NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE

48

PRIORITY PROGRAMMING AND PROJECT SELECTION

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

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

AREAS OF INTEREST:
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TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. 1978

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 and Transportation 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 Transportation Research Board of the 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 objectivity; 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 and transportation departments and by committees of AASHTO. 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 and Transportation 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 Transportation 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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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 and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation 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, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on 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
Transportation
Research Board

This synthesis will be of special interest and usefulness to transportation administrators and others seeking information on factors to be considered in determining project priorities and making project selection decisions. Detailed information is presented on methods used by transportation agencies at all levels of government.

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 often is fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem frequently is 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 correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems. Syntheses 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.

The basic programming process is quite complicated and has never been defined in a way useful to most transportation administrators. In addition, there has been no compilation of accepted definitions for planning-programming terms. This report of the Transportation Research Board contains the results of a selective survey of priority programming and project selection methods being successfully used by transportation agencies. A 15-step "Basic Programming Process" ranging from project initiation through modification is outlined, and a list of definitions for the basic terms used in planning and programming is provided.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic 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.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Kenneth E. Cook, Transportation Economist, and Robert E. Spicher, NCHRP Projects Engineer, both of the Transportation Research Board, assisted the Special Projects staff and the Topic Panel.

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

PRIORITY PROGRAMMING AND PROJECT SELECTION

SUMMARY

The basic programming process does not have a generally recognized format. Nor is there a list of accepted definitions for terms used in programming. This synthesis, which draws on published documents and existing practices as obtained from interviews with programming officials, provides some structure for programming and also a starting point for definitions.

Defined simply, programming is the matching of available projects with available funds to accomplish the goals of a given period. Thus there are three basic elements to a program: projects, funds, and priorities (or goals).

A program is rarely all new; it almost always contains commitments from prior years. Within a program the projects are in all stages of development. The funds may be restricted to certain categories, and priorities are constantly changing because of changing philosophies, transportation needs, economic conditions, and political conditions. The programmer must juggle all these variables to produce a workable program.

The procedures followed in programming generally fit into the 15-step basic programming process described below.

1. Project initiation. Projects have two major sources: technical (planning studies, special studies, and trained observations) and nontechnical (requests and observations).
2. Initial listing. Lists can come from four sources: the headquarters or central office, a district or regional office, a county, and a metropolitan planning organization (MPO).
3. Preliminary analysis. Projects are analyzed on the basis of existing or easily obtainable information.
4. Combined listing (first draft). The separate lists of new projects from headquarters, regions, counties, and MPOs are combined in a single list.
5. Advanced analysis and prioritizing. There are three major components of this step: technical prioritizing, nontechnical prioritizing, and feedback from project planning and development. Technical prioritizing includes development or review of (a) sufficiency ratings that evaluate physical conditions, geometrics,

and alignment of a highway or bridge and (b) priority ratings that add other factors, such as safety, capacity, economics, and quantifiable social and environmental items. Nontechnical prioritizing involves weighing in the minds of decision-makers without a technical analysis and includes such items as political commitments, legislative commitments, system continuity, and position in the pipeline. Feedback from project planning and development refers to the process of re-assessing a project after work has advanced to the point where costs and benefits are more accurately known.

6. Combined listing (second draft). The old projects are combined with the new projects from Step 4.

7. Financial analysis. Two fundamental issues are to be addressed: how much is available and how much is committed. This involves forecasting future federal-aid apportionments, estimating state matching requirements, estimating other state requirements, forecasting various other revenues, forecasting the funds to be available for each category, estimating manpower requirements and expenses, relating commitments to cash flow, and constantly monitoring and modifying accounts, project timing, and staging.

8. Preliminary program. The programmer puts together the first program, combining the list of projects with available funds and giving a priority order whenever possible.

9. Executive session. The top staff and the department head hold a meeting (or meetings) to select a program for publication.

10. Short-range program (first draft). Following the executive session, a short-range program is published.

11. Executive and legislative review. Before the program is formally adopted, the first draft is reviewed with the governor's staff and the legislative leadership.

12. Short-range program (final draft). After review (and change, if necessary), the final draft becomes the official program of the department.

13. Scheduling. The program usually contains a fiscal-year schedule of major phases, but some departments develop a more detailed schedule for all phases from planning to construction.

14. Monitoring. The actual progress is compared with the scheduled progress.

15. Modifying. The program is amended as necessary.

This synthesis should provide a framework for future discussions of programming and a starting point for a list of accepted definitions of the basic terms used in planning and programming. Following are some of the conclusions drawn in the synthesis.

- Some technical prioritizing processes have a significant effect on selection of projects; however, a "magic number" that sets priority order for major projects is of little interest to decision-makers, compared with their interest in nontechnical factors.
- Total appropriations have the greatest impact on financial planning and prioritizing. Categorical and geographical allocations are next in impact. Programming is a planning function. Although major decisions must be political ones, they should be the culmination of an orderly planning process.
- Politics—in its negative connotation—is not a significant factor in programming.
- To prevent substantial program modifications, better project concepts and monitoring processes are needed.

CHAPTER ONE

INTRODUCTION AND DEFINITIONS

This synthesis is based on interviews and discussions with programmers and those responsible for the programming process. It is intended to present programming from the viewpoint of the practitioner and to convey how programming is actually carried on today. Insofar as possible, the synthesis represents the opinions and practices of the practitioners and of the topic panel, both of which groups contributed extensively to its contents.

Interviews and studies involved about one-fourth of the states, encompassing one-fourth of the nation's population and including a mix of urban and rural and small and large states. Also interviewed were agencies in two large counties, agencies in two major cities, and two major transit agencies.

INTRODUCTION

The basic programming process has never been defined in a format that is recognized by and useful to a majority of transportation professionals. Many flow charts have been prepared to depict the programming process generally, but programming is so complicated and is influenced by so many factors that a universal programming flow chart does not exist.

Furthermore, and even more fundamental, there is no list of accepted definitions for the planning-programming area, although many excellent definitions have been proposed and used in many outstanding papers and at significant conferences, such as the 1974 Williamsburg, Virginia, conference on "Issues in Statewide Transportation Planning" (*1*) and the 1975 Orlando, Florida, conference on the "Transportation Programming Process" (*2*).

Form and structure, then, have not been provided for definitions of the basic programming process. Also, neither form nor structure has been recommended for the key element of programming: prioritizing. This synthesis therefore offers definitions for the more commonly used terms in planning and programming (drawing on existing sources and practices whenever possible) and structure for the basic programming process as well as for technical and nontechnical prioritizing.

The highway program was the primary source of information on existing programming procedures. With the exception of some very large transit agencies and other isolated cases, programming methodologies for modes of transportation other than highway have been developed only recently. Many states have just completed airport system studies and have recently entered the railroad field.

Of course, all transportation agencies and governmental jurisdictions conduct some form of programming process in moving projects from planning into design and construction. Many decisions are based on common sense, others on political expediency. This synthesis includes discussions on political realities, because decision-makers in transportation are politicians and it is important that programmers know if and to what extent technical prioritizing actually influences the decision-makers or has a significant impact on the allocation of transportation funds.

The purpose of this synthesis is to describe, in a structured manner, what is happening in priority programming today: what the key definitions and elements in programming are; how programming is managed; how decisions are made regarding why, when, where, and at what level improvements should be implemented; how initial decisions are later modified; what the balance is between technical and political factors; what impact technical prioritizing has on the allocation of resources and, conversely, how the allocation of resources affects priorities.

DEFINITIONS

At its meeting in the summer of 1976, the AASHTO Standing Committee on Planning emphasized the need for standard definitions in planning and programming. This section defines terms as they are used in this synthesis; it is recommended that they form an initial framework for a future consensus. The definitions draw, insofar as possible, on published works that are recognized as landmarks in planning and programming and on existing practices as gathered through interviews.

The first definitions are for the words *planning* and *programming*. A 1969 work by the Bureau of Public Roads (*3*) defined planning as "the preparation for action [by] . . . examining present conditions, forecasting future conditions; then recommending the objectives and the course of future action and policies to attain the goals in light of the forecasts."

The same work defined programming as "the process of stipulating the work to be performed in a specified period of time to accomplish the objectives set for that period, with due regard given to the relative urgency of the work . . . so as to most effectively use anticipated monies as they are made available."

Although adequate in most respects, the latter definition misses the influence of project availability on programming in actual practice. The following simpler but more complete definition is recommended for future use and is used in this synthesis: *programming is the matching of available projects with available funds to accomplish the goals of a given period.*

Planning is associated with such terms and concepts as long-range, goals and objectives, idealistic, uninhibited, unconstrained, and policy-oriented. Programming is more associated with such terms and concepts as short-range, fiscal constraints, priorities, and project-oriented. To emphasize the difference, only the terms *long-range plan* and

short-range program are used in this synthesis; *long-range program* and *short-range plan* are not used. Each requires some of the other, but the products are explicit.

A change in planning philosophies or goals and objectives can have enormous repercussions on programming. It thus seems worthwhile to present a series of definitions (as they are used in this synthesis) in the order in which they appear in the planning-programming process.

Policy planning: A conscious process leading to a set of coordinated policy decisions that, in turn, should lead to the achievement of a defined set of goals and objectives. Policy planning involves questions of resource allocation throughout a state, in terms of allocation by both geographic area and transportation mode. It does not involve the review or recommendation of specific facilities or corridors or even transportation networks. In this sense policy planning is a "top-down" approach, starting from basic state goals and working through the general state plan to a transportation policy consistent with these goals (*1*).

Systems planning: A process under which transportation networks and corridors are defined in a "bottom-up" approach, starting from forecasts of population and economic growth and continuing through estimates of person and goods movement to a physical description of the systems required to meet the real or implied needs (*1*). (This is the stage during which a long-range plan is developed.)

Comprehensive planning: The use of the word *comprehensive* refers to the formulation of a land-use-oriented plan, of which a transportation plan is one element.

Transportation plan: An idealistic plan that has general goals, is policy-oriented, and avoids short-term fiscal and other constraints in order to present an uninhibited view of a total transportation system that would provide maximum efficiency in fulfilling all major transportation needs of the comprehensive plan.

Needs study: A study that identifies present and future deficient segments of an existing transportation network and estimates the cost of improvements needed to bring that network to a desired level of service. (The study does not necessarily prescribe specific project improvements, programs, or priorities.)

Functional classification: Division of a transportation network into classes, or systems, according to the nature of the service they are to provide. For highways, the divisions are usually freeways, arterials, collectors, and local access. These divisions may be used as a basis for determining jurisdiction (state or local government), design standards, and allocation of funds.

Long-range transportation plan: A 10- to 20-year plan that has specific goals, is system- and major-project-oriented, and includes the highest-priority projects and a funding projection indicating that funds will probably be available for the plan's completion.

Prioritizing: The over-all process of producing a rank order of priority projects and project sections, using technical and nontechnical, quantifiable and nonquantifiable factors as the criteria for ranking.

Sufficiency rating: A numerical procedure that produces a single descriptive value for a location in terms of its existing structure, safety, and service relative to a standard. It usually does not include accident totals, benefit/cost ratios, or social, economic, and environmental factors. Rather, it is a measure of physieal sufficiency under existing conditions compared with a given standard. (It might be called a deficiency rating.)

Priority rating: A complex rating for evaluating or comparing projects. It usually includes the factors of service, structure, and safety found in a sufficiency rating, but it also includes many other factors, such as a safety rating (accident totals or rates), a capacity rating (volume/capacity), a benefit/cost (or cost-effectiveness) rating, impact ratings (economic, social, environmental), and such nonquantifiable factors as uncertainty, interrelationships with connecting or competing facilities, and agreements and commitments.

Sketch planning: The statement of plan alternatives at a low level of detail, with emphasis on broad policy implications rather than on details of (physical) plan configuration (*4*).

Short-range program: A project list that includes the location, description, category, and type of work (preconstruction and construction), the estimated cost and projected year (or month) of contract letting, and other related data over a period that in practice ranges from two to seven years. In some cases the short-range program is also an explicit schedule. The short-range program is designed to encumber all funds anticipated to be available in various funding categories.

Project: A specific, planned unit of proposed construction. The word *project* may be used initially to describe a large undertaking that is later subdivided into logical sections. If one of these sections becomes independent of the others, it may be listed and programmed as a separate project.

Scheduling: The process of developing a timetable of operations to carry out the short-range program. First, projects are broken down into activities; starting and ending times for those activities are set; and resources required to perform the work are determined. Then the times (and the program) are adjusted as necessary to balance the resource requirements (*3*). The activities include federal and state approvals, hearings, design and design approvals, right-of-way plans, appraisals and takings, advertising, and award and construction. The schedule gives transmittal dates and percent of completion (milestones) for the activities and thus is a management tool for project control.

Monitoring: The process of checking the actual progress and comparing it with the scheduled progress (*3*).

Modifying: The process of amending the short-range program (or prepared input for the short-range program) because of various factors, which may include new, high-priority projects; public controversy; new prioritizing techniques; needs of other agencies; cost of a designed project greatly exceeding estimated cost; inflation; slippage; and changes in anticipated revenues or allocations. Changes in philosophy would probably result in entirely new programs rather than the modification of the existing program.

CHAPTER TWO

THE BASIC PROGRAMMING PROCESS

INTRODUCTION

The simple definition of programming is "the matching of available projects with available funds to accomplish the goals of a given period." The phrase "to accomplish the goals of a given period" refers to the planning and priority aspects of programming. The phrase is included to ensure that the programmer does not merely conduct a mathematical exercise of matching projects and money, which is more a scheduling task than a programming task. As a practical matter, however, if there is a danger of lapsing funds or a desire to advertise projects in a construction season, programming may become temporarily a simple matching of projects and funds in complementary categories.

On average, programs are prepared in detail for a five-year period. Some states require an annual or biennial program by statute, but the programmer must look five years ahead to schedule properly for two years. On major projects, such as Interstate highways or heavy-rail-transit extensions, the programmer schedules for ten years to be reasonably accurate for the first five years.

Sources of funding can not be considered reliable beyond five years, because philosophies and priorities change. However, major projects probably average at least seven years for completion from the time the key decision-makers agree to the project's merits and proceed with plans for major feasibility and environmental studies. Even if construction plans are completed within a five-year period (including environmental studies, hearings, approvals, design, and land-takings), funds may be inadequate to allow work to proceed on all sections at once, and staging may be necessary.

The preceding discussion emphasizes an obvious point in programming: the program contains projects in various stages of development. Some projects are in the early feasibility-study phase; others are in the final-design phase. Because of the "goals of a given period," some of the projects in the feasibility-study phase may have higher priority than projects in the final-design phase.

Each phase (project planning, design, right-of-way acquisition, and construction) can be, and often is, programmed separately at a different time as the project moves along. Project planning and design may be programmed, with right-of-way acquisition and construction left unprogrammed, pending the determination of the scope of the project in the project planning or design process or in expectation of future infusion of funds. Or it may be that most of the projects are funded through all phases and some of the projects are funded only through project planning and design in order to provide substitutes in case some of the first group slip.

Another important point to note is that rarely is there a fresh, new program to create. The program for the next year includes funds dedicated to projects that started the previous year. Projects of lower priority will be started the next year simply because higher-priority projects are not ready for advertising.

Still another important point is that funds may be dedicated by statute or executive decree to certain categories of projects or certain geographical areas and thus are not available for projects considered to be of higher priority.

