, transit—are fairly well covered here, with only California and Delaware missing two modes. Again, pipelines are not covered in any of the states studied.

The power to license and/or regulate includes such regulations as license to operate, safety, passenger fares, freight rates, and franchises. In this regard, there is much less consistency between the states, particularly in the setting of freight rates and franchises. This power is generally found in a Public Utilities Commission, except in New York State where this power is vested in the DOT.

ORGANIZATION OF ACTIVITIES WITHIN THE STATE DOT

The major organizational divisions of each State DOT are indicated in Table 5. The variety of the major organizational headings reflects in part the existing transportation-related activities existing in the state before the DOT was established. The major headings in order of frequency of occurrence are airports, highways, planning, administration, motor vehicles, mass transit, and waterways.

There has been some question as to whether a modal organization or a functional organization is preferable. The New York State DOT organization is of the functional type and locates the planning of all modes within the Office of Planning and Development. Although several of the State DOT's are organized along modal lines, they also have a major planning group responsible for the planning and/or coordination of the plans of the several modes.

The "correct" organizational pattern cannot be prescribed for any state. However, it does seem clear that at some point in the development of a DOT, however it may be organized, it is necessary to bring plans for the different modes together and evaluate them as a single, multimodal transportation system. Whether the plans can be developed jointly or simultaneously would appear to be a matter that is as much methodological as it is organizational.

COORDINATION WITH OTHER AGENCIES

The need to coordinate and, to the extent feasible, utilize the relationship between transportation services and other activities (economic development, social development, education, housing, land development, etc.) is a dominant requirement of transportation planning. However, when the responsibility for the planning and implementation of transportation programs is located in one agency while the planning for other functional areas is housed in separate agencies, joint planning is extremely difficult and coordination requires real effort.

In Rhode Island the preparation of long-range transportation plans is not housed in the Department of Transportation, but is the responsibility of the Statewide Planning Program. The Program is charged with preparation and maintenance of plans for physical, economic, and

TABLE 4

AUTHORITY OF STATE DEPARTMENTS OF TRANSPORTATION TO PREPARE AND EFFECTUATE COMPREHENSIVE TRANSPORTATION PLANS

				AUTHORITY TO BUILD, OPERATE, AND MAINTAIN					AUTHORITY TO GIVE FINANCIAL AID TO:					AUTHORITY TO REGULATE, LICENSE, AND SET RATES FOR:							AUTHORITY TO LICENSE VEHICLES	
State	Authorization for Comprehensive Transportation Planning	Has a Comprehensive Transportation Plan Been Prepared? (Year)	Is Comprehensive Transportation Planning in Process?	Highways (state)	Airports	Ports	Canals and Waterways	Urban Transit	County or Municipal Roads	General Aviation Airports	Commercial Airports	Ports	Urban Transit	General Aviation Airports	Commercial Airlines	Bus Passenger Service	Rail Passenger Service	Truck Freight	Rail Freight	Urban Mass Transit	Motor Vehicles	General Aviation Airplanes
California	X		X	X	[a]				X	X	X			X							X	
Connecticut	X	1971	X	X	X	X	X	X	X	X	X	X	X	X	X	[b]	[b]			[b]		[c]
Delaware	X		X	X	X			X	X	X	X		X	X	X	X				X		X
Florida	X	1971 [d]	X	X	X	X	X	X	X	X	X	X	X	X	X							
Hawaii	X	1961 [e]	X	X	X	X																
Maryland	X		X	X	X	X			X	X	X	X	X	X	[f]						X	X
New Jersey	X	1968	X	X					X	[g]			X	X		[h]	[h]			[h]		X
New York	X	1968	X	X			X		X	X	X		X			X	[i]	X	X	[j]		
Oregon	X		X	X	X				X	X	X			X							X	X
Pennsylvania	X	1970	X	X	X				X	X	X	[k]	X	[f]	[f]						X	
Rhode Island	X	[l]	X	X	X	X	X		X	X	X	X	X	X	X						X	X
Wisconsin	X	[m]	X	X	[n]				X	X	X										X	[c]

Source: 1971 poll of states by author; see text for limits of accuracy.
[a] State law provides authority, but by policy it is not exercised.
[b] Only for service under contract to state.
[c] Authority to register, not to license.
[d] In accordance with National Transportation Planning Study.
[e] 1961 plan has been updated for major modes, but not re-published as a single document.
[f] For airports, but not airlines.
[g] For publicly owned airports only.
[h] Only when carrier is receiving public aid.
[i] New York has authority to give financial aid to Amtrak for subsidy of additions to the "basic system."
[j] Commuter and urban mass transit is now provided by public authorities exempt from New York State Department of Transportation regulations.
[k] Authorized by implication only.
[l] In draft stage (1971).
[m] For highways and airports only.
[n] Authority in statutes, but clouded.

TABLE 5

MAJOR ORGANIZATIONAL DIVISIONS IN STATE DOT'S

State	Administration and Business Management	Planning and Research	Public Works and Maintenance	Aeronautics and Airports	Highways	Mass Transit	Special Transit Districts	Rail and Motor Carrier Services	Waterways	Motor Vehicle	Highway Patrol	Safety	Legal	Business Regulatory
California			X	X						X	X			X
Connecticut	X	X		X	X			X	X					
Delaware	X	X		X	X		X							
Florida	X	X	X[1]			X								
Hawaii				X	X				X					
Maryland		X		X	X	X			X	X		X		
New Jersey	X	X		X	X	X								
New York		X[2]	X[3]										X	
Oregon				X	X	X			X	X				
Pennsylvania	X	X		X	X	X						X		
Rhode Island	X	X	X[4]	X						X				
Wisconsin	X	X		X	X					X				

1 Road Operations 2 Planning and Development 3 Office of Transportation Operations

4 Maintenance Separate Department

social development of the state; with providing planning services to the Governor, the General Assembly, and the operating agencies of the state government; and with coordinating the actions of state, local, and federal agencies and private individuals within the framework of the state's development goals. The Rhode Island DOT is responsible for the preparation of short-range plans and project plans, and for implementation of transportation programs and functions. Thus, in Rhode Island the organizational problems of coordination, quite aside from methodological issues, are largely averted. This is an unusual situation, however, because in most of the states contacted, the long-range transportation planning responsibility was located within the DOT or other highway agency.

Most other states have *ad hoc* arrangements for dealing with this kind of coordination. Wisconsin has no formal relationship with other functional planning agencies at the state level. New York State utilized an interagency task force in the formulation of their goal statement. The development of the long-range highway plan for the State of Wyoming will receive guidance from a steering committee with representation from the State Highway Department, the Natural Resources Board, the Recreation Commission, the University of Wyoming, the County Commissioners' Association, the Association of Municipalities, the Federal Highway Administration, and the U.S. Department of Housing and Urban Development (Fig. 2). Most states do not as yet have statewide economic and land-use development plans sufficiently developed or sufficiently detailed to serve as a basis for coordinating transportation plans. This means that, even with extensive efforts at coordination, the actual coordination emerges only at the detailed design and implementation stage, rather than at the planning stage.

Another area of coordination concerns the subdivision of states into development or planning regions. For example, the Minnesota Regionalization Act of 1969 permits counties to form Regional Commissions. The 1962 Highway Act, requiring establishment of a continuing cooperative comprehensive transportation planning process as a condition for further federal aid for regions with central city population of 50,000 or more, established in effect urban transportation planning programs with planning responsibilities. The several federal activities (transit demonstration grants, model cities programs, Regional Commissions, public hearing requirements for corridor and design projects, the National Environmental Policy Act of 1969, etc.) have resulted in a tremendous variety of regional and local programs.

These developments affect both the definition of statewide transportation planning and the requirements for coordination, because if the entire area of a state were contained in individual regions with more or less autonomous planning powers state planning would be largely the coordination of plans of these regions. It is obvious that if each of these regions, composed of subregions of counties, towns, and cities with their own planning programs, saw their role simply as coordination, planning eventually would be defined as the process of coordinating individual developers and business firms. Planning direction and general guidance should be provided by state planning agencies. Quite aside from the question of defining what issues and responsibilities are national, state, regional, and local, it is clear that the business of coordination is a major issue at the state level.

CITIZEN PARTICIPATION

The majority of the states queried believed that citizen participation in the planning process not only was useful, but that it also was vital to plan implementation. Citizen participation at the project scale has become typical, and the procedures for public hearings and location approval as described in PPM 20-8 ensure the citizen a chance to comment at the corridor or design stage. Citizen participation in the long-range planning phase at the statewide level would appear to be more difficult. What is expected of the citizens? to approve the plan; to act as a sounding board; to generate alternatives; to help formulate goals; to reconcile disputes; to educate the community? When in the planning process should citizens be involved? How will the citizens' efforts be serviced in terms of meeting room and work space, secretarial help, education, and technical support. How are the citizens selected and organized? How are their efforts to be funded? Should a citizens' group be organized for each region in a state rather than as a single statewide citizens' group?

New York State has taken an interesting approach. In each of the ten regions of the state (excluding the metropolitan New York City area, which used different procedures) public meetings were held. These meetings were co-sponsored by the New York State DOT and the Regional Planning Board, and were held in the region. Prior to the meeting DOT mailed out information on the meeting and asked for responses to questions dealing with facility priorities, changes in regulations, transportation services that were needed, directions and form of regional growth and development, and so on. These were directed to public agencies in the region, Chambers of Commerce, freight carriers, manufacturers, and others. Written responses in advance of the meeting were encouraged. When the meeting was held, it was fairly unstructured, but covered issues raised before the meeting and developed some additional issues. The meetings were taped and a report, cross referenced by speaker and issue, was prepared. New York expects to publish and circulate these reports for each district and then to hold public hearings. Then, and only then, will statewide plans be finalized.

