

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM  
SYNTHESIS OF HIGHWAY PRACTICE

151

PROCESS FOR RECAPITALIZING  
HIGHWAY TRANSPORTATION SYSTEMS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM  
SYNTHESIS OF HIGHWAY PRACTICE **151**

## PROCESS FOR RECAPITALIZING HIGHWAY TRANSPORTATION SYSTEMS

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TRANSPORTATION RESEARCH BOARD  
NATIONAL RESEARCH COUNCIL  
WASHINGTON, D.C.

DECEMBER 1989

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 the National Research Council 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 National Research Council 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 the responsibilities of the National Research Council and the 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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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration of the U.S. Department of Transportation.

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## **PREFACE**

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, 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 useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on 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 these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

## **FOREWORD**

*By Staff  
Transportation  
Research Board*

This synthesis will be of interest to administrators, fiscal officers, and programming and planning officials in large highway transportation organizations, as well as legislators and others interested in the planning and programming of highway transportation capital improvement projects. Information is presented on strategies related to project selection and budgeting for recapitalizing highway transportation systems.

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Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available 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 reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

There is increasing pressure on state transportation organizations to be more productive with existing resources. This report of the Transportation Research Board describes processes for planning and implementing highway capital improvements. General

frameworks for this process are discussed along with specific examples of how it is done by several states. Observations on the state of the practice are given along with some information on possible future trends.

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 researcher 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, Transportation Research Board, assisted the NCHRP Project 20-5 Staff and the Topic Panel.

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



# PROCESS FOR RECAPITALIZING HIGHWAY TRANSPORTATION SYSTEMS

## SUMMARY

Stepping into the decade of the 1990s, it is clear to even casual observers that the highway transportation business has undergone major changes in recent years. The system is mature, both in a geographical and chronological sense, causing previous priorities of geographical access and new construction to be replaced in part by new priorities of congestion relief, rehabilitation, and replacement. Transportation is also rapidly becoming a means of attaining a number of broader societal goals beyond just mobility, such as economic development, growth management, and minority employment, to name a few. The implications and importance of these factors are that the highway capital improvement or programming process is increasingly becoming a policy prerogative of state government officials, with increasing and overt political intervention to ensure that transportation fits into a larger social and economic context.

How are current state highway agency practices coping with these changes? A detailed examination of eight states suggests a growing emphasis on a strategic view of transportation but also reveals no standard model. Indeed, a more apt characterization is that capital planning and programming have been shaped by diversity and change, state to state and within states. A variety of creative approaches have thereby emerged. The state practices show diversity in practically all elements of successful capital planning: providing leadership, setting organizational objectives and structure, improving technical systems and capability, and responding to and shaping the political environment. The rewards of a successful capital improvement process are manifested in the ability to move projects forward, but the process itself is no less important. There will not be a continuing stream of good product, and resources to enable it, without a good process.

The examination of state practices does yield a number of practical observations:

- Creative, successful highway capital improvement processes, responsive to top management, flourish best in a “directed autonomy” type of environment, i.e., one that balances the need for direction and control on the one hand and freedom and flexibility on the other.
- Meaningful, contemporary categorization of the highway system (into priority components) is essential. Factors and formulas for prioritization should be rigorously defined and consistently applied but not viewed as sacrosanct.
- Increasingly sophisticated tools are available and need to be used for measuring, analyzing, and reporting system condition. This information needs to be fed into management’s decision-making processes. Data input should be decentralized and

include strong incentives for maintaining currency. Central access, control, and analysis capability is also required. A compact, high-level, attentive forum for decision making and program monitoring will enhance effectiveness.

- Time staging is critically important. The overall process must permit full project development, e.g., 10 years. Out beyond project development, perhaps another 10 years, is the period for developing a long-range vision of mobility and other objectives. Closer-in stages must signal onset of major expenditure, perhaps four to five years out, and estimated let-to-contract dates, six months to one year. Regular annual or biennial updates are necessary to keep the program current and responsive to the environment.

- The pressing nature of some projects, the inevitable imperfections in prioritization, and political reality dictate the need for relief mechanisms in the process such as overprogramming (up to 30 percent), discretionary budget allocation to the field for specified types and sizes of projects, and limited long-term concept development funds under tight, centralized control.

In terms of directions for the 1990s, several inferences can be made. First, the growing reliance on the automobile in our society and the concurrent congestion will increase pressure on program delivery i.e., shorter project cycle times. At the same time, disparate regional growth rates and competing priorities for resources may impede consensus building in transportation. Secondly, to be successful in this competitive environment, the capital programming process will need to focus on broader-ranging goals and be responsive through better technical analysis and articulate communication to increasing legislative and top-management input, direction, and control.

Finally, institutional relationships may change in dramatic ways. For example, the use of federal program requirements and funding support as both crutch and lever by states is likely to diminish. The role of partnerships with local/regional governments and the private sector will increase. Consensus among user groups will be more difficult to achieve, not only because of the disparate regional growth rates already noted, but also because of a lessening of modal choice: motor carrier presence will expand—numbers, size, weight, auto-truck interference, etc. Program consensus building efforts must face all of these new realities.

## INTRODUCTION

### CONTEXT AND DEFINITION

Highway capital improvements have been a principal justification for the creation and the support of highway and transportation agencies. Although this is now true to a lesser degree than when our transportation systems were being built, the highway capital improvement process remains highly visible, and the delivery of high-quality, high-priority capital projects is perhaps the most ready measure of transportation agency performance.

For discussion purposes it is useful to have a functional definition of the process for recapitalizing highway transportation systems (RCHS). This process, sometimes referred to as capital programming, program planning, or by various other names, and similar in many ways to capital budgeting, consists in broadest terms of the following five steps:

- Assessing current and projected future highway system conditions, physical and operating, using quantitative measures whenever possible.
- Determining within some framework for categorization where and in what priority, consistent with overall state and transportation agency strategy, goals, and objectives, improvements should be effected.
- For the priority improvement sites, developing a range of technically feasible improvement options and testing these against transportation, fiscal, political, environmental, and other impacts.
- Developing strategies that are creative to the point of being exploitive with respect to the identification and application of resources to implement the array of prioritized system improvements.
- Budgeting, scheduling, letting to contract, and controlling these capital improvements through to completion.

Subsequent paragraphs give details on each of these steps.

- **Assessing current and projected future highway system conditions, physical and operating, using quantitative measures whenever possible.**

Our ability to assess highway and bridge physical and operating conditions in quantitative terms has expanded rapidly. Methods now used include:

- road and bridge management systems
  - detailed bridge inspection
  - road friction measurement
  - road structural capacity
  - crack and roughness surveys

- various traffic surveys and capacity analysis
- accident analysis

In general, these methods provide an “off the shelf” capability for rapid field assessment and sophisticated data management and analysis. However, the road systems under consideration are vast and under heavy use, so condition assessment is not a trivial undertaking. Even more difficult is the matter of using any current assessment to project future conditions. Here, our abilities are limited and unreliable but improving. Only when filtered through mature judgment may such predictions be used to guide future investment strategies.

- **Determining within some framework for categorization where and in what priority, consistent with overall state and transportation agency strategy, goals, and objectives, improvements should be effected.**

Categorization of highway systems is complex and imprecise yet essential to RCHS. Federal funding has provided the basic framework: i.e., primary, secondary, urban, Interstate, etc. These funds are made available to the states for use on highway systems based on functional classification. Functional classification (e.g., arterial, collector, local) determines which routes can be included in the various federal-aid systems to ensure that federal funds are used effectively. Some states also relate their programs to system-based functional classification. However, other federal funding classes as well as unique state physical and fiscal circumstances complicate this.

Procedures for setting improvement priorities within the categorization framework also are key to the process. The literature is replete with sophisticated, computer-driven numerical methods, most unrealistically data intensive, for setting such priorities. Although these are helpful in providing rational, objective starting points, the agency professionals who exercise them must be aware that highway systems belong to citizens of an increasingly participatory democracy. Only by getting these citizens to voice their concerns and their goals, most often through elected officials, and then fashioning an overall prioritizing strategy will a successful RCHS be facilitated.

- **For the priority improvement sites, developing a range of technically feasible improvement options and testing these against transportation, fiscal, political, environmental, and other impacts.**

Broadly speaking, decisions are improved if the agenda of options is made richer and if the pros and cons of options are well defined. In recent years, the highway profession has developed a rich improvement option set, moving from the construction-only

fix of the recent past to a current emphasis on varying degrees of maintenance, from minor routine maintenance to full rehabilitation.

The chief difficulty here is selecting a treatment to provide some predicted future service requirement given our already-noted inability to project present conditions into the future. Testing options against various impact areas (fiscal, environmental, and others) clearly is limited by this imperfect vision of the future.

- **Developing strategies that are creative to the point of being exploitive with respect to the identification and application of resources to implement the array of prioritized system improvements.**

This charge "to be exploitive" is a strong assertion. The creative process is discussed in more detail later, but experience shows that aggressive, even exploitive, strategies do bear fruit in RCHS. This is true within states, as various agencies compete for resources and attention, and nationally, as states compete one with another. The details of successful, aggressive strategies can only be known to the practitioners and are not available for explication here or anywhere. However, the results can be observed, and the environment within which they flourish can be described. Such is the approach taken here.

- **Budgeting, scheduling, letting to contract, and controlling these capital improvements through to completion.**

Quality priority projects, delivered on time and within budget, provide the litmus test for a successful highway capital improvement selection process. Some may question including this fifth step in what is nominally a "selection" process. One justification derives from the circularity found here. To a remarkable degree, success in capital improvement breeds success, so controlling projects through to successful delivery will bring credibility on all counts, including selection and priority setting. An agency perceived as successful in RCHS will get better guidance from all sources, citizens and legislators, for its selection process, and such an agency will be a practiced, accomplished listener to such guidance. This will cause the process to spiral upward: Record of performance brings credibility; sincere, positive input and guidance; improved selection; public and legislative perception; resource support; performance; etc.

Given this complex function, or rather set of functions, and the highly diverse milieu in which they are embedded, it seems correct to assume that there is no single best model or methodology for RCHS. This was found to be the case. The states, each strongly individual, continuously seek to develop their resources and apply them to their option set, recognizing, albeit too weakly in some cases, the circularity between option identification, delivery effectiveness, and resource availability.

Overlying this mosaic of state processes is the venerable, intricate, and highly successful state-federal highway partnership. Through this partnership state desires and processes are supported, while concurrently broad national goals are advanced through continuing, customized, creative negotiations. Finally, there is the complex state/local government interaction around the RCHS. This part of the process has varying degrees of stature in the states, in part granted by federal and state statutes and in part derived from tradition and practice.

## THE CHANGING ENVIRONMENT—WHY ANOTHER REPORT ON RCHS

Even a casual observer may perceive significant changes in highway transportation recently. A more seasoned observer is struck by the pervasiveness and depth of the changes now in progress. In the baseball vernacular, it's rapidly becoming "a new ball game." Following are some dimensions to and reasons for that change:

- The system is mature geographically. There are almost no unserved communities, farms, businesses, or tourist sites.

- The system is mature physically. There is a growing maintenance and rehabilitation backlog as first life-cycles are lived out and exceeded. The rapid early 20th century initial system construction period makes this, in economic terms, a "lumpy" phenomenon, one in which investment occurs at irregular periodic intervals. For example, a large number of federal-aid primary system bridges are due or past due for replacement.

- In some states the planning process for highways is changing, with a growing emphasis on a strategic view of transportation, that is, using transportation to achieve specific, targeted social objectives such as economic development.

- The old institutional management and fiscal frameworks are vanishing and their replacements are only dimly perceived. As examples, with a relatively smaller dollar input and a smaller staff at the Federal Highway Administration (FHWA), the federal presence is being reduced. At the state level, growth in other programs has caused the highway presence to be reduced. Chief administrators of highway systems serve shorter terms, and so "institutional memory" is lost. Most important, the federal funding framework could change dramatically in 1991 when current federal legislation expires.

- Transportation is rapidly becoming more than transportation—society is redefining what it means by infrastructure in general and transportation in particular. For example, now more than just freight haulers, highway transport companies are components of a manufacturing production process that is competing in a global marketplace. They are responsible for accommodating just-in-time (JIT) inventory and the consequent opportunity for cost containment. With this redefinition, transportation infrastructure will come under more public and legislative scrutiny, and there will be increasing pressure for system performance. This improved performance will be gained at the margin rather than through grand increments (e.g., the Interstate system), as in the past.

- There is increasing sophistication and analytical capability among congressional and state legislative members and their staffs. To match this capability, the departments of transportation (DOTs) must develop similar resources.

- Loss of sovereign immunity and rising tort claims demand aggressive preventive measures focused on the potential targets for these claims.

- The resources pool is shrinking—in part from inflation and higher standards but even more by national budget constraints and competition. In the words of Becker (*1*), "Unfortunately, budget deficits and opposition to high taxes not only prompted cutbacks on many peripheral government programs but also on spending for roads. . ." and "It is not realistic to expect much weakening in the political power of the special interest groups that fight for agricultural price supports, Social Security, and

most other large public programs. For this reason, the prospects are dim for dramatic improvements in roads. . . .”

- The private sector's and local governments' share of highway financing is increasing, with a consequent blurring of accountability, which causes some loss of ability to forge a consensus for creating new programs.

- Sophistication of instrumentation and devices for measurement and in computer hardware and software for data management and analysis is growing at such a rapid pace that maintaining currency is difficult and expensive yet absolutely essential.

- The cadre of professionals brought to highway agencies by expanding programs (e.g., the Interstate) and the attendant opportunity for personal growth are now retiring or otherwise leaving this industry. Recently, civil engineering enrollments have begun to drop, and the percentage of civil engineering graduates has been declining for years (2). A more productive use of fewer professionals must evolve.

- Traditional tax revenue sources are being eroded because of the fixed nature of the levies (generally not responsive to inflation), through exemptions of agriculturally derived fuels, and through marked improvements in fuel efficiency for both trucks and cars. Meanwhile, the deficit in the federal general fund creates pressure to maintain surpluses in user fee trust funds, such as those for highways.

- Modal variety is narrowing. Of the \$700+ billion per year private and public U.S. transportation expenditure, highway transportation accounts for more than 90 percent of that total. When there are fewer modal options, expectations placed on those remaining are necessarily inevitably higher.

- With some localized exceptions, U.S. highway transportation over most of its history has enjoyed comfortable margins of overcapacity. As a prudent society dictates the narrowing of these margins, professionals, generally risk averse as a group, become increasingly uncomfortable.

- The highway program is used increasingly to achieve other societal goals. Some examples are to:

- attract and accommodate economic development
- enhance environmental quality
- manage growth and land use
- promote minority employment
- preserve cultural heritage
- reduce alcohol abuse
- promote agricultural production
- balance the federal budget

*Transportation Research Circular 334: Transportation Trends and Current Research Activities* (3) confirms several of these perceived changes. The 1988 Transportation Research Board staff field visits reported the following:

- Current emphasis continues to be on short-range problem solving and decision making, but an increasing number of states are moving toward longer horizons as they update long-range comprehensive highway plans.

- The year 1987 saw a continuing shift of financial responsibility from the federal government to state and local governments. While federal highway obligation ceilings were reduced from \$12.4 billion to \$11.8 billion per year, motor fuel taxes in the states produced \$14.1 billion and motor vehicle license taxes produced \$7.7 billion, an annual increase of about 7 percent.

- The “graying” of state transportation agencies continues. In some states 30 to 40 percent of the professional engineering staff is eligible to retire.

- Many state legislatures are concerned about the formulas and criteria used for allocating road-user funds among the states, counties, urban areas, and the states' geographic regions.

- One city plans to start using nonpetroleum-based fuels. As a result of the \$0.06 per gallon gasohol fuel tax exemption, there will be a federal gas tax loss of \$90 million per year from this single city.

- The Federal Highway Trust Fund balance remains at \$9 billion to \$10 billion, partly because of its effect in calculating the federal deficit. In addition, several bills would add \$0.10 to \$0.30 per gallon to motor fuel taxes or \$25 to \$30 per barrel of crude oil to aid in deficit reduction.

Others would add to or delete from this description of current change, but a persuasive list would probably remain. However, the conclusion is that highway transportation, in all its systemic ramifications [i.e., physical extent (Interstate), user mix, intergovernment relationships, etc.], is undergoing massive change. For this reason, a contemporary observation of and commentary on such critical elements as RCHS is justified and essential.

## RELATION TO PREVIOUS WORK

There is extensive literature on both existing practices and normative, prescriptive techniques of capital program management. The following is a brief presentation of some of the recent literature organized under four classes:

- Context to the current discussion of RCHS
- Description of current planning practices
- Description of current programming practices
- Theoretical concepts and approaches

### Context to the Current Discussion of RCHS

The National Council on Public Works Improvement published its report on America's public works in February 1988. Entitled “Fragile Foundations” (4), this report calls for “a national commitment shared by all levels of government, the private sector, and the public to vastly improve America's infrastructure.” In its “report card,” highways get a C+: “Spending for system expansion has fallen short in high-growth urban and suburban areas.”

“Beyond Gridlock” (5) is a summary report of 65 forums held to get the views of Americans concerning surface transportation. The sponsors' overall appraisal is that the U.S. population needs and wants mobility and is willing to pay for it. There are specific calls for massive capital investments across all modes of surface transportation.

A September 1988 news report of a study by the Federal Reserve Bank of Chicago (6) seems to give new impetus to capital investment in highways and other elements of infrastructure. The author of the study, David Aschauer, says, “The most productive use of the nation's resources is investment in highways. . . and other systems that aid in the production of goods and services.”

The need for highway capital investment, especially in suburban areas, is advanced persuasively by an Eno Foundation publication titled "Commuting in America" (7). Drawing on census data, it sets forth the nature and causes of current traffic congestion: More people are traveling by car to expanding suburban job sites on obsolescent roads.

### Current Planning Practices

Gundersen (8) describes the planning process used in Wisconsin to develop a state highway plan using alternative travel demand scenarios that reflect a wide range of potential energy and economic conditions. Alternative levels of improvement to the year 2000 were identified from a deficiency analysis process that had threshold levels for surface quality, safety, congestion, and geometric indicators. Similar efforts in Michigan, Arizona, Pennsylvania, and Florida, among others, are also described in literature (9–13).

### Current Programming Practices

Detailed descriptions of highway programming practices are available in two FHWA documents. The first, discussing practices in several states (Iowa, Wisconsin, Florida, Texas, Illinois, Louisiana, and Georgia), contrasts the weights given by these states to alternative aspects of program development, such as financial control, policy alternatives, pavement preservation, and program scheduling (14). The second document describes practices in four states, as well as providing an excellent framework that relates the various planning and programming tasks to each other (15). A similar and useful framework is provided in Synthesis 48 (16).

Synthesis 72 (17) describes how several states are coping with funding constraints and incorporating both highway improvement and financial management options into overall program development strategies. Case studies describe the processes in four states: Illinois, Massachusetts, Minnesota, and Wisconsin. Synthesis 84 (18) updates earlier reviews of project selection practices and summarizes both the quantifiable factors used in many states and many nonquantifiable factors, such as legislative mandates and political commitments. Zeeger and Rizenbergs describe the use of priority programming methods for highway reconstruction in Kentucky (19). An extensive bibliography on priority programming and project evaluation/selection methods and practices published before 1980 is also available (20). It has also been shown that integrated information systems can be extremely useful in effectively managing the programs (21).

### Theoretical Concepts and Approaches

There is a large historical body of literature on the general topics that lie at the heart of RCHS, namely planning, programming, and capital budgeting. Beyond the three classes already mentioned, a further distinction can be made in the literature between those concepts and approaches that focus on process as opposed to those that give quantitative treatment.