It should be borne in mind that the programmer is more of a referee than a decision-maker, helping decision-makers agree on a course of action. Ideally, the programmer is a catalyst who encourages key top staff members to make decisions, guided by their own predetermined policies, as to which projects should be built and in what order. When there are strong differences of opinion, the programmer referees the process of reaching a decision. When there is an absence of decision-making, the programmer must have enough clout to force a decision to be made. In practice, the programmer, perhaps guided by a legislatively mandated fund-distribution formula, may make decisions in the selection of a number of smaller projects for which there is to be an equitable geographical distribution.

Many of the preceding points are repeated later in this synthesis. They are presented here, before the basic programming process is explained, to facilitate understanding of the complexities facing a programmer.

The key points to keep in mind concerning programming are these:

- The program is rarely new; it usually contains commitments from previous years and to other agencies or groups.
- The projects are in all stages of development, from basic planning studies to final design. At any point and for any number of reasons, a project may be stopped temporarily and thrown off schedule.
- The funds available may be restricted to certain categories of use, although there may be some flexibility with regard to transferring funds between categories or reassigning projects to different categories.
- Priorities may be constantly changing because of changing philosophies, transportation needs, economic conditions, energy availability, political conditions, and other factors affecting individual or collective priorities.

To produce a workable program, the programmer must blend (or, more accurately, juggle) all these variables as they constantly change.

BASIC PROGRAMMING PROCESS

Table 1 gives the 15 steps that were found to be common in most programming processes. It might be argued that programming does not begin until Step 6, when a combined listing of projects is available and the highest-priority projects in each funding category can then be matched with

TABLE 1
15 STEPS IN THE BASIC PROGRAMMING PROCESS

1. Project initiation
   - A. Technical sources
   - B. Nontechnical sources
2. Initial listing
   - A. Headquarters
   - B. District
   - C. County
   - D. MPO
3. Preliminary analysis
   - A. Available data and analyses
   - B. Planning report (project description)
4. Combined listing (first draft)
5. Advanced analysis and prioritizing
   - A. Technical prioritizing
     - (1) Sufficiency ratings
     - (2) Priority ratings
     - (3) Option-evaluation techniques
     - (4) Input from other agencies
   - B. Nontechnical prioritizing
     - (1) Political commitments
     - (2) Legislative mandate
     - (3) Emergency
     - (4) Special emphasis
     - (5) Commitments to other agencies
     - (6) System continuity-connectivity
     - (7) Position in pipeline
   - C. Feedback from project planning and development
     - (1) Development of alternatives/joint development
     - (2) Environmental analysis (EIS-SEE)
     - (3) Community and technical interaction
     - (4) Input from other agencies
6. Combined listing (second draft)
7. Financial analysis
   - A. Categorical grants
   - B. Geographical distribution
   - C. Fiscal-year projections (fund forecasting)
   - D. Manpower analysis
   - E. Financial modifications
8. Preliminary program (projects vs. projected allocations)
9. Executive session
10. Short-range program (first draft)
11. Executive and legislative review
12. Short-range program (final draft)
13. Scheduling
14. Monitoring
15. Modifying

the categorical allocations. However, interviews indicated that there are few projects on the shelf waiting for funds; rather, it is a constant battle to get projects ready to meet the scheduled time in the program.

Programming, therefore, is considered to begin with project initiation. It is not uncommon—because of political, emergency, special emphasis, or other reasons—for a project to be placed on a program immediately after the project's initiation.

Note that Step 5 (advanced analysis and prioritizing) and Step 7 (financial analysis) are composed of many substeps. The three elements of programming (projects, funds, and priorities) are in a constant state of change. When they are first put all together in Step 8 (preliminary program), the programmer must forecast their position based on their current status. And this must be done for hundreds of projects.

The programmer must produce a final, printed document. Therefore, specific values must be extracted from Steps 5 and 7, as if each of these were only a single step. In practice, the values and times from Steps 5 and 7 keep changing, and thus a working program is a living document, constantly changing from the printed document.

Some of the aspects of Step 7 are discussed in more detail in Chapter Three, the prioritizing aspects of Step 5 in Chapter Five, and some of the project planning and development aspects in Chapter Six.

Programs are seldom fresh and new. Commitments from former programs must be carried into new programs. Projects often have been under consideration, with several alternatives and levels of development, for many years. Old or new projects are subject to change up to the completion of final design. The priority of projects is subject to change up to the day of construction, and the staging of construction may be subject to change. Total appropriations in the future, as well as allocations to categories and geographic areas within those appropriations, are subject to change.

Programming, therefore, includes the art of combining these variables into an orderly process of project implementation. Allowing for the complexities introduced by the many variables involved, programming generally follows the 15 steps given in Table 1. A brief description of each step follows.

1. Project Initiation

There are two major sources of projects: technical and nontechnical. Technical sources are broken down into three components: planning studies, special studies, and trained observations. Planning studies are related to the continuous, technical planning effort that is carried on by all major jurisdictions (e.g., needs studies). Special studies are technical studies not usually associated with a "top-down" planning approach. For example, a proposed shopping center usually requires an in-depth study. Or a city traffic engineer might make a parking or traffic-circulation study that would precipitate many projects. Trained observations consist of a periodic review of facilities by regular, trained staff, particularly for maintenance and safety projects.

Nontechnical sources produce the "political" projects, which seem to be relatively few in number. No matter who requests a project or how ridiculous the project may appear, most jurisdictions provide a courteous discussion with the initiator. An initiator sometimes is talked out of a project, accepts an explanation of a better method, or accepts the fact that the problem will be corrected under a future construction program. If the initiator persists, however, and is of any prominence, the project will be recorded for future screening.

2. Initial Listing

There are four sources of lists: a headquarters or central list; a district or region list; a county list; and a metropolitan planning organization (MPO) list, now part of the annual element of the required transportation improvement program (TIP).

In the larger states the transportation department depends primarily on the region or district for both urban and rural

projects. The headquarters planning staff is continually working on the prioritizing of projects, however. A variety of factors may cause a project to receive a new, high-priority rating, in which case the project is flagged for inclusion in the next program.

3. Preliminary Analysis

This analysis is based essentially on existing or easily obtainable or observable information. It includes two components: (a) available data and analyses and (b) a planning report. The former may include regularly recorded and computed data, such as needs studies, sufficiency ratings, bridge ratings, and accident data. Most projects are not new; they have been considered to some degree in some form in the past, and a file of information on them may exist.

A planning report is a brief description of a project. It contains fundamental data on location, length, number of accidents involved, ballpark cost estimate, and other information. It may also contain a brief description of the project's controversialism, its importance to the system of which it is a part, and various environmental, social, and economic factors. In many jurisdictions this information is computerized in what is called a project information system.

4. Combined Listing (First Draft)

The separate lists from headquarters, regions, counties, MPOs, and possibly from regional planning agencies or from a major city or county that sent a list directly to headquarters—in short, any and all lists—are combined in a single list.

Although there are very few entirely new projects, "new" may be applicable here to refer to a project that is new to a list of projects that are being seriously considered. At this point all but the most ridiculous projects may still be alive and have a chance for advancement.

It should be mentioned here that Step 6 is a combined listing (a second draft). At that point projects from the previous short-range program are added to the new listing, some prioritizing takes place, and the result is the second draft of the combined listing. In Step 4 it is assumed that these older projects, which have already received advanced analysis and probably some prioritizing analysis, have not yet been included with the new listing.

5. Advanced Analysis and Prioritizing

This step has three major components: technical prioritizing, nontechnical prioritizing, and feedback from project planning and development.

Step 5 does not necessarily begin in a uniform, orderly manner after Step 4. For example, technical prioritizing is a continual process, as is project planning. Either one may have begun several years prior to the listing of a project and then may have been suspended. As the project appears to have more priority, the analysis is reviewed and resumed. A project may have been studied originally only as one of many projects affected by new developments rather than for its individual significance.

5A. Technical Prioritizing

The first item of technical prioritizing is the development or review of less complicated ratings, such as sufficiency ratings, accident totals or rates, and traffic volumes. Almost every jurisdiction has some form of a more complicated rating, referred to here as priority ratings to differentiate them from sufficiency ratings. The priority ratings add more complex analyses to the sufficiency ratings and include benefit/cost, social, economic, and environmental factors. Chapter Five contains a more in-depth discussion of this point.

There is a new generation of sophisticated technical prioritizing techniques known as option-evaluation techniques. Included are sketch planning, alternative multimodal analysis, impact-prediction techniques, and so forth. Some of these techniques require extensive data input and make use of high-capacity computers; others, like sketch planning, require a minimum of data input. Other techniques are being developed to optimize the rate of return on funds invested in transportation projects.

It was found that in a few instances outside agencies produced some form of technical prioritizing that became part of the decision-making process of the programming agency. However, outside agencies have more influence in the nontechnical area of prioritizing.

5B. Nontechnical Prioritizing

This broad heading includes items that generally require no analysis to weigh their relative importance. The weighing is done in the minds of the decision-makers.

Nontechnical prioritizing includes all the factors that lead to political favoritism, such as support for a certain project because the project is owed to somebody in return for a special favor or because the support would keep a powerful legislator from attacking a budget or holding up necessary legislation. Such acts of favoritism are called political commitments, and there are several points to be made about them.

First, as practiced in recent years, political commitments—even at their worst—are not all bad. In one department it was succinctly stated that "we have built only three or four really political projects in the last twenty years, and they were needed anyway." Their priority might have changed, but they would have been built eventually.

Second, positive political input, which is the case more often than not, provides a user's view of the functioning of the transportation system. At the least, it is a valuable check on technical prioritizing. In many cases it illuminates items the technical system has missed. In those myriad programming decisions where a multifaceted value judgment is called for, this kind of political input is the only source provided by a democratic society.

The political commitments element is only one of seven major elements in nontechnical prioritizing. The others are:

1. Legislative mandate (line-item budgeting).
2. Emergency.
3. Special emphasis.

4. Commitments to other agencies.
5. System continuity-connectivity (missing links).
6. Position in pipeline (project readiness).

Each of these possesses a power almost as great as the power of politics in its negative connotation. Political commitments must compete with all of these real-world factors on almost an equal footing. Each of these priorities has a readily apparent constituency that may in turn work on the political influence in a variety of ways, both directly and indirectly.

5C. Feedback From Project Planning and Development

Different departments use different phrases to describe the development of a project: project planning, project development, and project analysis are examples. All these phrases refer to the intermediate steps between the planning report and final design. In larger jurisdictions a separate bureau usually carries out the function of project planning; in smaller jurisdictions project planning is a function of the design section.

Project planning is a process that usually continues for several years after a project has been listed in a short-range program. In the highway field a considerable amount of information often has been developed on a project, inasmuch as there are relatively few totally new projects. There are at least the following four major steps in project planning, all of which are overlapping:

- Development of alternatives, including joint development with land use and other considerations.
- Environmental analysis and possibly an environmental impact statement (EIS), but at least consideration of social, economic, and environmental (SEE) factors.
- Community and technical interaction, a good phrase to describe meaningful citizen participation.
- Input from other agencies, which may be in conjunction with the EIS and community interaction.

It is apparent that any one of these steps or a combination thereof can result in slippage, significant expansion or reduction, or even the tabling of a project. Of course, many minor projects, particularly in rural areas, do not require an in-depth development of these steps.

All jurisdictions have at least an annual formal checking and updating of their programs. Of particular concern are the cost estimates that result from the four-step process listed above. At some level in every jurisdiction there is at least some determination of the relative benefits and costs, even if only on an informal basis. It may be at the regional level, where, for example, the benefits and costs of a project are compared with those of other projects of similar magnitude that have been constructed in recent years. In some cases a benefit/cost study is made at either the region or headquarters. Although it may not be the one decisive factor, a benefit/cost ratio greater than 1.0 is a basic criterion for proceeding with the project.

As the project planning work advances and the acceptable alternatives become apparent, refined cost estimates can be made. If the project is relatively new, this step is accomplished months or years after the project has been included in the short-range program. If the project has been around for a long time, even though it must go through the environmental and citizen participation processes, considerable information on its approximate cost is available.

When project planning is completed and the project is in the process of development, there is a return to programming and to the long-range planning aspects of the system of which the project is a segment. Information about the need for the project, the impact of the project, and so on, is then related to the desired level of service and to other planning considerations. At this point the phases of remaining work on a project can be more accurately determined, and, if the project continues to meet the objective of the plan, the schedule in the short-range program can be brought up to date.

The preceding paragraphs discuss project planning and development as a phase of the programming process. This is the case when a project has been assigned a preliminary cost estimate and has been included, with a tentative construction date, in a published program. Project planning and development is not necessarily a part of programming, however. More and more, in all forms of transportation, projects are receiving serious analysis so that their potential can be assessed before they are included in the agency's published program.

The testing and analyzing of projects in a project development bureau is related also to the practice of overprogramming, or, more correctly, overproducing. The project development bureau may have twice as many projects under analysis and development as construction funds would permit. So that there are no credibility gaps with the public, a project is not listed in the official program until an agreement on project scope has been reached and most of the uncertainty about the project has been eliminated. Therefore, project planning and development is a major factor in the programming process but is also a major transportation agency activity that functions separately from the programming process.

6. Combined Listing (Second Draft)

As has been indicated, programming is not an orderly process in practice; virtually no jurisdiction follows a carefully prescribed, step-by-step development as suggested by the 15 steps in the basic programming process. An exception would be an agency that, under new leadership or a new policy emphasis, makes a total review of existing projects and programs. The emphasis today in the highway field would be on cutting out projects rather than adding new ones. The concern was expressed in several states that "we are losing our credibility with the public. We are promising hundreds of projects we can't deliver."

The first draft of the combined list (Step 4) refers essentially to new projects initiated by a variety of sources. In the second draft, Step 6, the old projects are combined with the new projects to make a large list that will have to be reduced. These projects will have received various degrees of advanced analysis and prioritizing. There are always some new projects that have received intensive analy-

sis. Other new projects may have received some advanced analysis, still others virtually none. The old projects would include those that had been in a previous program (some actually under stage construction) and others that had not been in a previous program but were found to have some priority as a result of advanced analysis.

Ideally, all these projects would be compared on a uniform basis, and those with the highest technical priority would be selected. As a practical matter, the factors listed under nontechnical prioritizing, such as position in pipeline, become important because a program must be produced and implemented.

7. Financial Analysis

The two fundamental issues to be addressed in financial analysis are how much is available and how much is committed. Most transportation funds are earmarked for a specific use and not totally flexible. Most funds come in the form of categorical grants or must be apportioned geographically, if not by formula then as a means of practical political expediency.

There are five components of financial analysis:

1. Categorical grants.
2. Geographical distribution.
3. Fiscal-year projections (fund forecasting).
4. Manpower analysis.
5. Financial modifications.

A more extensive discussion of these five components is contained in Chapter Three; a few summarizing comments are presented here.

Funds allocated by Congress are limited to certain categories of work. Broad categories, such as urban-rural and construction-operation-maintenance, are explicitly subdivided, often into many categories. Although the states complain about this federal action and want more flexibility, state legislatures often make categorical assignments that seem arbitrary to the cities.

Although some long-standing categories are slowly being modified to give more flexibility, there does not appear to be a willingness to grant total flexibility to the lowest possible level of government. For the programmer, consistency in the dedication of funds helps prevent the chaos that might result if there were total funding flexibility. Of course, the programmer must keep up to date on all categorical accounts and on forecasts of anticipated future income and debits.

Regarding geographical distribution, the general political philosophy is that "everybody gets something." Although a practical approach, this spreading out of funds undermines not only the ability to complete major projects that traverse several subregions but also the ability to assign funds to projects that have the highest over-all priority, inasmuch as funds are assigned to the highest-priority projects in the region to which the funds have been apportioned, in the category to which the funds have been allocated.