ORGANIZATION STRUCTURE

WYOMING STATEWIDE TRANSPORTATION PLANNING PROCESS

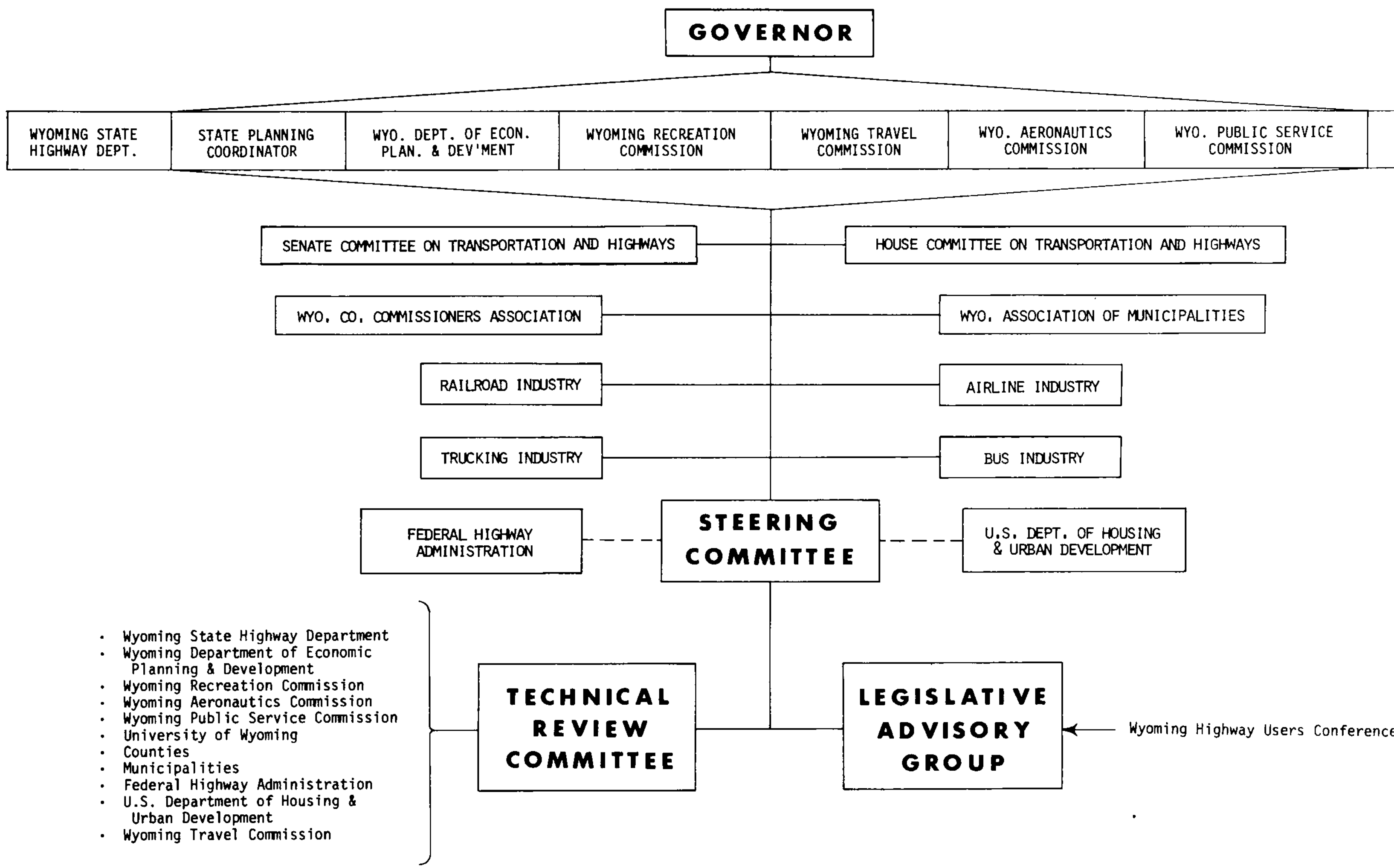

Figure 2. State organizational structure for transportation planning (Wyoming).

CHAPTER FOUR

DATA REQUIREMENTS AND MANAGEMENT

BASE YEAR

Preparation of a long-range plan typically relies on information developed for a base year and then used in the preparation of estimates of future demand for travel. There are basically three dimensions involved in transportation:

- Actual movements of people, vehicles, and goods.
- Transportation facilities.
- The spatial arrangement of human activities and natural resources.

It is for the movement of people and goods that the transport facilities are built and maintained, and it is the spatial separation of interacting activities that makes travel necessary. Essentially, the base year data consist of the information required to describe and understand the three dimensions of travel for each travel mode.

Person and Goods Movement

Highways

The transportation planner has had extensive experience in obtaining data on person movements using roadside interview and home interview survey techniques. The major issues here for statewide transportation planning are concerned with the following problems:

1. Home interview surveys can be expensive, ranging between $20 and $30 per processed interview for the typical urban home interview. However, there are several alternative forms that can be considered. The telephone home interview can significantly reduce the cost per completed interview and has been used by Connecticut, Rhode Island, Delaware, the City of Spokane, and others. Mail-back questionnaires and telephone surveys may also be considered, although the possibility of bias and nonresponse must be weighed against the potential economy of the technique. Cluster sampling techniques can produce lower costs per completed interview.
2. Home interview surveys appear typically to significantly understate long-distance trips that are basic to the understanding and simulation of interurban, intrastate, and interstate travel. This may be partially overcome by extending the survey period for this category of trip.
3. The cordon roadside interview typically obtains only limited data on the characteristics of the traveler. Moreover, as the spacing of cordon lines increases, the proportion of trips that are not included in the survey by virtue of their origin and destination being in the same zone (cordoned area) increases. As the cordon line spacing decreases, the trips that are counted twice, and thereby require special factoring, increase, as do total data collection costs.
4. Weekend and recreation travel is expected by many states to play a greater role in determining future statewide highway needs. This is a two-headed problem, because in most cases the home interview surveys conducted in the past in the major urban areas (a population of 50,000 or larger) obtained weekday travel data only, and long-haul travel data with only partial success.
5. Collection of goods movement data in most of the urban studies has been via commercial vehicle survey (truck survey). Although these surveys provide some information on the kinds of commodities being transported, such data do not yield commodity flows easily, if at all.
6. Use of a sample of waybills as a source of commodity flow data is a procedure that is being adopted or considered by several states.
7. Urban transit passenger movements are generally available from the urban study home interview surveys, reinforced by on-board surveys. Intercity bus passenger data are not generally available. The questionnaire handed out at the bus terminal is a possible technique, although response bias is a problem. An on-board survey may give better data, but requires the permission of the carriers and, even more important, the cooperation of operating personnel. Income and age groupings may provide some indication of the need for specific facilities.

Air

Person travel by commercial air carrier is not adequately covered by the urban home interview surveys. An on-board survey or terminal survey appears to provide the most accurate and complete data on the origin and destination and socioeconomic characteristics of commercial air passengers. On short flights, where on-board fare collection or beverage service preempts a substantial portion of the flight time, the on-board survey will necessarily be given secondary priority, or even be dropped completely. The on-board handout-pick-up questionnaire type of survey has become relatively common. Introduced initially as an aid to airport location planning, it appears to be a fairly inexpensive way to create a statewide file of commercial air passenger movements and characteristics (Fig. 3).

In addition, it will probably be necessary to design and conduct surveys of general aviation and nonscheduled air carriers to obtain passenger travel data by these modes.

To obtain data on the movement of goods by air will require the analysis of a sample of waybills as in the case of trucking or rail goods movement.

Rail

Rail passenger movement data can be obtained from surveys conducted at the terminal.

Rail freight data can be obtained by using a sample of

ABOUT YOUR FLIGHT TODAY

1. On which airline are you about to travel?

(1) ☐ Allegheny (8) ☐ Piedmont
(2) ☐ American (9) ☐ Southern
(3) ☐ Braniff (10) ☐ Texas Intl.
(4) ☐ Continental (11) ☐ United
(5) ☐ Delta (12) ☐ Semo Aviation
(6) ☐ Eastern (13) ☐ Volunteer
(7) ☐ Frontier

2. Flight Number? ________

3. Today is?

(1) ☐ Monday (5) ☐ Friday
(2) ☐ Tuesday (6) ☐ Saturday
(3) ☐ Wednesday (,) ☐ Sunday
(4) ☐ Thursday

FOR PASSENGERS NOT STARTING THEIR AIR TRAVEL AT THIS AIRPORT TODAY

If you arrived earlier on this flight and will continue on the same flight no further information will be required from you. Please deposit this form in one of the boxes provided.

If you are connecting with this flight from another flight earlier today, please answer the questions in this section.

4. I am transferring to this flight at this airport from a connecting flight of:

(1) ☐ This Airline (2) ☐ Another Airline________ Specify

5. Did you leave the airport between flights?

(1) ☐ YES (2) ☐ NO

If your answer to question 5 is YES, please complete all of the remaining questions.

If your answer to question 5 is NO, no further information is required and you may deposit this form in one of the boxes provided.

6. What is the PRIMARY purpose of the trip you are taking today?

(1) ☐ Business
(2) ☐ Brief Pleasure (less than one week)
(3) ☐ Vacation (more than one week)
(4) ☐ Military orders or leave
(5) ☐ Personal Matters
(6) ☐ Other________________ Please Specify

7. What is the duration of this trip?

(1) ☐ 1 day (5) ☐ 5 days
(2) ☐ 2 days (6) ☐ 6 days
(3) ☐ 3 days (7) ☐ 7 days
(4) ☐ 4 days (8) ☐ More than 7 days

8. At what city will you end your air travel today? ________

ABOUT YOUR TRIP TO THIS AIRPORT

9. From what location did you leave for the airport?

____
No. Street Address or Building Name

____
City County Zip Code

10. This location was:

(1) ☐ Private residence (4) ☐ Business you are visiting
(2) ☐ Hotel/Motel (5) ☐ Other ________ Please Specify
(3) ☐ Your Place of employment

11. What time did you leave for the airport?

________ (1) ☐ A.M. (2) ☐ P.M.

12. What time did you arrive at the airport?

________ (1) ☐ A.M. (2) ☐ P.M.

13. What was your PRIMARY means of travel to the airport?

(1) ☐ Private Car (5) ☐ Taxicab
(2) ☐ Rent–A–Car (6) ☐ Private Plane
(3) ☐ Airport Limousine (7) ☐ Air Taxi
(4) ☐ Bus (8) ☐ Hotel/Motel Courtesy Car
(9) ☐ Other ________

14. If you drove your own car and parked it at the airport, about how long do you expect it will be parked there?

(1) ☐ 0–4 hours (3) ☐ 10–24 hours
(2) ☐ 4–9 hours (4) ☐ Over 24 hours

15. How many persons accompanied you into the terminal today? ___

16. How many people who accompanied you will depart with you on this flight? ______

17. Are you a resident of this area?

(1) ☐ YES (2) ☐ NO

Figure 3. Airport system plan O-D survey.

waybills and developing a file of commodity flows within and between particular areas of the state.

Waterborne Freight and Pipelines

Data on the movement of goods via waterborne freight and pipelines are necessary. A waybill sample of shipments to obtain amounts, commodity type, origin and destination, and cost or rate per unit distance is needed. Data on pipeline flows may be obtained from the administrative records of the public utility commission or other appropriate agency.

Survey of Shippers

In addition to sampling the records of actual shipments to obtain the origin, destination, quantity, commodity type, and rate per ton-mile, New York has proposed to conduct a survey of major shippers. The purpose of this survey is first to "ascertain the transport needs and concerns as well as gross commodity type and volume." It would also be useful to determine the reasons for shippers' preferences with regard to mode, route, schedule, and terminal. More detailed data on goods movement might be obtained in a follow-up survey conducted with a sample of shippers.

Flows

The discussion under the foregoing sections on "Highways," "Air," "Rail," and "Waterborne Freight and Pipelines" was concerned with base year data needs in terms of movement origin and destination. In the case of the highway mode, the planner attempts to replicate flows of traffic on links of the highway network by assigning vehicle origin-and-destination data to the network. The result is in fact a simulation of traffic network volumes. To check the assignment results there needs to be a survey of the actual traffic on the network. Such data are usually available from the continuous-count programs maintained by many states, although the data may require augmenting with additional traffic counts.