Dealing first with process, many textbooks on public-sector management provide detailed treatment of key phases and ele-

ments of planning, programming, and budgeting. For instance, Anthony and Herzlinger (22) describe the process in terms of initiation, screening, analysis, decision making, and selling or marketing a program. Roles in the technical analysis of such well-known tools as benefit-cost analysis, discount present value, and risk assessment are also described. Starling (23) describes alternative methods of planning, budgeting, and decision making, indicating the role that can be played by various operations research methods, such as linear programming and decision trees. Manheim (24) and Haefner (25) provide extensions of these concepts to the transportation environment, focusing on the process of search and choice in planning and programming. Abouchar (26) also provides a normative treatment of transport planning, investment analysis, and financing with a strong economic orientation. Various works in the fields of political science, public administration, and engineering management add to this rich collection.

There is no shortage of literature on the quantitative side either, focusing on both project level and program or network level with varying degrees of mathematical sophistication. This literature includes texts and articles rooted in engineering and planning, as exemplified by Morlok (27), land use and regional planning, as illustrated by Blunden and Black (28), as well as operations research, as in Steenbrink (29). A number of approaches are also available for establishing road project priorities (30–32), some based on sufficiency ratings (33), or the Highway Performance Monitoring System data (34), as well as weighting schemes for dealing with multiple objectives (35). Most of the references cited here demonstrate the presented technique through specific applications.

*NCHRP Report 156* (36) is a guide to decision making in transportation, taking into account not only economic but also social and environmental considerations. The report focuses on the necessary interactions between the transportation agency on the one hand and the community affected by the proposed projects on the other. *NCHRP Reports 179 and 199* (37, 38) are more specifically focused on the methods and techniques available for evaluating options and decision making in both fiscal and program impact aspects of transportation. Techniques of revenue forecasting as a function of alternative policy inputs are described, for example. The literature also contains extensive treatment of sophisticated mathematical models and techniques for project evaluation, priority setting, and capital budgeting, including the use of linear and integer programming and multiobjective criteria (39–43). These methods are especially well suited for manipulating quantitative factors and data, and are increasingly found in pavement/roadway management computer program systems being used by states.

In 1984, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Planning and Programming Methodologies prepared a report (44) entitled "A Survey of Programming Practices." Among the findings of this survey were the following:

- Programming is art rather than science.
- Project selection is influenced most heavily by legislators and boards or commissions.
- Project selection on the basis of technical data, although heavily used and important, is rated less important than commission policy or legislative initiative.
- The criteria used most frequently to prioritize projects are

available funds, system preservation, commission policy, and legislative mandates. Sufficiency ratings and cost-benefit ratios are relatively low on the list of criteria.

- The survey data suggest that using computerized methods does not increase efficiency or effectiveness.

- All states overprogram by some means. The most common method is to include excess projects in the programming document. Sixty percent of the states overprogram between 10 and 30 percent.

- The frequency of changes in the program is mentioned as a problem by almost all the states. The most often mentioned reasons for these changes are: (a) a change in available revenues, (b) a change in internal priorities, (c) a change in public support of a project, and (d) project delays caused by right-of-way purchases, environmental clearances, and similar obstacles. (The mismatch between political cycles of 2 to 4 years and the 6- to 10-year lead time for highway capital improvements drives much of this program change.)

- The (program) monitoring task generally falls to the central programming office or a departmental committee. In some cases, a division or bureau chief performs this function.

**Summary**

In the literature search, evidence of frustration was detected among those attempting to describe a technical/planning/programming process that, as the AASHTO survey found, has become more nearly an art form. That sense of frustration is shared by many professionals. Seeking form and clear substance, attempts have been made to sketch appropriate diagrams and charts. Figures 1, 2, and 3 are illustrative of several approaches. They are helpful to understand the mechanisms of RCHS, but for those lacking a detailed working understanding of the process they fail to communicate the "art" of highway capital budgeting.

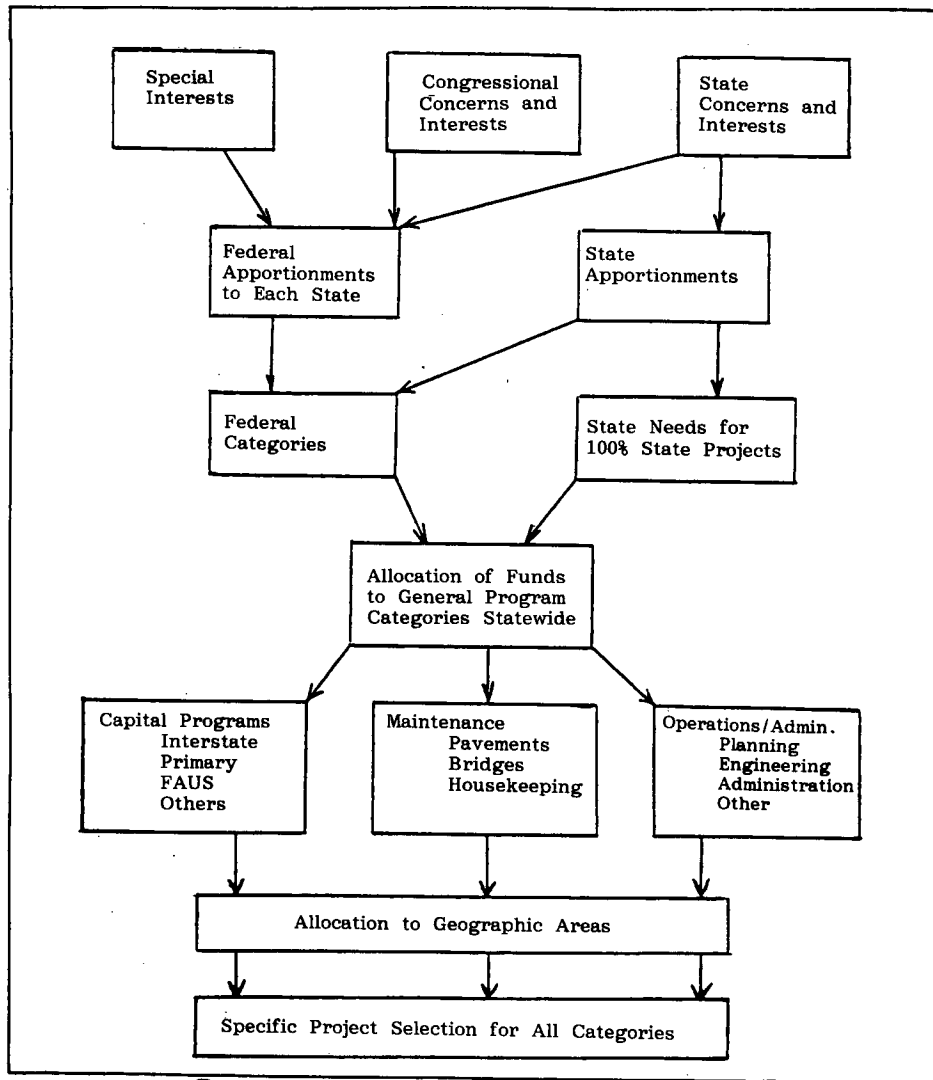


FIGURE 1 An illustration of the problem being addressed (18).

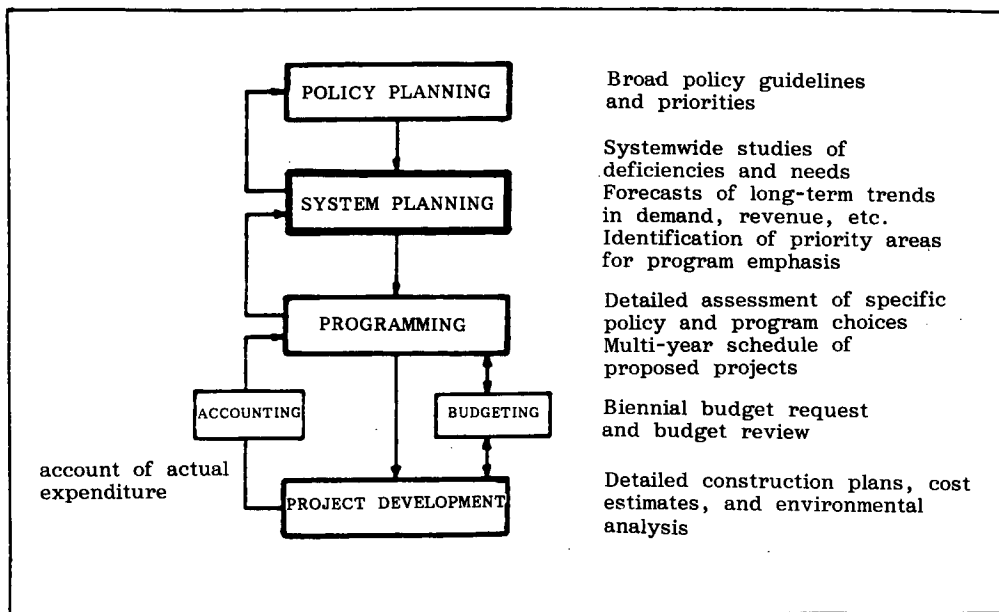


FIGURE 2 Highway investment process (8).

Given the obvious diversity among the states and the extensive literature treating the process, there is a natural tendency to press for a generalized theory, for a normalized highway capital improvement selection process. Can there be a contribution to the understanding of this important area otherwise? A position on this point, normalizing may indeed be counterproductive, has evolved over the performance of this synthesis. It evolved as states were visited; talks were held with creative practitioners; as planning, programming, financial, and management literature was read; and as the totality of this experience was reconsidered.

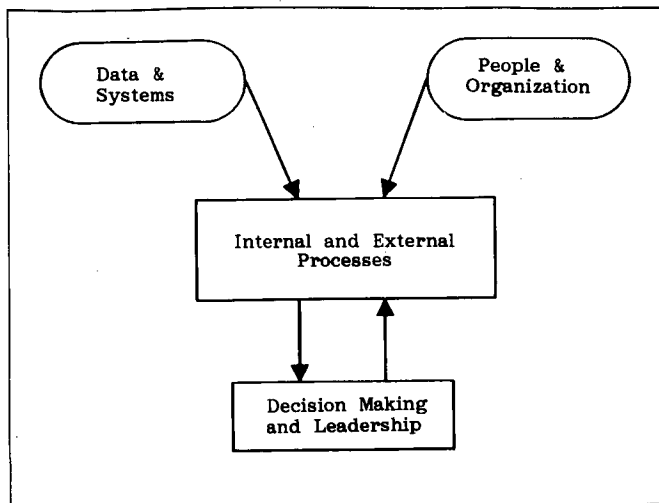


FIGURE 3 Elements of the process for recapitalization of highway systems.

#### NOTES ON CREATIVE PROCESS

Stating that creativity has marked the RCHS and pointing to its successful products justifies a more careful examination into the reasons for such creativity. Such an examination using several metaphors follows.

RCHS has been marked by the "edge" concept. The edge concept as we know it came from Congressman Buddy McKay of Florida. Speaking on creativity to a group that was assembled by the National Academy of Engineering and charged with bringing forth recommendations to improve U.S. competitiveness, he likened sources of societal creativity to forest edges and wetlands. It is such places of rich diversity and change, rather than in deep forests or on open seas, that nature demonstrates her creativity. Similarly, in U.S. society diversity and change of structure, governance, education, resources, and objectives are acknowledged contributors to creativity. Congressman McKay's point was the importance of maintaining this "edge," this key resource for creativity in the face of maturity and under the increasing forces for conformity throughout our society. (Although some decry the delays sometimes occasioned, the Corps of Engineers and others charged with protecting the environment are deeply committed to actions preserving these places of natural creativity, with wetlands as a special emphasis.)

RCHS skills have been shaped by diversity and change, state to state and within states. Competition for resources to pay today's high capital improvement costs has been a driving force. This competition, as noted earlier, has been nourished by a diverse environment, naturally found among the 50 states. This has led to different approaches, different experiments in capital programming. RCHS has indeed been marked by "edge."

The RCHS has prospered as a directed autonomy. Robert Waterman, Jr., in his book *The Renewal Factor* (45), says, "In directed autonomy, people in every nook and cranny of the



company are empowered—encouraged in fact—to do things their way. . . but this all takes place within a context of direction.”

While state program managers strive, with strong encouragement from all sides, for creative new approaches in the highway capital improvement selection process, FHWA, governors, and commissioners provide, in Waterman’s words, “the context of direction.” That such a diverse approach could survive since the early 1900s, when state highway agencies were created, and flourish under a federal-state partnership dated to 1916 is a near miracle, especially considering the massive overbureaucratization suffered during that same time by both public and private enterprise. One explanation for this seeming miracle is that here is a process that has benefited from frequent renewal, renewal from legislative input, gubernatorial change, federal program reauthorization, professional skill enhancement, and much more.

More of Waterman’s words are worth noting:

We have never come to grips with this question of management and control versus freedom and empowerment. Unless we do, our ability to restore high productivity and growth in this country is in doubt. . . . There exists. . . a way of managing that keeps the leader in the position of directing while recognizing that, at some level of detail, the employee does know the job better.

As the RCHS process was studied, an appreciation of its inherent creativity was gained. Meeting its practitioners, it became apparent that in this area there was an early and has been a continuing understanding of management and control versus freedom and empowerment. It became apparent that the genius of RCHS, its creativity, rests, in large part, on the early acceptance of a “directed autonomy” philosophy and this philosophy must not be disturbed.

#### **BASIC PROPOSITIONS, DISCUSSION OF REPORT FORMAT**

Recapping in part what has been stated in this chapter, a basic position rests on the following propositions:

- In RCHS, as in few other public-sector areas, there has been created and exists an unusual environment for creativity resulting from the rich blend of agencies, disciplines, programmatic thrusts, funding streams, public and private interests, and much more.

- As a result, no single normalizing description or diagram is likely to capture adequately the U.S. knowledge and practice of RCHS. If this were possible, publicizing and adopting such a description may tend to stifle the creativity so in evidence now.

- Finally, the creativity and skillful process execution found in RCHS has in general been rewarded. In spite of much current handwringing, governors’ platform promises have been kept and members of Congress and of state legislative bodies have generally been satisfied. They have demonstrated this by their long-term willingness to provide additional resources. Most important, through the RCHS, with all its diversity, citizens’ expectations for ever-improving mobility have been met, although today we face increasing congestion because the supply of highway capacity has failed to keep up with demand.

The remainder of this report will be developed as follows: Chapter Two accepts the concept of RCHS as art rather than science—but not entirely. Various conceptual frameworks are discussed, primarily as a means to identify and describe the important elements of the process quite independent of their precise individual importance, application, or of the relative interaction between them, as the process is played out in different agencies.

Chapter Three examines how the process is played out in the several states. These process descriptions are based on personal interviews (spring 1988) with the chief administrative officers or senior managers in every case, and they are believed to represent contemporary practice.

A final chapter is future oriented. If change in the highway business is as massive as predicted, then there is more profit in discerning and shaping the future than in describing and preserving the present.

## CHAPTER TWO

## CONCEPTS

To relegate the process of recapitalizing our highway systems to pure art demeans the technical contributions of professionals nationwide over several decades. However, accepting the other extreme—an unquestioning dependence on scientific rigor in a subject area so obviously affected by technical uncertainty, citizen need, and political priorities—is equally troublesome. Clearly a balance must be struck. In this chapter frameworks and elements, building blocks of the RCHS, are discussed. By this means an attempt is made to find the middle ground between art and science.

## CONCEPTUAL FRAMEWORKS FOR ARTICULATING RCHS

## Roberts' Circles

A framework “for all seasons” is one advanced by Professor Marc Roberts of Harvard’s Kennedy School of Government. It is deceptively simple, consisting of three circles, each one representing elements of management (Figure 4). Vision and leadership are first. What does the state, through its highway agency, through leadership, want to accomplish? Note here that goals for the highway function are defined as derivative. Only as highway programs serve social, economic, and political purposes will they be perceived as successful. As the concept of infrastructure is more completely defined by society, so is this proposition of highway service as a derived function more nearly true. Thus, a proper vision for the RCHS is not simply of more highways or bridges; such a small vision will surely fail to garner support in an increasingly competitive environment. The vision must be to help the state and the nation in global economic competition through improved transportation. A recent observer has given substance to such a vision by noting parallel movement between indicators of infrastructure investment and productivity growth (6).

The vision also must include worthy social and environmental goals, reducing CO<sub>2</sub> emissions, and so the “greenhouse effect,” by searching out new fuels and propulsion systems and by reducing congestion. The vision must now offer more than getting farmers out of the mud, the catch phrase during the first half of this century. It must help them in all aspects of their enterprise, providing a system of non-weight-restricted roads and bridges.

The vision must include cleaner, safer neighborhoods, a notion strong in 1894 when, at the Good Roads Convention in Minneapolis, the following lyric appeal was offered:

It [a perfect highway] brings into pleasant communion people who otherwise would have remained at a perpetual distance. It

awakens emulation, cements friendships, and adds new charm to social life. It makes the region it traverses more attractive, and the residences more delightful.

The vision now must have a citizen/customer service focus. Citizens pay taxes expecting that their needs will be met, courteously, always, promptly and economically, if at all possible.

Finally, the vision must deal with equity as well as efficiency issues. Transportation professionals may indeed have a priority set that is optimal from a transportation efficiency perspective, but government will always be constrained by equity considerations. Nowhere is this more critically true than in highway transportation. In its redefined role, transportation is an essential good for social and economic reasons, a fundamental right to young and old, to rich and poor, to urban, suburban, exurban, and rural citizens. Any vision of a highway capital improvement selection process that is less global than suggested by these few thoughts will not succeed.

The prospect for success relates to all of the affected constituencies. This is the subject of the second circle, the authorizing environment. Governments exist by the consent of the governed. The governed authorize all programs, including the highway program. For the highway system, this authorizing environment is very extensive. It is difficult to exclude any individual function,

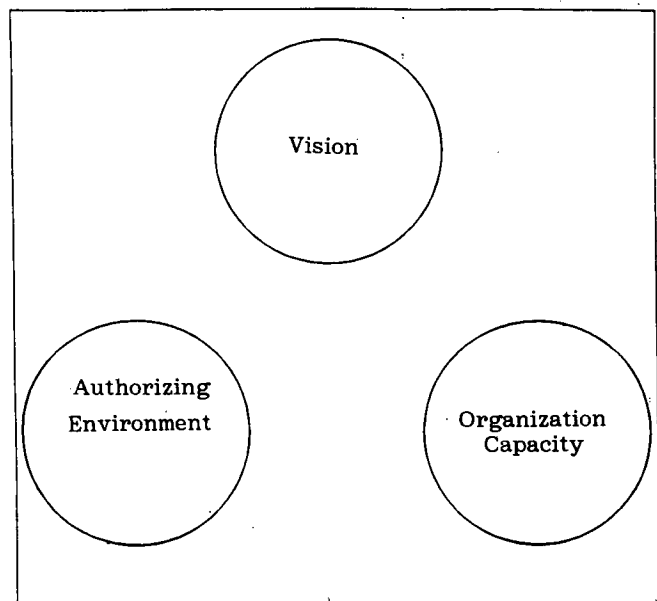


FIGURE 4 Roberts' Circles elements of management.

group, or institution. How does this authorizing environment speak? Concerning the need for highways, it spoke in a 1916 congressional action. It—mostly the farm society of the day—said, “Get us out of the mud and ensure regular mail delivery with a system of federally aided roads.” Later, in 1944, an increasingly urban population said, “Look after some of the major urban highways in essentially the same fashion as you are looking after rural roads.” Still later, in 1956, again through congressional action, the authorizing environment—now a more dispersed population, one recently exposed to two world wars and facing burgeoning economic growth—said, “Connect all major economic and political centers with a national network of free-flowing defense-supportive highways.” The 1982 Surface Transportation Assistance Act said, “Let us increase spending for the preservation and restoration of existing roads and bridges.”