Fund forecasting is a continual and complex process, and the programmer usually shares responsibility for this process with the financial officers in the administrative branch of the agency. The programmer is concerned with matching projects with available project funds, taking advantage of all funds, not allowing funds to lapse, and so on. The financial officer is concerned with overseeing the total cash flow and all budgets, obtaining short-term interest if possible, perhaps floating bond issues (but of minimum magnitude and at best market opportunities). It may be appropriate to delay or advance projects, depending on the department's total financial situation.

Fund forecasting requires estimating the amount, timing, and restrictions of federal funding; estimating state matching amounts and their timing; estimating surpluses or deficits in state revenues and determining how the surpluses can be used and the deficits overcome; estimating manpower requirements and various related expenditures; relating commitments to cash flow; and constantly monitoring and modifying perhaps dozens of accounts, project timing, and staging.

In formulating a program, the programmer uses the current best estimate of what the financial situation will be each year for as many as ten years into the future. Within days of setting a final program, changes in project status, inflationary cost trends, federal or state revenues, and many other factors may require alteration of program projections.

8. Preliminary Program

The programmer puts together the first program, combining the list of projects with available (projected) funding. This program includes all necessary breakdowns, such as fund source, geographical distribution, and a schedule that includes the timing of at least such major phases as environmental and feasibility studies, preliminary engineering, acquisition of right-of-way, final design, and construction.

A priority order is given whenever possible, and each category is overprogrammed either by a preset, authorized percentage or by an amount the programmer considers reasonable, based on experience. Again it should be pointed out that, particularly in the highway field, this is not a new program as much as a reorientation and an addition to an old program.

A series of staff meetings is held to revise and improve the program. All jurisdictions want to present a program in which the department head will make few, if any, changes. Knowing the department head wants to please the elected head of the executive branch, department staff are sensitive to the philosophies and goals of the administration. There is thus a great deal of give-and-take at the middle- to upper-staff level in preparing the preliminary program so that only unavoidable staff differences will be taken to the department head.

9. Executive Session

In many jurisdictions top staff meet with the department head to select a final preliminary program for publication. This final executive session may have been preceded by several meetings, perhaps even regular staff meetings, at which the program was discussed; but usually there is one

culminating meeting. In one jurisdiction this meeting is picturesquely referred to as "bloody Saturday"; top staff meet with the department head on a Saturday morning, when there will be no interference from critical telephone calls or emergencies, and go through the program item by item until a final program is hammered out.

In interviews, several department heads claimed to be uninterested in program details or individual projects and claimed their staff meetings were policy-oriented, not project-oriented. Interviews with lower staff revealed that, although this was generally true, the department head would approve the program "as long as it contained the things we discussed"—in other words, the emphasis or projects considered critical by the department head and the department head's boss, the executive branch head.

10. Short-Range Program (First Draft)

Following the executive session, or with departmental approval, a first draft of the short-range program is published. It may be sent to key members of the executive and legislative branches for review. Usually there must be consultation with key advisors in the executive branch and key committee members and leaders in the legislative branch so that their support may be gained.

This publication will not be their first contact with or understanding of the short-range program. There may have been public hearings or informal reviews to assure key politicians that their projects are to be included in some form to apprise them of why they had to be omitted. However, there is an element of distrust between the executive and legislative branches in almost every jurisdiction at any level of government. The legislative branch wants to see everything in print.

11. Executive and Legislative Review

Before a program is formally adopted, the first draft of the short-range program usually is reviewed with the governor's staff and the legislative leadership. Politicians do not like surprises. Even when the governor and legislature are of different parties, a working relationship of some type has been established among the governor's office, legislative leaders, and staff personnel.

The legislative body, whether a state legislature, a city council, county commissioners, or town selectmen, either must appropriate the funds for a program or are in a position to defeat or alter the text of the appropriation. There is some give-and-take, and a compromise usually can be reached.

There is a trend toward line-item budgeting, in which the legislative body lists the projects that can be built with the funds appropriated. This is considered a very unfortunate development by transportation professionals who prefer flexibility in order to adjust to changing conditions. Line-item budgeting can also defeat the priority programming process by substituting legislative priorities for carefully developed staff priorities. Compromise is often necessary on a few controversial projects so that flexibility for the majority of the program can be maintained.

12. Short-Range Program (Final Draft)

When the homework has been done well, there is little difference between the first and the final draft. The final draft becomes the official program of the transportation department. It may be altered by action of the legislative body that appropriates the funds for its implementation, particularly if it is customary to produce a line-item budget appropriating a specific sum for a specific project.

13. Scheduling

The short-range program usually contains a fiscal-year scheduling of the major phases of a project, such as planning, design (preliminary engineering), right-of-way acquisition, and construction. These phases may be measured in percent completion, which gives a good control of progress.

Some jurisdictions develop a much more specific, detailed schedule that includes, for example, progress on planning, feasibility, and environmental studies; dates for public hearings; percent completion of design and right-of-way acquisition; necessary federal and state approvals; dates of advertising and awarding projects; and construction progress in detail. In short, all recognizable mileposts are listed and even programmed in the department computer.

The significance that detailed scheduling has for programming is apparent. In Chapter One scheduling was defined as "the process of developing a timetable of operations to carry out the short-range program." If the program falls behind, the programmer must be ready to substitute. The schedule, then, is the management tool for monitoring the program. The more complete and detailed the schedule, the easier it is for the programmer to make necessary modifications in current and future programs.

14. Monitoring

In Chapter One monitoring was defined as "the process of checking the actual progress and comparing it with the scheduled progress." A program is a living document. The short-range program is probably out of date the day it is printed, and Steps 14 and 15 really go hand in hand.

15. Modifying

In Chapter One modifying was defined as "the process of amending the short-range program . . . because of various factors. . . ." Monitoring and modifying are necessary to keep a program up to date and properly manage its process.

CHAPTER THREE

FINANCIAL ASPECTS OF PRIORITY PROGRAMMING

TWO-COLUMN PROGRAMMING

The 15-step basic programming process emphasizes the project element of programming: the initiation, listing, developing, prioritizing, and so forth, of projects. Financial analysis is listed as only one step in the basic programming process.

In practice, financial analysis is a constant process, just as is programming. The "two-column" nature of programming—one finances, the other projects—is shown in Figure 1. There is a constant interface between the two columns as the programmer develops and monitors the agency's program.

The major legislative appropriations, starting with those from Congress, set the program level for most transportation agencies. In normal years, new appropriations tend to represent a percentage of increase or decrease in established categories, compared with appropriations of the previous year. In the highway field it was assumed that all identified projects in every category would eventually be constructed to nationally accepted levels of system development.

On the left side of Figure 1, the "financial column," it can be seen that legislative appropriations immediately introduce budget constraints. These must be recognized early in the programming process so that the programmer can warn the project development staff that fewer projects than were hoped for are possible or, perhaps, that more will be needed in a certain category. It would be a great waste of time and funds to permit the design of many projects long in advance of funding.

It is important to anticipate the trends in funding, and forecasting becomes a most critical and complicated factor in the programming process. (The actual process is discussed later in this chapter.) The allocations for a current year are known, but because it takes many years to bring a major project to fruition, financial forecasting can dictate management control of project development.

Once allocations are finalized for a given year, they must be adjusted (i.e., reduced) for the needs of previous program commitments. Projects under construction usually encounter unanticipated problems that increase their cost. At this point the remaining available allocations for new projects are known, by category and geographical distribution.

On the right side of Figure 1, the "project column," it can be observed that systems planning and prioritizing is a continuing process that is adjusted as short-range goals are adjusted. A desired level of system development for safety and estimated capacity has been set for continuity and as a guide to project development. Level of system development is directly related to the budget constraints in the financial column, because these constraints may reduce the development level.

To meet the needs of system improvements, a first array of projects is selected, based on technical and nontechnical prioritizing. The needs in each category are cut off at the point where they include critical and emergency projects plus some desirable projects.

The available funds are then matched with the available, desired projects, and, undoubtedly, it is found that the funds are substantially overprogrammed. The broken lines on Figure 1 indicate the primary iteration that takes place. On the project side: not all short-range goals can be accomplished. Should projects be partially built, if possible, or further sectionalized? Should the level of system development be reduced for a less important system? On the financial side: are more funds forecast in a certain category in future years, thus enabling these projects to be put off? Are new federal or state programs developing? Are there other sources of funding for some projects? Will the crunch encourage the legislative body to consider a new bond issue?

The reduced program that is put together may or may not balance; if it does not, another iteration is necessary.

OVERPROGRAMMING

Many highway categories were greatly overprogrammed in the 1960s. Hundreds of projects were in various phases of development. In recent years it has become very clear that many of these projects will not be built. It is now considered a matter of good programming to introduce budget constraints early in the process to prevent the waste of manpower and engineering funds.

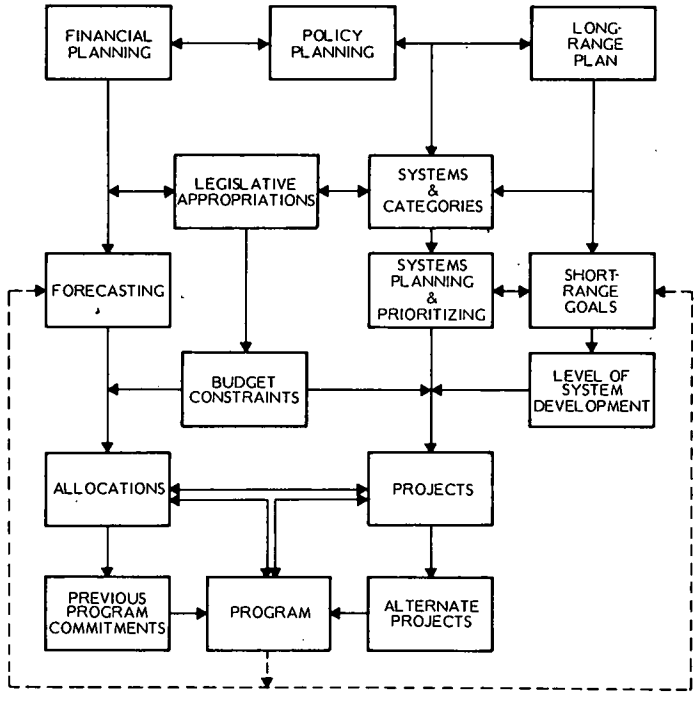

Figure 1. The programming process flow chart.

On the other hand, overprogramming is essential, because slippage or changing needs or priorities may hold up desirable projects. Also, overprogramming maintains an advocacy role for transportation. If projects are well advanced in development and design, and if a construction date can be targeted, there will be pressure to appropriate the funds necessary for construction.

The previous discussion indicates the wide range of programming options available to decision-makers and the resulting difficulties for the programmer who is trying to maintain a realistic program. Hundreds of variables are involved in trying to obtain the correct balance of projects and available funding, and intentional overprogramming adds yet another dimension.

Although occasionally projects are not available to take advantage of available funds, it is not because the programmer did not intentionally overprogram. The extent to which overprogramming takes place may depend on the advocacy role. Interviews indicate that 25 percent would be a minimum overprogramming when larger projects are involved and when some uncertainty exists as to final project approval. For smaller projects, where there is a greater degree of certainty (safety, resurfacing, etc.), 10 to 15 percent overprogramming may be recommended. These percentages represent forecasts for the next two years, a reasonably predictable period of time.

Overprogramming has led to a credibility gap in many states where promises were made that could not be kept. The Florida Department of Transportation has overcome this problem through a plans-in-readiness, or projects-in-readiness, approach. Through advance production, the plans for projects are brought to the stage from which they can be completed rapidly if there is slippage in any of the programmed projects. In all cases the project funds allocated to the districts represent the best estimate of funds available for contract letting. This approach prevents the buildup of expectations that can not be met.

In summary, overprogramming appears to be encouraged not only by pressures outside of every agency but also by the staff of every agency in their effort to ensure that no transportation funds will lapse because projects were programmed inadequately.

CATEGORICAL GRANTS

There are major concerns about the urban-rural split and capital versus operating funds for transportation. The concept that federal funds are to be used only for new capital construction is eroding rapidly, although it has been the philosophy controlling most federal grant and reimbursement programs.

There is usually a struggle between the executive and the legislative branches and between the federal and the state governments to control what is done with available funds. Each believes strongly that the other will not meet proper objectives without proper guidance. The trend seems to be in the direction of adopting the philosophy that decisions should be made at the lowest level of government. The interviews conducted for this project, however, indicate that this will not happen overnight.

The same struggle exists to varying degrees between state and local officials. In many cases the locals want to use available state highway monies to reduce local taxes (and tax rates), which pay local highway maintenance costs. State highway officials prefer to see the money used for safety and road improvements.

The large transit authorities also are very concerned about obtaining all possible funds for operations and maintenance, which would reduce their deficits. There are considerable funds for capital improvements. Transit authorities want to spend as much as possible to improve current operating procedures, which would reduce the number of personnel required; salaries are by far their largest expenditure.

It is obvious that there are pressures to increase flexibility in categorical grants. In the highway field, the states express a desire for much more flexibility than the 40 percent transferability between the federal-aid primary and secondary categories and the 20 percent between primary and urban.

Whatever the complaints at the state and local levels in the past, there were practically no examples of a state or jurisdiction failing to match available federal funds. Now, however, there are reports from several states about the lack of state funds to match federal funds, and significant apportionments may lapse. If this should happen, it might indicate that states with adequate funds can obtain federal grants and that those without can not.

Some legislatures spell out exactly where transportation funds can be used, project by project. Other state legislatures assign a lump sum to a certain category. When a statutory formula for distribution does not exist, the state department of transportation has some flexibility as to which systems or projects or special emphasis programs will benefit. If a governor has expressed concern over bridges and road surface conditions, for example, these programs are certain to benefit.

From a purely technical viewpoint, funds should be assigned to projects that have the greatest need (highest benefit/cost ratio, etc.), but large sums usually are assigned in specific proportions to various categories. This may be the first setback in assigning funds by the most desirable priority; as a practical matter, it is the first refinement in the prioritizing process and starts the process. Furthermore, there are not nearly enough funds to accomplish even half of the desirable transportation projects. It is to be hoped that the funds are allotted in proportion to the needs in each category. To further complicate matters, each category in itself has a different priority if consideration is given to what service is provided, who receives it, in what section of the state (or city) it is provided, how it affects the economy, and so forth. Figure 2 shows the categorical distribution of motor fuel taxes in Florida into various federally designated and state-designated highway categories (*5*).