These observed traffic volumes provide, at the least, a basis for calibration of traffic assignment procedures, and may in fact verify the accuracy of the assignment process. Similar data may be desirable for other modes, but certainly to a lesser degree, inasmuch as the number of alternate routes is far smaller and the opportunity to change routes is far less than for highway travel.

Transport Facilities

Highways

An inventory of highway facilities is obviously necessary as a basis for planning and as input to the simulation process. Considerable experience has been gained in the symbolic representation of highways as a collection of links, each with an associated travel speed, capacity, number of lanes, geometric design, facility class, intersection control, etc. In the assignment process vehicles are dealt with separately, as are parking terminals. In general (in contrast with other modes), transfers between links are accomplished with a nominal loss of time and, with the exception of toll facilities, at no significant cost.

In the case of bus passenger travel, the transport system consists of a collection of routes or lines available at only certain times of the day but using the highway network. Here it is necessary to obtain data on each route, the time of day during which the route operates, the average speed, the fare, transfer possibilities and charges, the transit vehicle characteristics, and terminal locations and parking arrangements.

When one looks at highways from the viewpoint of freight movement, information on freight rate charges, truck registration fees, vehicle capital costs, operating costs, regulation, and operating agreements are some of the additional kinds of information necessary to an understanding of trucking in relationship to the highway network and alternate modes.

Selection of facilities to be included in the inventory will depend in part on the traffic assignment methodology being employed. The major arterials and collectors obviously would be included, whereas some or all local streets might be excluded. If a hierarchical system of zones and networks is used, the network inventory could err on the side of being overly inclusive, because the minor facilities would then be used only in those cases where a "blowup" of the process was required for design and other purposes.

Air Facilities

A survey of commercial air facilities requires an inventory of the interairport connections available; the times at which the connections are available (times of departure and arrival); the fares; ground transportation facilities; the companies operating these flights; and the number, type, seating capacity, capital costs, and operating costs of the equipment being used.

In addition to the data on the air network, the survey should include data on airport location and size, control equipment, number of runways, length of runways, employment at the airport, and parking facilities.

General aviation studies would require data on the number of general aviation aircraft based at, leaving, and arriving at each airport by time of day, and data on the origin, destination, and purpose of such travel.

The air freight aspect of air facilities requires knowledge of freight rates, freight carriers, commodity restrictions, air/ground facility connections, interairport connections, and associated times.

Finally, the capital costs and operating costs of airports, together with existing revenue sources, would need to be obtained.

Rail Facilities

An inventory of rail passenger service will be required. Included in these data would be points served, departure and arrival times, fares, terminal facilities, and capital and operating costs of equipment used. With the bulk of all intercity rail passenger service being provided by Amtrak, most of these data should be readily available.

From the viewpoint of rail freight movement, an inventory of trackage (by railroad), frequency of use, and alternative modes are needed. Points served by each line would be required. The freight rates by commodity class between origin and destination pairs would be required, together with data on regulations and interline operating agreements. The capital and operating costs of equipment would also be needed. Finally, the adjacent land associated with each segment of track may be obtained as a measure of potential developmental impact if service were increased or curtailed.

Waterways and Pipelines

Data needed on these facilities include points connected; commodities that can be carried; rates by carrier by commodity class and distance; capital costs, operating costs, and capacity of equipment, including ports and cargo handling facilities; rail and highway access; and relevant state and interstate regulations.

Spatial Arrangement of Resources and Human Activities

The chief purpose of transportation is to reduce the friction of movement associated with the interaction of resources and human activities. The utilization of land-use data in developing a process for simulation of person travel in urban regions is well known. Intuitively, one would expect the same procedure to be appropriate to the simulation of intrastate and interstate movements of persons and goods. The questions of level of detail required in terms of kind of land use and geographic precision (zone size) are crucial but are not, however, so easily answered. Connecticut has made land-use inventories since the early 1960's. Many states have adopted the minor civil subdivision as a basic geographic unit. New York has a statewide land-use inventory coded to this system with measurement of agricultural, recreational, forest, urban residential, and urban nonresidential land use for each unit. Where townships are used as zones, the emphasis is on general system planning and corridor location, whereas systems with smaller zones (Connecticut has 1,700 traffic zones) are used where the emphasis is on design. It appears that the required area scale and detail of land use and characteristics of population, income, car ownership, etc., must wait on the specification of the processes to be used in the simulation of intrastate persons and goods movement.

Certain directions, however, seem apparent at this time. Transportation facilities can have a direct impact on land use adjacent to the facility and, in the case of proposed facilities, on the land directly in the path of the right-of-way. Special surveys can be conducted to obtain the affected land uses. However, if a complete survey of land use is maintained at a fairly fine level of detail, it would be possible to assess land-use impact from a knowledge of the route location. Or, if special concerns (such as historic buildings, recreation areas, soil types) are mapped and coded to a grid, paths or routes that connect two points but avoid or minimize impacts on particular uses can be selected by computer. Such a technique has been used by Lewis in Wisconsin. The increasing concern with environmental impacts of transportation underscores the need for an inventory of valuable environmental resources.

Another aspect concerns the control of development along highways and at interchanges. Use of land development controls and regulations and zoning as a method of achieving balance between travel demand and facility capacity is gaining increasing recognition. An inventory of existing development controls should be mandatory.

Most important, however, is the impact that improved or changed access has on land development. Here, however, the knowledge of the relationship between access and type of development is not sufficiently precise to permit specification of the inventories appropriate to deal with this problem much beyond specification of broad categories and as vacant, residential, recreational, industrial, agricultural, and commercial.

SECONDARY DATA

There is a wealth of data, collected for purposes other than planning, that should be evaluated in terms of its usefulness to statewide planning before primary data collection programs are undertaken.

1970 Census: Journey-to-Work Data

During the 1970 Census a sample of work journeys was collected. Rhode Island has definite plans to use these data in its statewide transportation planning program. These data should be useful as an indicator of total person movements at the urban and metropolitan scale and, for a relatively small state such as Rhode Island, also at the state level. The utility of these work trips as a proxy for intrastate movements in larger states is open to question because the geographic coding of the destinations of this travel is quite coarse outside metropolitan areas, in contrast to block coding within metropolitan areas.

Waybills

For goods movement inventories the waybills of the different carriers constitute a vast and (at the state level) largely untapped source of data. Designing the sample and obtaining the data from the carriers are major hurdles that must be overcome before these sources can be utilized.

CAB Air Passenger Data

The Civil Aeronautics Board publishes data on passenger interchanges between airports based on a 10 percent sample of ticket sales. Although these data do not give ground connection information or actual city of trip origin or destination, they do represent an excellent basic source of information on commercial air passenger travel.

Other Administrative Records

The bulk of the data describing transport networks, routes, lines, service, traffic control devices, regulations, and tariffs can be obtained from administrative records maintained by operating and regulatory agencies. In addition, some movement data, such as gross freight movements through ports and pipelines, may be obtained from actual operating records.

MONITORING VS BASE YEAR DATA REQUIREMENTS

With the exception of continuous traffic counts on state highways, little in the way of monitoring appears to have been undertaken, and limited data exist on the number of air, rail, and bus passengers. In general, the comment of planners was that the data needed for monitoring constitute the minimum data sample required to estimate current system performance and to verify or calibrate the simulation models used in forecasting the future utilization of transportation systems.

From the previous brief discussion of types of data needed, techniques of collecting data, and the variety of secondary data that may be available, the need for a carefully designed data collection program becomes obvious. Without attempting to prescribe the collection paradigm, the following operations appear to be mandatory:

1. All existing data sources should be carefully reviewed and cataloged in terms of source, availability, format, relevance, and reliability.

2. A data collection design should be undertaken to acquire data needed to fill the gaps in existing data. This design would need to consider the planning program of the state itself and presumably would vary from state to state, depending on the particular characteristics and needs of a given state. Questions of cost-effective sample design and

collection methodologies would be considered here. The extent to which available data would be integrated with synthesized data for areas not covered by previous surveys should be carefully weighed. California, for example, expects to combine and use actual surveys of origins and destinations with synthesized data.

3. The design should give consideration to the problems of updating the data base. Use of a panel of households as a basis for measuring trends in significant travel and travel consumption parameters might be explored. The modification of form and/or content of periodic reports by other agencies (tax assessors, the sample of airport-to-airport travel, etc.) to provide updated data should also receive careful attention.

SPECIAL CODING PROBLEMS

In general, the states do not appear to have found any special coding problems in attempting to conduct statewide transportation planning. This may reflect the fact that most of the work has been centered on highways and airports, and that the difficulties of treating freight data have simply not yet emerged.

With regard to zone size, counties are generally considered to be too coarse, but anything finer than minor civil division is considered to be too detailed. It is suggested that a hierarchical zone system could be devised that would permit a variety of levels of aggregation of data depending on the use or purpose of the analysis. Such an approach has already been followed. The Texas Transportation Institute, under contract with the Federal Highway Administration, prepared a program that permits the combination of state networks into a national network in one of four levels. The Michigan Department of State Highways has developed a program that allows specification of the level of detail by area of the state.

INFORMATION SYSTEMS

The foregoing discussion suggests that a consolidation and integration of the base data for statewide planning would result in an information system suitable not only for subsequent use in analysis and simulation, but also in preparing annual reports describing transportation system use (*Wisconsin Transportation Facts,* for example), and for filling special requests for transport data from other state agencies, the Federal Government, and others. Both New York and Wisconsin have shown some interest in moving in this direction.

Development of a formal information system is a major undertaking and should not be treated casually. The definition of planning listed plan preparation, monitoring, evaluation of regulatory impacts, service, and coordination as the major functional responsibilities of statewide transportation planning. The procedures necessary to fulfill these responsibilities include data collection, data management, analysis, and research. An information system should be designed to interconnect these functions and procedures. In short, the information system should be designed around the statewide transportation planning process.