More recently, the voice of the highway authorizing environment seems, to those conditioned by previous clarion calls to action, to be muted and confused. However, this does not imply that the authorizing environment has gone awry. It only means that listening is more difficult, more important. A major item to note here is the role of leadership, vis-à-vis this authorizing environment. Highway agencies do not have to wait for a clear voice. Proactive listening requires knowledge, sharing of ideas, discipline, courage, and respect for all elements of the authorizing environment. These are more likely to be found in an agency under empowering leadership.

Finally, there is organizational capacity. There is no good in selecting, prioritizing, and promising capital improvements that will not be delivered. Indeed, it is counterproductive to select, prioritize, and promise and fund improvements that the agency cannot deliver. The long-range urban planning process of the '60s and early '70s that raised expectations without adequate attention to delivery proved this point. In many regions of the country, a public exposed to undeliverable, unrealistic, threatening plans rapidly lost faith in the agency proffering them.

Organizational capacity rests in part on particular skills and numbers, but in the highway capital improvement arena, it rests even more on creativity, as noted earlier in this report.

When vision, authorizing environment, and organizational capacity are all carefully managed—when vision is captured by empowering leaders, an authorizing environment is generated through tireless communication, and organizational capacity is enhanced by strong management—an overlap, creating maneuvering room in these three elements, results (Figure 5). Note that it is a compromise situation, and the overlap areas represent a trade-off among the three elements.

It is not suggested that this framework is in any sense operational. Rather, it can provoke the strategic view of what the vision of the agency is, its capacity to deliver, and its mandate from its authorizing environment, so necessary in these times of dramatic change.

**Seven-S Framework**

A more nearly operational framework is suggested by the Seven-S management model described by Waterman (45). Clearly, the original Seven-S elements do not fit RCHS, but the concept of many elements interacting does. Figure 6 is a suggested RCHS version with seven interacting elements. Each of these merits attention, because they become important in de-

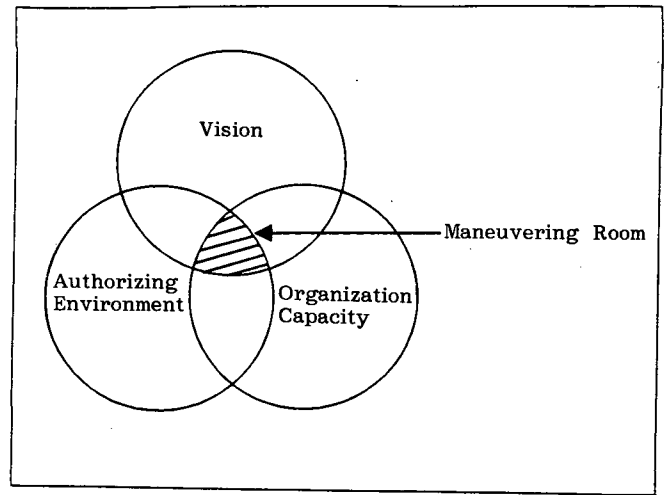


FIGURE 5 Balance in elements of management.

scribing state practices in the next chapter. Again, this concept focuses as much on the interaction among the elements as on the influence of any one of them.

*Vision, Leadership*

Just as in the Roberts model, vision must reach beyond the transportation function and service a larger, contemporary, societal ambition. It must be articulated clearly and repeatedly until it becomes a subliminal driving force in the agency. Leadership is integral to meaningful vision. The task of leadership is bringing vision to reality by harnessing external support and internal resources.

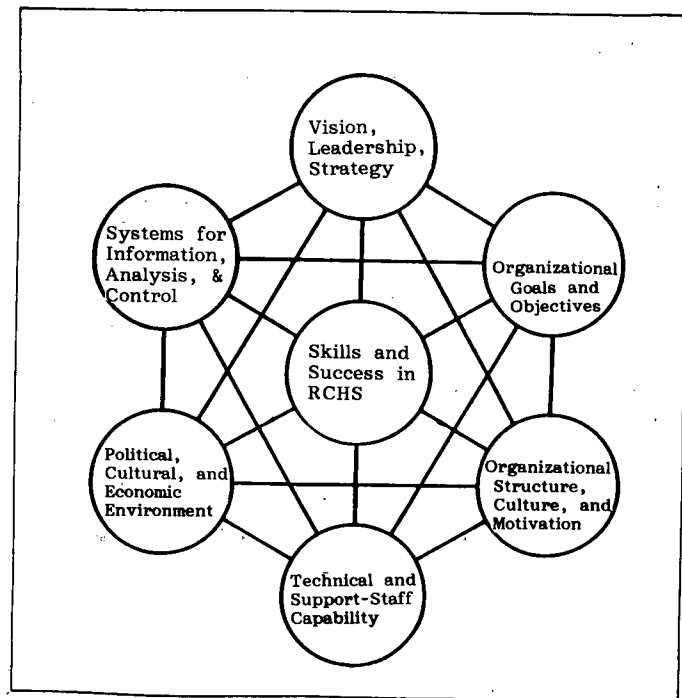


FIGURE 6 Seven interrelated elements of RCHS.

### *Organizational Goals and Objectives*

Organizations come to grips with something more specific than a vision. Leadership must provide manageable packages set in realistic time frames. Only then can they become part of the driving force, the empowerment for the agency.

### *Organizational Structure, Culture, and Motivation*

How well the internal resources are used is the issue here. No one structure or culture is uniquely right for RCHS. However, as noted earlier, a directed autonomy is more likely to produce the necessary culture, motivation, and creativity to move the process forward and to reflect the constant stream of change that is the environment.

### *Technical and Support Staff Capability*

Along with much art, RCHS has strong elements of science, as we have already noted. People who know federal programs well, understand political and organizational processes, are facile in data management and analysis, and finally are willing to work long, very hard, and with complete integrity are absolutely essential to success in this arena.

### *Systems for Information, Analyses, and Control*

The data volume is too great, the required analyses too extensive, and the requirements for control too pressing to operate without the benefit of state-of-the-art systems. This is no longer a matter for debate. The systems are available for success in RCHS, and they must be used. As an obvious example of element interaction, these systems must be authorized by a forward-looking leadership, one that sees improved systems as part of the overall strategy, and as a further interaction, these systems become the tools whereby the support staff meets its obligation in creative ways.

### *Political, Cultural, and Economic Environment*

Although knowledge is power and giving knowledge results in influence, it is generally not the sole purpose of RCHS professionals to shape these environments. However, at a minimum, they must understand them. Active listening is the key to success here, along with a willingness to tailor the process to what is heard through such listening. The process must be tailored to short-term citizen/legislative/gubernatorial imperatives as well as to long-term federal or technical purposes.

### *Skill and Success in RCHS*

The derived element is skill and success in a recapitalizing of highway transportation systems. Lack of this success, this skill, will not be hidden. Ability to move projects through the pipeline is perhaps the most common, most readily identifiable measure of transportation agencies' success, as was noted earlier. It relies

on skill and success in all the contributory elements. The obvious final note on this Seven-S type of framework is that the process itself, the way in which all the interactions occur, is important in its own right, perhaps almost as important as the product. There will not be a continuing stream of good product without a good process.

### **The Pipeline Analogy**

Citizens don't understand or care about complex conceptual frameworks. They want to know if projects important to them are being handled in a fair, expeditious fashion. A common metaphor they use in querying a highway capital improvement process is to ask, "Is my project in the pipeline?" Because of this common usage, as well as for more technical reasons, the pipeline analogy is also useful.

Some obvious aspects of this analogy follow:

- Things, projects, must be loaded into the pipeline. What's not put in can't come out.
- Even if projects are loaded into the pipeline, they may "leak" out. Leak management is always important.
- Pipeline capacity is a function at least of size, friction, and pressure. The RCHS analogs are perhaps available funds; staff size, capability, and motivation; agency credibility (or lack thereof); and citizen/political demand.
- Any pipeline has some finite length before products can emerge. As noted earlier, there is a mismatch between the RCHS pipeline length and the working political time frame.

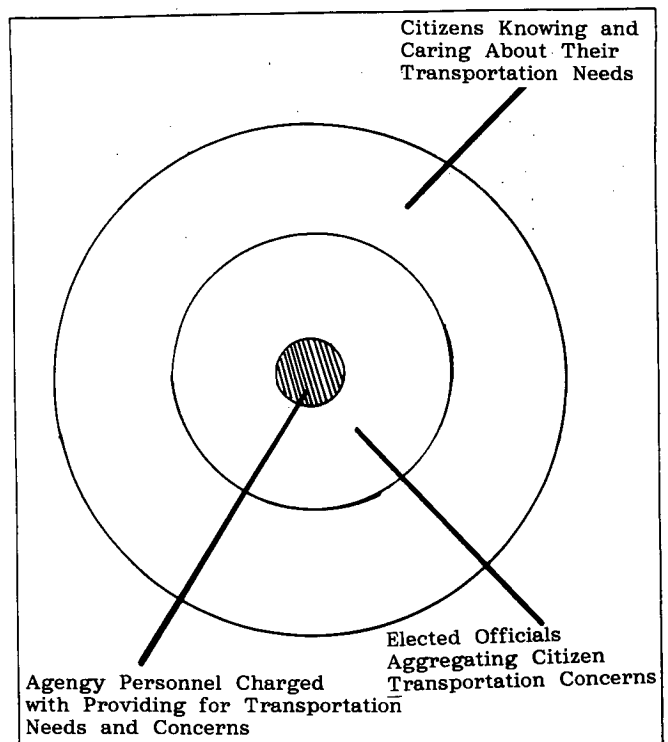


FIGURE 7 Focus in the RCHS process.

- A mix of products can move through a pipeline, but proper discrimination, prioritization, and control must be maintained.

Citizens, on average, know and care about transportation matters only so far as such matters affect their world. Therefore, they ask and expect answers to such questions as, "What's in the pipeline for me?" Such questions are most often aggregated through elected officials and directed to the agency (see Figure 7). Developing this pipeline analogy provides a means for providing relatively detailed responses to single or aggregated inquiries as they are made.

## **SUMMARY**

This chapter sets forth elements essential to RCHS and suggests several frameworks for considering these elements individually and as they interact one with another. These concepts are offered as a means for using the substantial technical rigor that has been developed, while at the same time not becoming captive to it. This is a complex area, one for which most citizens and their representatives feel ownership. As such ownership is encouraged and properly cultivated, the highway capital improvement selection process can be successful even in a world of rapid change and competing demands.

# STATE PRACTICES

The sample of states, limited by the process chosen, included California, Colorado, Connecticut, Florida, New York, Pennsylvania, Texas, and Washington. In each case, there were detailed discussions with top-level officials followed by careful observation and study. The results of this effort are presented here in alphabetical order.

## CALIFORNIA

Size, diversity, politicization, complexity—all of these words can be used to describe the California highway capital improvement selection process. Perhaps complexity is the place to start. This section begins by outlining the State Transportation Improvement Program (STIP) as mandated by California Assembly Bill 402 of 1977. This act set in place what may well be the most complex of the processes used by the states in managing this function. Next, the working details of the California process, emphasizing the interactive features of the STIP, are discussed

in the context of the seven-element framework. This section closes with notes on the pipeline analogy, why it fits imperfectly here, and what the California experience may portend for the future of RCHS elsewhere.

In briefest terms, AB 402:

- required development of an annual STIP that meets specified milestone dates,
- established an independent California Transportation Commission (CTC),
- established a formal, legislative budgeting procedure, and
- increased regional input to the transportation improvement identification process by requiring development of regional transportation improvement programs to be fed into the STIP.

Figure 8 shows inputs to the proposed annual STIP, and Figure 9 shows the complex adoption process. Finally, Table 1 shows milestone dates and gives process detail.

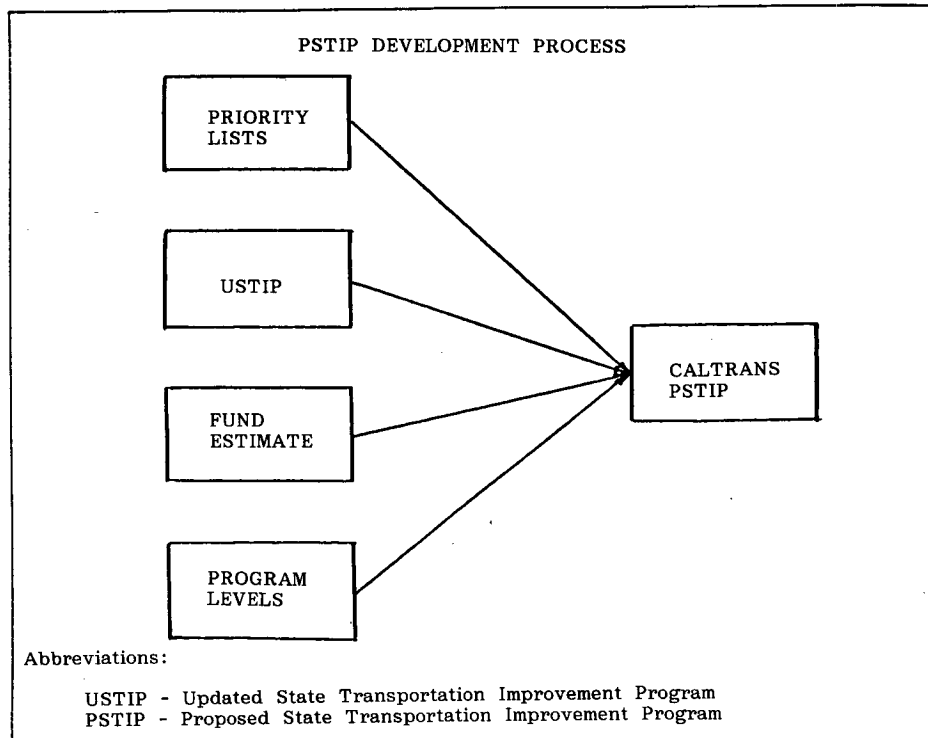


FIGURE 8 Elements of California proposed State Transportation Improvement Program.

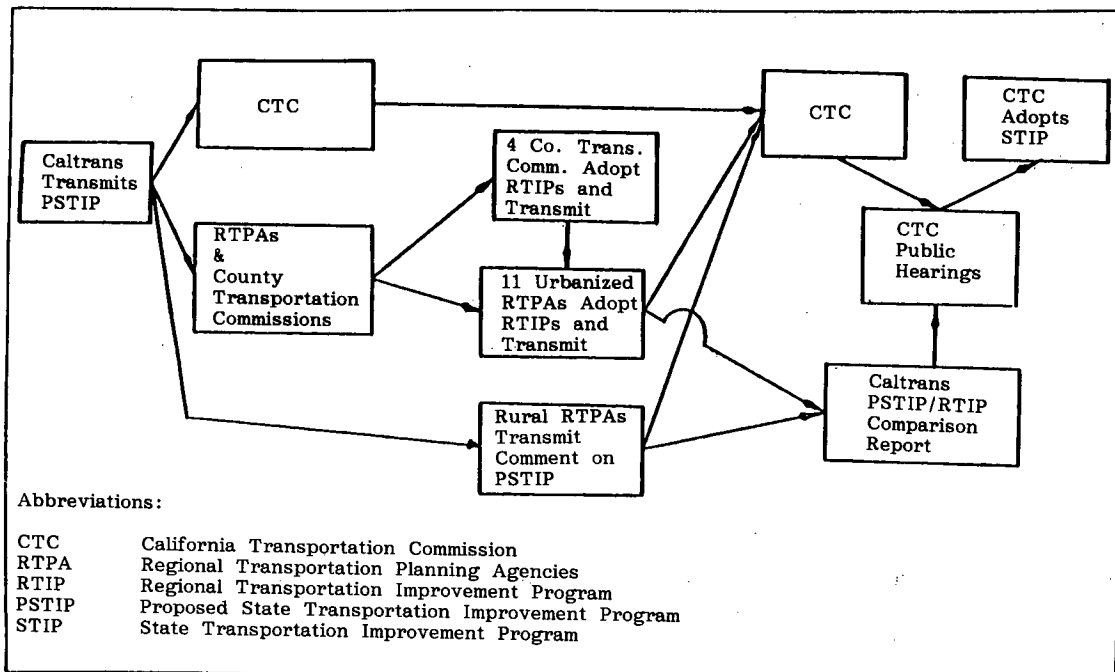


FIGURE 9 California STIP adoption process.

TABLE 1  
 SUMMARY OF CALIFORNIA STIP DEVELOPMENT PROCESS

	Districts	Hdqtrs.	Local Agencies	CTC
STIP Adopted				Jun 25
Final Priority List Candidates to Hdqtrs.	Jul 5			
STIP Distributed		Jul 15		
USTIP to Hdqtrs.	Aug 15			
Escalation Rates to CTC		Aug 10		
Escalation Rates Adopted				Aug 25
PSTIP Recommendations to Hdqtrs.	Oct 1			
Fund Estimate & USTIP to CTC		Oct 15		
Priority List Approved by Chief Deputy Director		Oct 15		
Program Levels Approved by Chief Deputy Director		Oct 15		
Fund Estimate Adopted				Nov 15
Draft PSTIP to District & Local Agencies		Jan 15		
PSTIP to CTC		Mar 1		
RTIP to CTC			May 1	
Local Comments to CTC			May 1	
Comparison Report to CTC (PSTIP vs RTIP)		May 15		
STIP Adopted				Jun 25

A good place to begin in considering the seven-element framework (see Figure 6) is with the political, cultural, and economic features relating to transportation in California. Some noteworthy aspects of this element include:

- The political will for dealing with transportation needs in California may have been eroded by the more than two-decade period during which previously provided capacity had accommodated growth. Governors Reagan, Brown, and Deukmejian campaigned as no-tax governors, but the enormous expansion of facilities before their terms for highways, water, and education provided the cushion for such a strategy to be acceptable. Now there is little tradition for and much political opposition to raising taxes and adding infrastructure capacity in an acceptable time frame, even though strains on the various systems are increasingly apparent.

- In California, there has developed a large local government and private-sector contribution to transportation capital improvements, an amount well into the hundreds of millions of dollars (under so-called "innovative financing methods," including public-private partnerships). This is fragmenting transportation authority and appears to require a newer and greater effort at the statewide level to build a political consensus for any broad improvement thrust.

- The California "Super-Cabinet" places the director of Caltrans under a cabinet officer charged with oversight of transportation, commerce, and housing. This means that transportation is one layer removed from the governor. In addition, transportation has lost importance in the California budget. In the 1960s, the highway program constituted approximately a third of the total state budget; at the present time it is on the order of one-twelfth.

- In general, Caltrans and the STIP are oversubscribed in needed projects versus funds available. As a result, the STIP is a highly controversial document and Caltrans is exposed to criticism from politicians and citizens alike. Some in California transportation circles believe the STIP must go through a major downward readjustment (in terms of dollars and number of projects) before it can become a credible document, but there appears

to be little political will for such a downsizing in the face of a demanding citizenry.

- During California's expansion period, the state matched all federal aid and had a state-funded improvement program that was as much as a billion dollars per year. More recently, the policy has been to use state money only to match federal aid. Because very large blocks of federal money have been identified for Interstate completion and because only a few of the California counties have Interstate work still to be completed, there is major stress on the mandated distribution formula.
- The California legislature has dealt with resource allocation in a north versus south, urban versus rural fashion. Given all the program limitations that otherwise exist, this political solution becomes a major constraint to the RCHS.

Perhaps organizational structure is the next most significant of the seven elements. As noted earlier, by action of the California legislature in 1977, the California Transportation Commission was created and given final authority for approval of the State Transportation Improvement Plan. The STIP is a five-year program with an annual update. Until a recent legislative amendment, no funds could be expended outside of the five-year period. These features raise several potential conflict points:

- A time frame of five years is inadequate for early phase project preparation because an overall time of 10 years is not unusual for major projects.
- Caltrans is charged with implementing a program for which it may feel a limited ownership.
- The Transportation Commission is charged with adopting a program but is left without resources for implementation. Actually, the structure provides for a shifting of responsibility. District offices identify candidate projects for the annual update and provide the sophisticated benefit-cost analysis information used for project prioritization. This is provided to the Caltrans central programming staff. Then, as shown in Table 1, this information passes to local authorities and then back to the Transportation Commission for ultimate adoption.