GEOGRAPHICAL DISTRIBUTION

Perhaps the most concise comment that can be made about geographical distribution is that, over a period of time, "everybody gets something." Politically, in any connotation of that word, no constituency can be or should

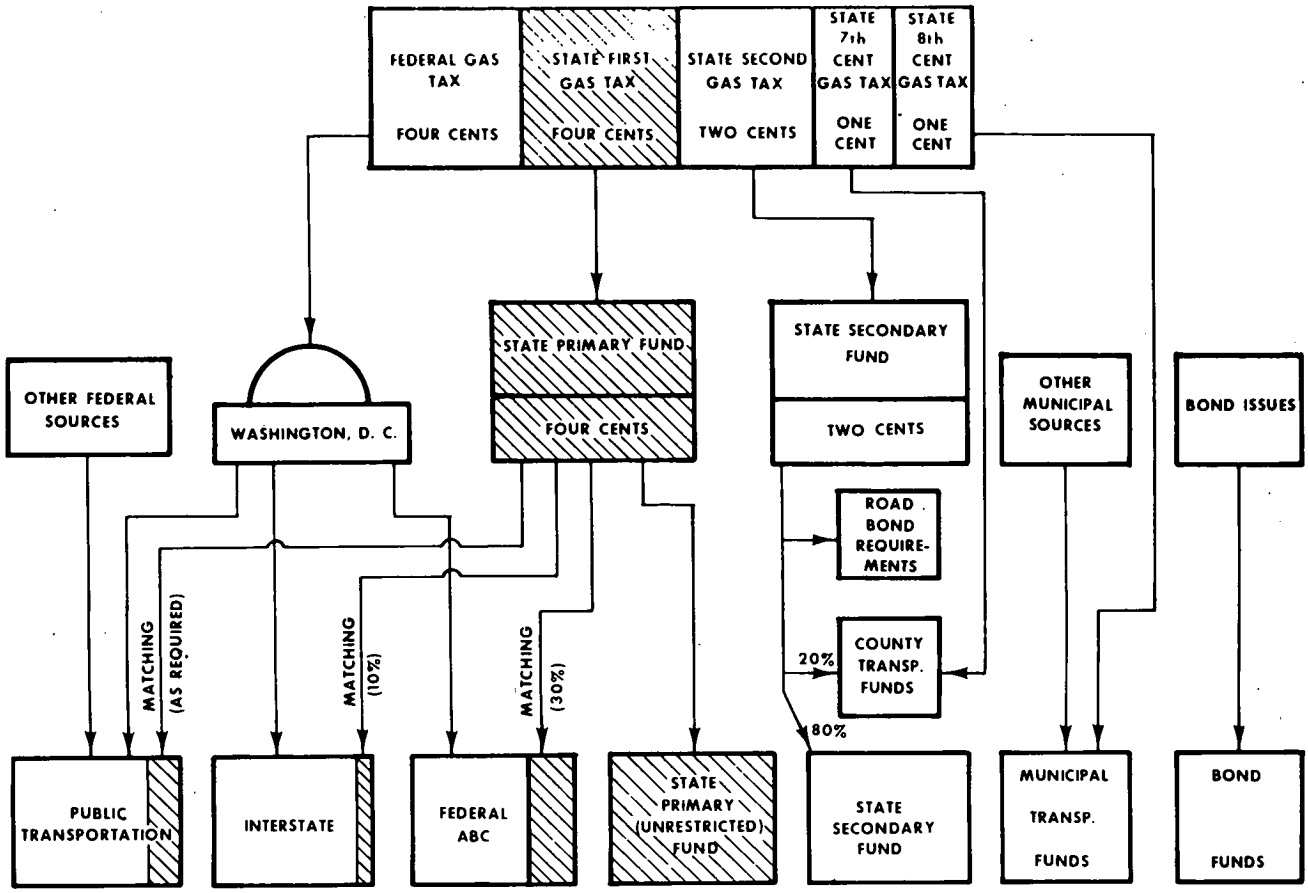

Figure 2. Fund distribution of motor fuel tax (Florida) (5).

be overlooked. Geographical distribution is partly a balance of payments, inasmuch as tax dollars, in some proportion and form, are returned to the area from which they were contributed. This becomes a negative consideration in the case of transit deficits.

Within a state, federal funds that are allocated for urban system highways must be dispersed to areas having a population of 200,000 or greater in accordance with an approved formula or the population ratio. Other than the urban-rural split implicit in federal-aid highway categories, this geographic (population) distribution of highway funds is the first instance of the federal government dictating to the states how highway funds must be distributed *within* the state. Many states are concerned that the state government might be bypassed and that the Federal Highway Administration (FHWA) might eventually deal directly with cities, as the Urban Mass Transportation Administration (UMTA) has been doing with transit authorities.

The creation of the MPOs heightened the fears of some states when the initial directives were released by FHWA-UMTA. Many cities and towns would like to deal directly with FHWA, as transit authorities do with UMTA. State governments believe that the cities are creatures of the state and that giving out funds in small amounts to cities every year could hinder progress on bigger projects. A state can assist a city in building major projects that cost the equivalent of several years' apportionments; the state can assist one city in one year, another in another year, and so on. The states believe that having greater flexibility with federal funding would allow them to do more prioritizing on a statewide basis. In the long run, they believe, the funds would be evenly distributed.

Several states expressed an interesting thought about the TIP requirements. Although still apprehensive about the long-range implications, these states welcomed the transit authorities' listing of future projects as their first real opportunity to develop a view of statewide transit needs.

State geographical distribution may be set by statutory formula or at the discretion of the state department of transportation or highway department. In all states interviewed, even where discretion is possible, there are carefully worked out formulas containing a full explanation of the method of calculation. These formulas do not pertain to major projects but do apply to maintenance funding.

FISCAL-YEAR PROJECTIONS (FUND FORECASTING)

The forecasting of funds for future years is one of the terms in the equation of establishing a program. Funds for the next year or two either are definitely established or can be estimated accurately. However, it is necessary to estimate potential funds for at least five years, preferably ten. Important projects are under design constantly

as the pipeline grinds inexorably on. Generally a project under final design is a committed project. Design takes two to three years on a complex project, as does construction. It is necessary to juggle funds to ensure that sufficient funds will be available when they are needed. For example, it may be possible (or necessary) to set aside funds that would be available two years from now for a project to be constructed three years from now.

The programmer (or fiscal analyst, if financial projections are made by a financially oriented bureau) must anticipate the actions of Congress, state legislatures, and other (regional and local) legislative bodies regarding total amount and categorical distribution. The programmer must also be sure that geographical distribution formulas will remain constant. Obviously, as has been the case in recent years, projections will be incorrect, but they must be made nevertheless so that the basis of the program can be developed.

Although this synthesis is not intended as a thorough textbook on programming, it is intended to convey the great number of variables and complexities facing a programmer. Fund forecasting is at the heart of the programmer's work. It requires a total knowledge of transportation: trends in priorities and funding on the part of Congress, state legislatures, county boards, and city councils; departmental and executive-branch priorities and trends; and project development in various modes for different types of projects and the way projects might be affected by everything from environmental laws and citizen opposition to design delays.

Fund forecasting is easy in jurisdictions where funds are earmarked for capital projects and separately for such operating and maintenance costs as salaries, facilities, equipment, and materials. Although there are manpower requirements to spend capital funds, the gross amount of capital funds (possibly from a bond issue) is known and can be spent until it is gone. As it diminishes, of course, new funding must be anticipated.

In departments operating on a cash-flow basis, programming of capital projects is interwoven with all other expenses of the department. Because the public is being taxed and expects its taxes to be used in an orderly process to produce transportation improvements at the earliest possible date, there is a mandate to anticipate and spend income properly. It is not possible, however, to spend more than the cash flow will support, even by borrowing from available surpluses.

The following six-step process is the general method of fund forecasting.

1. *Forecast future federal-aid apportionments.* These apportionments are usually for a two-year period for highways and may vary for airport and transit projects. For good financial planning, it is necessary to estimate future congressional authorizations for up to ten years beyond the life of the federal enabling act.

2. *Estimate state or local matching requirements.* Federal aid may be in the form of grants, either outright or requiring matching, or in the form of reimbursements for portions of the cost of completed and approved projects. A schedule of cash flow must be worked out so that federal aid can be accepted.

3. *Estimate other departmental cash requirements.* Every department has cash requirements for salaries, facilities, equipment, and related expenses. It may be necessary to borrow from cash pools when budgets and cash flow do not coincide. In states where highway taxes are dedicated, these taxes must support the operating budgets of several departments as well as pay for capital projects.

4. *Forecast various revenues.* In addition to federal aid, revenues available to transportation include gas taxes, motor vehicle fees, general funds, tolls, sales of bonds, and income (such as surpluses) that may be available temporarily. Portions of these funds may be dedicated for special purposes. Trends in population, motor vehicle registration and use, and many other factors must be monitored so that accurate forecasts can be developed.

5. *Forecast funds to be available in every category.* Knowing the anticipated revenues and the funds required to match federal aid in every category, it is possible to estimate the surpluses or deficits in each category. In addition to federal-aid categories, there are 100-percent-state funds, in which matching federal aid is not a factor. In many cases portions of state gas tax funds are dedicated to specific categories, such as local road improvement. There may be a predetermined formula, even a statutory formula, for distribution of these funds.

If surplus funds are available, their distribution among a variety of categories must be determined. This distribution may be guided by an over-all transportation needs study that was conducted in the past. If needs were determined by state region, for example, funds may first be allocated geographically and then assigned in terms of critical projects in that region rather than assigned proportionately to certain categories. Flexibility of this type is rapidly disappearing in the highway programs of many states where the 100-percent-state funds are unavailable and it is even becoming difficult to match federal aid.

In any event, in this step the specific amounts of cash to be available for specific periods in the future are forecast in all categories.

6. *Convert available cash into commitment authority.* In Step 1 federal-aid apportionments were forecast. For reimbursement programs, federal aid was automatically in the form of commitment authority. In Step 6 the cash from Step 5 must be anticipated and projects undertaken well in advance so that cash availability can be taken advantage of. For construction projects the cash is not required until the work is performed by the contractor, although there will have been cash flow for the design phase, right-of-way acquisition, and so on.

A serious problem faces forecasting in the highway field: the depletion of projected funds that results when (a) income from gas taxes levels off as motor vehicle registration levels off and vehicle miles per gallon increase; (b) inflation greatly increases project costs; and (c) legislative bodies redirect gas taxes to other programs for the purpose of underwriting increased costs in all phases of government.

The picture has changed drastically from what it was in the 1960s. From 1954 to 1970 states were spending money for highway projects at a rate far in excess of meeting federal matching requirements. Only 3 of 48 states had excess expenditures of less than 10 percent of their total ABC expenditures. The range was 3.4 to 69.4 percent over and above minimal matching requirements expressed as a fraction of total expenditures on the ABC systems. In one year, 1963, New York spent $60.315 million to match federal aid but spent in excess of $200 million in state funds (*6*).

By contrast, at the end of 1976 FHWA reported that a shortage of state matching funds had slowed down programs in at least 18 states. Further, state highway and transportation departments obligated less than 70 percent of the federal-aid highway funds available to them in fiscal year 1976 (*7*).

Figure 3 shows the type of forecasting the programmer must do and the problem created by the anticipated lack of highway funds (*8*). In 1976 the Texas State Department of Highways and Public Transportation projected available state revenue to the year 2000 at then current rates (*8*). Three projections were that (a) by 1981, no construction funds would be available to build 100-percent-state-financed projects; (b) by 1982, state funds would be insufficient to match any FHWA Urban Systems funds; and (c) by 1985, state funds would be insufficient to match any FHWA funds except where special General Fund appropriations permit. (Since these projections were made, additional revenues have been provided by the legislature, and the projections are no longer valid.)

Because the programmer has the best grasp of the project-fund relationship, it is the programmer's job to alert the decision-makers as to the dates by which major decisions must be made for future years. Time and effort should not be wasted on designing projects that will not be funded. If they are to be funded, additional sources of funding must be lined up well in advance.

The preceding discussion relates to the highway program, by far the largest and most disciplined of the federal-aid or state transportation programs. A look into the future indicates parallel problems in the transit field.

The projections in the highway program serve as a warning that there will be pressure at the state and local levels to eliminate all matching funds and turn all federal programs into grant programs. Without the state and local matching funds, the federal-aid programs will shrink. Again, the programmer must look ahead and anticipate these cyclical developments to maintain a balanced program.

MANPOWER ANALYSIS

Studies, environmental statements, design, acquisition of right-of-way, and construction all require the guidance of experienced supervisory personnel. In-house forces in any jurisdiction are seldom capable of carrying out all these supervisory functions.

A manpower analysis is therefore necessary so that a determination can be made regarding the need for obtaining consultants, shifting personnel within the department,

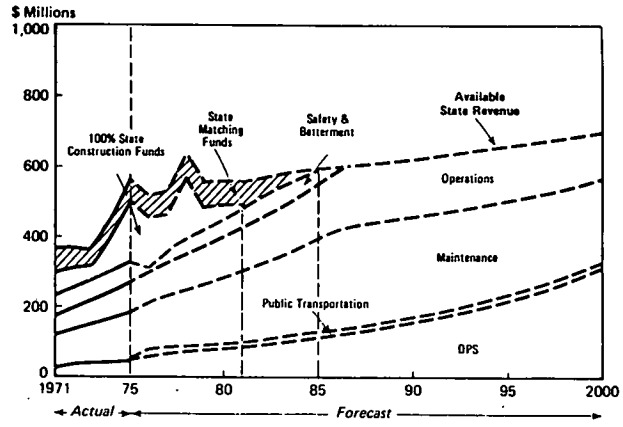

Figure 3. Application of available state revenue (Texas) (8).

or borrowing personnel from other agencies. Although this analysis is often not a function of the programmer, the results of such an analysis can affect the amount of funds set aside for these assignments. If the mix of in-house and consultant projects is not anticipated, projects may not enter the design phase when expected.

Although manpower analysis could be considered a basic aspect of programming in itself, to the programmer it is a function of timing and funding; it is thus listed here as one of the components of the financial aspects.

FINANCIAL MODIFICATIONS

The programmer may develop a five-year program, including all high-priority projects, that is acceptable in every way except for distribution of funds. It may be possible to juggle 100-percent-state funds and federal-aid funds in such a way that most of the high-priority projects can be included and the objectives of the five-year program can still be accomplished. For example, projects not intended initially as federal-aid projects may be submitted for federal aid, and the 100-percent-state monies thus made available would be used to balance geographical distribution.

Another financial modification is the correction of cost estimates of projects under construction because of such things as inflationary increases, unexpected construction (blasting, poor soil, additional drainage), and add-ons (lighting, additional transit equipment, beautification).

The initial estimate of project cost may increase greatly by the time design is completed. This and a hundred other factors associated with projects already in a program, projects carried on into succeeding programs, and new projects are constantly changing the over-all program.

Some jurisdictions are also involved in the time-staging of investments. The Ontario Ministry of Transportation and Communications has been working for several years on priority-programming techniques that achieve the objectives for a given period and also optimize the investment of funds (*9, 10*). These techniques and others, such as the "Highway Investment Analysis Package" that was developed for FHWA (*11*), are important to financial modification because, even if projects are selected by the use of less technical, more politically oriented techniques, the time-

staging of the projects might provide the optimum return from the funds invested.

One final point should be made in this chapter. In most large departments, long- and short-term financial planning and programming are usually organizationally separated. The University of Massachusetts a few years ago conducted a survey of fiscal planning and programming in California, Illinois, New York, Virginia, Washington, and Wisconsin (*12*). The survey concluded:

> While we find fiscal planning being performed in several different units, the practice is consonant with a sound management concept of proceeding from the general long term policy needs through planning and programming to near term operating needs. . . . The changes projected for the units in the states surveyed indicated that fiscal planning in general will be expected to employ more sophisticated techniques. Greater emphasis on computerization of analysis, more extensive use of cost benefit analysis and greater reliance on models and information systems incorporating social, economic and environmental factors were forecast.

Interviews conducted for this synthesis also indicated the separation between long-term planning and short-term programming. Some agencies use a clearly iterative process: the programmer produces a short-range program, which is reviewed and modified at meetings with long-range planners in give-and-take staff sessions. Changes are limited by the need to obligate funds in certain categories, to apportion funds geographically, and so forth, but the process is obviously iterative. In other agencies long-range planners perform their function only in dealing with systems planning and the development of large projects. The programming function, however, is separate from the planning process, so iteration is minimal; this is a weakness clearly recognized by those involved.

CHAPTER FOUR

POLICY AND SYSTEMS PLANNING

This synthesis is concerned primarily with programming, which is essentially the matching of proposed projects with available resources. Programming should be the natural extension of planning from the study phase to the operations phase.

It is apparent that changes in goals and objectives can change planning philosophies, which, in turn, can drastically change the programming process.