In the development of an information system some of the major factors to be considered include:

1. The kinds of data available and to be collected in order to accomplish the functions of statewide transportation planning. Particular emphasis should be given to the review of possible consolidation of ongoing programs such as the inventory of physical condition and geometrics of the network and ongoing traffic counting programs.
2. Maximization of file interchangeability through use of a common geographic coding system.
3. Design for and integration of file updating procedures with data collection programs for updating and monitoring.
4. Retrieval capability designed not only in terms of rapid access to files but also in specific form or format, such

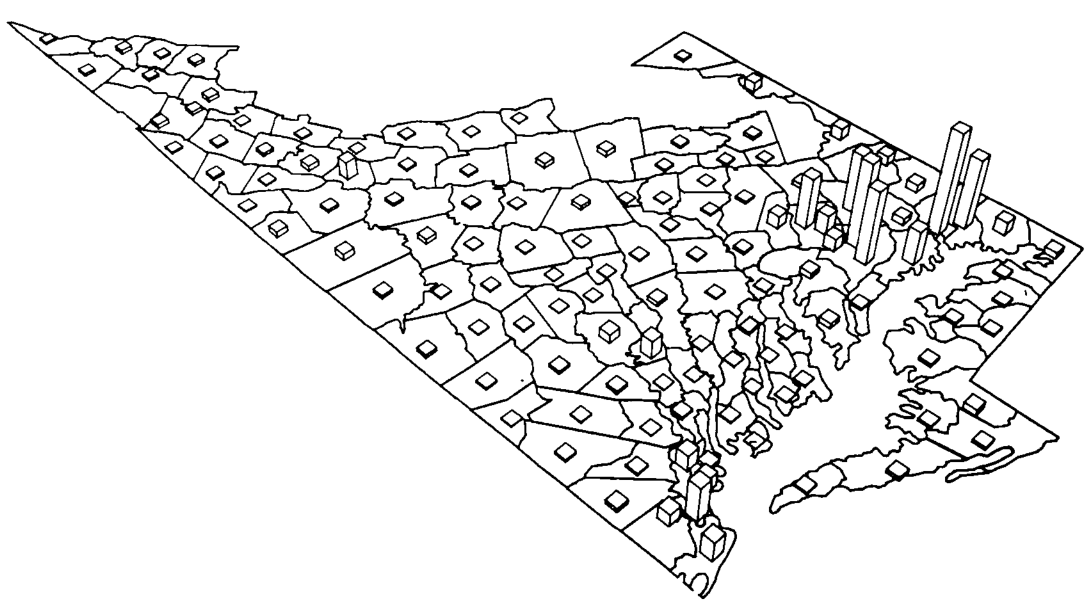

Figure 4. Population distribution chart for Maryland and Virginia.

as input to models being used, standardized tabulation and statistical routines, and available display programs (Fig. 4).

5. The capability to store, manipulate, integrate, and report information from primary data sources, secondary data sources, and synthesized data from models.

Information obtained in the urban transportation programs should be utilized whether or not a formal information system is instituted. All of the states contacted indicated that they were using these data or were planning to use them.

CHAPTER FIVE

ANALYSIS (METHODOLOGY AND SIMULATION MODELS)

One measure of the transportation planner's capability is his ability to anticipate the consequences of the implementation of a particular action such as, for example, the building of a new expressway. Because everything tends to be related to everything else in some fashion, it seems clear that the planner cannot hope to anticipate all of the effects that will flow out of his plan. Nevertheless, the tendency is to judge harshly the designers of facilities that, when implemented, receive little or no use, or, at the other extreme, are overloaded from the day they are opened for use.

Out of this concern to avoid monumental errors, the transportation planners, working mainly in the urban area studies during the 1950's and 1960's, developed a series of methodologies that were designed initially to give estimates of the traffic on a transportation facility, and eventually to estimate the distribution of traffic over an entire transportation system (Fig. 5). In studying this development, one can trace a growing concern with the interrelatedness of travel, the spatial arrangement of human activities, and the channels of communication available.

USE OF THE TRIP

The origin-destination study provided the planner with an inventory of present travel in terms of trips in a corridor or an entire region. This travel inventory consisted of trips that originated at one point in the region and were destined to another point. If a new route were introduced into the region, one could measure, for each of the inventoried trips, the times and distances associated with the use of various combinations of the existing network and the new facility. By developing a routing algorithm (diversion curves or least time or cost paths) the planner could assign the inventory of present trips to the modified network and obtain the travel that might be expected if the facility were built overnight, if O-D patterns remained constant, and if trip makers actually behaved according to the algorithm used.

THE TRIP INTERCHANGE MODEL

The need to test transportation alternatives under changed conditions, such as urban redevelopment and new near-term land development, as well as under future conditions, resulted in development of the trip interchange simulation model. The two best known models are the gravity and the opportunity models, which were preceded by the growth factor model, of which the Fratar was the best known and most used. In the growth factor models, an inventory of the trips between two zones is assumed as a given factor. The expected trips between those two zones, given increases or decreases in zonal activity, would be the number of trips occurring before any zone changes, factored by the average of the change in each zone expressed as a growth factor; that is, changed (future) development/present development. Because simple averaging of different growth factors would necessarily give interchanges inconsistent with the growth factors, some way of smoothing out or eliminating these inconsistencies was needed. The Fratar model accomplished this effectively. Its most notable shortcoming is its assumption that the existing patterns of trip interchanges are a representative basis by which to estimate trip interchanges under changed conditions of development. A largely rural zone that comes into urban use is one example of this problem. The problem of zero interchanges (quite common when sampling trips) is an extreme example of a major problem in the growth factor technique.

The interactance or trip interchange models assumed that trip ends exist—people starting out to work, people returning from shopping, and so on. These trip ends are connected to create trips. In the gravity model, the number of trips is assumed to be directly related to the product of the trip ends in each zone (attractions and productions) and inversely related to their temporal separation (usually a negative exponential). In the opportunity model, the number of trips between two zones is assumed to be the sum of the trips in both directions, each of which in turn is a function of the number of trips originating from the sending zone, the number of trip opportunities that are

Figure 5. Collection of information for O-D studies.

closer in time than the zone in question, the number of trip opportunities in the zone in question, and the probability that a trip destination will be acceptable as a match for a trip origin (a constant for a given class of trip).

In both of these models, the sensitivity of calculated trip interchanges to characteristics of the network suggested that even without any proposed change or growth in activities, introduction of a change into the transportation system would result in a change in the trip interchanges. In the growth factor approach, which does not consider network characteristics, this effect is lost.

TRIP GENERATION

An inventory of trips automatically provides an inventory of trip ends. However, the simulation of travel over facilities, under changed network and land development conditions, presumes the ability to estimate trip ends for any given spatial arrangement of human activity.

A variety of techniques (trip generation procedures) has evolved to estimate trip ends (attractions and productions) by zone. Most commonly, these consist of equations, developed through regression analysis, that estimate the number of trip ends of a particular class, based on the amount of activity of a given class in the zone. Work trip ends can be obtained from employment data; shopping trip ends from the retail floor area in the zone; shopping trips (from homes) from the income and car ownership and other demographic characteristics of the resident zone; and so on. Of course, for future conditions, either these zone characteristics must be estimated, or they may be derived from a land-use plan. Forecasting the future pattern of land development is discussed in Chapter Six.

As an alternative to the preceding method of trip generation, which is based on trip production by zone determined from zonal characteristics, and in which over-all trip production is the sum for the individual zones, an allocation approach can be used. In the allocation method, an over-all estimate of trips is prepared, based on resident location and forecast demographic characteristics. This total is then allocated to zones according to their characteristics.

It should be noted that the impact of the accessibility provided by the transportation network is rarely considered directly in estimating the trip production, but may be considered indirectly in the impact on the location of activities (because different locations have different trip production characteristics). Failure to deal with this question of impact of accessibility on travel consumption (induced traffic) has often been rated as a major shortcoming of the urban transportation planning process.

MODAL SPLIT

Attention to the question of modal split in the urban area transportation studies began at about the time that computer network simulation became available (late 1950's). This area received substantial attention in the transportation studies conducted by larger cities, and also from special-purpose public transportation planning studies. At first, two schools of thought competed—the "trip-end captive" school, which held that public transit use could largely be determined by the socioeconomic characteristics of the trip maker, versus the "service" school, which held that the key to understanding transit use (and increasing the use) lay in the comparison of the service provided by public transit with that of its competitor, the automobile.

These contending forces have now generally been unified and the approach most often recommended for simulating transit use involves the characteristics of the trip maker, the purpose for which the trip is being made, and the service level alternatives available at the time the trip is being made. Moreover, in some simulation models the total number of trips between any pair of zones depends on the combined services provided by transit and highways. Although the relative service levels of the two networks are often used in calculating the trip interchange, as well as the modal split for a given O-D pair, the assignment of trips is usually done separately. This leaves some need for adjustment of service levels in response to traffic loadings, which in turn calls for a new run of the modal split model. Total trip making is usually held constant; in other words, the sensitivity of total travel to service level is not typically considered.

PUTTING THEM ALL TOGETHER

A different type of approach is taken by Schneider in his access and land development model. Given the transportation system, a description of the sites for development, and the total development (or the ratio of accessibility to development), the model derives the amount of development expected at each zone, the travel between zones, and the modal split of that travel, in such a way that both development and accessibility are brought into equilibrium. The equilibrium solution, however, is derived from networks not subject to capacity restraints, so that the initial specification of service determines the final solution. The specified service levels, however, may not be feasible, given the resulting loads.

The authors of the report on the *Methodological Framework for Comprehensive Transportation Planning* also make a plea for putting together as many as possible of these separate models. For theoretical as well as practical reasons, they recommend putting trip generation, trip distribution, and modal split into a single model.

Before the suitability of the preceding simulation models at a statewide level is examined it might be well to assess the utility of these models at the urban scale.

In general, the simulation models developed and used in the urban studies not only were necessary, but they also were indispensable to the development and testing of *system plans.* However, when one turns to the question of implementing a specific element of the plan, and attempts to use the simulation methods to develop design volumes, environmental impacts, programming priorities, etc., the methods are generally inadequate. Some efforts to remedy their shortcomings have centered on the use of smaller zones, more detailed network descriptions, and use of small time intervals, especially during the peak hours. Thus, a question that clearly needs to be answered by persons desiring to use simulation at the statewide level, is that of scale or level of detail.

PRESENT PRACTICE WITH REGARD TO SIMULATION AT THE STATEWIDE LEVEL

Of the ten states contacted, eight had completed statewide simulations of vehicular traffic over a network, and the other two were in the preparatory stages of making traffic assignments. Clearly, these states had already committed themselves to a minimum level of traffic simulation.

Table 6 summarizes the activity of the ten states surveyed with respect to simulation. Major differences among the states are shown under the column "Base Year Trip Table." Several of the states used a screen-line method rather than a personal visit or telephone-type home interview survey for obtaining trip data. In this technique the traffic crossing a screen line is sampled by use of the roadside interview technique (other techniques are possible, such as recording license plate numbers at the screen lines and then mailing questionnaires to the owners). Although the main virtue of the screen line method is its economy, it does have serious limitations. First, because of the short time in which roadside interviews must be conducted, few socioeconomic-demographic data can be obtained. This information is essential in determining the characteristics of each zone from which to generate trip origins and destinations (productions and attractions). Second, unless the screen lines are closely spaced, a significant number of trips, representing a substantial volume of travel, may never cross a screen line and therefore may never appear in the trip table. Because of the omission of this intragrid travel, the accuracy of the simulation of network travel becomes a function of a link's proximity to the screen line; that is, links located near a screen line tend to have more accurate assigned volumes than do links located in the middle of an area formed by screen lines.