It appears that vision and leadership for transportation improvements in California are divided between the governor and his Super-Cabinet officer, Caltrans, and the California Transportation Commission. This arrangement may lead to some blurring of vision unless there is complete, informed interaction within this tripartite arrangement. One thing is clear—California is a complex, congested, highly mobile, rapid-growth state where transportation service will be an increasingly contentious issue.

In California, the goals and objectives of at least two governmental units are critical to the RCHS: Caltrans and CTC, and there is basis for natural differences here. For the CTC, the goal is to define a rational capital program, one meeting statutory and fiscal constraints and at the same time meeting citizen expectations. For Caltrans, the goal is to deliver capital improvements within its organizational constraints, i.e., a staff significantly curtailed by administrative action.

Caltrans has been and remains a leader in many aspects of highway technology. It is not surprising, therefore, that its work

in program development, including benefit-cost analyses and overall program management, is of high quality. Similarly, the California Transportation Commission has developed a small but highly qualified staff, expert in transportation policy and program development. This staff uses modern information, analysis, and control systems in its highway capital improvement-related work.

California's transportation requirements are so large, the climate for highway improvements so complex, and the organizational structure for highway capital improvement so unusual that it is impossible to judge the derivative element in Figure 6 (the seven-element framework), skill and success in the highway capital improvement process based on a short-term external view. Too many questions remain. For example, does the unusual legislative process contribute to or inhibit success in the unusual California environment? Will the political will for infrastructure expansions match the need and be more cost-effective than past system enhancements that provided excess and perhaps unecological capacity? What can be said is that a complex experiment in meeting highway capital needs is under way in California at this time.

Turning to the pipeline analogy, it was noted earlier that it fits less well here than in other states. This is true for several reasons. The five-year time period, as already noted, does not provide an adequate "product-loading" period, and the complex adoption process makes the addition of any project to the pipeline highly uncertain. At this time, it appears that the California project pipeline capacity is inadequate. Reportedly, priority projects are slipping from their delivery schedule, whereas other projects cannot be added because of the real or implied fiscal constraints. This capacity restraint causes a disjointed or, if you will, "turbulent" flow condition. Finally, the complex STIP process builds pressure at many points—within Caltrans, within county and regional government, and within the Transportation Commission. There does not appear to be a series of adequate pressure-relief mechanisms.

What does the California experience portend for the highway capital improvement selection process in other states? There are several possibilities worth noting:

- The transportation function may become too interwoven with other state missions (e.g., economic development, too politically sensitive an issue for responsibility to be vested in a transportation-only agency). This will require a new focus on leadership and on building the "authorizing environment."
- Equity concerns in transportation may become important to a point at which they must be dealt with by overt political action versus transportation agency negotiations, as is the case in California, with its legislatively mandated resource allocation.
- Philosophic differences—for example, growth versus no-growth—may exist within relatively small political divisions and so make consensus building increasingly difficult.
- The application of local and private funding, although much touted as a solution for the future, may further confuse and complicate the consensus building necessary for major legislative initiatives to be successful.
- The trend from long-term planning, as in Caltrans's earlier experience, to a short-term, immediate need orientation and now, as seemingly is the case in California, a trend toward a longer



horizon may well reflect fundamental public perception of ways to address transportation needs at any particular time.

- Shifts in federally funded programs and allocation procedures will cause major state dislocations, causing them to need to find new ways of rationalizing and using state resources in conjunction with federal funds and priorities, particularly in states where matching federal funds is used as a relatively simplistic approach to meeting transportation needs.

- The highway needs/identification processes, developed to an advanced degree by Caltrans in its expansionist days, appear to serve less well in today's increasingly complex environments. Full attention to enhancing technical inputs will be required.

These and other trends now discernible in California should be carefully watched to determine their validity for other locations and applications.

Recently, the California transportation capital improvement selection process was changed by Chapters 105 and 106 of the Statutes of 1989. Currently, the new legislation is being implemented, so a full understanding of the impact of all of the revisions is not yet known. The principal reason for the change was to recognize that transportation problems should be treated as a whole, rather than as discrete problems for individual modes. It is hoped that this will allow greater funding flexibility to address these problems.

Lessons from California and perhaps other organizations in the forefront of the RCHS process could improve the potential for positive management elsewhere.

## COLORADO

The project selection, resource allocation, and programming process in Colorado appears to illustrate a transition from an anti-growth, anti-highway construction emphasis of the 1970s to a populist, aggressive attitude toward the use of highways as an instrument for economic development in the late 1980s and beyond. This change is reflected in the active interest of Governor Romer in selecting critical major projects and marketing and building support among the constituencies for their development. The change is reflected in the highway department's rationalization of its construction priorities and establishment of allocation processes that are more consistent on a statewide basis than policies of the past. The change is also reflected in a highway commission that has directed the department to develop a performance budgeting system to closely relate expenditure decisions with system performance.

The change noted above, a new vision in terms of Figure 6, the seven-element framework, is motivated at least in part by the decline in the economy from the slowdown in mineral- and energy-related businesses and the need to diversify and encourage new economic activities. The change to a populist leadership is necessitated by two roots, two features of the political environment intrinsic to public-sector management in Colorado. One is that Colorado is a "weak-governor" state where the state's chief executive must use personal style and leadership to accomplish objectives rather than constitutional powers, which are few. The

other is that the highway department is somewhat insulated from the legislature because of its commission structure, which gives the commission broad goal-setting and allocative powers, and constitutional earmarking of highway user fees to the State Highway Fund, the revenues of which are immediately available for use by the department without further appropriation by the General Assembly. The lack of "purse-string control" by the legislature makes it less attractive for legislators to vote for highway user fee increases. Indeed, a frequent charge by legislators (and often an excuse for voting against fee increases) is that the highway department spends too much money on administration and not enough on project delivery. The department has attempted to address these issues through careful delineation of past and proposed future expenditures, relating them to revenue increases that have recently been enacted into law.

The populist mode of operation appears well suited to the style of the current governor, who has brought drama and excitement to the programming process through numerous personally chaired public project hearings across the state. This is another hint that transportation is perceived by some leaders as being too important for transportation agency attention only. Both the Colorado Highway Department, whose director reports to the governor, and the commission, which does not, have been fully brought into the process of building constituent support for the governor's highway proposals, which at the time of this report focused on 42 critical major highway projects throughout the state.

Equally important to the welfare of the highway system in Colorado is avoidance of further decision-making fragmentation. Already, the deemphasis on highways during the 1970s has led to new thrusts and new solutions that could lessen the state's role. For example, the 50-mile E-470 limited-access freeway system on the eastern outskirts of Denver, with a price tag of almost a billion dollars, is planned to be completed by a special-purpose authority using a combination of tolls, local taxes, and impact fees. Such authorities have been sanctioned by law with powers not only to issue bonds and charge tolls (as is common in other states for turnpikes), but also to tax real or personal property within their jurisdiction. They can also impose charges for the privilege of traveling on public highways financed and maintained by the authorities, including the imposition of annual motor vehicle registration fees of up to \$10 per vehicle. (A \$10 increase in motor vehicle registration fees was approved by the voters in the three-county E-470 corridor in the November 1988 election.) Authorities can be formed by any combination of two or more municipalities or counties and can build public highways (expressways) for major traffic movement at high speeds in metropolitan areas of the state. This portends major structural shifts in programming responsibility.

In order for the Colorado Department of Highways to obtain a better estimate of the needs of the highway system throughout the state, the commission initiated the development of a Forecast of the Year 2001 State Highway System. This evaluation provides a blueprint of the highway needs over the next decade to accommodate Colorado's economic growth. The 42 critical projects personally lobbied for by the governor are at the core of this blueprint. Very significant, possibly unachievable revenue increases would be necessary to meet this proposal.

The department annually develops its primary highway programming tool, The Five-Year Highway Program of Projects.

Colorado's five-year highway program is a schedule of highway-improvement projects proposed for construction on the state highway system during the state fiscal year. The program is prepared by the Department of Highways as authorized by the State Highway Commission and is used primarily to guide the development of the state's annual highway construction budget, which is then approved by the State Highway Commission. The five-year program also promotes community awareness of proposed state actions.

The program is revised annually to eliminate those projects that have been budgeted for and are being constructed (primarily the first-year projects) and to add sufficient projects to make a new fifth year. Additionally, the program is revised to reflect changed or improved levels of information and conditions. Improvements and priorities, as submitted each autumn to the Highway Commission by local officials, change with time. Changes in state revenue estimates, federal funding policies, and inflation rates require periodic adjustment in the program. Finally, reports indicating roadway conditions and estimates of future needs are updated annually. All of these factors are carefully considered in preparing the annual program revision.

Actual project selection is made by each of the six engineering districts in consultation with the respective state highway commissioners representing the specific district. After a preliminary draft is approved by department management, a final draft is approved by the Highway Commission and submitted to the public for review and comment. After reviewing the comments received, the commission amends the document as appropriate and adopts a final version.

Five-year program projects are described according to location, major type of improvement (reconstruction, major widening, bridge replacement, etc.), timing of proposed activity, phase of project (P.E., R.O.W., utilities, construction, etc.), and cost. These projects are shown in State Highway System or Federal Aid Urban System number order and do not reflect an implied prioritization of one project over another. Certain projects are described as funding pools that are available for specific types of improvement, such as signals, overlays, and bridge replacement. These pools are typically used to fund smaller, short-term projects not readily identified over a five-year period. Projects drawn from these pools are defined in the annual construction budget. The department's maintenance and operations program is not included in the five-year program.

The five-year program traditionally included only those projects containing some element of federal funding. However, the passage of a significant state motor fuel tax increase in 1986 provided the department with enough additional motor fuel tax revenues to increase its program of state-funded construction projects. These projects, based on estimates of available state funds remaining for this program after matching federal funds and meeting the needs of the state-funded maintenance and operations budget, are now included in the document.

The department, by state statute, must provide to the state legislature by January 15 of each year its draft budget for the upcoming fiscal year; that is, the FY 90 element of the '90 to '94 five-year program, adopted by the Highway Commission in December of 1988, will be provided to the legislature on January 15, 1989, as the Draft FY 90 Construction Budget. The legislature only has the authority to review and comment on this draft budget.

In order to strengthen the organizational capacity to manage

and deliver its plan, the department has developed new systems and processes for planning and control. For example, its Resource Allocation and Project Prioritization program (RAPP) determines a recommended funding allocation plan by work group, project type, and engineering district, taking into account roadway conditions and needs, and goals and priorities established by the commission (see Figure 10). The RAPP program is applied only to Interstate resurfacing, restoration, rehabilitation, and reconstruction (4R) and federal-aid primary and secondary funds. Figure 11 shows an example of the decision tree process used to translate road conditions into needs by project type and engineering district using predetermined threshold levels. For example, if the volume to capacity ratio is more than 1.0, the specific roadway section being examined falls into the major widening category. If this ratio is less than 1.0, the section is subjected to additional analysis to determine need for other activity, such as safety improvements or reconstruction. Such rationalization of road expenditure allocation is seen as one way of addressing citizen and legislative concerns about accountability. Geographical equity, especially regarding the Front Range counties (i.e., counties east and west of the Rocky Mountains) versus the rest of the state, is a major factor in success of the programming process. A revenue increase bill in 1987 failed to move forward in part because of such a concern. Subsequently, the department is giving greater weight to distributional effects. This, along with the aforementioned governor's focus on critical projects statewide, reflects an attempt to convince the population that the programming process and product do meet citizen needs throughout Colorado.

The department has developed a pavement management system (PMS) and maintenance management system (MMS). They also anticipate having a system that allows for improved measurement of highway conditions with options for determining, inventorying, and treating maintenance needs, and the evaluation of fiscal and budgetary performance. The strong emphasis on rational systems coupled with the populist leadership style described earlier form the unique features of this state's approach to RCHS.

## CONNECTICUT

The Connecticut Department of Transportation is relatively unusual among its peer organizations for the breadth of its multimodal operations. In addition to its highway responsibilities, the department is primarily responsible for the financing and operation of bus operations in Hartford, New Haven, Stamford, and other Connecticut cities. It also runs express commuter buses between various cities and outlying suburbs. Jointly with the state of New York, the department participates in the financing and operation of commuter rail service in the southwestern part of the state near New York City. The agency also operates the Bradley International Airport and several other smaller airports, as well as the State Pier and Connecticut River ferries.

This multimodal responsibility, with comparable breadth in organizational goals, is a significant factor affecting the allocation of resources in Connecticut. For example, the transit (bus and rail) budget represented 34 percent of the entire FY 89 operating budget that the department requested. Another factor, political/cultural/economic (see Figure 6), is the high degree of urbanization in the state. As a result, the metropolitan planning

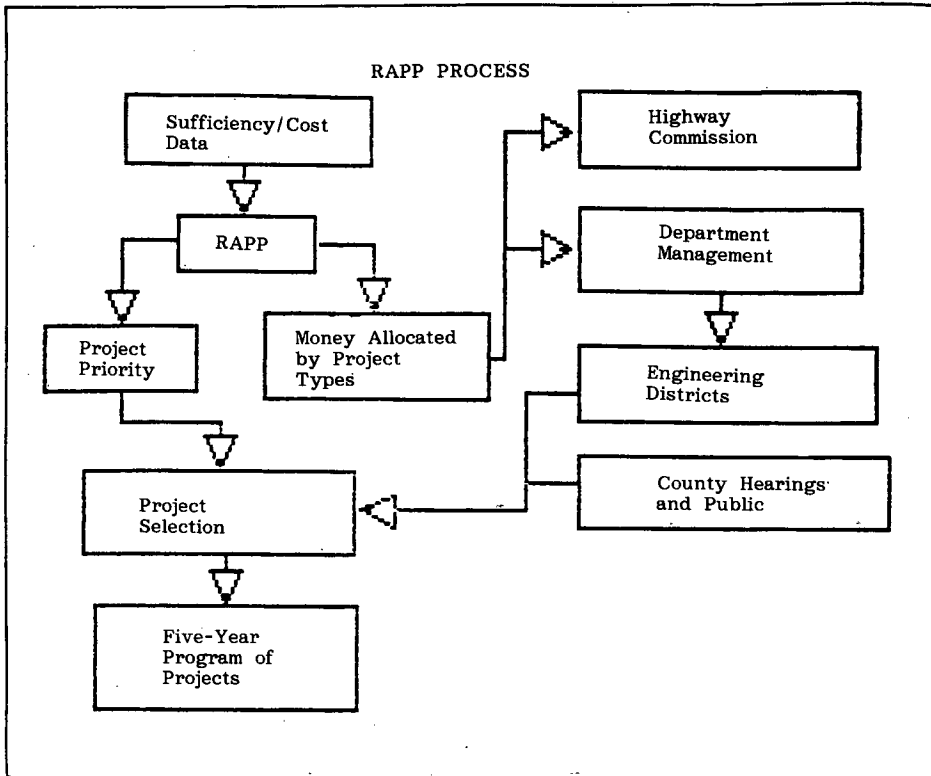


FIGURE 10 Colorado Highway Department Resource Allocation and Project Prioritization process.

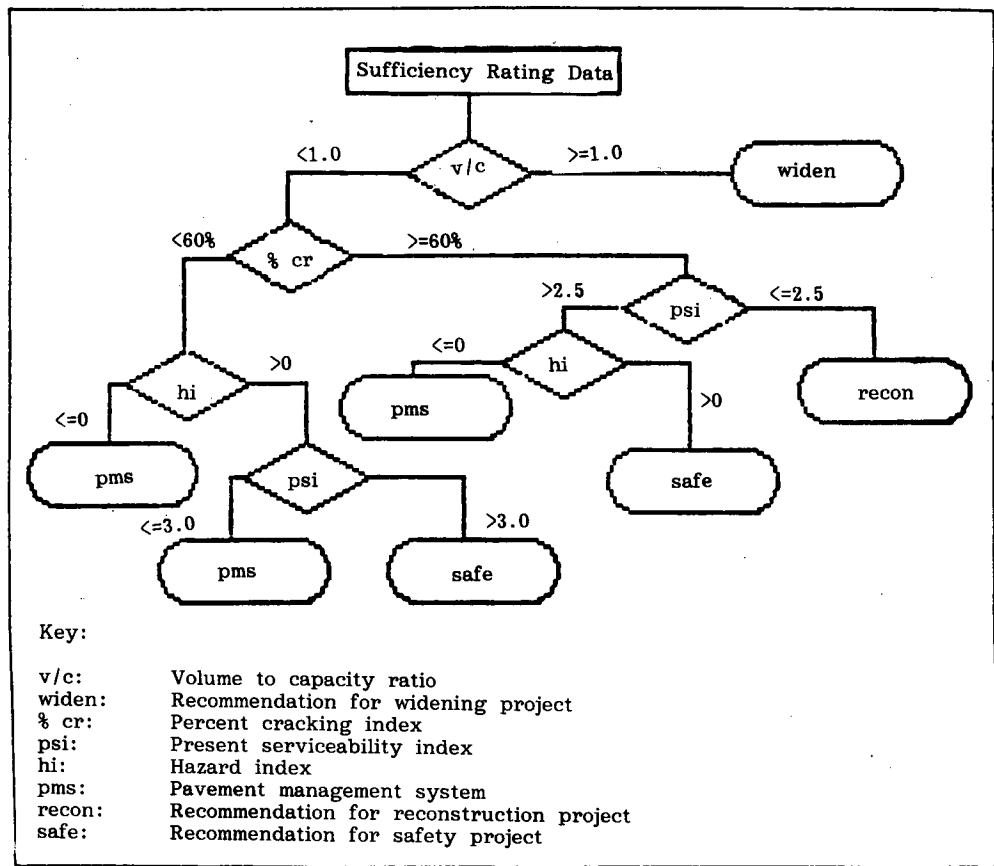


FIGURE 11 Colorado Highway Department Interstate decision tree.

organizations (MPOs) represent more than 80 percent of the population in the state, giving them an important role in transportation decisions in their regions. Indeed, as a unique feature of their organizational structure and culture, the state DOT has chosen not to be represented in the MPOs. Connecticut's cooperative process is such that all of the major expressway improvements that ConnDOT can pursue during a 10-year program have been endorsed by the appropriate MPOs.

As a result of statewide financial concerns in the early 1970s, the state's dedicated transportation fund was eliminated and transportation-related revenues were deposited into the general fund. Transportation programs had to compete annually for general fund financing. In 1984, with a general recognition of highway deterioration brought into sharp focus by the collapse of the Mianus River Bridge on I-95, a new Special Transportation Fund was established to finance a 10-year Transportation Infrastructure Renewal Program that would restore, maintain, and improve the state's transportation systems. A unique feature of the Special Transportation Fund was the legislative enactment of a series of motor fuel tax, fee, and fine increases that will go into effect incrementally through a 10-year period (see Table 2). For example, the gasoline tax will increase from \$0.14 per gallon in 1984 to \$0.23 per gallon by 1992, unless changed by legislation during the interim (the tax rate during FY 89 will be \$0.20 per gallon). The revenues generated by these tax and fee increases have been and will continue to be used to finance operating costs, support a pay-as-you-go program (projects funded by current revenues), and amortize the issuance of more than \$2 billion in bond issues that in turn, together with federal aid, pay for the bulk of the Infrastructure Renewal Program.