The report of the 1974 Williamsburg conference (*1*) states:

> Perhaps the most important [shortcoming] for statewide planning is the extremely weak ties that have existed with the programming process. The existing planning techniques are generally used only to provide volume estimates for the location or design engineer. In only a relatively few cases have systems planning techniques been considered a vital part of determining priorities and the programming process.

Efforts are still being made to bridge the planning-programming gap. *NCHRP Report 179* recognizes that the planning-programming process is still in the evolutionary stage (*13*). The work on which the report was based is ongoing, and it has the following objectives:

> The general objective of this research is to provide transportation planning methodologies that will be policy-sensitive, allowing the testing and evaluation of options in a fashion that will produce timely results for decision-making. This research addresses reasonable-cost, sketch-planning-type techniques having an application to issues of statewide transportation planning as part of the programming process.

CHANGING TIMES

The programmer must select projects that lead to the accomplishment of a long-range plan. In recent years, environmental, economic, and energy considerations have led to changing philosophies, goals, and objectives. There is a tendency to unbalance programs to favor modes with secondary (nontransportation) benefits: less air pollution, less fuel (energy) consumption, less social impact, and the like.

The programmer faces uncertainty not only in the long-range plan but also in the ability to accomplish individual projects. A few recent developments are noted below.

In a report entitled "New Directions for Penn DOT" (*14*), a fiscal review task force states in part:

> The Task Force recommends that a broad reversal of priorities recently initiated by the Department be given additional impetus. For the future, these priorities should be:
>
> A. Preservation of our existing highway plant.
> B. A capital program viewed as enhancing the maintenance function.
>
> This order of priorities is consistent with the wishes of the public as well as the Legislature—as demonstrated by the fact that the last two revenue increases were specifically earmarked for maintenance.

The California Department of Transportation listed these four priorities (as published in the *Los Angeles Times*, July 15, 1976) for an era of limited highway funds and changing transportation needs:

1. Maintain existing roadways.
2. Develop projects designed to limit congestion.
3. Close gaps in the system.
4. Build new roadways.

The introduction to the Florida Department of Transportation's "Construction Plan, July 1, 1975 through June 30, 1980" (*15*) states in part:

> The Department has progressed through a number of very trying periods this past year brought about by a shortage of revenues and extraordinary inflation rates. The slow down in revenue and the rapid cost increases due to inflation have had a tremendous impact on the Department's Five-year Construction Plan and Work Program. These factors have caused the Department to defer projects that had been planned for letting. Although the Department has been able to continue its Federal-aid program without interruptions, many critically needed projects funded with state 100 per cent monies are not funded.

Clearly, we are in a period of changing times and changing philosophies. More and more authorities have decided not to meet the capacity needs of the automobile in the future, at least for the peak commuting hours. With conservative projections of a 50 percent increase in motor vehicle mileage indicated for the late 1980s, adequate capacity for even off-peak volumes in the future is in question (*16*). One philosophy, simply stated, is "we will not build highways that compete with transit." However, with transit deficits on the rise (according to one source, up from $11 million in 1965 to $1.7 billion in 1974 and rising rapidly), the future of transit is not too clear.

All this leads to the conclusion that for the next five years or more, as new experience is gained, new problems arise, and economic crises become more varied, there probably will be constant changes in transportation philosophies. Philosophical changes will lead to policy changes, planning changes, and, in turn, program changes. However, it is expected that throughout this changing era the fundamentals of systems planning and functional classification will prevail. In other words, while goals and objectives change, the attainment of the new goals will be planned in terms of systems.

Systems planning is the form of planning that is most closely related to programming and appears to have the greatest application for the next few years. Systems planing indicates a practical, bottom-up effort starting from population and economic forecasts and ending with a physical description of the facilities required to meet projected transportation needs. Systems planning usually is oriented more for corridor or regional development than for large-scale, statewide planning efforts, which are more policy-oriented. It is doubtful in these changing times that many states, much less their subdivisions, will consider new comprehensive or transportation plans that seem destined to be outmoded before they are completed.

In the course of preparing this synthesis, it was found that thoughtful planners and programmers expressed concern—even a sense of guilt—for the lack of development of new transportation plans that incorporated many of the new ideas and philosophies of recent years. Yet they also expressed the futility of looking beyond five years into the future. To quote one state planner, "Anything beyond three years becomes very fuzzy."

TIES BETWEEN PLANNING AND PROGRAMMING

What are the specific ties between planning and programming today? Figure 4 shows how certain planning factors affect programming. There could be a long, involved argument about whether programming is a part of planning or vice versa. The determination of new systems is clearly planning, as is setting the initial priority of projects within those systems. When available funds with predetermined allocations to geographical regions and various categories are superimposed on the priorities, a juggling act begins. It is complicated by commitments to other agencies, a desire for route continuity, the need to meet emergencies, and a host of other factors.

The programmer attempts to present a balanced program that comes as close as possible to meeting the letter of the law for such factors as geographical distribution. The programmer may not make it in the short run but must in the

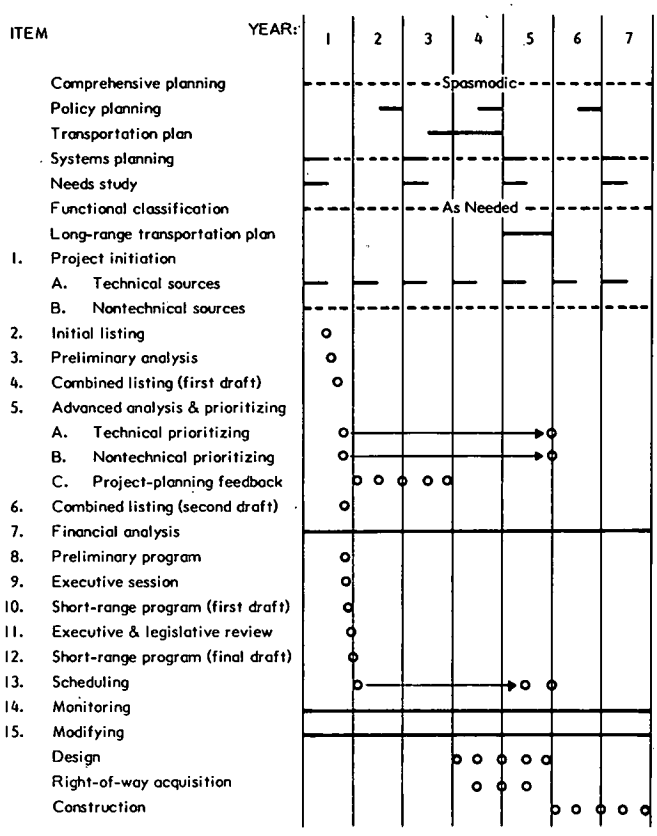

Figure 4. Planning, programming, and design process phasing.

long run. The programmer may find a variety of ways to achieve a balanced program. The outstanding programmer constantly looks back to the planning goals and objectives. This check by the programmer functions as the tie between planning and programming as it is practiced today.

Figure 4 covers a seven-year period, which is an average (minimum) time in which to accomplish a major project in the range of $5 to $10 million today. The broad time periods are as follows: one year is needed for the project's initial study, planning report, and inclusion on the list of active projects; two years are needed for assessing the project's social, economic, environmental, and ecological impacts and for reviewing public hearings and developing alternatives; two years are needed for design; and two years are needed for construction. All forms of slippage can extend this period, but seven years seems to be a realistic minimum.

The solid bars in Figure 4 represent a function that is continuous and that relates to all projects. The small circles indicate the progress of a single project through the many steps leading to construction. At almost any point in the long process of planning, programming, project planning, and design, progress on a project can be interrupted and the steps leading up to the point of development repeated. Following are comments on each type of planning.

Comprehensive Planning

In interviews, most jurisdictions indicated that comprehensive, land-use planning does not have the influence it should have on transportation planning. In fact, most transportation officials interviewed consider that they have contributed more to comprehensive planning through transportation planning than any structured, consistent comprehensive planning effort has contributed to transportation. In many states the role of the state planner is ineffectual. Comprehensive planning is thus depicted in Figure 4 as continuous but spasmodic. A-95 review procedures have been the one consistent tie between comprehensive and transportation planning, and the development of metropolitan planning organizations (MPOs) can be expected to have an increasing impact.

Policy Planning

This top-down process leading to a set of coordinated policy decisions generally peaks at two-year intervals. In past years policy planning usually was left to transportation professionals and was reviewed by elected officials. However, as transportation issues have become more controversial and therefore more involved in politics, new policies are becoming related to biennial elections and the philosophies that the newly elected officials bring to office. In considering the steps shown in Figure 4 for a specific project, it is assumed that policy planning has produced a defined set of goals and objectives at the end of the year prior to the start of the figure. Systems planning, then, begins with the start of the figure and results in modifications of previous systems, changes in level of service to be satisfied, and so on.

Transportation Plan

Few jurisdictions are talking about an effort to do a major new transportation plan. As the 1980s approach, however, it can be expected that a new look at the problems of the next decade will produce new transportation plans that are based on new philosophies; this is why Figure 4 shows a transportation plan effort in the third and fourth years. With a minimum project span of seven years, such a major new effort could trip up some projects currently listed in short-range programs and compound the problems of programmers.

Systems Planning

This is the phase of planning closely related to programming. The planning and updating of networks, corridors, and related projects is the area the outstanding programmer looks to when juggling the funds and projects available. Changes in systems planning cause changes in the priorities that the programmer gives to projects when making adjustments to the schedule. Most agencies constantly need systems planning policies to guide day-to-day decision-making, especially with regard to level of system development.

Needs Study

A needs study is part of systems planning and is shown in the same time period on Figure 4. A general needs study usually is a sampling of over-all systems and does not necessarily prescribe specific project improvements, programs, or priorities. However, many jurisdictions make an in-depth study of, for example, resurfacing or structural problems. The jurisdictions call such a study a "resurfacing needs study" or a "bridge needs study"; these studies are covered under Step 5 of the basic programming process.

Functional Classification

Because of such factors as the planning or construction of a new route or bypass, the functional classification of a route on which a project is located may be changed. This change may affect the priority of the project, even if the project is under design.

Long-Range Transportation Plan

Figure 4 shows a new long-range transportation plan in the fifth year, following a new transportation plan. Most jurisdictions are in the process of cutting back the number of highway projects in their long-range transportation plans. The TIP requirements for MPOs in urbanized areas include a transportation plan containing a long-range element, a three- to five-year program, and an annual element.

Listed below the long-range transportation plan in Figure 4 are the 15 steps in the basic programming process. It is apparent that the long-range transportation plan should be the management tool for tying planning to programming. It is also apparent that the long-range transportation plan must be a living document, constantly changing with feedback from the programming process.

The feedback comes from four elements in the program-

ming process, and they are the key elements leading to a short-range program as well. Each has important subdivisions, any one of which may be critical for a particular project. The four elements are:

1. Technical prioritizing.
2. Nontechnical prioritizing.
3. Project planning and development.
4. Financial planning.

PLANNING VERSUS PROGRAMMING

It is strongly desired today that programming not be substituted for planning. Also, as stated earlier, the Williamsburg (*1*) and Orlando (*2*) conferees were concerned about the lack of ties between planning and programming.

The breakdown appears to come in the perception of programming and its key elements in relation to the planning process. If the four key elements listed above are considered a continuing part of the planning effort, the ties between planning and programming will be close. Specifically, if the planners involved with producing and updating the long-range transportation plan constantly monitor these four elements as they relate to projects, modify their systems planning policies for changing times, and translate this systems planning into an updated long-range transportation plan, then programming and planning will be inseparable.

If the four key elements are considered only a means for producing a short-range program so that available funds can be expended, planning and programming will be separate.

In practice, top-level staff follow only a few major projects in detail. However, it is top-level staff that must set policy to guide the agency. It should be interjected at this point that third-level staff make the majority of project decisions in terms of sheer number. Third-level staff (in a large agency) consists of the division or bureau heads and regional administrators. Second-level staff consists of their supervisors, such as the assistant secretary, highway or transit administrator, or chief engineer. First-level staff is the secretary or commissioner.

Large departments produce hundreds of projects annually. The prioritizing and selecting of smaller projects is done at the third staff level. The third level should be guided by policy approved at the first level. It is at the third level that policy is actually applied. Policymaking should be a constant, iterative process: if it originates at the third level, it should be approved at the first level; if it originates at the first level (or above, e.g., the legislature or governor), it should be tested at the third level for its practicality of application before being formalized, or it could disrupt many projects and the financial planning for their implementation.

The above paragraphs concern day-to-day policy for systems planning rather than top-down policy planning. Of course, a buildup of lower-level policy decisions leads to major policy changes.

The departments and agencies in which there is a constant, iterative process between planners and programmers and between third-level staff applying policy and first-level staff approving policy appear to be those in which programs are closely related to planning objectives. In departments and agencies where the planning staff either is restricted from a constant review of programming or abdicates its role of program review and planning guidance, the ties between planning and programming are very weak.

CHAPTER FIVE

PRIORITIZING

Prioritizing is the over-all process of producing a rank order of priority projects and project sections on the basis of technical and nontechnical, quantifiable and nonquantifiable factors.

In the 15-step basic programming process, prioritizing is separated into technical and nontechnical elements (see Table 1, Steps 5A and 5B). Figure 4 shows prioritizing beginning after the combined listing of projects in the first draft and continuing even through the design stage. Technical and nontechnical elements are combined when decisions are made. There are increasing efforts to combine nontechnical, nonquantifiable elements into more of a technical prioritizing process when developing a rank order of priority projects.

Obviously, prioritizing is a very complex process that defies a simple breakdown into two elements, such as technical and nontechnical. These two elements are constantly interacting, and many final decisions are intuitive. It is rare that a decision regarding a major project is based on technical data only, although technical data can have a strong influence on a go, no-go decision. Also, technical factors are often the major determinants of the priority of hundreds of smaller projects. However, a nontechnical factor—for example, the inappropriateness of a project for

the time or conditions—can terminate the technical analysis of that project.

Table 2, based on the interviews and research conducted in the preparation of this synthesis, gives a list of various types of prioritizing now in use. The table lists three major types of prioritizing: technical, nontechnical, and financial (categorical-geographical). Financial prioritizing refers to the process described in Step 7 of the basic programming process. This type of prioritizing is not specifically project-related, but it has a significant impact on which projects are constructed and how they are selected.

TECHNICAL PRIORITIZING

Table 3 gives a list of factors now being considered in technical prioritizing. The early techniques, such as sufficiency ratings, used only the very definitive factors at the top of the list. In recent years other factors have been added to the list—first the quantifiable SEE factors and then the nonquantifiable SEE factors and other nonquantifiable factors to which some weighted value might be given.

Research efforts are being directed toward combining all these factors in one rating. Obviously, some factors defy any effort to be assigned a point value or even some type of weighting. The implication of technical prioritizing is that a person or staff having technical training could evaluate all important factors and come up with a "magic number" for ranking all projects. This would completely remove politics, in its negative connotation, from influencing the spending of available transportation funds.

This approach contains one drawback. Dozens of factors may be involved in technical prioritizing. Each has its own point value assigned by a technician. This value is then taken for granted as the proper value and used in further computations. In fact, however, this value can be greater or less than the appropriate value, depending on (a) the particular project, (b) the set of projects, or (c) the relationship of the factor in question to all other factors, which can change for various reasons, including project timing.

This is not to undervalue technical prioritizing. It can be particularly useful in dealing with large numbers of small projects, such as TOPICS (safety in urban systems) or resurfacing projects.