However, as the screen line spacing is decreased, the number of trips crossing two or more screen lines increases significantly, requiring adjustment of the raising factors (1/Sample Rate), but, more significantly, resulting in some

TABLE 6

STATEWIDE TRANSPORTATION SIMULATION MODELS

State	Simulate Trips Over Statewide Network	Base Year Trip Table	Future Trip Table		Assignment to Statewide Network			
			Trip End Generation	Trip Distribution	Spider	Free	Capacitated	Multi-Modal
Rhode Island	Yes	O & D	Regression Equations	Gravity		X		No
California	No	O & D and Synthesis	Regression	Gravity		X		No
New York	No	Combined O&D & Synthesis	Regression (Pop.&Emp.)	Gravity or Opportunity			X	No
Pennsylvania	Yes	Screen Line & Synthesis	Growth Factors	Fratar		X		No
Iowa	Yes	Screen Line	Population	Fratar		X		No
Wisconsin	Yes	Screen Line & Synthesis	Growth Factors	Fratar		X		No
Minnesota	Yes	Screen Line	Regression on Pop.	Fratar	X	X		No
Connecticut	Yes	1% O & D	Regression	Gravity				
New Jersey								
Florida								No
Washington	No	---	---	---	--	--	--	No
Wyoming	No	?	?	Fratar	?	?	?	No

loss in economy because the same trip may be interviewed several times with no increase in precision.

Although the base year trip table obtained in the screen-line approach has its shortcomings, home interview O-D study could be very expensive at the statewide scale. Attempts to synthesize rural and small area urban travel and combine it with the inventoried travel obtained in the urban studies have not been completely successful to date, although California, New York, and Pennsylvania are using or plan to use such an approach.

Another major difference in the simulation efforts lies in the reliance by several states on a growth factor technique to generate future trip ends and the use of the Fratar technique for estimating future trip interchanges (that is, for extrapolating the base year trip interchange base). Reliance on growth factor techniques to simulate trip interchanges can be a serious shortcoming when there is substantial growth in land development and/or major changes in the transportation system.

Still another difference lies in the basic assignment technique itself. For instance, the use by some states of very large zones and a spider network gives trip interchanges and traffic flows only along broad corridors. The utility of such traffic estimates for design purposes is questionable; indeed, the ability of the "spider" network technique to simulate traffic in fine enough detail for a corridor study, if such simulation were requested, is itself in serious doubt.

With respect to free versus capacity restrained assignment, the bulk of the states use free assignments; none has attempted multimodal assignments of passenger travel.

It is clear that so long as the volume of travel using a facility is relatively small compared to the capacity of the facility, the characterization of facility performance using a "free speed" is not inappropriate. However, many links in the state network would be expected to experience high volumes relative to their capacity and these links not only will be biased in themselves, but also will tend to bias the routing of trips over links not so heavily used.

In summary, although all of the states surveyed in this study made some use of the simulation techniques used in the urban studies, it appears that there are still methodological questions to be answered.

The assignment of traffic to a network, which all of the states either are doing or intend to do, is a commitment to the use of simulation. However, a major question must be asked about such a process if the results do not give an estimate of *all* the traffic that would occur on a specified link of given design and operating characteristics, but, rather, only of the relatively long trips. That is, if the trip table is incomplete, if the network is incomplete (e.g., a spider network), or if the assignment is a free assignment, the resulting assigned volume is a number that must be handled in an artful way. However, such assignment of long trips aids in functionally classifying routes or corridors where trip length is a major factor. It may be useful in deciding when a particular corridor is woefully undersupplied with network capacity, but it will be difficult to use in designing specific improvements (Table 7).

In short, the general direction that simulation has taken at the statewide level has resulted in larger zones, coarser transportation networks, and, presumably, less precision than in the case of the urban studies. There are real questions as to which direction statewide use of simulation of network flows should take in future work. The alternatives include (a) an attempt to improve present highway traffic assignment simulation procedures, (b) extension of the simulation process to other modes, and (c) an attempt to integrate the simulation models into a larger, more comprehensive frame. These alternatives are discussed in the following section.

IMPROVING THE HIGHWAY TRAFFIC ASSIGNMENT PROCESS

In any complex methodology one can always choose specific elements in the process and by improving each element improve the over-all process. Such an approach may be worthwhile. However, experience with urban traffic simulation models suggests that a major avenue of improvement will be the development of an assignment technique in which variable levels of detail are possible. This would call for greater network detail and smaller zone sizes than has been typical in many statewide traffic assignment procedures. However, both the zone structure and the network details would be capable of aggregation as demanded by computer limitations, but, in particular, in response to proximity to a facility or area that is of special interest or concern. The direct traffic assignment developed for the Tri-State Transportation Study is one example of how one might approach this problem. In this technique the more removed a place is from the link of interest, the less network and zone structuring detail is required. Problems with this technique, however, are its inability to deal explicitly with capacity, and its inability to provide systemwide measures without going through the process for each of the links in the system. Another approach might be to operate at a macro scale for state system considerations but retain network and zone detail sufficient to operate in a micro-type assignment mode when dealing with the evaluation and/or in the design of specific corridors or facilities.

For a dissenting opinion on this subject see *Methodological Framework for Comprehensive Planning*, in which the authors suggest that, for statewide purposes, a system of coarse zones coupled with a spider network is appropriate, and that only for regional studies should this finer grain be considered.

Continued research into trip-length frequency for different types of travel, or for different types of resident or activity location (rural versus small urban versus large urban) would seem to hold promise for improving the ability to simulate trip interchanges and thereby avoid the use of extrapolative techniques such as zonal growth factors and the Fratar technique.

TABLE 7

PERCENTAGE OF TOTAL VEHICLE-MILES OF TRAVEL ASSIGNED WHEN TRIPS OF A GIVEN LENGTH OR LESS ARE OMITTED

AV. TRIP LENGTH (MI)	PROPORTION ASSIGNED [a] (%), WHEN OMITTED TRIP LENGTH IS 5 MIN	6 MIN	10 MIN	20 MIN
5	74	66	41	9
6	80	74	50	16
10	91	88	74	41
20	97	96	91	74

[a] An approximation can be obtained if the trip length distribution is assumed to be negative exponential.

SIMULATION OF MODES OF TRAVEL OTHER THAN HIGHWAY

At the statewide level, little work has been done in simulating passenger flows for modes other than highway. A significant exception is the work done in the Northeast Corridor Project, in which a multimodal model was developed to derive expected passenger volumes simultaneously for each mode of travel available in the Corridor, including hypothetical modes of travel that do not as yet exist but whose service level characteristics can be described.

In the *Abstract Mode Model*, the simultaneity basic to trip generation, trip interchange, and modal split is presumed to be accounted for by dealing with all three elements simultaneously. This approach is recommended in the *Methodological Framework for Comprehensive Transportation Planning* report. These efforts to deal simultaneously with trip generation, trip distribution, and mode split are to be applauded, although there are serious reservations concerning the use of regression analysis as the basis for developing and calibrating such models.

In any case, it would seem that there are techniques available or which could be adapted relatively easily for simulating the modal split of passenger travel at the statewide and interstate level. Furthermore, it would seem appropriate for many states, if not all states, to develop the capability to use these techniques. These models would obviously have to incorporate factors such as frequency of service, fare, and intermodal transfer capabilities and costs in addition to the usual link characteristics of speed, length, and capacity. Given such a model calibrated to base year conditions, it would be possible for a state planning agency to examine the modal mix of intercity travel under varying assumptions of fare, main line speed, frequency of service, and other factors stemming from facility design as well as public and private decisions. In the absence of such simulation, decisions can be obtained only from time-consuming and potentially very expensive trial-and-error procedures.

SIMULATION OF GOODS MOVEMENT

Simulation of goods movement at the state level is virtually an unexplored area. There are many reasons for this state of affairs, but it is due largely to the fact that the major part of freight movements is made by private carriers, whose needs have not to date figured largely in the transportation planning process. Another factor is the multiplicity of agencies at both the federal and state levels that impinge on the operations of freight carriers in terms of the granting of routes or franchises, setting of rates, regulating safety, and so on. Hopefully, the existence of a federal DOT and the expanding creation of state DOT's will provide a better institutional framework within which to attempt to rationalize and coordinate public investments with private investments in the facilities that collectively represent goods movement systems.

Before one can attempt to simulate these systems, however, considerable spadework must be done. Defining what elements constitute the system for a given mode and obtaining data with regard to these elements and to the magnitude of present investments—public and private—for the different carrier modes is a necessary first step.

A major investigation is required in order for the planner to become familiar with the factors that go into choice of mode. In effect, the planner must become a transportation expert in evaluating the time, cost, and reliability of shipping by different modes.

At present, only in the State of New York does the DOT have state regulatory functions: in most other states these regulatory functions are housed in a public utilities commission. In addition, one must consider all the interstate regulations that are administered by the Federal Government. Simulation techniques that have been used successfully in studying vehicular traffic reveal serious shortcomings when attempts are made to apply them to goods movement simulation. For example, most of the simulation techniques for assigning automobiles to a highway network use a minimum time or cost path algorithm. Such a simple assumption for rail freight movements would probably not accurately simulate freight ton-miles.* Another factor with which one must deal is the various modal combinations that can be used in the movement of freight. Without an understanding of the factors involved in choosing between alternative modes and/or modal combinations, one could not reasonably expect to replicate existing freight movements, much less evaluate the impact that a change in rates, schedules, or service would have upon goods movements.

It seems that we are in the infancy of long-range goods movement system planning. It is a period during which planners must obtain data and develop analysis techniques before even attempting to simulate those systems. However, if the states or the Federal Government, working cooperatively with private enterprise, are to coordinate, invest, and encourage investments in transportation facilities and service for the movement of goods, a crude simulation capability must be developed.

If a policy of encouraging industrial and commercial development, new towns, and resultant employment opportunities is to be undertaken, the effect of all proposed transportation plans must be incorporated into the process.

How much lead time is necessary before a useful capability can be developed cannot be stated with any degree of certainty. Yet if a beginning is not made, it is certain that public and private investments will continue to be made without consideration of their impact not only on the total transportation system, but also on the over-all development pattern of the state itself.

CONCERN WITH GOODS MOVEMENT AT THE NATIONAL LEVEL

There has been considerable interest in and some significant work on goods movement undertaken by the United States Department of Transportation. The Office of Systems Analysis and Information of the U.S. Department of Transportation is engaged in development and application of a network simulation model of long-distance domestic passenger and freight movement in the United States.* The model parallels in structure the models developed and used by urban transportation planning agencies in the simulation and analysis of urban travel. The National Network Model is being developed in three major areas: synthesis of "trip tables" for both freight and passenger flows; computerized networks for the national systems of the primary intercity freight and passenger carriers; assorted statistical models used at various points in the simulation.

The model operates with approximately 530 analysis zones accounting for the full continental United States plus Alaska and Hawaii. Commodity trip tables utilizing a four-category classification have been developed for the full interzonal matrix for the following modes: rail, truck, waterway, petroleum pipeline, air. The data base year is 1967. Person trip tables have been developed for the same zonal system for 1967 for the following transportation modes: auto, bus, rail, air.