As a result of these program and funding thrusts, the state DOT has a strong vision of what must be delivered, namely a 10-year Master Transportation Plan. It is well funded and enjoys a high degree of consensus around the state concerning its programs. Figure 12 and Table 3 show key elements of the Connecticut 10-year plan. In order to ensure continuation of these circumstances, in 1985 the agency began a strategic planning process designed to identify and analyze social, economic, technological, and other trends and assess the impacts of these trends on transportation plans and programs. The strategic-planning process has shown that human resources will be a major constraint in the future as many experienced transportation professionals and technicians retire, creating key voids or limitations in terms of the 7-S framework. In addition to aggressive participation in the employment market, the state agency is emphasizing productivity improvement and employee recruitment and retention

through computerization and automation of various engineering, planning, and administrative activities. For example, the state has recently converted its process for highway inventory from film photolog to a laser videodisc. The latter is superior in terms of storage density, durability, duplication, and access. The state also has a multi-million-dollar initiative in automating its pre-construction and construction management activities.

Are there additional clouds in the silver lining? One concern is the high degree of debt. Use of a moderate level of debt provides enormous leverage in addressing current transportation problems. But high levels of debt can create difficulties, especially in revenue cycle downturns. This fact is well recognized by the state DOT financial planners. Through strategic planning, they are attempting to look ahead for ways of warding off the debt hangover.

In terms of the programming process, it is dynamic and evolutionary. The program is continually monitored and adjusted to respond to changing conditions, i.e., federal funding levels, project cost estimates, project schedule changes, new or revised need estimates, and the financial capacity of the Special Transportation Fund. At least annually the plan is fully updated and extended to maintain a 10-year horizon. To date, Transportation Fund resources have been sufficient to facilitate the changes to the program. The challenge for the future is to maintain the dynamics of the program within the financial capacity of the Special Transportation Fund and not accumulate a debt level that restricts future program capacity.

## FLORIDA

Rapid population growth, consequent development patterns, and the regular influx of tourists underlie the explosive growth in transportation demands in Florida. Since 1960, Florida's population has grown more than four times the average U.S. growth rate. Coupled with the limited availability and use of public transportation, this growth has led to heavy traffic and congestion, particularly in urban corridors.

Florida's local governments, which have a significant responsibility for local roads and bridges, have seen similar strains on their transportation budgets. Making use of local options provided by state law, they have imposed significant impact fees on developers and other commercial interests to pay for needed transportation improvements. The first such local option was provided in 1972 when the legislature authorized counties to piggyback the state's fuel tax with their own tax. This was fol-

TABLE 2  
STATE OF CONNECTICUT SUMMARY OF ENACTED TAX AND FEE INCREASE

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Motor Fuels Tax (Increase per gallon)	1¢	1¢	1¢	2¢	1¢	0	2¢	1¢	0	0
Motor Vehicle Receipts (% Increase)	25%	0	24%	0	0	0	0	0	12.9%	0
LPF Revenue (% Increase)	0	50%	0	0	0	50%	0	25%	0	25%

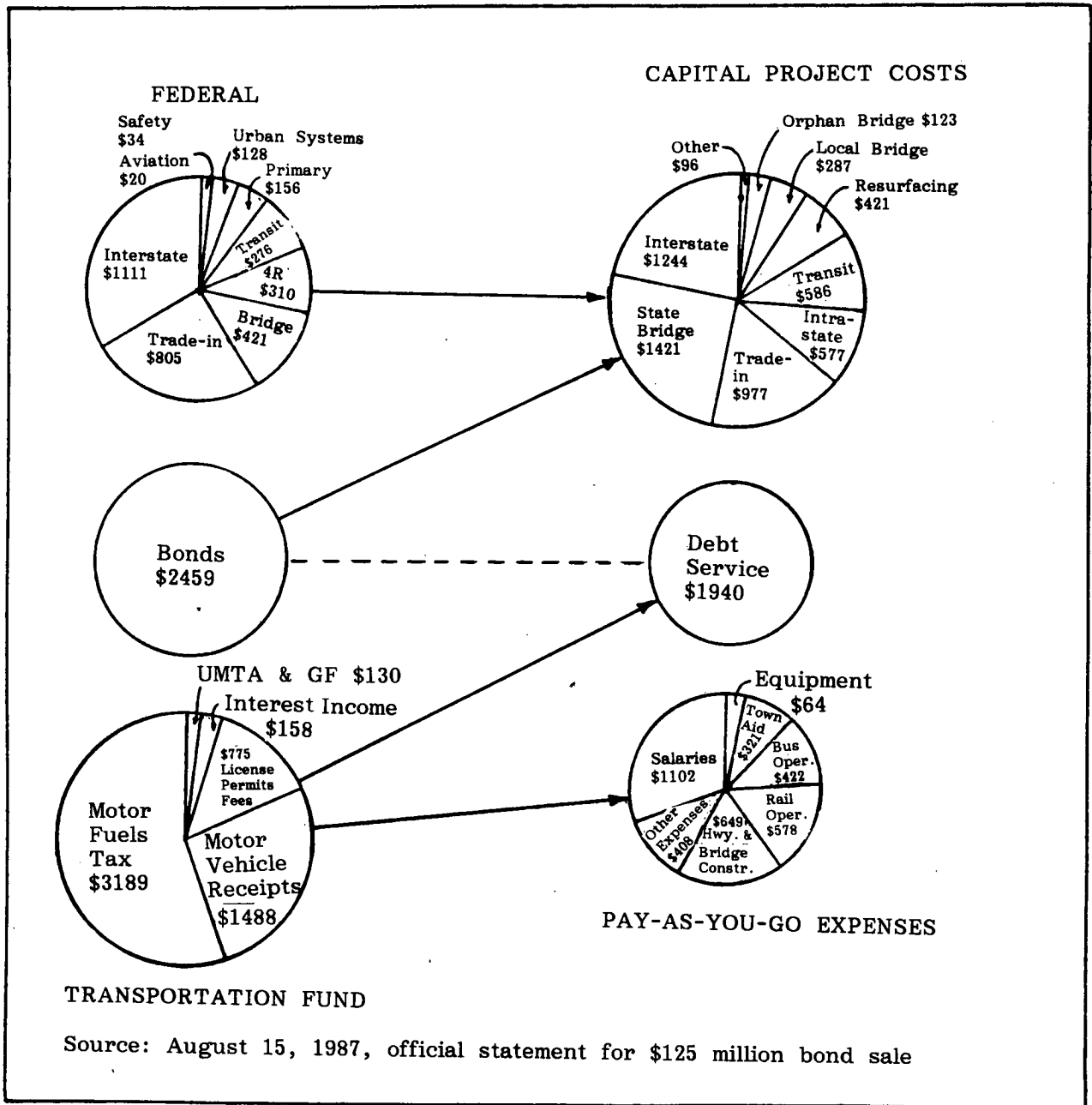


FIGURE 12 Connecticut 10-year transportation plan (1985-1994).

lowed by many different additional options, four of which now deal exclusively with transportation needs.

The explosive demand for new infrastructure is also reflected in the legislature's increasing tendency to add unplanned special-interest projects into the annual appropriation bills. Given that highway fund allocations are highly structured (formula driven) in Florida, these special projects have created a new dilemma for the state DOT: Do the project funds come off the top or must they be accommodated within the geographical allocations (a problem similar to the special-project additions by Congress)? The department hopes that its new program, its new vision, will more adequately address the infrastructure needs of the state and alleviate some of these problems.

The vision advanced by the agency to meet the challenge is ambitious, a \$40 billion program over 10 years for which existing revenues will provide about \$15 billion. Hence, the revenue base will need to be increased by 166 percent during the 10-year time frame, or more than 10 percent per year compounded. To increase the organization's capacity to undertake this mammoth expansion, several key initiatives have been set in motion:

- A new strategic planning process led by the Strategic Planning Group, composed of the secretary and his executive committee.
- Doubling production by cutting the delivery time in half in the highway project development process. Each element in the

TABLE 3

## CONNECTICUT DEPARTMENT OF TRANSPORTATION INFRASTRUCTURE PROGRAM PROJECTED FUNDING SOURCES

	1989*	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
<b>Interstate</b>											
Bonds	13.5	19.3	16.1	15.5	2.5	3.0	3.0	3.0	3.0	3.0	81.9
Federal	121.4	173.9	145.4	138.7	22.5	27.0	27.0	27.0	27.0	27.0	736.9
<b>Intrastate</b>											
Bonds	39.8	28.1	44.6	45.9	18.0	28.8	83.2	113.1	40.4	40.4	482.3
Federal	0.0	29.3	0.0	29.3	0.0	28.3	15.7	17.6	0.0	29.3	149.5
Other											
<b>Interstate Trade-in</b>											
Bonds	16.1	16.1	19.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	61.7
Federal	92.1	92.1	107.7	59.4	0.0	0.0	0.0	0.0	0.0	0.0	351.3
<b>State Bridge</b>											
Bonds	81.2	128.1	145.3	107.4	83.4	58.9	66.7	75.1	84.2	94.0	924.3
Federal	28.5	31.6	31.6	31.6	38.6	38.6	38.6	38.6	38.6	38.6	354.9
<b>Local Bridge</b>											
Bonds <sup>a</sup>	5.0	15.0	15.0	15.0	10.0	10.0	15.0	15.0	15.0	15.0	130.0
Other <sup>b, c</sup>	4.2	17.3	18.6	20.6	23.0	25.3	25.3	25.3	25.3	25.3	210.2
<b>Orphan Bridge</b>											
Bonds	15.2	9.9	9.9	9.9	0.0	0.0	0.0	0.0	0.0	0.0	44.9
Federal	10.0	7.0	7.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0
Other <sup>b</sup>	7.7	5.1	5.1	5.1	0.0	0.0	0.0	0.0	0.0	0.0	23.0
<b>Noise Barriers</b>											
Bonds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Transit</b>											
Bonds	21.3	92.2	24.7	38.1	14.5	7.3	14.7	9.3	6.3	10.5	238.9
Appropriations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal	23.0	23.0	23.0	23.0	23.0	21.8	23.0	21.8	18.9	23.0	223.5
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Aviation<sup>d</sup></b>											
Bonds	1.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.4
Federal	1.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	14.5
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Resurfacing</b>											
Bonds	10.4	8.6	12.1	10.8	14.8	19.1	19.1	19.1	19.1	19.1	152.2
Appropriations	36.7	44.5	47.4	40.7	44.2	48.1	51.9	61.4	71.6	82.6	529.1
Federal	27.5	27.5	27.5	42.5	42.5	42.5	47.5	47.5	47.5	47.5	400.0
<b>Dept. Facilities</b>											
Bonds	10.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	19.8
<b>Safety</b>											
Appropriations	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	7.5
Federal	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	33.0
<b>Urban Systems</b>											
Appropriations	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	34.0
Federal	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	132.0
Other <sup>b</sup>	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0
<b>Other Road &amp; Bridge</b>											
Appropriations	10.6	11.5	12.4	13.4	14.4	15.6	16.8	18.2	19.6	21.2	153.7
<b>Hazardous Waste</b>											
Bonds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Special Projects</b>											
Bonds	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
<b>Waterways</b>											
Bonds	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
<b>Totals</b>											
Bonds	217.5	318.8	288.1	254.5	144.6	128.5	203.1	236.0	169.4	183.4	2143.9
Appropriations	51.3	60.1	63.9	58.2	62.7	67.9	72.9	83.8	95.4	108.1	724.3
Federal	320.0	402.4	360.2	349.5	144.6	176.2	169.8	170.5	150.0	183.4	2426.6
Other	12.9	23.4	24.7	26.7	24.0	26.3	26.3	26.3	26.3	26.3	243.2
	601.7	804.7	736.9	688.9	375.9	398.9	472.1	516.6	441.1	501.2	5538.0

<sup>a</sup> Deposits to the Local Bridge Revolving Fund.

<sup>b</sup> Local Funds.

<sup>c</sup> Including borrowing from the Local Bridge Revolving Fund.

<sup>d</sup> Excluding Bradley International Airport.

\* Reflects anticipated FY88 Capital Budget Request.

life of a project has been shortened, including right-of-way acquisition, permitting, planning, design, and construction.

- Partnerships with the private sector and local governments to further increase production capacity.

The agency's programming of projects over a five-year time frame is described in a work program, which constitutes its transportation plan. The development of this plan is linked to a statewide comprehensive planning process of all state agencies mandated by statute (see Figure 13).

In addition to this strong focus on planning, Florida also publishes evaluations containing assessments of performance. The 1987 Program Objectives and Accomplishments Report fulfills the statute requiring performance reporting while also providing a preview of anticipated performance during the subsequent year.

Unlike California, where programming is centralized via an independent commission, but more similar to Texas, as will be seen later, the Florida DOT has a highly decentralized structure to its mission (46). Its seven district directors report directly to the secretary and have authority to make most decisions, subject only to certain aggregate fiscal and administrative restrictions. The department's funds are allocated between the seven districts by detailed formulas and procedures (47). Districts have the authority to determine the best use of their funds in a manner consistent with the work program instructions, which are updated and published annually. A new seven-member commission reviews the department's budget and work programs and pro-

vides policy reviews but does not engage in project-level programming.

Florida statutes require that the department's programs be driven by "policies" and by "program objectives." Thus, for each major subprogram (expressway, arterial, bridge, etc.), objectives, operating policies, and performance measures are explicitly stated and become part of the work program. For example, in the highway preservation subprogram, the objective is to "reduce the backlog of structurally deficient highways and bridges to 10 percent by the year 2000." Preliminary performance measures for this subprogram for FY 1988-89 included:

- the number of lane miles resurfaced annually,
- the repair/replacement of seven large structurally deficient bridges by 1993,
- the replacement of four additional major bridges by 1993,
- the number of state and local bridges inspected every two years, and
- bridge maintenance standards adopted by executive committee within four months.

In the expressway subprogram, the objective is to "ensure that by the year 2000 no more than 27 percent of the State Highway System operates below the department's level of service standards" (which are based on the 1985 AASHTO *Highway Capacity Manual*). A variety of performance measures indicate progress in meeting this objective.

The department's work program, the actual identification of projects, is developed by the districts, working with local governments, in accordance with the subprogram objectives and operating policies as contained in the annual program and resource plan (see Figure 13). The districts identify projects and develop schedules based on project priorities within the limitations of the funds allocated to them in the work program instructions. In this program-development process, the districts are required to seek the participation of the MPOs in the process by requesting from them their priority lists of projects.

The agency's support services have been designed to strengthen policy management under this decentralized approach. The structure of the work program illustrates this. The development of the Work Program generally occurs annually during the period from November to March. During this period, called "gaming," computer programs allow district offices to create parallel and separate project files in the data base. In effect, districts develop another five-year work program, which includes proposed changes to be reviewed and ultimately adopted. District offices have the power at their fingertips to manipulate the program and data bases to consider new projects and phases, change fiscal years of existing phases, alter funding, etc. After the proposed Work Program has been developed during the gaming period, it is subjected to review at the local, departmental, and statewide level before finally being adopted.

In addition to serving as an essential tool in planning and programming, the computer system and procedures collectively referred to as Work Program Administration (WPA) also tracks performance and aids in execution of the plan. For example, WPA aids districts in performing allocation swaps when one district has an excess of funds in one category and another district has a shortage. The WPA also identifies the annual element of the five-year work program as begun by the FHWA.

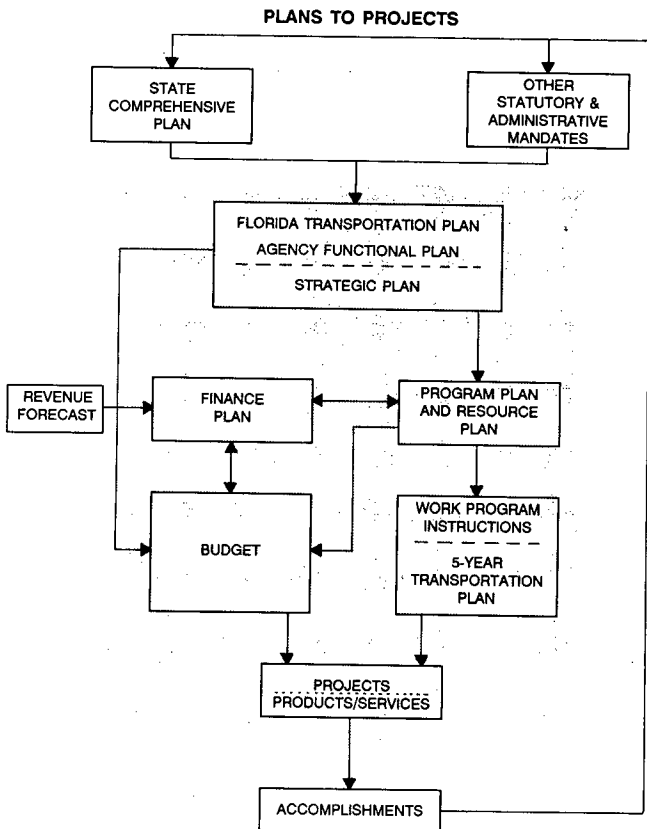


FIGURE 13 Florida comprehensive planning process.

Figure 14 shows the information data bases and flows accessed via WPA. Obviously, without a powerful tool such as WPA, decentralized management would be very difficult in Florida DOT.

In summary, the RCHS in Florida is characterized by several key features: a forward-looking planning process given impetus by the rapid population and economic growth and the large needs for infrastructure; a strong orientation toward explicit definition, measurement, and monitoring of objectives, policies, and performance; highly defined, statutory allocation formulas; dictating the funds available by geographic region and highway subprogram, which have recently seen some strain because of legislatively mandated projects; and a highly decentralized process of project identification and program development performed by seven regional districts in cooperation with local governments. The current RCHS in Florida will clearly be tested as the program more than doubles in size over the next decade.

**NEW YORK**

The current NYSDOT thrust is toward a more goal-oriented highway capital selection process. In terms of the seven-element

concept (Figure 6), this represents first a new vision, new leadership, but impacts of this vision percolate rapidly into all of the other diagram elements. Indeed, the New York case provides an excellent illustration of how a change in vision triggers broad institution-wide change.

New York DOT management launched its goal-oriented capital programming process as a way to make the agency more responsive and supportive to statewide social, economic, and transportation goals. This vision, moving transportation into support of broader goals, is in consonance with national trends but sets up potential conflict within an agency conditioned to a more inward, self-sufficing focus, one managed by transportation traditionalists in a highly centralized structure. Conflicts surface as the vision fosters decentralization for wider input and crisper delivery. The conflict is nourished by the need to understand and deal with the broader goals.