Further, if all other factors are of equal value, especially the nontechnical prioritizing factors, a priority rating is most helpful in guiding decisions. The mere presence of a carefully developed priority rating influences the programming of projects in many, if not all, cases. In relation to large departments that deal with hundreds of projects annually, interviews conducted for this synthesis make it apparent that the programming process is too complicated for most legislators, local officials, and special-interest groups to understand. There are exceptions, but they are usually technically oriented individuals. Those who do

TABLE 2
TYPES OF PRIORITIZING

- A. Technical
  - (1) Sufficiency ratings
  - (2) Priority ratings
  - (3) Option-evaluation techniques
    - a. Comprehensive
    - b. Sketch planning
- B. Nontechnical
  - (1) Political commitments
  - (2) Legislative mandate (line-item budgeting)
  - (3) Emergency
  - (4) Special emphasis
  - (5) Commitments to other agencies
  - (6) System continuity-connectivity (missing links)
  - (7) Position in pipeline (project readiness)
    - a. Certainty
    - b. Uncertainty
- C. Financial (categorical-geographical)
  - (1) Appropriations
  - (2) Categorical
  - (3) Geographical
  - (4) Rate of return

TABLE 3
FACTORS INVOLVED IN PRIORITY RATINGS

QUANTIFIABLE FACTORS

Physical condition (deterioration): road surface, pavement structure, foundation, shoulders, drainage
Geometrics: pavement width, shoulder width
Alignment: horizontal, vertical
Bridges: condition rating, operating rating
Safety rating: accident totals and/or rates
Capacity rating: volume/capacity
Benefit/cost rating
Cost-effectiveness index
Recreational use
Social: families displaced
Economic: businesses displaced, direct routings, jobs during construction, use of air rights
Environmental: air-noise-water pollution

NONQUANTIFIABLE FACTORS

Social: neighborhood cohesion, minority-elderly-handicapped impacts, disruption, proximity
Economic: build vs. no-build, economic base, mobility, accessibility, employment after construction
Environmental: effect on natural resources, aesthetics, water pollution, vibration, noise
Land-use impacts: future development, community standards
Transportation need
Uncertainty: public support, court cases

INTERRELATIONSHIPS

Impacts on connecting facilities
Impacts on competing facilities
Stage construction
System continuity
Agreements and commitments (other agency plans)

understand the complexities of programming and realize the difficulties faced by the transportation agency tend to accept the process being used, except perhaps in the case of their own projects.

Technical prioritizing techniques are necessary, are important, and should be improved, but they must be kept in proper perspective. Some of the priority ratings may not be worth the time and effort for data collection and processing if they will not influence large allocations, and shortcut methods may be used to equal advantage. It is interesting that all officials interviewed, including those intimately involved with their department's preparation of priority ratings, accept the fact that technical priorities can be outweighed by other factors in the process of project selection.

Studies such as *NCHRP Report 179* present more complete information on all prioritizing methods and factors, particularly on sketch planning (*13*). Sketch planning is extremely interesting, because it is an effort to capture in a technical process the broad political decision-making process responsible for most major decisions.

A good beginning for the study of technical prioritizing is the 1973 FHWA report "Objective Priority Programming Procedures," which reviews the procedures that were then in use in all state highway programs (*17*). The earliest and simplest ratings were sufficiency ratings, which were based on the structure, service, and safety of the section of roadway. The early sufficiency ratings did not consider traffic volumes, accidents, or SEE factors. They were, and still are, deficiency ratings in the many states where they are used. It is important that this is understood in an era when the fundamental objective in many states is to "maintain the existing system to prevent further service deterioration" (*18*).

Many states today, including several of those interviewed, prepare sufficiency ratings, usually on a biennial basis, and have done so for 25 years or more. The FHWA report (*17*) presents a good summary on sufficiency ratings:

> Sufficiency ratings have proven to be very useful as a tool for highway priority planning. The basic simplicity of the system has resulted in its wide-spread acceptance. A major shortcoming of conventional sufficiency rating methods, however, is their failure to directly evaluate significant economic factors. The methods identify problems in existing sections of roadway, but do not identify alternative improvements, specify optimal solutions, or consider timing or budgetary constraints. Consequently, when prioritization is based solely on conventional sufficiency ratings, neither the cost nor the effectiveness of improvement programs is considered. Finally, as presently used, sufficiency ratings do not apply to new highways.

The next generation of ratings, which incorporates traffic volumes (or volume/capacity factors), accidents or accident rates, and SEE factors, is referred to as priority ratings. Below is an outline of the evolution of priority ratings.

1. Sufficiency (deficiency) ratings
2. Priority ratings
   a. Addition of safety factors (accident totals, rates, specific locations)
   b. Addition of capacity factors
   c. Addition of economic factors (e.g., benefit/cost, cost-effectiveness, displacement of businesses, jobs during construction, direct routings, use of air rights)
   d. Addition of quantifiable social and environmental factors (e.g., displacement of families, air pollution)
   e. Addition of nonquantifiable SEE factors *
      (1) Social (e.g., disruption, proximity, neighborhood cohesion, minority-elderly-handicapped impacts)
      (2) Economic (e.g., economic base, mobility, accessibility, employment after construction, land-use impacts)
      (3) Environmental (e.g., aesthetics, effect on natural resources, water pollution, vibration, noise)
3. Option-evaluation techniques
   a. Comprehensive
   b. Sketch planning

Number 3 above, option-evaluation techniques, indicates the third generation of technical prioritizing methodologies. It refers to the more sophisticated techniques that attempt to be all-encompassing. A word of explanation is in order about the two suggested types, comprehensive and sketch planning.

Comprehensive methodologies attempt to provide optimal project selection and maximum return on investment. Work by the Ontario Ministry of Transportation and Communications (*9, 10*) and FHWA's "Highway Investment Analysis Package" (HIAP) (*11*) are recent developments in this area.

Sketch planning is intended "to test and analyze policies and programs at a broad scale without delving into the specifics of project development and implementation" (*19*). The North Carolina paper from which this quotation comes also says that the state's work "indicates that sketch planning can be effective and economical as a planning approach. As a decision-making tool, it seems that more time and better reconciliation of conflicts in the public and private sector are needed before full usefulness is accomplished." *NCHRP Report 179* delineates these problems, and the ongoing research on which the report is based will lead to another, more detailed report.

As suggested by Tables 2 and 3, a structured format for prioritizing should be helpful in the determination of what factors are being emphasized, which need greater research, which are of little value or of value only within certain categories or projects, and where there may be gaps in knowledge.

A list of rating systems up to 1973 is covered in the FHWA report "Objective Priority Programming Procedures" (*17*). Although the report concentrates on sufficiency ratings, it also discusses the Arizona impact system.

The Arizona system includes condition (35 points),

* Values or weights were assigned to some of these nonquantifiable factors, but it is doubtful that a consensus would be found on their relative values.

safety (30 points), and service (35 points), to which were added three new factors: environmental (40 points), socio-economic (35 points), and traffic safety (25 points). After discussing this system, the FHWA report then develops its own recommended priority rating with selected SEE factors. Each item under each impact is assigned suggested point ranges for weighting.

Complete as it was in 1973, the FHWA report does not include some of the factors of great concern today. Recent research deals with some of the factors generated by the rapidly changing economic and energy picture, the practical politics of distributing available funds, and the growing opposition to some transportation projects.

An interesting study in this regard was prepared by Juster and Pecknold (*20*). They selected six major elements that most state programming processes are required to address:

1. Multiple and conflicting objectives.
2. Total budget constraints.
3. Geographical constraints.
4. Special-purpose allocations.
5. Network and project interrelationships.
6. Uncertainty.

This is a very practical list of the major elements influencing programming today. Although it may not be all-inclusive, it adequately alerts programmers and other decision-makers to tentative multiple-period investment programs that are reasonably efficient economically and that comply with a variety of funding, legislative, and community constraints.

This does not mean there is no place for complex priority ratings. It does indicate, however, that the place for complex ratings may be in comparing projects and making selections within one category of funding or functional classification.

The interviews conducted in the preparation of this synthesis produced information on a variety of simple ratings, particularly in the highway field. They include bridge ratings, safety (high-accident location) ratings, ridability (surface smoothness) indexes, skid ratings, and even guardrail ratings. Simple as these sound, it is worth discussing one of them, the bridge rating, to show that they are never simple in practice.

One bridge rating, in addition to structural condition, includes service and safety. Safety is the number and monetary value of accidents associated with bridges. Service is a measure of the inconvenience caused if the bridge failed: the cost of travel by alternate routes (for additional gas, oil, wear and tear, etc.) plus an estimate of the value of the time lost. If even a very small value (perhaps $2.00 per hour) is placed on the extra time required for thousands of motorists to traverse a detour route, and if the actual accident costs are multiplied by a factor of 5 or even more, it is difficult to project the accident factor as critical in the priority project selection process. Assume that 20 accidents a year are associated with one bridge, none are associated with a second bridge, and both are in danger of collapse. If the loss of the second bridge would require a detour of a mile longer than would be needed for the first bridge, the second bridge would have the higher monetary priority despite the accident differential. As a practical matter, the accidents may have caused so much public reaction that the first bridge is repaired despite any benefit/cost studies.

One jurisdiction interviewed has an excellent bridge priority-rating program based on detailed structural condition, bypass detour lengths, and land-use considerations. Seven of the ten worst bridges in this jurisdiction were not programmed for replacement, and the following reasons were given:

- Should not be replaced.
- Funds not available; hold for possible new bridge replacement or toll bridge program.
- Dispute over width and encroachment (two cases).
- Withhold until redevelopment plans are complete.
- Dispute on share of funding between adjacent jurisdictions.
- Hold for replacement with concurrent road construction.

These bridges were in very poor condition, although none were considered to be in structural danger. The fact that they were not programmed for replacement creates problems for the programmer, because they will bunch up in future years.

In summary, technical prioritizing can have an important influence on project selection, particularly in a large department where there are hundreds of projects and where top staff select most of the projects. Also, technical prioritizing is important within categories in the selection among projects of similar types. Although researchers have made significant efforts to produce comprehensive priority ratings—"magic numbers" for evaluating and selecting projects—it seems very unlikely that in the near future such ratings will take precedence over the factors in the following two sections, "Nontechnical Prioritizing" and "Financial Prioritizing."

NONTECHNICAL PRIORITIZING

The seven items in this category listed below were compiled from interviews:

1. Political commitments.
2. Legislative mandate (line-item budgeting).
3. Emergency.
4. Special emphasis.
5. Commitments to other agencies.
6. System continuity-connectivity (missing links).
7. Position in pipeline (project readiness).

These items may have some technical as well as nontechnical aspects. For example, a Minnesota priority rating system assigns 5 points out of a total of 35 to system continuity (*21*). (Five other items evaluated in the Minnesota system are economic development, recreation use, road user benefits, cost-effectiveness, and present road conditions.)

Although there are undoubtedly additional items in this

category, the seven items above were discussed at some length in Chapter Two because of their substantial impact on the programming process. One or two interesting points can be added here with regard to the last two items.

In a recent paper, Juster and Pecknold (*20*) present the constraints of uncertainty and project interdependencies that must be included in the programming algorithm. They consider them the most difficult constraints to handle because they are the hardest to define and measure; they are thus the weakest elements in their proposed methodology. However, they consider them critical constraints and suggest such methods as decision analysis for their inclusion.

Juster and Pecknold's term *project interdependencies* is probably a better one than *system continuity-connectivity*. It implies the latter but also considers the fact that "the benefits of building two separate projects may considerably exceed the sum of the benefits from each if it alone were constructed." This type of reasoning can be accomplished by the human mind without a computer program, but the human mind can not remember hundreds of projects and compare them all on many items. Therefore, as much as possible is put into the computer, although it is realized that, at least at the present time, top decision-makers and elected officials do not make decisions based on computer programs alone.

In recent years there has been a trend, in both research and practice, to use nonquantifiable rather than quantifiable factors for decision-making. Thus there are also attempts to quantify the nonquantifiable, or at least apply weightings to them.

A Georgia report (*22*) notes this:

> As in many other states, priorities are assigned to improvement projects largely on the basis of subjective judgments developed from past experience. Priorities that are established subjectively run the risk of personal engineering bias, lack of comprehensiveness, and political bias. Furthermore, the increasing number, magnitude, and complexity of the programs will soon make subjective analysis unmanageable.

Position in the pipeline is definitely a factor in project selection. It was put very simply in an Arizona report (*23*):

> As Arizona's new priority system gets under way, certain "impurities" in the ratings are inevitable. Projects take several years to advance through planning, design, and construction. It would not be in the public interest to drop a project in which the state has already invested planning and design funds simply because the newer rating elements put another project ahead of it . . . nor can the elevated project be readied for contract without all necessary preparations and the time this requires. Gradually, the system will be purged of these situations and a "pure priority program" using the new formula will emerge.

This statement says a great deal about prioritizing in transportation agencies—why projects in advanced stages have a built-in priority and why it is difficult to alter programs when changes in officials and policies require their alteration. All those interviewed expressed deep concern about the continuity of the pipeline and about newly elected officials who want significant changes in policy and emphasis overnight. Most new programs proclaimed by newly elected officials must consist of the projects in the old program, perhaps modified or in a different format, if the new official hopes to see them implemented while still in office.

Another concern expressed by several of those interviewed regards the new TIP regulations. They said that once local officials made a commitment to a project, the state officials did not want them to change their minds.

FINANCIAL PRIORITIZING

Financial prioritizing refers to aspects of prioritizing that are primarily related to the appropriation and allocation of transportation funds. Following is a discussion of four components of financial prioritizing: appropriations, categorical prioritizing, geographical prioritizing, and rate of return.

Appropriations

The first act of prioritizing is the decision by Congress or another legislative body regarding how much in total funds the legislative body will appropriate to transportation. Almost without exception, appropriations on all governmental levels are by mode, and relatively minor amounts are available for multimodal use. In the federal government, and even more at the state level, there is a trend to look at the relative amounts appropriated for different modes. In Massachusetts, the state's share of the deficit of the Massachusetts Bay Transportation Authority (MBTA), the Greater Boston transit agency, is offset by a parity appropriation of highway funds to communities outside the MBTA district. More and more states are eliminating constitutional provisions that reserve the gas tax for highway construction and maintenance only. The gas tax rather goes into the general fund, and highway appropriations must compete with not only transit, rail, air, and water appropriations but all other appropriations.

In the 1960s, which were more stable times for transportation, total appropriations probably had a greater influence on project selection, that is, on how many projects advanced to the construction phase. Huge bond issues, supported by gas-tax income, permitted extensive highway construction. Now, in the mid-1970s, with revolution replacing evolution from the highway planner's viewpoint, and with inflation cutting into dollar value, total appropriations are still important but are rivaled by project acceptability. Most states report that the demand for highway projects that appear acceptable is equal to several times the available funds. These projects are not on the shelf, however, and many will not be advanced without a funding commitment, as they might have been ten years ago.

The Arizona report (*23*) states:

> The most inexact science connected with planning public road improvements today is forecasting the funds that will be available to meet the documented needs. And the uncertainties increase each year.

A Georgia report (*24*) states:

> Ten billion dollars is required to fill the estimated highway needs in Georgia for years 1973–1993. Faced with an increased responsibility for other transportation modes, a highway trust fund no longer earmarked for highways and declining revenues resulting from energy shortages, it must be assumed that sufficient resources to fill all the proposed transportation needs of the state will not be available. Therefore, evaluating proposed improvements as investments is becoming crucial.

This is reported from California (*25*):

> In 1972 the California highway program faced a number of problems including rising construction costs, declining revenue growth, and the resulting unmanageable $17 billion project backlog.