Computer networks have been developed for the transportation modes mentioned and they have been manipulated, using standard software, to produce least time and costs paths, as well as in assignments for both the freight and passenger movements.

Assorted models have been developed for the purposes

* In conversations with the FRA it was disclosed that use of a minimum distance algorithm tends to understate freight ton-miles, presumably because individual rail carriers attempt to maximize mileage on their own roads.

* See "Developing a National Network Model of Intercity Freight Movement in the United States," Carl N. Swerdloff, U.S. Dept. of Transportation, Presented at the PTRC International Symposium on Freight Traffic Models, May 4-7, 1971.

of synthesizing the base data files, as well as for developing cost relationships for transporting goods or persons on the individual modes, which in turn are used by the model in simulating route choice and/or mode selection. Modal choice relationships have also been developed for both freight and passenger movement. The models are multimodal in nature and operate on the relative times and costs of shipment between competing modes as the basis of mode selection.

Projections of both the freight and passenger trip tables through 1980 and 1990 are being developed and will be used in a series of simulation experiments, with the overall model focusing on future modal shares for long-distance freight and passenger transportation in the United States.

SOME WORDS OF CAUTION

Throughout this chapter the need to acquire the capability to anticipate the impact of proposed actions short of actually implementing the action has been stressed. This capability, or simulation, spans a wide range of cost, precision, and time. In this chapter, the incorporation of coded networks into the simulation process has been described. It should be pointed out that there are grave risks inherent in a complicated simulation process that relies on a string of computer models that, in turn, require massive data inputs. The urban transportation planning process has been accused of delaying important decisions because of its reliance on the time-consuming process of collecting detailed data, coding and processing the data, calibrating computer models, and then evaluating alternatives using the results of simulation.

Of course, the risks of barging ahead without a measured conception of the impact of a proposed action must also be considered. The transportation planner must be constantly weighing his methodology in terms of timeliness, cost, and precision. For a particular problem, it may be possible to dispense with an elaborately detailed network and deal instead with generalized access notions based on spacing concepts. The model developed by the FHWA in connection with the 1972 Needs Report is a prime example of macroscopic simulation.*

* Harold Kassoff and David S. Gendell, "An Approach to Multiregional Urban Transportation Policy Planning," *Hwy. Res. Record No. 348* (1971), pp. 76-93.

CHAPTER SIX

FORECASTING REQUIREMENTS AND PROCEDURES

The very magnitude of investment for providing new or improved transport systems, and the relatively long life of transportation facilities themselves, impose a requirement that the future demand for travel be included in the transportation planning process. Some of the difficult questions that arise out of this necessity are: Are estimates of future travel based on plans or forecasts? Who has the responsibility for preparing these estimates? What form shall these estimates take in terms of specific items such as population, employment, income, and location? Are present methods adequate to obtain such estimates?

PLANS VS FORECASTS

The choice of plans vs forecasts generated considerable debate during the conduct of the regional transportation studies. The pro-plan advocates argued that a forecast, often based on an extrapolation of trends, constituted an advocacy for sprawl and inefficient land development. The regional transportation planner often pointed to the lack of plans, the inability to quantify existing plans, or the uncertainty of the plans' status, and embraced the future forecast as the best available measure of future conditions.

The state of affairs appears to be little different at the state level except, perhaps, that enthusiasm for a comprehensive statewide development plan does not appear to be as widespread as it is in the case of the metropolitan or regional area. Although the problems of poverty and unemployment in various parts of the country have received the attention of such special bodies as the Appalachian Regional Commission, statewide comprehensive planning appears still to be in its infancy.

It should be pointed out that the difference between a plan and a forecast is often greatest when the techniques utilized pay little or only casual attention to behavioral characteristics and interrelationships of the systems for which a plan or a forecast is prepared. For example, an estimate of the future population of a region based on a linear or nonlinear extrapolation of past time series data ignores many of the vital factors involved, including fertility, mortality, migration, age composition, and land available for residential development. A plan that ignores these factors would also be exposed to the risk of being unimplementable. To the extent that planning and forecasting place increased reliance on simulation techniques incorporating the best available theory of land and economic development, consumption of travel, and spatial interaction, the distinction between the two will become less and less significant. This is because the planning activity will be, or should be, focused at those points where the outcome of unplanned growth falls short of the desired goal achievement, and will utilize its better understanding of metropolitan dynamics to institute realistic and implementable mechanisms to direct growth to a better over-all pattern of settlement and development. Thus, one should expect to see comprehensive planning agencies developing and utilizing techniques that will ensure more realistic plans, because the techniques will be based on fundamental structural relationships of human organization and growth.

WHO SHOULD/WILL BE RESPONSIBLE FOR PLANS (FORECASTS)?

The spatial arrangement of human activities, the interaction of these activities in terms of movements of people and goods, and the network of facilities, are simply special aspects or ways of viewing cities, regions, states, and nations. Therefore, one cannot expect to make changes in the transport facilities without influencing the spatial organization of activities. An agency cannot construct a bridge without causing an impact on the economy and development of land in the region adjacent to the bridge. Neither can a redevelopment agency or an Urban Development Corporation develop a large site with houses, shopping centers, office buildings and industrial parks without significantly affecting the demand for travel over the existing channels of transportation.

This has been recognized for some time in the metropolitan transportation studies, although the methodology employed in these studies has not, in the main, been able to adequately incorporate the interrelationships between land development, travel consumption and interaction, and transport facilities. How much this failure has been methodological and how much organizational is hard to ascertain. Certainly the fact that two-thirds of transportation planning organizations for metropolitan areas across the nation are either *ad hoc* or specialized transportation agencies with no formal organizational tie to the comprehensive planning agency has not helped the situation.* It is interesting that the U.S. DOT, in establishing Inter-Modal Coordination Committees in each of the ten regions of the United States, listed as a major goal the lodging of transportation planning in a single recipient (of federal grant) agency, responsible for comprehensive planning.

Whether such a policy is appropriate or even feasible at a state level is beyond the scope of this report. It does seem certain, however, that transportation planning cannot move more quickly than comprehensive planning at the state level without assuming (some may say usurping) the planning functions appropriate to other agencies in the areas of housing, recreation, education, economic development, to name but a few.

* Based on an unpublished tabulation furnished by the Urban Planning Division, Federal Highway Administration, United States Department of Transportation.

POPULATION FORECASTS

One of the clear needs for preparing transportation plans is an estimate of the amount and location of the future population within a state. Techniques vary, of course, but a fairly well-accepted technique utilizes the "cohort survival" model, in which assumptions of fertility, mortality, and migration may be specified. This method has been used at the national, state, metropolitan, and county scale. As the size of the area decreases, the data related to migration and vital statistics are not easily obtained, and the projection of these rates for the future becomes increasingly problematical. The New York State Office of Planning Coordination used such a model to estimate population by county.

However, for simulation of passenger travel, county estimates are usually too gross, and further detailing is required. This has typically been done by the transportation planning agency using ratio techniques. This of course places the agency in the position of forecasting development by small area and raises the question of who should fill this planning vacuum—the state or the county (or agencies within the county).

Certainly the availability of agreed-upon future population estimates by county is superior to the situation in which no official population estimates exist. However, the absence of finer-grain estimates, and related estimates of employment, recreation, etc., leaves a serious void in the data on which to base a transportation plan.

Furthermore, population estimates should reflect distribution and density characteristics prescribed or implied by the state plan, which in turn reflects state planning goals.

A future view of this same problem concerns the question of over-all controls. If each area or region that has planning responsibility prepares its own estimates of expected growth without coordinating these estimates with state, multistate and national estimates, substantial discrepancies in regional totals may and probably will occur. Resolution of such conflicts is not obvious, because on a local scale the local planners typically consider themselves closest to and most knowledgeable about vital statistics and plans for growth, whereas at the national level the impact of migration is more susceptible to forecasting. Without coordination and resolution of substantial differences, a chaotic and confused condition of multiple population estimates will ensue. It would seem that statewide transportation planning should take an active role in encouraging the establishment of and supporting the resulting estimates of population within the state, as well as encouraging the review and adoption of a statewide population forecast consistent with the national estimates prepared by the U.S. Bureau of the Census. Where seemingly irreconcilable differences surface, a dialogue between the appropriate state and federal agencies should be encouraged.

FUTURE ECONOMIC DEVELOPMENT

Although it is possible to make future population estimates by the state and by small area within the state on the basis of trends in vital statistics and migration rates, the process tends to ignore the question of whether the evolving economic developmental pattern in the state will match or change the estimated population distribution. The question of whether jobs locate where there are people or vice versa cannot be answered definitively, but generally it is assumed that the latter rather than the former holds sway. Several simulation models have been developed for estimating future development at the metropolitan scale. However, at the statewide scale, where efforts have been made, the approaches often have been more of a design process than an objective modeling effort.

There has been some use of "input-output" models to attempt to deal with the question of economic development at the statewide level. Both the State of New York, which recently released a comprehensive statewide development plan, and the State of Hawaii have used this type of model to estimate future economic development by industry type, and the number of future employees in each industry. These models, however, yield statewide totals that still must be disaggregated by geographic areas in the state before they can be used for planning transport facilities. Connecticut has worked with both the socioeconomic growth and the growth distribution model.

In the report on statewide planning for Pennsylvania prepared by Pennsylvania State University and Carnegie-Mellon University, a proposal was put forth to utilize an input-output model by subregions in the state. Such a model, if successful, would yield directly the goods movement demand between industry types and between regions in the state. In general, however, the disaggregation of the input-output approach to a fine system of zones would appear to be impractical both computationally and conceptually.

LAND-USE DEVELOPMENT

Many public agencies at the state level are concerned with statewide development. Foremost, of course, are the state planning agencies themselves. Also included are education authorities, recreation agencies, water resources agencies, industrial development commissions, etc. At the regional and municipal level, many public agencies also are concerned with the development and redevelopment of land. Finally, there are private and quasi-public agencies, such as new town developers, manufacturers, utility and power companies, who are vitally interested in the development of the state and its subregions.

Coordinating the activities of these agencies and ensuring that there is communication between and among their planning activities is seen as a major responsibility of a comprehensive land-use planning agency. In the absence of such communication, coordination, or even joint planning, the agency charged with the planning of a state transportation system must either undertake this responsibility itself or prepare plans without a basic comprehensive planning foundation. Either alternative seems wrong. This says, in effect, that only those states that are able and willing to undertake comprehensive planning and coordination programs can expect to undertake transportation planning programs that will yield transportation systems best serving the state's interests. Of course, it may also be said that transportation planning plays a critical role in the development of statewide economic development and land-use policy planning.

The issue, then, is how to use all of the states' planning agencies to bring about simultaneous and coordinated statewide planning programs.

TRAVEL CONSUMPTION

The common method of estimating future travel is to calculate trip ends based on the product of the number of trip ends per unit of activity in the base year times the forecast or planned amount of that activity in the target year.