From this vision for a more carefully targeted and managed capital program come specific organizational objectives. These include (a) delegating project decisions effectively by having the appropriate balance of authority and accountability, (b) controlling capital project and program costs to stay within expenditure ceilings and minimize surprises affecting budget priorities, (c) coordinating and controlling project schedules to deliver com-

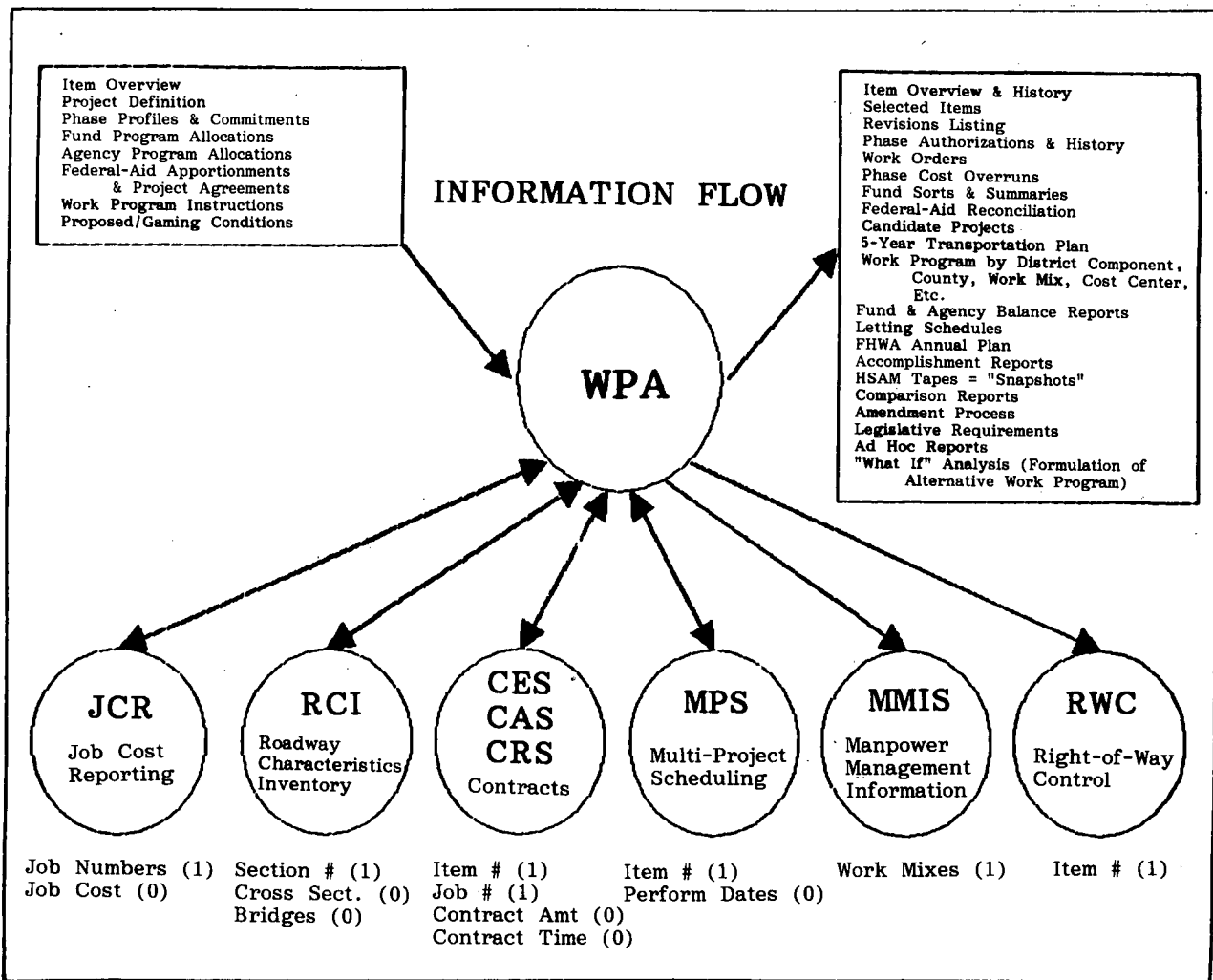


FIGURE 14 Florida Department of Transportation Work Program Administration.



mitments on time, sticking to agreed-upon priorities, and making the most efficient use of department resources, (d) measuring performance, accurately and on time, against agreed-upon goals, (e) adjusting capital resources to changes in program emphasis and budget priorities in a timely manner and on an informed basis, (f) managing department resources to most effectively and efficiently meet program goals, and (g) centralizing the coordination of capital program policy and procedures.

Objectives such as these go directly to matters of organiza-

tional structure, culture, and motivation. For example, the last objective calls for central coordination of capital program policy and procedures, whereas the first speaks to delegating certain decision making. Throughout the set such words as "control," "coordinate," "measure," "adjust," and "manage" denote structural impacts. It is in effecting necessary structural impacts that the potential conflicts noted earlier become real.

Figure 15 overviews the New York capital programming system. The components are described in Figure 16.

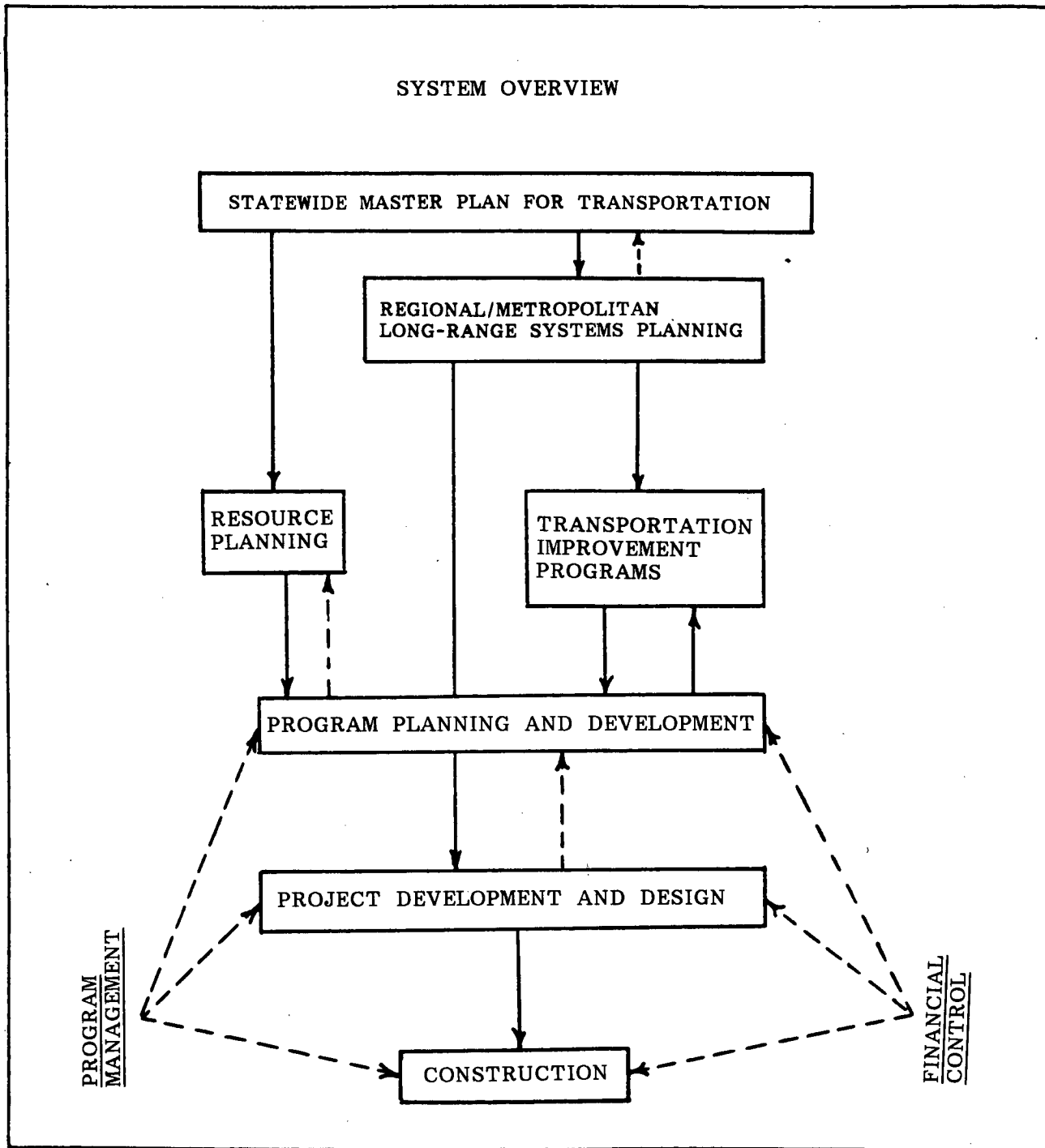


FIGURE 15 New York Department of Transportation Capital Program System.

### MAJOR SYSTEM COMPONENTS

Current responsibilities for the capital program subsystems diagrammed here are assigned to different Divisions throughout the Department. Coordinating their inputs and outputs falls to a variety of Bureau and Division Directors, Regional Directors, Assistant and Deputy Commissioners, and often the Commissioner. A brief description of nominal assignments of responsibility follows:

The Statewide Master Plan is updated periodically by the Planning Division. Planning conducts needs and financing studies and makes policy analyses for Master Plan updates.

The lead for metropolitan transportation planning is with the Planning Division, working closely with the Region Offices and local Metropolitan Planning Organizations. Regional systems planning is done as needed, often initiated by a Region Office. Corridor and sub-area studies are shared between the Planning Division and Regions.

Transportation Improvement Programs are developed by local Metropolitan Planning Organizations. The Department's interests as an MPO member are coordinated by the Planning Division, working through Region Offices.

Resource planning is closely allied to the Master Plan function. The Planning Division usually has the lead, with assistance from Program Planning and the Policy Group.

Program planning and development is a primary function of the Program Planning and Management Group (PPMG), working with Region Offices.

The early stages of project development are shared by the Planning Division and the Regions. Design responsibilities fall to the Facilities Design Division, the Structures Division, and the Regions, depending on the type of project.

Construction is supervised by the Regions, overseen by the Construction Division.

Program management is the responsibility of PPMG. The Executive Capital Program Committee has been formed to oversee this effort.

Financial control responsibilities are shared by PPMG and the Office of Administration and Finance.

FIGURE 16 New York Department of Transportation Capital Program System.

The subelements of the seven-element diagram, organizational culture and motivation, deserve special note. Unless these are managed—or perhaps more accurately, nurtured—the conflicts can become disruptive. New York has used various communication techniques, together with an infusion of new management, to address this concern.

Broader vision for the New York RCHS sets up special requirements for technical and support staff and for support systems. In short, it requires new management approaches. Figure 17 charts the inputs to this new management approach.

The goals function deserves expansion because the reason for change in New York is to achieve a stronger goals orientation. Figure 18 provides more detail on the goals function. Note particularly:

- Goal teams develop disaggregated goals looking beyond transportation per se.
- Goal achievement is tied to network performance measurement and capital resource allocation.

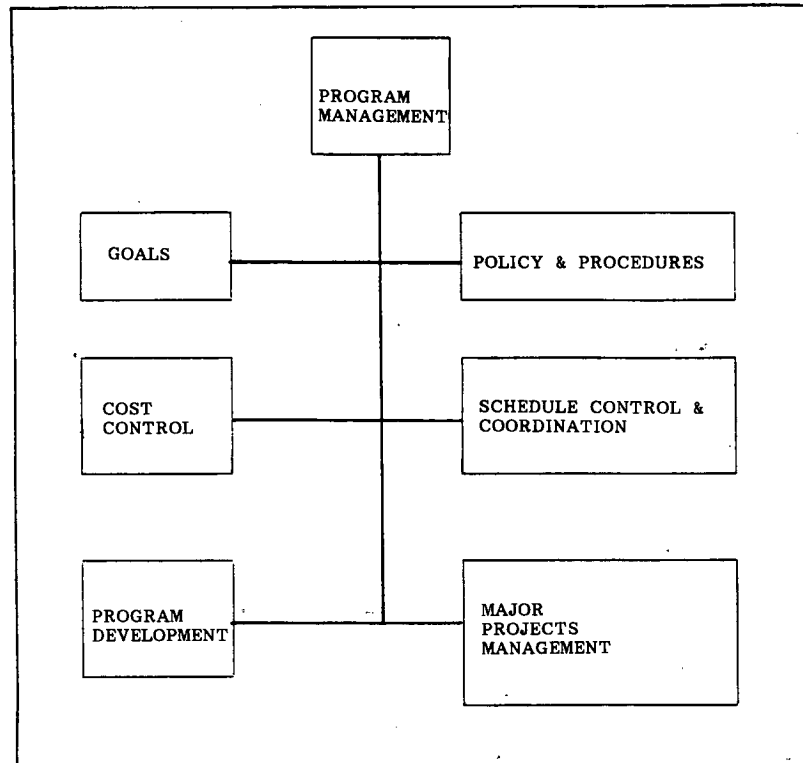


FIGURE 17 New York Department of Transportation Capital Program System organization for program management.

- Implicit in a goals approach is depth and sophistication in information management.

The last of the seven elements to be discussed here, political, cultural, and economic environment, is really the beginning. The new vision for New York DOT was not an accident; it was a considered response to the contemporary political, cultural, and economic environment in New York State. To some degree, this New York initiative reflects the forces operating in California, a similarly large, complex, physical and political entity. In New York State, as in California, the following factors deserve attention:

- The transportation function may be too politically sensitive for this function to have the degree of independence it once enjoyed.
  - It appears that the New York City versus upstate political realities must be dealt with by overt political action.
  - The trend in planning, similar to that in California, is now toward a somewhat longer horizon.
  - Shifts in federally funded programs and allocations are causing dislocations and a need for new approaches to funding.
  - The conventional highway needs identification processes appear to serve less well in today's increasingly complex environments.

Clearly, for New York State, it is too early to judge the derivative elements: skill and success in RCHS. It is, however, timely to note again the contemporary nature of the vision and the complexity and stress attending implementation.

Only the briefest comment on the pipeline analogy will be offered for the New York case. What the New York DOT is attempting is to regularize delivery of the proper mix of highway capital "products." It is relating product mix to goals and quite literally rebuilding the pipeline to deliver these products.

## PENNSYLVANIA

Evolutionary development of the Pennsylvania Department of Transportation's (PennDOT's) RCHS, beginning in 1979, was undertaken out of direct necessity, shaped by an energetic management team, funded by citizens and legislators who were willing to pay for obviously necessary and rationally prioritized projects, and empowered by an organization seeking to regain its pride. These were the principal elements to the success enjoyed by this program, but each of the seven elements (Figure 6) played a part.

Looking first at the derivative element, skills and success in delivery of a capital program, Pennsylvania's citizens regained confidence in their highway-building organization and convinc-

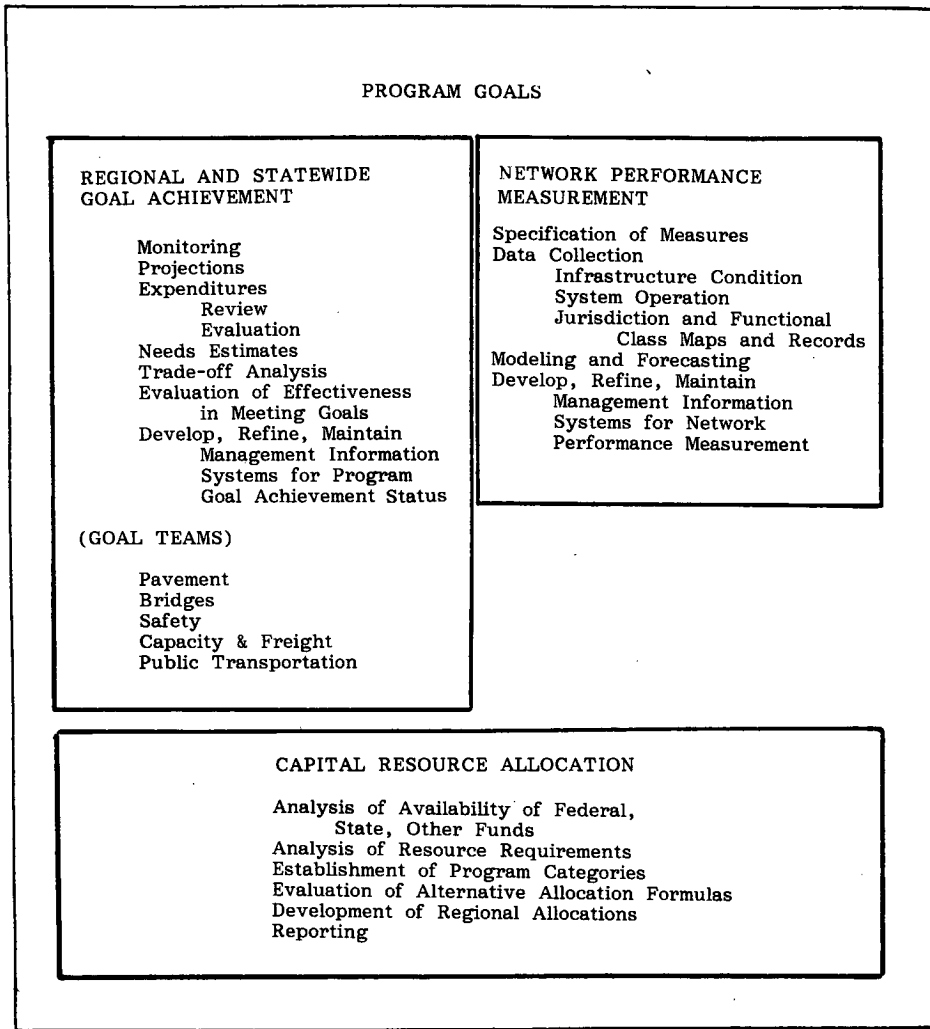


FIGURE 18 New York Department of Transportation goals process.

ingly demonstrated this confidence by supporting major funding increases in five successive years. Over these same years, the drawdown of federal funds became one of the largest in the nation. Using this dual support, record capital programs were planned, prioritized, authorized, let to contract, and completed in most cases on time and within budget.

In 1979, the political, cultural, and economic environment at PennDOT could hardly have been worse. The agency had been racked by scandal and scores of criminal indictments handed down, the state economy was in recession, and excesses in borrowing had left Pennsylvania with the largest highway bond indebtedness among the 50 states (almost \$2.5 billion) and the largest amount of lapsed and unused federal funds. Massive furloughs, some 7000, had dissipated staff capability and motivation, and except for safety improvements, all capital programming and construction had been stopped in 1977.

The vision brought by a new governor and his team was of a leaner, more credible agency that would maintain what it had and buy for cash, plus federal aid, selected improvements and system completions. The agency took this vision and strategized

on how to make it happen. They strategized on how to reshape federal legislation (join national organizations and use congressional strengths), how to craft funding proposals (package projects thematically and look carefully to the equity issue), how to energize interest groups (make them believe in a program with something for everyone), where to find legislative champions (look for someone who takes personal ownership in advancing legislation), how to recruit, train, and otherwise motivate staff (with a mix of rewards, but mostly with improved communications and challenging work), and how to buy systems for information and control (through an intensive agency consultant cooperative arrangement). The vision was widely communicated internally to the organization and to every external audience that would listen.

Organizational structure, culture, and motivation got continuous attention. A Program Management Committee involving all senior managers was created to be the focus for full program development and control. A value-driven culture, "service for citizens," was expounded tirelessly from an agency "making a difference." After a prolonged period of top-down management,

motivation was renewed through participatory management, quality circles, total quality initiatives, and heavy emphasis on sharply focused skills training.

Technical and support resources from all over the department were aggregated into a Program Management Center. This, with a real-time project-management system, became the nerve center for RCHS. As agency confidence grew, this approach was partially replicated in 11 field districts, which were given increasing authority and autonomy. Within broad categories, there was an intense focus on prioritization. A yearly, mile-by-mile survey of the 44,000-mile system provided the basic data, but project selection was negotiated with department managers, citizens, the Pennsylvania General Assembly, and the administration.

A real-time computer-based project-management system came first, but then some \$67 million in new and enhanced systems came on-line to provide data management, improved communications, design and analysis capability, and management control.

Interaction among these elements was incessant. The program was shaped to meet real needs of highway interest groups: farmers (agricultural access network), truckers (eliminate posted bridges), and industry (industrial and commercial access networks). It was targeted to provide equity (the bridge program identified needed bridges in all legislative and senatorial districts). Carefully structured internal communication efforts told employees of goals, programs, problems, and successes. In a carefully nurtured federal climate, national highway legislation was shaped, federal funds were restored and drawn down, debt retirement was begun, and overall agency credibility was restored.

No simple process diagram could describe this evolutionary development of RCHS. It flourished because of the "edge" created at PennDOT by a broad-based coalition of motivated people.

For Pennsylvania, the 12-year transportation plan follows the pipeline analogy in some detail:

- Projects are regularly loaded into the pipeline by means of a highly public biennial update. This update involves field and central office staff, representatives from state and local governments, and citizens through a public-hearing process, interest groups, and particularly the transportation commission acting in an advisory capacity. Each update is constrained by projected revenues from all sources and shaped along particular program initiatives and categories.

- Expectations for pipeline throughput are high. A large, mature system, heavily used to serve industry, a mix of economic conditions, some locations needing stimulation while others are experiencing overheated growth, an aggressive design and construction industry, and a period of neglect all press for more projects, more pipeline capacity.