And this from Illinois (*18*):

> Illinois spent $850 million from 1970 to 1974 to retire non-Interstate highway needs on its state-maintained system. The objective of this expenditure was to reduce the large backlog of needed improvements. But, during the same period, inflation escalated the cost of meeting this 1970 backlog by $1.3 billion. Thus, the net result in 1975 was that after 5 years and the expenditure of $850 million the backlog of remaining 1970 needs is $450 million larger than when the program started out 5 years ago. To further compound it, new needs entered the picture each year because of continuing normal physical deterioration and obsolescence.

Categorical Prioritizing

Some very important work in bridging the gap between appropriations and categorical prioritizing was done in 1972 by the Highway Users Federation for Safety and Mobility (*26*). It was estimated that the net available income from a continuation of the Federal Highway Trust Fund to meet indicated needs between 1970 and 1990 would be $94 billion. Matching funds would equal $37.2 billion. But the $131.2 billion total would permit meeting only 43 percent of the $308.8 billion needs. Highways were divided into four functional systems:

1. Interstate (improvement only—additional trust funds to complete the Interstate were assumed).
2. Principal arterials (rural and urban).
3. Minor arterials (rural and urban).
4. Rural major collectors.

The following goals were set: Interstate—100 percent; principal arterials—60 percent; minor arterials—17 percent (as close to 20 percent as possible); rural major collectors—13 percent.

This process acknowledged the inadequacy of gross appropriations and suggested policy decisions with regard to the four categories. Congress actually makes this kind of decision every time it passes a federal-aid highway act, an airport and airway development act, or an urban mass transportation act. The total amount appropriated and the categories to which this amount is allocated draw an invisible cutoff line for projects in every category.

A Maine official stated: "Categorization imposes false priorities in the process." Illinois officials attempt to establish priorities without first making categorical assignments. It was noted (*18*):

> Most states adopted, for convenience, a similar method of allocating moneys, usually to the point of making categorical allocations to geographic areas of highway districts. The result was that funds became the tail that wagged the highway problem dog. In more financially stable times, the method worked. In today's environment it will not work satisfactorily. Clearly, transportation service problems have to be the fundamental base on which programming solutions are built.

Nevertheless, categorical allocations are still with us and are themselves an important form of prioritizing in all modes of transportation.

Geographical Prioritizing

In some states geographical distribution of transportation funds (particularly highway funds) is required by state statute. The formulas for distribution may be included in the statute or may be calculated by the state transportation department. Formulas are usually based on mileage of highways, population, area, and similar factors, so it is not necessary to know exactly how much was collected.

In one state an effort is made to return about 85 percent of the available funding to the region from which it was collected and to distribute the remainder on the basis of needs studies. This is a balance-of-payments system not possible in states that have not attempted to determine, by region, the amount of gas tax collected.

As has been stated before, politics dictates that everyone has to get something. There can not be large transportation appropriations for the construction of numerous projects without the legislators of every area wanting something for their own districts. Recent years have seen a reversal of this trend, voters turning against transportation projects of all types because of the projects' controversialism and potential impact.

However, geographical distribution is itself an important form of prioritizing and must be dealt with in all programming in all modes of transportation.

Rate of Return

Several research projects have keyed in on maximizing the rate of return on the investment of transportation funds (*9, 10, 11*). Because these methods also involve technical prioritizing, this subject might be appropriately dealt with in a discussion on option-evaluation techniques.

There are various aspects to rate of return. When the primary emphasis is on how to get the greatest number of projects for the dollars available or on how to obtain highway-user benefits alone rather than total transportation and related service, then prioritizing is fiscally oriented.

SUMMARY OF PRIORITIZING

An interesting summary on prioritizing is given in the Illinois reference (*18*):

> Setting priorities today means all of these factors plus

a host of others including the roles and influences of the political executive, the legislature, the transportation administrator, the planner, and the citizen. Consideration must be given to energy efficiency and social and environmental consequences. Differences must be solved in goals, values, and priorities within communities and metropolitan areas, as well as between local and state governments. Federal guidelines, regulations, and restrictions can also limit programming options.

Setting priorities and measuring programming success are a cyclical process, one feeding the other. Both involve efficiency, safety, cost effectiveness, user benefits, social benefits, achievement of long-range plans, adequate levels of service, balancing and integration of modal systems, serving minority and disadvantaged needs, and environmental safeguards. Clearly, no structured programming process exists to fully incorporate all of these requirements. Just as clearly, such setting of priorities and evaluation must be done in the emerging multimodal trade-off context in which resources are also scarce and many desirable improvements are being postponed. . . .

The overriding inadequacy, however, in typical current programming procedures today is the inability to deal with uncertainty. Traditional programming processes have not been designed to operate in this framework. Planning inputs have tended to be somewhat rigid long-range goals that set precise levels of facilities and offered few options. Funding and programming have tended to prescribe improvements based on developing networks or systems to design standards rather than on transportation service solution options. The current programming environment will not allow either of these concepts. Continuing them can only be detrimental to developing effective and responsive highway transportation problem solutions. Flexibility to change emphasis, to increase or decrease program scopes as conditions require, and to focus on solutions versus needs is mandatory.

CHAPTER SIX

PROGRAM MODIFICATIONS

A program is a living document, out of date the minute it is printed. The real program is the one that is in the programmer's file (computer) and has been modified by dozens of factors and hundreds of entries as projects have been developed, designed, and constructed (or have become operational).

When there is a change in the factors that were used to establish a program, the program changes. Philosophical changes that lead to changes in the planning objectives previously established to guide a program can cause major program changes. The detailed design of a project can reveal problems or alternatives that were not apparent during the preparation of the planning report or in previous studies. As a result the project may be put aside or may be continued at a cost far exceeding the programmed "upset limit."

The three areas of program modification discussed briefly in this chapter are philosophical changes, project and finance-related changes, and design changes.

PHILOSOPHICAL CHANGES

Philosophical changes, which lead to significant modifications of transportation programs, generally are attributable to either major economic and social upheavals (e.g., energy shortages, inflation, displacement of families, changes in environment or in quality of life) or the election or appointment of new officials. An interesting list of eight factors leading to philosophical changes was given by Altshuler (*27*) when he was secretary of transportation in Massachusetts. Following is a summary of these eight factors.

1. Policies of the 1960s emerged from the decade of the 1950s, when public policy was primarily attuned to concerns of business and the middle class. Since 1960, public policy has been increasingly attuned as well to concerns of those who are deprived—the poor, racial minorities, the handicapped, and so on.

2. The demand for citizen participation, increasingly mandated by statute, puts great restraints on public officials. Plans developed with citizen participation are unlikely to call for demolition of the neighborhoods in which the participants live, the factories in which they work, or the parks in which their children play.

3. Massive use of eminent domain to acquire already developed land was an experiment of the 1950s and 1960s that quickly produced overwhelming citizen resistance. It was used for urban renewal programs and the Interstate highway program. Urban renewal shifted its emphasis from total clearance to rehabilitation, but the highway program could not adjust as easily. As a result, urban expressways are stalled all over the country. By 1973 even the most pro-highway members of Congress recognized the need to find a graceful way of dropping those urban expressway plans that were highly controversial.

4. Federal and state environmental laws and Section 4(f) of the Department of Transportation Act, with strong public support behind them, became enormous deterrents to many transportation projects.

5. The concern for the hardships visited on residents who were displaced to make way for public projects, plus the fact that at the beginning of the federal highway program there were no federal provisions for aiding families

with their moving expenses, led to the 1968 and 1970 Federal Uniform Relocation Acts. The relocation requirements are humane but very time-consuming, and in some instances they preclude going forward with projects.

6. Increasingly we have come to recognize that transportation modes are interrelated and that we can not allow threatened modes—most notably, urban public transit and intercity railroads—to continue their drift toward extinction. There has been an increasing demand not only that they be preserved and modernized but also that they be evaluated as realistic alternatives when highway and airport investments are contemplated. This demand has imposed a new discipline on transportation planning, and it has produced a great deal of discomfort for traditional, single-modal transportation planners who have been unable or unwilling to adapt.

7. Similarly, there has been an increasing demand that transportation planning be integrated with comprehensive land-use planning. We are still not very good at doing this, but public demand that we do it effectively continues to intensify and thus to challenge our best efforts.

8. The energy crisis has made clear that a policy directed solely at providing maximum speed and convenience for those who can afford it in the private marketplace not only is antithetical to many of our domestic values but also severely threatens our national security, our balance of payments, and our capacity to act independently in world affairs.

The philosophical changes that grew out of these concerns led to an enormous increase in transit funding as well as to railroad investment in the Northeast Corridor. Also, "transit-transfer," the shifting of allocations for urban Interstate highways from the Highway Trust Fund to general funds for transit meant substantial program changes for both modes. Further, new airports and runway extensions were eliminated, the locations of transit stations and dredging contracts were changed, and programs in all modes were affected.

To the list of concerns can be added inflation, which forced the implementation of many new philosophical and policy changes when there was a choice to be made among various projects, not all of which could be constructed.

Not as obvious a factor, but one revealed by interviews, is the desire for credibility. In the past, too many promises that were made could not be kept, and newly elected and appointed officials do not wish to inherit a credibility gap that burdened their predecessors.

By way of background, hundreds of new highway projects were initiated in every jurisdiction in the 1960s. There was an underlying optimism that somehow, someday, all the projects would be constructed. Each new project required some form of basic, or planning, report. Even though there were no environmental or citizen participation programs at today's level of concentration and complication, there was a conscientious effort to develop projects that conformed with the comprehensive studies initiated by the 1962 Federal-Aid Highway Act.

Hundreds of projects were at different positions in the pipeline, that is, at different levels of development. As one official put it, "We not only had jammed the pipeline, we had even jammed the funnel leading into the pipeline." It was often stated that certain jurisdictions had projects on the shelf. Supposedly, plans, specifications, and estimates had been prepared, all approvals had been completed, and only the funds were missing.

Specific questioning in interviews does not support the contention that projects were on the shelf and thus out of the pipeline. A few officials said that projects could have been wrapped up in short order if the funds had been available, but many stated that they had "never had the luxury of projects on the shelf."

If projects were not on the shelf in the 1960s, they certainly are not on the shelf now. In view of the difficulty of producing projects today, it is almost certain that, where implementation is possible, a project near the end of the pipeline is going to have increased priority simply because of its position in the pipeline.

An excellent example of a response to new philosophies, the energy crisis, inflation, and the desire for credibility is the Five-Year Transportation Program for New York State, published in July 1976 (*28*). It is a revision and condensation of the 1973 Statewide Master Plan for Transportation. The newly elected governor had called for this revised program in a transportation address to the New York State legislature. One requirement of the program was that it be "affordable within reasonable estimates of expected state and federal funds."

This requirement for affordability, and therefore credibility, meant that hundreds of previously anticipated projects had to be removed from the active program. New program priorities were important in project selection; the priorities were based on the governor's concern for energy, employment, and the environment, but they took their direction from the 1973 master plan. Table 4 gives the New York program priorities (*28*).

In order to arrive at a reasonable program for a five-year period, it was necessary that New York plan for ten years

TABLE 4

PROGRAM PRIORITIES FOR STATE FUNDS, BY MODE (NEW YORK) (*28*)

	Program Category		
	FIRST PRIORITY Maintenance of Existing System		SECOND PRIORITY Major Projects
Mode	Specific Capital Programs	Operating Assistance Program	Specific Capital Programs
Highway	Reconditioning & Preservation, Bridges, Safety, Traffic Operations	None	Major Reconstruction, some new construction
Transit	Replacement of Rolling Stock & Capital Facilities	State, Federal & local	Major new rail mass transit lines (New York City & Buffalo)
Rail	Reconditioning/Replacement of Rolling Stock & Capital Facilities	Some, but limited	Major Reconstruction of trackage, New Stations[a]
Aviation	Safety, Preservation	None	Major Reconstruction
Waterways	Preservation	None	Major Reconstruction

in the future. It was assumed that periodic updates would be required, even for this totally revised program, and that transportation would be greatly influenced by future levels of funding, new legislation, and unanticipated events.

Indeed, transportation has been affected dramatically in the first half of the 1970s by unanticipated events and situations, such as citizen participation, the environment, energy shortages, inflation, and unemployment. It will be interesting to see if still new concerns emerge by 1980.

The list of New York priorities in Table 4 exemplifies what is occurring in most states: a shift from the construction of new projects to the maintenance and operation of existing facilities. On the one hand, the elimination of some major projects was the automatic result of the passage of federal and state environmental laws. These laws, in effect, made many projects illegal. Even where there was little doubt about a project's legality, the courts would have been receptive to long, involved cases. The question of legality, plus the problems of relocation requirements, design, and construction, moved these controversial projects into the next decade. And they are not of much interest to today's elected officials, because most of them do not expect to be in office when the time comes to cut the ribbon. Also, in the face of increasing transit deficits, a fairly common philosophy among officials is that "we will not build projects that compete with mass transit." Therefore, projects that might have had some value in and of themselves, perhaps even high benefit/cost ratios, were automatically eliminated by new laws and even conservative philosophies.

On the other hand, interviews conducted for this synthesis produced a consistent response from the permanent staffs of transportation agencies with regard to projects of local value only. These staffs conducted meetings and hearings to promote the local projects that they could afford to construct. However, if local opposition was too great and there were no clear regional benefits, the staffs would shelve the projects until some form of local support developed.

In transit, priorities can clearly be ranked in this order: reliability, safety, expansion. If the trains are not running, it hardly matters how safe they are. Once they are running and on schedule, safety (signals, communications, operational practices) becomes paramount. The desire to construct new lines and expand existing ones has been tempered not only by increasing deficits but also by the need to maintain and improve existing service. At the Orlando conference (*2*), an official from a large transit authority said that the permanent staff of that transit authority was interested only in capital investments that would reduce its operating deficit (e.g., better shops and yards, improved communications, station improvements). He said the transit authority was willing to build new lines if it could come close to breaking even or if the ridership would increase substantially. But he added, "I simply don't know of such lines."

PROJECT AND FINANCE-RELATED CHANGES

Project and finance-related factors leading to program changes are given in Tables 2 and 3. These changes exclude design changes, which are discussed below. It should be pointed out that there is a long list of factors and that any one, alone or in combination with others, can delay a project or a category of projects. A programmer must be experienced and seasoned to be able to anticipate changes correctly as they are developing.

It should be noted also that these are planning-related factors. Bouchard et al. (*29*) have listed five forms of planning: systems planning, corridor planning, project planning, engineering design, and planning for operations. The implication of the list is that planning does not stop at some midpoint between conception and implementation but rather is a constant process. There is a point at which planning stops and programming begins. Programming requires financial planning as well. Therefore, programming and financial planning can be added to the types of planning. Programming is the pivotal point in planning, and it can be affected by modifications in all the other planning areas.

DESIGN CHANGES

Project planning and development is a critical part of the planning process. Interviews made it clear that a weakness in many agencies is a lack of staff agreement on project concept. In such cases a project moves to design before there is full analysis or agreement on concept.

It is probably too much to expect that there would be unanimity of opinion on a complicated project before design begins, especially if it is multimodal or has an impact on land use. Feasibility studies include a certain amount of basic design, but some problems can not be dealt with properly until more finite designs (25-percent plans) have been prepared.

Interviews revealed another disagreement problem in the project-planning/design process, one that may be diminishing but is very evident and is important to programming. This is the conflict between the project-planning staff and the design staff. The project planners believe that their recommendations should be followed to the letter by the designers. After all, the project planners feel, they have participated in the community interaction, are aware of the need for joint development, have often conducted the EIS, and have spelled out for the designers what the objectives of the project are.