These trip ends (productions and attractions) are then assumed to interact with one another in a regular fashion within specified travel purpose classes (work, shop, recreation, etc.) The interaction formula most often used is the so-called gravity model, in which the number of trips (the interaction of trip ends) between two points is directly related to the product of the volume of trip ends at each point and the inverse of the separation between the points, expressed in time units, and raised to a power (usually larger than 1).

The resulting trips are then assigned to a travel network by a process that may or may not utilize a capacity restraint mechanism to adjust network speeds so as to reflect the tendency of speed to decline as volumes become significant in terms of capacity.

This methodology of simulating travel over a network usually treats trip generation, interchange calculation, modal split, and trip assignment as sequential steps. However, because the location, type, and number of trip ends are determined or at least affected by the network of connecting transportation facilities, this sequential treatment introduces errors of unknown magnitude into the process. Therefore, a joint or simultaneous treatment of these factors is often recommended. The same criticism and recommendations are offered for trip interchange calculations and modal split estimates.

In addition, failure to include induced travel is put forth as a shortcoming of many forecasts. Induced travel is defined as the additional travel that occurs due solely to improvements in the transportation system. Induced travel is, of course, difficult to measure from longitudinal analyses.

Although these are significant methodological issues, they can be resolved with existing methodology.

There are questions of travel consumption for which satisfactory answers do not appear to be available at this time. One of these concerns changes over the consumption of travel in time. Will increases in income result in substantial increases in travel for a given area measured either in terms of more frequent trips or longer trips? Will the increased travel (if any) be across the board, or only in specialized activities such as recreation travel and weekend travel? Will the advent of a shorter work week significantly reduce peak-hour travel while increasing over-all travel? How will factors such as better communications and the coaxial cable affect travel?

It appears that special studies addressed to such questions should be undertaken by statewide planning agencies.

Although intermodal forecasts of passenger movements have not generally been produced (the Northeast Corridor Project is an outstanding exception), it would also appear necessary for statewide planning agencies to undertake research in this area. This research might involve the development of new methodology, but it would appear that methodology has outstripped the data necessary to calibrate intermodal models such as the Abstract Mode Model, or Schneider's concept of modal interaction.

GOODS MOVEMENT (FREIGHT) ANALYSIS

The bulk of the work that has been done to date with regard to forecasting and simulating future travel and resulting transport requirements has been addressed to passenger movement. This is true at the urban or metropolitan level, and especially so at the statewide level.

As noted in the sections on data and simulation, the lack of any real experience in this area, coupled with the apparently greater complexities of network routing, regulatory and rate impacts, and mixed public and private financing with different long-run investment objectives, makes simulating goods movement imprecise at best. It appears that a substantial program of research will be needed before one can expect a coordinated and comprehensive program of analysis, forecasting and/or planning, and plan preparation that will be appropriate to both the public and private interests of the state. A major consideration here might be the sharing or participation of several states and the Federal Government in a research program to address this set of problems.

CHAPTER SEVEN

PLAN GENERATION AND EVALUATION

The planning process has been described as one in which the planner catalogs the goals of society that are affected by transportation, and attempts to specify the effect of transportation decisions on goal performance. Achieving this capability is no small matter and requires acquisition of substantial quantities of data and development of techniques for simulating the behavior of transportation systems under present and forecast future conditions. Given these skills, one may still ask such questions as: What is a plan? How are alternative plans generated? How are alternative plans evaluated? Who is responsible for this evaluation?

One use of the term "plan" is the representation of a collection of proposed actions to be undertaken at some future time. A transportation plan would consist of a set of proposed actions involving the transportation system. A highway plan would be the set of proposed actions involving highway facilities and related services. The plan should not be confused with the system of facilities or with the program of implementing the plan, although these concepts are closely related. When one refers to the planned highway network for the year 1980, one is referring to the highway network that would exist in the year 1980 *if a particular plan were implemented.* Many elements in such a plan—the existing highway system, for example—are often simply assumed to be present in the 1980 network, although they are not specified in the plan.

Some people will argue that a plan should not be a list or map specifying future facilities to be added, modified, or abandoned based on a long-range forecast of future demand for travel. Instead, a plan should be a set of policy statements that will guide the development of the transportation system in response to changing demands and conditions. They argue that long-range forecasts are too prone to error to serve as the basis for major and irrevocable transportation decisions.

It seems necessary, however, that certain types of decisions need to be made on a fairly long-term basis. If action is delayed until the land development and economic activities clearly justify a new bridge, a subway system extension, or a new expressway, it is likely that the new development itself will make provision of the needed facility difficult or even impossible. Without advance right-of-way acquisition, or reservation, and public awareness of the eventual facility, implementation based on quick response may take too high a toll in terms of disruption and displacement of existing economic activities to be palatable to the community. Much of the distress that suburban arterials experience when urbanization overtakes formerly rural land can be attributed to the lack of a long-range highway plan. In this example, however, a policy plan, imposing standards to protect these existing but low-performance facilities from the crippling encroachment of land development, could permit their upgrading to higher-performance facilities.

Thus, a plan may consist of both (a) the specifications of the location of major new facilities and services and (b) policies protecting and governing the actual construction of new facilities or improvements of existing facilities in response to actual or near-term development.

GENERATION OF PLANS

Many proposals for new or improved highway facilities are simply responses to existing problems. Over a period of time, it is noted that the speed on a particular link is very low because of congestion, or because the number of accidents per vehicle-mile of travel is very high. In responding to existing problems, of course, one runs the very real risk of providing solutions that are totally inadequate, or are needlessly expensive, simply because the origins of the congestion have not been considered.

This same technique is often applied to forecast future traffic. The assigned future volume on a link is expressed in terms of a ratio to capacity. The links that show the greatest disparity between estimated use and capacity then become candidates for improvement. Often the assignment is a free assignment (no capacity restraints) and the assigned link volumes represent the volumes that would occur at the specified speed regardless of congestion effects. This technique, by concentrating on locations that are in obvious need of improvement, will certainly result in some benefits. However, failure to consider specific traffic and facilities as elements of a larger system runs the risk of failing to match the correction with the needs, because an engineering improvement in one location may simply attract more traffic to that location, with no appartnt improvement in the traffic flow. Also, other criteria, such as local development goals, are not considered in such a process.

Another approach to designing a plan is through the use of place classification. In this approach, places are classified by characteristics of size and activity. The appropriate transportation connections for various places are then specified. For example, in the case of the highway system, cities of 50,000 or more, or cities having particular economic characteristics, will be directly connected by primary arterials. With a set of such connection rules, and forecasts of future development within the states, the highway facilities that would have to be built or improved to meet the connectivity criteria can be specified.

Functional classification is still another way of attempting to generate a transportation plan. This technique is a basic element in determining the future highway needs to be transmitted to Congress in the 1972 "needs" report by U.S. DOT. In the classification approach, highways are viewed as providing access to land (local), providing high-speed movement to long trips (arterials), and serving the mixed function of doing both (collectors).

If the system of links can be properly classified, and a level of service specified, the plan is the set of actions necessary to ensure that each link can provide the specified service. A major consideration, of course, is the specification of those links, not presently in the system, that will have to be added. In this regard, the process must fall back on techniques similar to deficiency analysis and place classification.

A tempting approach is to endeavor to generate network alternatives from the very goals against which the network is to be evaluated. The optimum spacing approach developed in the Chicago Area Transportation Study is an example. The criteria or goals used involved capital and maintenance costs, and travel operating costs, for both expressways and surface arterials. The model specifies the grid spacing of both types of facilities which, for a specified average trip length, and for an unbounded region of constant (specifiable) trip end density, results in the least total costs. This model, because of the assumptions of grid networks and constant density of development, could produce only rule-of-thumb spacings which, although useful in layout of a network, do not actually specify a unique network. Moreover, the number of goals used falls short of the goal structure discussed in Chapter Two.

In addition, even if a model could be developed that would generate a unique network that satisfied the goals set in some optimum way (and the development of such a model does not appear to be imminent), the specification of which goals, what performance, and how to handle the trade-off between performance with respect to different goals remains. These specifications are considered by some to lie outside the responsibilities of the planner and within the province of the decision maker and indirectly, or even directly, within the concern of the public.

Nevertheless, unless the decision maker is to be converted to transportation planner, or citizen planners are to be trained, it would seem that the planner does have responsibility for preparation of alternative plans to be submitted to decision maker and citizen alike.

Considering the present state of knowledge, generation of alternative highway plans would require utilization of a method combining a review of the goals for rules-of-thumb, deficiency analysis, and functional classification.

A major effort should be made to have a fairly "rich" set of alternatives to test (1) to ensure that a family of promising alternatives is not simply overlooked, and (2) to serve to educate decision makers and citizens alike as to the range of choices and the goal performance associated with those choices.

EVALUATION OF PLANS

There are two basic steps in evaluating plans. The first is the ability to ascertain what will happen if and when the plan is implemented. These consequences include estimates of the number of users and/or the amount of goods directly affected by the plans. In addition, the impacts in nontransport areas (such as land development, social systems, and environmental resources) also need to be enumerated and measured as accurately as possible. The use of simulation techniques will be instrumental in this determination.

The second step requires an evaluation of these impacts. This evaluation should be in terms of the goals that have been advanced as appropriate to the statewide transportation planning process.

For each goal, the several alternative plans should be compared in terms of their performance with respect to that goal. The alternatives should include the null plan; that is, a program of maintaining the existing transportation system without improving facilities or adding new facilities. For many of the commonly accepted goals, such as inexpensive, fast, and safe transportation, the measures can be obtained directly from the capital costs of the alternative plans and the simulation of their use. However, goal performance with respect to economic development or land development may be considerably more difficult to quantify, particularly since our understanding of the land development and access relationship is at best imperfect.

The problem of land and economic development may be approached from a different direction. To the extent that a state has taken a position with respect to the future economic development and population settlement patterns within the state, and has designated a "plan" toward which the state should be moving, a transportation plan may be evaluated in terms of how well it serves the plan. To the extent that there is interaction between land development and the access provided by the transportation system, and to the extent that the provision of the transportation system represents a very substantial commitment of society's resources, one would argue that the planning of statewide land use and economic development should be conducted jointly with transportation planning. It certainly argues against attempting to prepare a statewide transportation plan in the absence of a planning program or a plan for land and economic development, because it places the transportation planner in the position of recommending a transportation plan that will generate land development and will have economic impacts that have not received evaluation with respect to statewide interests or welfare.

The Problem of Trade-Offs

Even if the performance of alternatives with respect to each relevant goal can be quantified, a major problem in the evaluation of alternatives remains. Plan A requires the taking of a significant number of parcels of developed land, with attendant acquisition costs and neighborhood disruption. Plan B avoids this problem but passes through a wildlife preserve, with significant impact on several species of wildlife. The null plan avoids both of these impacts but has substantially higher travel and accident costs. This problem of goal trade-offs has not been solved, either in the urban transportation study or at the statewide level. The National Environmental Preservation Act, which became effective January 1, 1970, requires, and will continue to require, that these difficult trade-off decisions be made *de facto*.