- The length of the pipeline, the time to get projects out, is always perceived as too long. Various approaches to shortening this time were pursued. For example:

- adopting computer-aided drafting and design (CADD) agency wide
- developing automated bridge-design methods
- developing standardized bridge plans
- decentralization of project-control functions
- wider use of consultants for design and construction inspection
- computerized contract management

- accelerated payment to vendors

- accelerated central office project development process

- close cooperation with federal approval agencies

- open working partnership with the FHWA

- continuous dialoguing and problem solving with engineers and contractors

- early focus on environmental or other constraints

- continued emphasis on training of all PennDOT employees

- Mix of projects in the pipeline was highly structured to: meet agreed-upon goals

- reflect funding capabilities and opportunities

- provide an easily understood prioritization scheme, i.e., a

- 12-year plan divided into three 4-year segments: (a) first 4

- years—projects for final design and construction, (b) second

- 4 years—preliminary plans and clearances, (c) third 4

- years—discussion, planning, no dollar commitments

This discrimination was maintained, control was maintained, and projects moved as planned and promised.

- Nonappropriation of federal aid and limited discretionary state emergency funds provided "relief valves" to the pipeline.

## TEXAS

The Texas RCHS presents something of a paradox among such systems. It combines a high level of technical sophistication with political sensitivity and accommodation. Reasons for this may include unusual stability in leadership, strong ties to strong university programs, and an effective, powerful three-person transportation commission. It would be difficult to find a more concise statement of the Texas RCHS than the one given in the 10-Year Project Development Plan 1986–1996 (PDP) Executive Summary (48):

Transportation needs for added capacity and new location facilities are established in the twenty year Strategic Mobility Plan. This plan identifies long range needs for these type projects that amount to approximately \$30.2 billion. Projects so identified are then evaluated, ranked, and prioritized. Then only the highest most cost-effective projects, commensurate with estimated available funds, are selected for inclusion in the PDP. The 1986 10-Year PDP consists of \$13.6 billion in projects separated into time frames of 12-month, 4-year, and 5-year for development and scheduling requirements. Another \$2.6 billion in projects are shown under a section designated "Tentative Commission Commitments." Projects under this category (Tentative Commission Commitments) have specific Commission Minute Order approval for planning authority but construction authorization has been withheld pending clearer project definition. Although the dollar value proposed for the 1986 10-year PDP exceeds anticipated available construction funds (\$10.6 billion), this practice of overprogramming is considered acceptable because many of the projects in later phases of the plan are still being evaluated for feasibility and ultimately may or may not prove to be viable projects. We propose to control construction funding authorization through a priority system that is discussed later in this summary.

This quote expresses the overall Texas strategy, and it can be captured by the seven elements (Figure 6). Note that the vision ranges outward from 1 to 20 years, dealing with the immediate and long-range needs. It also treats fiscal capability and the political reality of overprogramming.

Most process diagrams are of limited effectiveness in communicating the RCHS. However, Texas DOT executives, working with the Texas Transportation Commission, devised Figure 19,

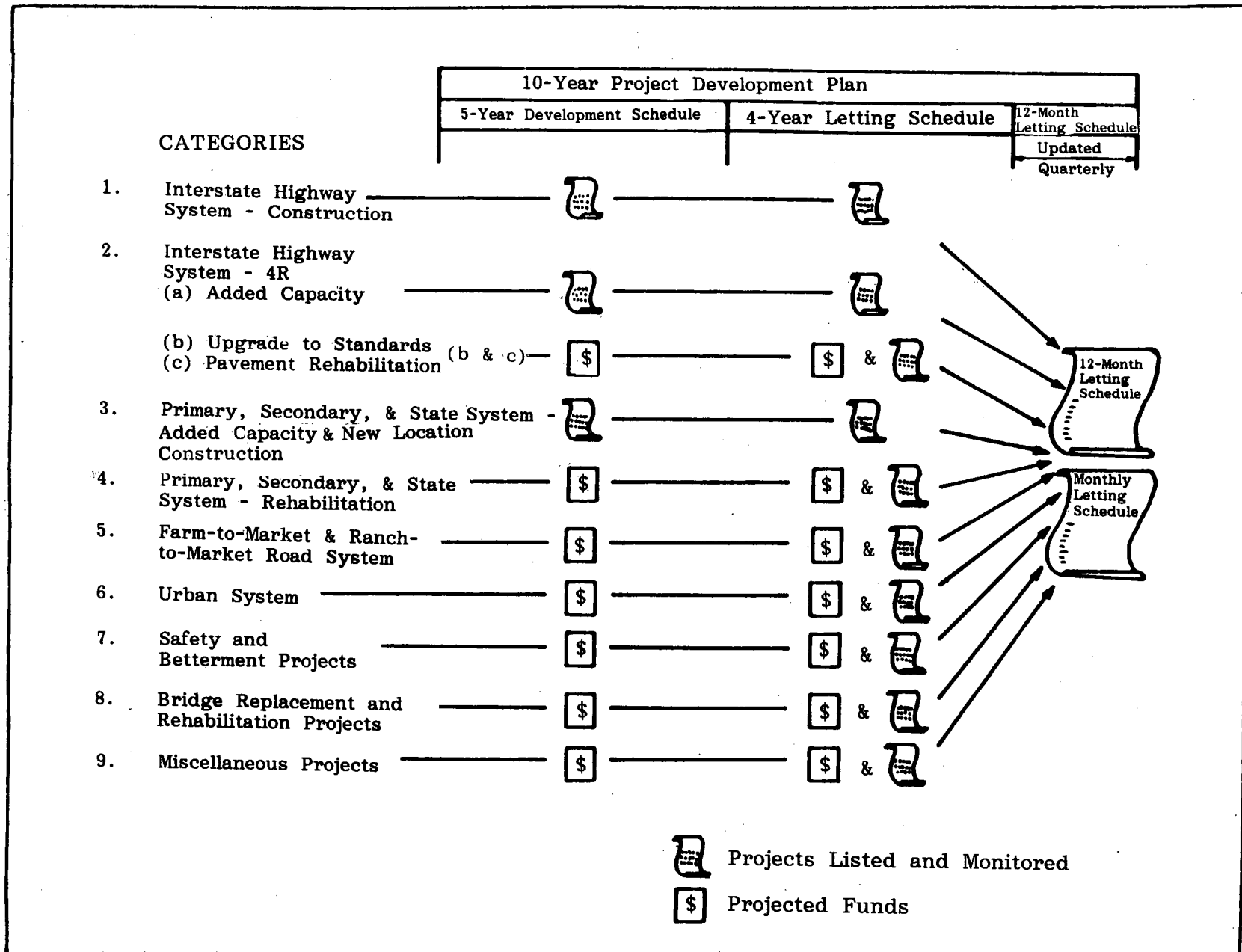


FIGURE 19 Ten-year project development plan for construction projects (48).

which tends to disprove the general rule. This diagram communicates the essence of a highly developed and successful capital program management strategy.

Construction projects are divided into nine categories. The first three categories are added-capacity and new-location types of projects. These projects are selected on a statewide basis using ranking indexes that establish need and determine cost-effectiveness. These selected projects in Categories 1, 2a, and 3 represent a 10-year time frame plus an approximate 30 percent overprogrammed amount that provides a planning safety factor for unexpected future variations. The projects are placed into either the five-year development schedule or the four-year letting schedule, based on cost-effectiveness, estimated development time, and estimated available revenues. The 10-year plan for the Categories 1, 2a, and 3 types of projects is updated every 2 years.

The remaining work categories, 4 through 9, are project specific only for the length of the program. The length of the program is determined, for the most part, by either work type or by funding source. As an example, the Safety and Betterment Program (Category 7) will be project specific for only a one-year span because this type of work (preventive maintenance construction) can be developed, let to contract, and completed in a relatively short time. Identifying specific projects several years in the future for this type of construction is not considered necessary or practical.

Other programs may be controlled by a specific funding source. The length of these programs is keyed to enabling legislation, and individual projects would be identified for the authorized time frame of the legislation. An example of this would be the Urban System Program (Category 6), where a five-year federal authorization will generate a five-year, project-specific program funded in an amount of anticipated available revenues.

Regarding goals, the Texas PDP notes that although fiscal constraints make it impossible to meet all long-term needs, significant progress will be made. Examples of goals to be met by the PDP include the following:

- Completion of the current eligible Interstate system
- Reconstruction and expansion of currently congested urban and freeway facilities
- The construction of approximately 258 miles of new location facilities in urban high-growth areas
- Expansion of virtually all sections of currently congested two-lane roadways in the state

Systems for information analysis and control come in all forms. The presumption of many is that all of today's effective systems are complex and typically computer based. Although such systems are used in Texas, the department also uses deceptively simple tables for information, analysis, and control. Table 4 shows the basis of funds distribution and allocation across the nine categories.

Table 5 shows performance under the prescribed allocation rules for the 25 Texas department districts. This is a remarkably "credible" document making the following points:

- Different districts have different program emphasis, e.g., some have no Interstates, all have farm-to-market roads.
- Equity relates in part to population distribution and this is clearly shown.

- Tentative commission commitments signal likely funding thrusts.

Elements of control that foster credibility merit discussion here. For Texas, it begins with the funding projections. Figure 20 shows estimated 10-year revenue of \$29.1 billion, operating expenses at \$11.5 billion, aggregated allocation for program categories 4 through 9, \$6 billion, and available funds for categories 1 through 3, \$11.6 billion. The assumptions behind these numbers are clearly stated.

Next is project selection. Here the basic pool of projects is the 20-year Strategic Mobility Plan. For categories involving added capacity and new location, one of the more competitive areas, specific ranking indexes are followed (see Table 6). Although these indexes are not discussed in detail here, they are carefully described in source documents. It should be noted, however, that (a) they exist and are used, (b) subcategorizations are a means to facilitate meaningful comparisons, and (c) these highly important indexes are kept current.

A third PDP control element comes from prioritization within the plan. Projects within the nine categories are prioritized into three approximately equal (by cost) groupings identified as Priority A, B, and C. These groupings determine how projects move to letting under current or future fiscal circumstances. Major resources, such as right-of-way purchase and construction plans and specifications, are expended only on priority groups A and B.

Factors used in developing these priority groupings include the following:

- safety needs
- economic development
- environmental effects
- local support
- commission report input
- local contribution
- system benefits
- district priorities
- department commitments

Finally, there is a clear statement of control shown in Figure 21. This authority for moving projects was promulgated by the 1984 administrative order (#33-84 of December 14, 1984) that advanced the overall 10-year project development concept.

The two remaining RCHS elements from the seven-element diagram will be noted more briefly. Concerning structure, the Texas department has positioned its RCHS in the highway design division, depending on the high technical competence and stability found there. However, the small (three-person) Texas Transportation Commission takes an active, involved role in directing the process. Indeed, it was at the commission's request that the process was reduced to the clear format now available. It is critically important that the 25 relatively autonomous districts support input and updating functions of the 10-year plan on an almost continuous basis. Based both on interviews and the long record of accomplishments in Texas, this mix of top-level control and bottoms-up program building has provided high motivation to the Texas department.

One other feature of this agency and its capital improvement environment is the top management stability it enjoys. Nationwide, chief administrative officer positions in departments of

TABLE 4  
BASIS OF FUNDS DISTRIBUTION AND ALLOCATION FOR DEPARTMENTAL 10-YEAR PROJECT DEVELOPMENT  
PLAN (48)

Category of Work	Category 1 (Interstate)	Category 2 (Interstate 4R)	Category 3 (Capacity Increase Construction)	Category 4 (Rehabilitation)	Category 5 (Farm-to-Market)	Category 6 (Urban System)	Category 7 (Safety and Betterment)	Category 8 (Bridge Rehabilitation)	Category 9* (Miscellaneous)
Highway System	Interstate Eligible Only	Interstate System	Primary Secondary State	Primary Secondary State	Farm-to-Market	Urban System	Primary Secondary State	Primary Secondary State Off System	Primary Secondary State
Work Type	New Construction or Reconstruction of Interstate Eligible Work	2a Reconstruction 2b & c Rehabilitation and Upgrade to Standards	Added Capacity and New Location	Rehabilitation and Upgrade to Standards	New Construction, Reconstruction, Rehabilitation	New Construction, Reconstruction, Rehabilitation	Preventive Maintenance (Seal Coat and Thin Overlays)	Bridge Rehabilitation or Replacement	HES--Safety Improvements Discretionary (All Type Construction)
Project Selection Process	Approved in Interstate Needs Estimate Selected Statewide Basis	2a Added Capacity, Selected Statewide Basis 2b & c District Allocation Combined with Cat. 4	Selected Statewide	District Allocation	District Allocation	District Allocation on FHWA-Approved Formula	District Allocation	Selected Statewide	HES--Selected Statewide Discretionary District Allocation
Ranking Index or Allocation Formula	Cost/Veh. Mile to Prioritize Schedule	2a Congestion/Relief Index 2b & c Combined with and Allocated as a Part of Cat. 4	Cost/Veh. Mile and Congestion/Relief Index	50% Veh. Mile 50% Lane Mile	1/3 Rural Population 1/3 Co. Rd. Miles 1/3 Avg. Daily Vehicle Miles Co. Rds.	Cities above 200,000 Select Projects for Their Allocation. District Discretionary on Remaining (Approx. 25%)	67% Veh. Mile 33% Lane Mile	Evaluated on Bridge Sufficiency Rating. Selected by District's Priority	Prioritized by Safety Index Discretionary District Selection
Funding Type and % Participation	Interstate (Only)	Interstate 4R (Only)	Primary Secondary Minimum Allocation	Primary Rehabilitation Secondary Rehabilitation	State (Only)	Urban System (Only)	State (Only)	Bridge Rehab. & Replacement	(HES) Hazard Elimination and Safety
(Federal-State)	(90-10)	(90-10)	(75-25) or State (Only)	(75-25) or State (Only)		(75-25)		(80-20) or Some Rdwy. Work State (Only)	(90-10) Discretionary State (Only)
(State)			(100)	(100)	(100)		(100)	(100)	(100)
Anticipated Annual \$ Volume Contracted (Approx.)	\$209,000,000	\$276,000,000 (Includes \$100 Million for 2b & c Combined with Cat. 4)	\$800,000,000	\$200,000,000	\$23,000,000	\$55,000,000 (Based on Past Years)	\$100,000,000	\$70,000,000 (\$55,000,000 Based on Past Years)	HES \$14,000,000 Discretionary \$50,000,000
Planning or Programming Process	10-Year PDP with Biennial Update	2a 10-Year PDP with Biennial Update 2b & c Combined with Cat. 4 in Annual Consolidated Rehab. Program	10-Year PDP with Biennial Update	Annual Program Allocation	Biennial Program Allocation	Program Allocation (In Accord with Fed. Hwy. Act)	Annual Program Allocation	Program Allocation (In Accord with Fed. Hwy. Act)	HES Program Allocation (In Accord with Fed. Hwy. Act) Discretionary Annual Program Allocation

\*This is a miscellaneous category, but the most significant programs are Safety (HES) and Discretionary.



TABLE 5

TEXAS 10-YEAR PROJECT DEVELOPMENT PLAN (ESTIMATED EXPENDITURES IN MILLIONS OF DOLLARS) (48)

District	Cat. 1 Interstate New	Cat. 2A Interst. (4R) Add Capacity	Cat. 3 Primary Second & St. Add Capacity	Cat. 4 Interstate, Primary, Second & State Rehabilitation	Cat. 5 Farm-to- Market	Cat. 6 Urban System	Cat. 7 Preventive Maintenance	Cat. 8 Bridge Rehab./ Replace	Cat. 9 Safety, Misc. & Disc.	District Total	% of 10-Yr PDP Total	% PDP	Tentative Commission Commitments (TCC)
1-Paris	0.00	0.00	133.35	91.87	8.05	6.55	48.00	12.71	19.89	320.40	1.58%	1.80%	0.00
2-Ft. Worth	205.95	362.43	988.71	189.10	8.97	44.72	82.22	43.34	40.95	1966.38	9.67%	7.89%	72.94
3-Wichita Falls	0.00	0.00	71.78	79.23	5.06	7.92	42.20	10.29	17.16	233.63	1.15%	1.47%	0.00
4-Amarillo	4.62	2.04	13.60	112.52	7.82	12.27	60.61	14.25	24.38	252.10	1.24%	2.12%	0.00
5-Lubbock	131.40	0.00	33.19	136.01	15.18	13.64	74.68	14.91	29.45	448.45	2.21%	2.68%	125.65
6-Odessa	27.82	0.00	17.65	98.31	5.29	10.73	52.49	12.32	21.32	245.92	1.21%	2.20%	0.00
7-San Angelo	6.02	0.00	37.98	89.03	4.83	5.17	50.17	8.03	19.31	220.54	1.08%	1.20%	0.00
8-Abilene	0.00	0.00	14.68	99.09	6.90	7.70	53.94	11.50	21.45	215.26	1.06%	1.63%	0.00
9-Waco	0.00	5.83	71.78	110.58	8.97	14.25	55.39	17.88	23.99	308.65	1.52%	3.11%	2.77
10-Tyler	0.00	0.00	249.04	128.02	11.27	10.29	63.22	22.00	27.76	511.59	2.52%	3.12%	45.80
11-Lufkin	0.00	0.00	86.64	81.11	6.90	3.96	42.34	11.66	17.55	250.16	1.23%	1.49%	3.00
12-Houston	241.08	932.06	4090.35	322.28	46.92	139.26	126.15	97.57	69.81	6065.48	29.84%	21.96%	1565.01
13-Yoakum	0.00	0.00	154.85	106.98	8.74	5.56	54.96	16.50	23.21	370.78	1.82%	1.92%	0.00
14-Austin	24.50	169.34	748.24	154.41	12.19	23.32	71.49	29.87	33.48	1266.82	6.23%	4.84%	497.36
15-San Antonio	139.18	363.92	404.30	229.50	13.80	55.22	107.74	43.73	49.73	1407.10	6.92%	8.87%	0.00
16-Corpus Christi	24.49	20.60	351.07	103.55	6.44	18.04	51.04	18.54	22.43	616.19	3.03%	3.25%	79.86
17-Bryan	0.00	0.00	171.80	96.72	6.44	7.32	49.16	15.40	20.93	367.76	1.81%	1.90%	0.00
18-Dallas	16.39	1028.15	1686.99	287.07	8.28	94.11	118.18	73.32	62.21	3374.68	16.60%	14.02%	134.82
19-Atlanta	0.00	0.00	152.99	88.56	7.82	4.35	44.95	14.08	19.18	331.92	1.63%	1.76%	9.78
20-Beaumont	3.90	66.24	319.29	98.08	8.51	15.24	45.82	20.79	21.26	599.12	2.95%	3.32%	0.00
21-Pharr	0.00	0.00	173.45	104.44	8.97	23.38	51.62	17.55	22.62	402.02	1.98%	4.91%	0.00
23-Brownwood	0.00	0.00	12.20	62.69	5.29	2.20	35.09	6.16	13.59	137.21	0.68%	0.78%	0.00
24-El Paso	31.13	10.50	81.23	74.90	3.22	24.64	36.25	13.20	16.25	291.32	1.43%	3.43%	14.34
25-Childress	0.00	0.00	14.46	55.95	4.14	0.22	32.34	4.46	12.16	123.72	0.61%	0.33%	0.00
Total	*856.48	*2961.11	*10,079.62	3000.00	230.00	550.00	1450.00	550.00	650.00	20,327.21	100.00%	100.00%	2551.33

\* Funds est. to be available for Cat. 1, 2a, & 3 are approx. \$10.6 billion. (Dollars shown exceeding this amount are considered as being overprogrammed.)