Some jurisdictions assign an "upset limit" to the designers when the project is turned over to the design section. This is essentially the cost estimate for the project listed in the short-range program and, in several cases, included in the computerized listing. If the "upset limit" (plus, perhaps, some allowable percentage for inflation and contingencies) is significantly exceeded, the design section should immediately report the change to the project-planning section and enter the change in the computer to permit the programmer to modify the program.

For their part, the designers may cite such requirements as Section 109 of United States Code Title 23, Highways, entitled "Standards." This section requires that certain standards be met in the interest of safety and capacity. Similar standards exist, and more are constantly being promulgated, for other modes of transportation.

Whatever the conflict between planners and designers,

the programmer uses the "upset limit" as a guide. If the "upset limit" is to be a management tool, it must be updated constantly. This does not seem to happen, however. Moreover, some departments make no effort to set a specific "upset limit" that might lead to early resolution of project-planning/design differences. A project that has a benefit/cost ratio of 2/1 at the $1-million level is much less interesting and more difficult to fund at the $2-million level.

In the same vein, there has been a strong movement to relax design standards, especially in the highway field. It has always been questioned whether states use federal-aid project standards for speed, shoulder width, and so on, on 100-percent-state-funded projects. States often take the approach that it is better to make some essential improvements on ten miles of road than to make all the improvements on only one mile of road. Of course, this spreads the money and thus satisfies more people—at least to some degree.

Chansky (*30*) recently decried what he called the "all or nothing" requirement for design standards. He stated that 6,370 federal-aid projects improved only 7,856 miles of roadway in 1973. This is about 0.2 percent of the nation's 3.8 million total miles of roadway. His conclusion: "Let's turn our federal-aid and state construction funds loose for widescale upgrading even if there is not full compliance with AASHTO design standards."

The Iowa Department of Transportation has introduced a "tolerable standard" in conjunction with airport design. The first thing developed was a sufficiency rating analysis similar to the one used for highways. In this analysis, 100 points are divided among three categories: structural adequacy—30; safety—40; service—30. Associated with each maximum point value is a minimum point value that is called a tolerable standard, which is defined as the minimum prudent condition, geometric or structural, that can exist without being in critical need of upgrading. The tolerable point level is one-half the specified maximum for each rating item (*31*).

Perhaps Iowa's approach will catch on in various areas of the different modes. There are obvious shortcomings to this approach, but it is also apparent that 100-percent standards can be reached for only a small percentage of roads, airports, transit facilities, waterway projects, and so forth.

CHAPTER SEVEN

CONCLUSIONS

A FRAMEWORK AND STRUCTURE FOR PROGRAMMING

Very little has been written and distributed through the normal publication routings on the subject of programming, so this synthesis may serve as a primer on programming—what it is, where it fits into the planning-development-design process, how it is managed and influenced—rather than an in-depth review of the actual mechanics of programming.

Two excellent documents on programming are available, although they are not widely distributed: Florida's "Transportation Financing and Programming" (*32*) and New York's "Five-Year Transportation Program for New York State" (*28*). More such documents probably exist but have not entered the usual literature catalogs.

This synthesis, then, may be one of the first attempts in recent years to assign some form of structure to programming as it is practiced today—to such topics as definitions, the programming process, prioritizing, and financial planning. Interviews and studies undertaken for the synthesis involved about one-fourth of the states, encompassing one-fourth of the nation's population and including a mix of urban and rural and small and large states. Also interviewed were agencies in two large counties, agencies in two major cities, and two major transit agencies. The synthesis relies heavily on highway programming, inasmuch as this is the source of the most voluminous and most developed information on programming. The findings and conclusions of the synthesis, with minor adjustments, relate closely to the transit field, as revealed by interviews with transit officials.

PROGRAMMING

The simple definition of programming is the matching of available projects with available funds to accomplish the goals of a given period. Programming thus has three basic elements: projects, funds, and goals. If projects are not ready, funds are useless. If funds are not allocated to the projects available, there can be no progress. If projects do not pertain to previously established planning goals, the over-all program will not be effective.

DEFINITIONS

A set of accepted definitions for the basic terms used in planning and programming would be very helpful for improving communication and understanding. This synthesis offers a list of suggested definitions as a starting point.

THE BASIC PROGRAMMING PROCESS

There are fundamental similarities between the programming processes in state transportation and highway departments and other transportation agencies. The 15-step basic programming process presented here certainly can be improved, but it appears to be an adequate starting point for defining the universal programming process. The proposed set of definitions and the 15-step process would be the basis for structuring the programming process. Not only would this structuring aid in the training of new personnel in programming, it also would provide a means of showing executives the potential repercussions of their decisions in the planning-programming-design-construction pipeline.

It is important that there be a definitive programming process that is fully understood by everyone in an agency who may affect it. It is difficult enough to maintain an effective program without having to unnecessarily alter the schedule of project implementation. Having an understanding of the process can help prevent delays in project development and will encourage stabilized budgeting of available funds. In most agencies, unfortunately, only a few key staff members have a clear understanding of how projects get into or out of a program.

PRIORITIZING

Some technical prioritizing procedures have a significant effect on the selection of projects, especially when it is necessary to select among many small projects. Also, a technical analysis should be available to the decision-maker as a guide. However, the availability of a "magic number" that sets the order of priority for major projects appears to be of little interest to decision-makers, compared with their interest in nontechnical factors.

A structure also would be desirable for prioritizing in the technical, nontechnical, and financial areas. Although technical prioritizing should not be underestimated—particularly at the third staff level, where the majority of the programming decisions are made—it appears to have little effect on political decisions involving major projects. A structuring and an understanding of the limits of technical prioritizing actually should enhance its value and produce a greater return for staff efforts.

FINANCIAL PLANNING AND PRIORITIZING

Total appropriations for transportation have the greatest impact on financial planning and prioritizing. Categorical and geographical allocations usually are next in impact. Although they create inequities in terms of over-all technical prioritizing (assuming funds should be allocated to the most critical projects regardless of category or location), categorical and geographical allocations are necessary from a political viewpoint.

The states criticize the federal formulas and want more flexibility in financial planning and prioritizing as they see it. Similarly, counties, cities, and towns criticize the state formulas and project-selection procedures.

The increase in inflation, coupled with a decrease in available funds in many categories, such as 100-percent-state funds, has reduced the programmer's opportunities to juggle funds. This fact, plus a desire for credibility, has led to a significant reduction in overprogramming in many jurisdictions. Overprogramming still is used as a hedge against the delay of controversial projects and in some cases as a strategic attempt to increase over-all appropriations.

The forecasting of future funding is perhaps the most complex area of financial planning. Forecasting is constantly affected not only by future appropriations, which may be allocated to dozens of different categories (with built-in geographical distributions), but also by the cash demands of the current program, above or below the forecasts in dozens of categories. The forecasts must be converted to budget estimates and often are complicated by the over-all cash-flow practices of the agency.

PLANNING VERSUS PROGRAMMING

The Williamsburg conference concluded: "There are now no effective ties between planning and programming, and program decisions are based more on what can be built than on what should be built" (*1*). The problem appears to be in the concept of planning in some transportation agencies. Planning is considered a long-range and data-gathering effort that is almost divorced from the process of programming, decision-making, and project selection.

Programming is definitely a planning function. In some agencies the planners appear to have abdicated responsibility for implementing their long-range objectives by seeking to accomplish specific goals in a short-range program. In other agencies the programming process is considered the prerogative of the decision-makers or of a small clique around the department head who want to make the final decisions.

All responsible staff members agree that major decisions must be political decisions but must be the culmination of an orderly planning process. There is a concern that, because of shrinking funds and the difficulty of bringing projects to the point of implementation, planning may be replaced by programming in its interpretation as "what can be built rather than what should be built." However, if programming is not divorced from planning but is seen as the pivotal implementation step in the planning process, then it is planning and not a separate programming function that leads to the political decisions.

The effective ties between planning and programming, as indicated in the 15-step basic programming process, are Step 5 (advanced analysis and prioritizing) and Step 7 (financial analysis).

Interviews confirmed that the effective programmer is an extremely accomplished individual who has a knowledge of all project-related matters: planning, feasibility studies, environmental impact statements, project development, design, and construction costs. The programmer also must be knowledgeable about finances from legislative appropriations and trends in budgeting, bond issues, and cash flow. The programmer must attempt to accomplish the objectives of the department and not be swayed by his or her own preferences. Often the programmer must be a referee

between opposing factions, work under pressure when data is late from a dozen sources, and be able to stand the cross-examination of a legislative committee.

An individual does not become a programmer early in his or her career; the individual has been in the department, usually working in several different bureaus, before being given the program responsibility. There are exceptions in departments where programming is divorced from planning. In such departments the programmer is more of a scheduler than a planner-programmer; the individual is given a set of projects and juggles the available funds mechanically.

POLITICS

Most jurisdictions seem satisfied that politics—in its negative connotation—is not a significant factor in programming. It is rare that a project is inserted in a program as a favor rather than because it has high priority; such an occurrence may happen only three or four times in ten or more years, and the projects involved undoubtedly would have been built sooner or later anyway.

One reason for the lack of politics appears to be the long time it now takes for a project to reach the construction stage, which is the stage when a politician can point with pride to an accomplishment. In the 1960s a major highway project could be brought to the design stage in a year (most major projects are not new but have been discussed and studied for years), be designed in the next two years, and be under construction in less than four years. Today it usually takes seven years to reach the construction stage. Even if there is no significant opposition, the project and the promises become stale over that long a period.

POLICY UNIT

To guide day-to-day decision-making, it is necessary that policy planning be done not only by technical staff at the top level of a transportation agency but also by technical staff at other levels in the agency. How much full-time staff effort is required depends on the size and organization of the agency. Top executives must submit their policies to technical analysis for an impact evaluation. Policy staff, in turn, must indicate to executives the existing voids in policy at all levels of operation.

Lack of policy guidance makes the difficult programming process even more complicated, because policy is needed to settle staff differences concerning project priorities.

PROJECT PLANNING AND DEVELOPMENT VERSUS DESIGN

Interviews revealed that a problem exists between the project-planning section and the design section in many departments. The project planners believe that their recommendations should be followed to the letter by the designers, and the designers are concerned about meeting accepted standards for safety and capacity.

It is not unusual in some agencies that a project in the late stages of design is found to cost much more than was anticipated in the project development stage. To prevent this, some agencies assign an "upset limit" to aid the programmer in scheduling the project for some time in the future.

There is a need for better procedures for clarifying project concept. Project planners and designers alike usually are involved in project planning and development, but a consensus on project concept is not necessarily reached when design begins and in some cases can not be reached without further design studies.

The "upset limit" approach, used as a management tool, appears to be a logical method of project control, but improved monitoring procedures are needed in many jurisdictions if substantial program modifications are to be avoided.

REFERENCES

1. "Issues in Statewide Transportation Planning." Rep. of a conf. in Williamsburg, Va., Feb. 21–24, 1974. *TRB Spec. Rep. 146* (1974) 262 pp.
2. "Transportation Programming Process." Proc. of a conf. in Orlando, Fla., Mar. 23–26, 1975. *TRB Spec. Rep. 157* (1975) 75 pp.
3. STEARNS, P. N., and HODGENS, D. A., "Programing and Scheduling Highway Improvements." *Hwy. Planning Tech. Rep. No. 4,* Bur. of Pub. Roads, FHWA (Feb. 1969).
4. POLLOCK, L. S., "Statewide Planning for Alternative Futures: The North Carolina Multimodal Transportation Sketch Plan." Paper presented at 57th Ann. Conf., Amer. Inst. of Planners (1975).
5. "Fund Distribution of Motor Fuel Tax, Transportation Financing and Programming." Florida DOT (Sept. 1975).
6. SHERMAN, L., "The Impacts of the Federal-Aid Highway Program on State and Local Highway Expenditures." Doctoral thesis, MIT (Feb. 1975).

7. "The Year That Might Have Been." *ARBA Newsletter*, Vol. 20, No. 38 (Dec. 7, 1976).
8. YANCEY, M. L., "Cash Forecasting and Allocation." Paper presented at AASHTO Subcommittee on Computer Technology, Birmingham, Ala. (Nov. 1976).
9. MELINYSHYN, W., ET AL., "Transportation Planning Improvement Priorities: Development of a Methodology." *Hwy. Res. Record 458* (1973) pp. 1–12.
10. SHORTREED, J. H., and CROWTHER, R. F., "Programming Transport Investment: A Priority-Planning Procedure." *Transp. Res. Record No. 574* (1976) pp. 48–57.
11. GRUVER, J. E., ET AL., "Highway Investment Analysis Package." *Transp. Res. Record No. 599* (1976) pp. 13–18.
12. SHULDINER, P., ET AL., "Survey of Fiscal Planning and Programming in Selected States." Mass. Dept. of Pub. Works (circa 1973).
13. BELLOMO, S. J., ET AL., "Evaluating Options in Statewide Transportation Planning/Programming." *NCHRP Rep. 179* (1977) 91 pp.
14. "New Directions for Penn DOT." State Transp. Advisory Comm., Commonwealth of Pennsylvania (Apr. 1976).
15. "Construction Plan, July 1, 1975 Through June 30, 1980." Florida DOT (Oct. 1975).
16. "Highway Travel Forecasts." Office of Hwy. Planning, FHWA (Nov. 1974).
17. "Objective Priority Programming Procedures." *Rep. No. DOT-FH-11-7882*, FHWA (Mar. 1973).
18. KNOX, R. R., ET AL., "Programming Highway Improvements in the New Funding Environment." *Transp. Res. Record No. 599* (1976) pp. 7–12.
19. RIHANI, F. A., ET AL., "Statewide Transportation Planning: The North Carolina Experience (1974/75)." Paper presented at 55th Ann. Meet., TRB (Jan. 1976).
20. JUSTER, R. D., and PECKNOLD, W. M., "Improving the Process of Programming Transportation Investments." *Transp. Res. Record No. 599* (1976) pp. 19–24.
21. GILDEMEISTER, M., "Statewide Highway System Construction Priority Evaluation Procedure." Minnesota DOT (Feb. 1976).
22. MAK, K. K., and JONES, P. S., "Priority Analysis Procedure for Ranking Highway Improvement Projects." *Transp. Res. Record No. 585* (1976) pp. 35–48.
23. "Arizona's Five-Year Highway Construction Program." Arizona Hwy. Dept. (1972–73).
24. BREEN, F. L., JR., and COVAULT, D. O., "Testing and Calibration of a Priority Array Model for Priority Analysis and Ranking of Highway Improvement Projects." Georgia DOT and Georgia Inst. of Tech. (Aug. 1975).
25. FORBES, C. E., and WOMACK, R. R., "A New Direction for the Highway Program." *Transp. Res. Record No. 585* (1976) pp. 1–16.
26. MICKLE, D. G., "Statement Before the Subcommittee on Roads, Committee on Public Works, U.S. House of Representatives, March 21, 1972." Hwy. Users Fed. for Safety and Mobility, Washington, D.C. (1972).
27. ALTSHULER, A., Speech at Boston Citizen Seminar on Transportation Plans and Planning for the Future, Boston, Mass. (Mar. 1974).
28. "Five-Year Transportation Program for New York State." New York DOT (July 1976).
29. BOUCHARD, R. J., ET AL., "Techniques for Considering Social, Economic, and Environmental Factors in Planning Transportation Systems." *Hwy. Res. Record 410* (1972) pp. 1–7.
30. CHANSKY, S. B., "Must Highway Construction Always Comply With Design Standards?" *Traffic Eng.*, Vol. 45, No. 7 (July 1975), pp. 58–60.
31. "Iowa Airport Sufficiency Ratings." Iowa DOT (July 1976).
32. "Transportation Financing and Programming." Florida DOT (Sept. 1975).

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