Although rating systems have been proposed as a vehicle by which to deal with these questions, it appears that decisions will generally reflect subjective appraisals of relative significance among conflicting goal achievements.

Lacking an objective basis for measuring over-all goal performance, it would seem that the statewide planning process should be moving toward development of techniques to place this comparison of alternatives before the decision makers and the public, rather than attempting to select the "best" plan.

Goal Performance by Region

One of the major objections that has been voiced to the evaluation of regional transportation plans in the urban transportation planning process has been the failure to compare goal achievement by socioeconomic group or small area. Critics of the "best" regional plan argue that its benefits are not equally distributed among all the people in the region; that one group or subarea is, in effect, subsidizing other groups or subareas.

It appears necessary for the statewide transportation evaluation process to be able to analyze goal performance by subareas of the state in order to be able to address such questions of equity and, if necessary or warranted, make appropriate adjustments to the plan.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

DEFINITION OF STATEWIDE PLANNING

1. The plea that a particular situation is different and unique has often been used as a rationalization for rejecting standards or uniform definitions. In the case of states, however, there exists a tremendous variety of problems resulting from differences in size, location, natural resources, and human settlement. These differences make it mandatory that each state define the statewide transportation planning program that best fits its requirements.

This is not to suggest that each state will have a different process for developing and evaluating plans for a given mode. The states should be moving toward uniformity in this regard. Rather, states may differ in the emphasis and answers they give to a particular modal problem or type of travel, such as waterways or data collection efforts to obtain information on tourism.

Starting from a broad definition of comprehensive statewide transportation planning, as given in Chapter One, each state should specify those elements that are of importance to it (as determined by its legislation, area, topography, population settlement pattern, land-use pattern, existing transportation system, and other factors) and define the content of its own planning program. The content should specify modes of transportation to be planned, areas to be covered, level of detail of resulting plans, basic techniques to be used, methods of implementing plans, and methods of monitoring results.

2. It is not possible to overemphasize the vital importance of positive action on the part of both transportation planners and other planners to coordinate their plans not only in matters of broad strategy (such as the location of population and economic activity) but also in matters of detail (such as in the designation of industrial areas that must be served by railroads, or in the control of access on future collector and nonexpressway streets). Transportation planners should strive to develop better means of forecasting the impact of new facilities on land use. Land-use planners should attempt to develop better means of forecasting future land-use development, and/or better means of controlling or persuading people to follow plans. At present, there is almost universal lack of certainty as to the order of magnitude of the impact of transportation facilities on land use, and there is no certainty that statewide land-use plans, including policies, will be attained.

ORGANIZATIONAL CONSIDERATIONS

1. For reasons of consistent policy development and greater effectiveness in providing and coordinating transportation improvements, administrative efficiency, and basic governmental economy, all states should consider bringing modal agencies, where separate, into a unified state agency, whether it be a department of transportation or some other omnibus agency.

2. The planning function in state departments of transportation should be located as the sole function of a single unit reporting directly to the head of the department of transportation. The planning unit should handle planning for all modes of transportation.

3. Definite, regular lines of coordination should be established between the planning arm of a state department of transportation, state planning agencies, regional and local planners, and other agencies, *both public and private,* that relate closely to transportation. It is extremely important that close technical working relationships be established with state general planners, with planners working for carriers, and with planners working in other areas (such as recreation and conservation).

4. It is important that data be obtained and performances be evaluated on factual bases, and that this information be made public in understandable form at the earliest opportunity so that better-informed decisions can be made. The public and governmental leaders may not always follow the planner's advice, but they should be informed of the facts. This lends a special urgency to fact-gathering and performance evaluation.

GOALS

1. The use of goals in the sense of performance criteria, against which transportation system performance is judged, does not appear to have been widely accepted in statewide transportation planning. Some programs use the word "goal" to describe an actual element in a transportation plan. It appears that the definition of what constitutes a goal, the specification of relevant goals, and the development of measures of goal performance or attainment should be the first order of business in statewide transportation planning.

2. At present, most states, in following the 1972 National Transportation Needs Study manuals, are estimating needs on the basis of standards. These standards (particularly those relating to highways) are generally reasonable and reflect extensive experience in design, construction, maintenance, safety, and levels of service. However, these standards reflect only user costs; rarely do they reflect nonuser costs and benefits, environmental costs, and other factors. Further, the standards do not cover all modes of personal travel, or all modes of freight transportation. The performance of systems and the "profits" or cost reductions to be obtained from new investments are not analyzed. Performance measure concepts are embodied in the 1974 National Transportation Needs Study.

It is recommended that statewide transportation planning move in the direction of measuring performance of modal systems of transportation in relationship to a broad set of user, community, supplier, economic, and environmental goals, and also calculating the net returns that investment will produce as measured by better performance of the systems.

IMPROVEMENT IN METHODS

It probably will take at least five years to make substantial progress in developing techniques for statewide transportation planning. Funds for making needed improvements are limited. Accordingly, effort should be put into certain high-priority areas, of which the following are considered vital:

1. Development of techniques for measuring performance of all the major modes of transportation in terms of basic user, community, environmental cost, and operator costs.

2. Development of data collection techniques for (a) systems represented, and (b) travel of persons and transport of goods.

3. Improvement of simulation models for (a) auto and motor carrier systems, (b) rail freight and passenger systems, (c) air carrier systems, and (d) waterway systems, leading ultimately to development of a methodology that will deal simultaneously with all modes as required.

4. Development of better methods for simulating the mutual impact of transportation facilities and regional development.

5. Assistance in development of better means of estimating dollar costs and social benefits of alternative land development patterns, and the transportation systems to serve them. Also, development of better methods of implementation of transportation plans.

ANALYSIS AND EVALUATION

Development of a Framework for Allocation of Investment Between Alternative Modes

One of the main objectives of statewide transportation planning is the development of a framework for the rational allocation of both public and private funds between the several transport modes. This goes well beyond the objective of simply allocating available funds among various projects. It is not satisfactory to have to say, "We know this facility is a good investment, but we can't afford it." By definition, a good investment is one that gives a good return. Put another way, a good investment is one that, if foregone, will result in a greater total cost than would have resulted if the investment had been made. A manufacturer seeks to maximize profits: by analogy a transportation planner must seek to maximize social returns. However, if projects must be deferred for lack of available funds, those projects that have the highest relative return should be advanced.

The recommendation made here is addressed to the development of a measurement framework within which all the costs of acquiring and using alternative transport systems can be assessed. These costs include not only construction, maintenance, right-of-way acquisition, and user costs, but also impacts of the system on other systems, including environmental and ecological systems. Considerable progress toward developing such a framework for highways and public transit in urban areas has been achieved, but this work needs to be extended to all modes. Initially, each mode may be dealt with independently, but eventually all modes must be dealt with simultaneously.

A separate recommendation in this report deals with the specification and measurement of performance goals or criteria.

Federal Policy for Funding Investments in Transportation

It follows from the discussion of the need for specification and measurement of transportation performance criteria, and the eventual substitution of such performance criteria for standards, that investments within and among the different modes should be based on the marginal rate of return as measured in terms of these criteria. This may have implications for the Federal Government's policy on funding transportation investment.

The current federal funding policy, by stipulating different federal matching ratios for the various transportation investment programs, does not recognize the different needs among states for one mode of transportation over another. To the extent that one mode or program has a higher federal matching ratio than another, a state is encouraged to invest in the mode or program that has the highest federal matching ratio, rather than in the program that gives the highest rate of return.

This suggests that at the federal level, consideration should be given to abolition of differential matching ratios. Instead, a single over-all matching ratio might be considered. Each project would be required to meet the level of return in terms of the performance criteria. The assumptions stated in the National Transportation Planning Manual appear to be moving in this general direction, although the Interstate Highway System and airport ratios are quite different from the requirements for other modal investments.

Generation and Testing of Alternative Plans

In the main, it appears that alternatives, although desirable, are not developed before testing and evaluation. Rather, in the case of highways, the final plan evolves from an examination of congestion or underutilization in a first cut best plan. Clearly, if transportation is to foster development, alternative plans could mean alternative development patterns and may have varying impacts on the existing situation. This will require some desire and effort on the part of the state to specify development and conservation objectives. It will also require land development-transport facility simulation capability.

It is difficult to say how many, if any, transportation alternatives should be considered in the case of a single land development forecast or plan. Intuitively, one would argue that some conceptual, system-type alternatives should be considered in order to evaluate alternative mixes of mode and location.

Forecasting Requirements

From the point of view of planning transportation facilities to serve people, it is clear that a forecast or the existence of an approved plan for a future human settlement pattern in the state is required. In the absence of such a plan or forecast, the transportation planner cannot determine where facilities might be located to foster development, nor can he estimate the volume of passengers, vehicles, and goods that would use a facility (existing or hypothetical) in the future. This means that he is unable to evaluate alternative facilities in terms of their potential service and use.

In the main, estimates of the location of the future population within each state have not been available to the transportation planner. Several states have prepared estimates of future population by county. However, although county totals represent an important first step, the county is still, in general, far too large an area for purposes of simulation of passenger travel.

This has made it necessary for the transportation planner to make small-area estimates of the future location of population, except for the urban areas of 50,000 or more, for which estimates may already have been prepared under the urban planning program. Although these estimates are the best available, it seems clear that such estimates would be better made within the context of a statewide planning program that included recreation, tourism, land use, economic development, water resources, educational facilities, industrial development, and other functional planning areas.

SPECIAL STUDIES

Rail Study

Above and beyond the need for a basic inventory and analysis of rail freight and passenger movements and rail facilities, there exists the need for a study of the potential economies inherent in optimizing the extent and pattern of existing railroad trackage.

There appears to be extensive duplication of trackage, resulting from the existence of competing railroads. In particular, many feeder tracks receive only marginal use. If these facilities were pooled, what would be the magnitude of resulting reductions in operating costs, maintenance costs, and travel costs? Which lines or tracks might no longer be necessary? What use could be made of abandoned right-of-way? Would a small amount of new construction provide better service? If some lines were abandoned, what would be the impact on the local economy and the shippers affected? What alternative means of goods movement would be available or could be developed? What is the trade-off between these impacts and increased operating efficiencies?

If a considerable savings were indicated, one would next need to consider the organizational arrangements necessary to secure them. These might involve cooperative arrangements between selected railroads, a private corporation to hold and manage the trackage, or some other arrangement. The arrangements necessary to implement such a consolidation would require a separate study; but a study would be justified only if research indicated that substantial savings were realizable. Such studies might be undertaken at either the state or multistate level. Ideally, the entire nation should be covered by several of these studies.

Air Passenger Study

It appears that a study of air passenger service at a state or multistate level should be undertaken. This should be done in conjunction with the statewide airport system planning process, but it would be more comprehensive than an airport location study.

The study would consider the pattern of airports and the equipment required to meet existing travel desires and compare this with existing patterns and equipment. Given substantial potential economies that might result if service were consolidated, or expanded, or if the mode were changed, one might then recommend public policies that would encourage the realization of those economies.

APPENDIX A

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