- Category 1 Selected 10-year PDP, including 1987 additions & modifications. (Amount needed to complete eligible Interstate construction.)
- Category 2A Selected 10-year PDP, including 1987 additions & modifications.
- Category 3 Selected 10-year PDP, including 1987 additions & modifications.
- Category 4 Allocation based on 50% lane miles and 50% vehicle miles. Annual program of \$300 million.
- Category 5 Allocation based on 1/3 rural population, 1/3 co. rd. mileage, and 1/3 average daily vehicle miles traveled on county roads. Annual program of \$23 million.
- Category 6 Allocation based on percentage of urbanized population. Annual lettings of approximately \$55 million are historical.
- Category 7 Allocation based on 2/3 lane miles & 1/3 vehicle miles traveled. Annual program of \$145 million.
- Category 8 \*\* Allocation based on % of vehicle miles traveled on all highway systems. Annual lettings of approximately \$55 million are historical.
- Category 9 Allocation for annual program of \$50 million in district discretionary funds based on 50% vehicle miles traveled & 50% lane miles (actual allocation).
- Category 9 \*\* Allocation for annual program of \$15 million in safety & miscellaneous funds based same 50/50 formula for planning purposes.

Tentative commission commitments are projects specifically authorized by the Commission for planning but not for construction.

\*\* Amounts shown in Categories 8 & 9 (Safety) are based on assumed allocation formulas that are used for planning purposes only.

- Available construction funds based upon the following assumptions:
  - o Federal revenues to grow at 2.5% annual rate and state revenues to grow at 1.4% annual rate.
  - o Available federal revenues established by using 1986 obligation control and expanding at above growth rate.
  - o Available dollars not discounted.
  - o Operation and maintenance budget remains constant at \$1.15 billion per year. This establishes available state construction funds and assumes no inflation.
  - o All available minimum allocation funds are shown for Category 3.
  - o When \$887.8 million Interstate funds are expended per 10-year PDP, the funds that would be available for Category 1 are assumed to be available for Category 2a.
  - o Approximately \$3.3 billion overprogrammed projects (Added Capacity--Categories 1, 2a, & 3) are included in the \$20.3 billion 10-year statewide total.



TABLE 6  
PROPOSED ADDED CAPACITY INDEXES (48)

Cat.-Subcat.	Ranking Index 1984	Proposed Ranking Index--1986	Comments
1-Interstate Added Capacity Construction	Cost/Veh./Mile (Exist. Traffic)	Cost/Veh. Mile (Exist. Traffic)	Eligibility Established by Interstate Needs Est.
2a-Interstate 4R Added Capacity Reconstruction			
Additional Lanes	$\frac{1}{\text{Index 1}}$	Congestion Relief Index (CRI)	Discussed in Report
Interchange Upgrade	$\frac{\text{Cost}}{\text{Veh. Impacted}}$	$\frac{\text{Cost}}{\text{Veh. Impacted}}$	Same Value
Main Lane Bridges	$\frac{1}{\text{Index 1}}$	Congestion Relief Index (CRI)	Discussed in Report
3-Capacity Increase & New Location Construction			
3a-Loops & Bypasses	Cost/Veh. Mile (Projected Traffic)	Cost/Veh. Mile (Opening Traffic Inc. Truck Factor)	Proposed Assumes All Projects Opened 1986
3b-Interchanges	Interchange Ranking Index	Modified Interchange Ranking Index	Modified Improved Delay Model, Discount Rate Reduced to 6%
3c1-2 Ln to 4 Ln Expansions	Cost/Veh. Mile (Exist. Traffic)	Congestion Relief Index (CRI)	Discussed in Report
3c2-Multilane Expansions (All Others)	Cost/Veh. Mile (Exist. Traffic)	Congestion Relief Index (CRI)	Discussed in Report
3d-New Location	Cost/Veh. Mile (Projected Traffic)	Cost/Veh. Mile (Opening Traffic)	Proposed Assumes All Projects Opened 1986
3e-Principal Arterial System Gaps	Cost/Veh. Mile (Exist. Traffic)	Cost/Veh. Mile (Exist. Traffic)	Same Value

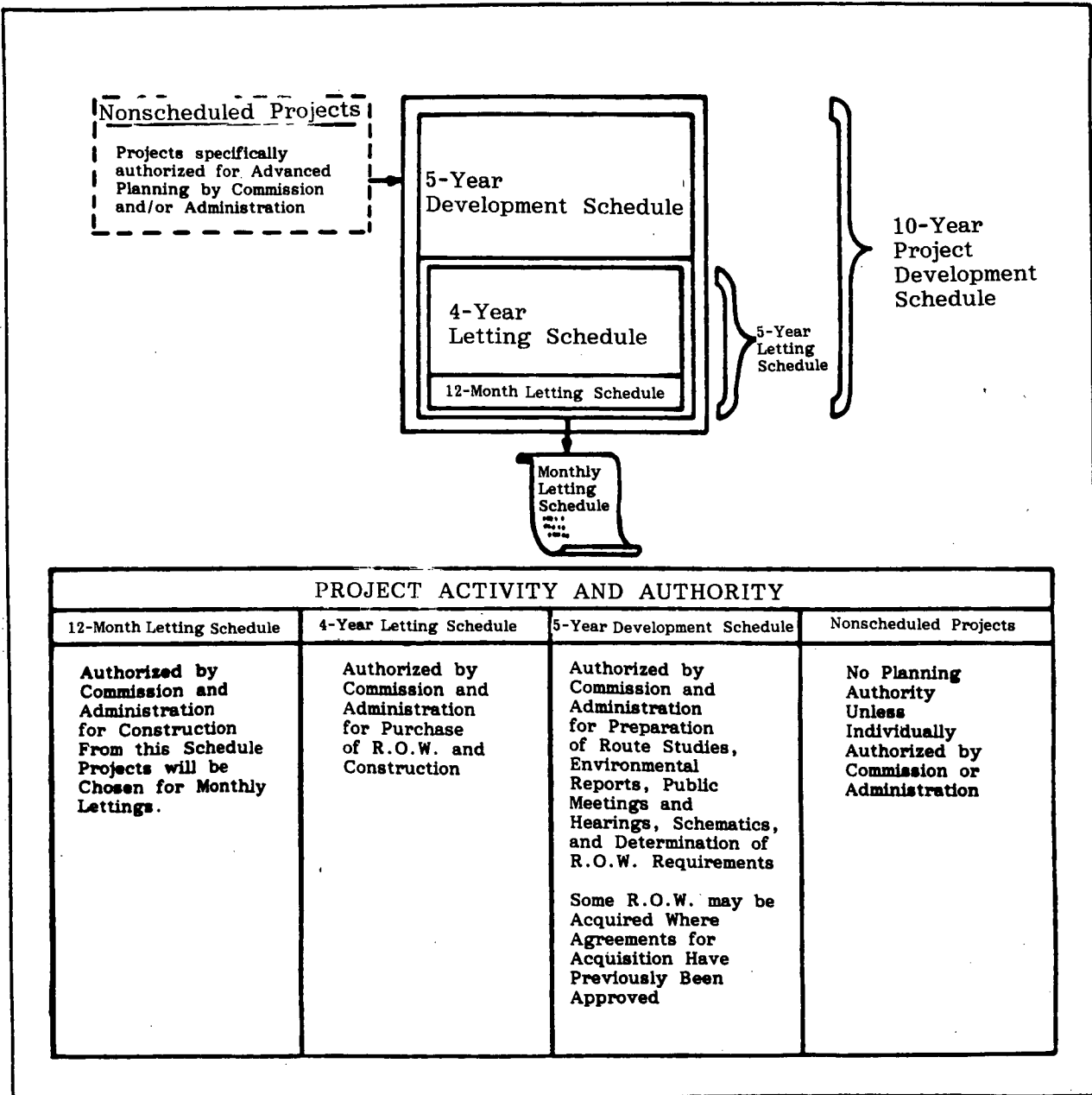


FIGURE 21 Ten-year project development plan for construction projects (for categories 1, 2A, & 3) (48).

transportation or highways are increasingly short term and often filled from outside the agency. In contrast, the top positions in Texas have been and are now filled with people of considerable experience in the agency serving on a professional career basis. This stability is particularly important to long-term, publicly sensitive programs such as RCHS. Finally, in Texas the support staff for the capital improvement process is also made up of long-term, highly skilled professionals. They apply their skills to the formidable task of managing a multi-billion-dollar annual capital program for the largest (in mileage) of the 50 state highway systems. Innovations such as the program being described are in part a reflection of this excellent staff.

**The Pipeline Analogy**

For Texans, the various figures shown earlier leave little doubt as to what is in the pipeline. Furthermore, they know that for the projects listed—and in one document or another every project is specified in complete detail—there is a rational categorization and prioritization process that has attended managing the pipeline. Projects are loaded at two-year intervals in a way that matches pipeline capacity, i.e., available dollars.

Two interesting features fit the pipeline relief valve analogy, protecting against unmanageable pressure buildup. First, in the 1986 update, there is \$2.6 billion for projects identified as “tenta-

tive commission commitments.” This permits real input from commissioners and ensures their “ownership” of the program but does not permit uncontrolled expenditure. As noted in the quotation given earlier, these projects are available “for planning authority only.”

The other relief valve is the \$50 million in discretionary funds allocated to the districts. Often, the greatest citizen and political pressures build up over relatively low-cost needs, i.e., an improved traffic signal, an anti-skid surface, better signs or markings, or other spot safety improvements. The ability of the district management team to proactively seek out and immediately fund such concerns permits the larger process to flow more smoothly and to maintain higher credibility.

For students of and practitioners in the highway capital improvement arena, the full documentation of the Texas 10-year project development is a valuable reference. Full details of the necessarily sketchy descriptions provided herein can be obtained from the Texas documentation.

## WASHINGTON

Washington has a tradition longer than that of most states in rational priority setting in its approach to RCHS. This tradition, set by the political, economic, and social environment of Washington, is rooted in a priority programming law passed in 1963 (RCW 47.05) that has as its basis “the rational selection of projects according to factual need, systematically scheduled to carry out defined objectives within limits of money and manpower, and fixed in advance with reasonable flexibility to meet changed conditions.”

The now 25-year-old priority programming law established rules for the programming process that, with periodic modifications, have worked remarkably well in a stable organizational structure. The law’s “rules,” really organizational goals, include:

- Functional classification. The law requires the transportation commission to conduct periodic analyses and classify roads into three classes: principal arterial, minor arterial, and collector.

- Six-Year Program and Financial Plan. The law requires that the commission adopt and periodically revise, after consultation with the legislative transportation committee, a comprehensive six-year program and financial plan by highway improvement category.

- Highway improvement categories. Specific categories enumerated in law are:

Category A—improvements necessary to sustain the structural, safety, and operating integrity of the existing non-Interstate highway system;

Category B—improvements for the continued development of the Interstate system;

Category C—major improvements off of the Interstate system, such as additional or passing lanes and new interchanges;

Category H—improvements to ensure integrity of the state’s bridges.

- Priorities in selection of projects. The current statute specifies that for projects in Category A and H, the priorities are structural adequacy, traffic-carrying capacity, alignment adequacy, and safety record. For Category C, priorities include the above as well as a variety of other factors such as system continu-

ity, modal coordination, energy conservation, and financial feasibility.

The state also has a 12-year transportation plan of strategies for system development, including a model financing plan. Although this plan defines the overall goals for the department, a subset of the plan defines the “real world” of improvements that will be proposed. The Level of Development Plan defines the level of effort that is anticipated for each highway segment at one of three levels of development: design standards (highest level), 3R standards (extending service life and enhancement), or preservation (maintain structural integrity and operational safety). The updated 1986 model for preservation of non-Interstate highways establishes a “normal” level of financing to accomplish the required work in Category A as well as in the bridge program. For Category C, the financial plan indicates the funding level required to accomplish about 75 percent of the work in the transportation plan, recognizing that some of the work will not be able to be accomplished because of environmental or other considerations.

The programming process involves converting this overarching vision into highway needs and allocations through a five-step process:

- Priority Array: This defines the deficiencies of the existing highway system. Each mile of the state highway system is addressed and specific deficiencies are noted with respect to three major groups: bridge life expectancy, pavement condition, and hazardous-accident locations. Each of the three groups is defined by a set of parameters relating to the group. Highway sections indicating a condition defined by the parameters are listed as having those deficiencies and are prioritized in order of the magnitude of the deficiency.

- Biennial Budget Request: The modeling method described above is used as a basis to request funding for correcting deficiencies in accordance with the objectives for each program. A pavement management system is used to determine appropriate paving strategy for each section of highway.

- Allocations: Funds are allocated to districts based on the needs as portrayed in the preservation model. (Although needs studies have lost credibility in some states, the Washington needs process has, through careful attention to design and execution, remained highly credible.) Other subprograms, such as Interstate, are managed on a statewide basis and project-specific allocations to the districts are at the level of funds needed to accomplish those selected projects.

- Capital Program Management System: In the fall of 1988, a comprehensive information system went on-line. This system provides a common project and program data base as well as an instant update and balancing capability. Coupled with this is a recently completed program management and control study that has led to well-defined expectations for project delivery in terms of scope, cost, and schedule. Regular reports of progress are made to the legislature and to the public.

- Program Review and Approval: After funds have been assigned to projects and the projects have been defined in terms of scope, cost, and schedule, each subprogram is balanced in each district. Projects are then reviewed by the secretary before approval for submission to the commission for final approval.

As the above description suggests, Washington’s highway practices to preserve and improve its transportation system are

strongly influenced by the legislature and its mandated requirements. The department of transportation is also one of the agencies most tightly controlled by the legislature in the state. The Legislative Transportation Committee, a joint entity of the two legislative houses, exercises strong leadership over the agency's mission. Its legislative staff is funded out of highway revenues and has access to the department's project management system and monthly management reports.

Perhaps as a result of this close interaction with the legislature, the agency has benefited in some ways in addressing pressing concerns. For example, in 1976 Washington enacted a variable fuel tax with a floor and ceiling to maintain stability in revenues. Since then, even more responsive measures have been considered.

The agency has avoided the inflexibility of fixed geographic formulas and at the same time adopted a sophisticated approach to project classification and prioritization without sacrificing regional equity in its distribution of capital improvements. In other words, a mandated close relationship between this agency and the legislative branch has so far avoided the "transportation is too important to be left to the transportation agency" syndrome noted elsewhere. Finally, Washington's priority programming law is a model of rational decision making, providing both an orderly process, along the pipeline analogy, as well as relief valves such as overprogramming. The result of all this, as illustrated in Figure 6, the basic seven-element model, is evident skill and success in RCHS.

## SUMMARY OBSERVATIONS AND FUTURE DIRECTIONS

In this short chapter, useful observations for current practitioners are collected in a more succinct format. As noted earlier, if change in the highway transportation function is to be as pervasive as believed, then notes on future directions extrapolated carefully from present practice and reflecting changes now apparent may be a useful addition to this synthesis.

### SUMMARY OBSERVATIONS ON CURRENT PRACTICE

- There is no natural, normative, static model by which to study and prescribe RCHS. Appropriate concepts and frameworks must be adapted to meet changing local conditions and needs.
- This work, and that of others (14, 18, 44), points to a process that although hungry for and benefiting from quantitative inputs (i.e., condition, measurements, and benefit-cost analyses) is viewed increasingly as a policy prerogative of highway agency and state government top management. These conditions need not be viewed as mutually exclusive, and success in RCHS requires that they not be.
- Creative, successful highway capital processes responsive to top management flourish best in a “directed autonomy” environment. It requires a lot of talent and commitment to make this process work at all levels.
- Successful transportation goal setting, given this management context, demands an understanding of the larger social and economic context, and increasingly attracts overt political intervention to ensure meeting larger goals.
- Increasingly sophisticated tools are available for measuring, analyzing, and reporting system condition. In today’s constrained environments, these must be used to provide inputs to management’s decision-making processes.
- Meaningful, contemporary categorization of systems is an essential precondition to RCHS.
- Factors and formulas for prioritization should be rigorously defined and consistently applied but not viewed as sacrosanct.
- Modern, interconnected, system-wide data bases with appropriate software to access, analyze, format, and present these data are increasingly the required tools for an effective process.
- Data input into system characterizations and prioritization schemes should be decentralized and should include strong incentives for maintaining currency. Central access, control, and analysis capability is also required.
- A compact, high-level, attentive forum for decision making and program monitoring, an RCHS management center, will enhance effectiveness.
- Staging of RCHS is critically important. The overall process

must permit full project development, e.g., 10 years. Out beyond project development, perhaps another 10 years, is the period for developing a mobility vision. Closer-in stages must signal onset of major expenditure, perhaps four to five years out, and estimated let-to-contract dates, six months to one year. Regular updates on an annual or biennial schedule keep the program current and provide opportunities for broad communication with the authorizing environment.

- The immediacy of some types of projects, the imperfect nature of prioritization, and political reality require relief mechanisms: overprogramming (up to 30 percent), budget allocation to the field for specified types and sizes of projects, and limited long-term concept development funds under tight, centralized control.
- RCHS should be seen as a continuing process through project construction, because delivery of the right projects on time and within budget are the ultimate measures of success.
- RCHS provides a major communications opportunity—internal communications for the agency, external to all citizens, elected officials, and interest groups. This use should be promoted aggressively.
- Capital improvements represent the less frequently affordable solution in contemporary highway practice. Considering a full range of options, maintenance through rehabilitation, enhances management effectiveness.
- Successful RCHS demands a very high level of creativity, skill, and dedication. It also demands the best and brightest of agencies’ human resources.

### FUTURE DIRECTIONS

What of the 1990s? Something of what might be future trends for RCHS are perceived, especially in California and New York. Often important future trends follow from changes now in progress, and it is believed to be the case here. Therefore, observed changes are grouped as geographic/system, political, institutional, technological, financial, and management changes, and for each class of change, inferences for RCHS are postulated.

#### Geographic/System

- Mature, basic coverage in place for all areas of the country.
- Growth versus stagnation for different regions and within states.
- Decrease in modal choice; greater dependence on the highway system.

*Inferences for RCHS*

- Must face increasing demands for maintenance and respond to more localized pressures.
- Highway capital improvement options may be the only means to provide mobility, so pressure on program delivery will mount and shorter project cycle times will be required.
- Regional difference may impede consensus building.

**Political**

- Transportation is critical to economic growth and vitality, now prime political concerns.
- Transportation is a mature function and therefore has lower profile and less political urgency than it had in earlier days.
- The transportation program has been used, especially by the Congress, to achieve other societal objectives, i.e., minority employment, preservation of cultural heritage, and so forth.

*Inferences for RCHS*

- In general, a more competitive environment, where new factors will influence political decisions, will require new focus on broader-ranging goals.
- Program prioritization will be likely to include an ever wider range of nonhighway objectives.
- Legislative and top management control and influence in RCHS will increase.
- Excellence in "process" will be a prerequisite to success.

**Institutional**

- The federal-state partnership is changing and may, in fact, change dramatically in the near term (1991) as systems and needs change and as the Congress directs.
- Interest groups gain and lose strength and coalitions are formed and broken.
- Federal, state, local, and private roles are in transition.

*Inferences for RCHS*

- The use of federal requirements and funding as both crutch and lever will decrease.
- Program consensus building must face new realities, especially a greatly expanded motor carrier presence: numbers, size, weight, car-truck interference, and all of this in an increasingly adversarial climate.

**Technological**

- Meaningful and complete measurement of system conditions is now feasible and improvements are continuing.
- Data processing systems, hardware and software, permit assembling these measurements and statistics into communicat-

ing data bases that can provide meaningful input to RCHS management.

*Inferences for RCHS*

- RCHS will face simultaneously an increasingly persuasive technical prioritization capability and increasingly politicized decision making.
- Data collection and processing system costs will rise dramatically because of far more extensive use even though unit costs will probably decrease. This means more than commensurate increases in productivity as well.

**Financial**

- Improved fuel economy, tax exemptions for nonconventional fuels, and the use of trust funds for budget management have adversely affected user fee revenues.
- Local government and private source funding may make consensus building for revenue enhancement and other purposes more challenging.
- Fuel prices show short-term variability and so tend to mask tax increments.
- New fuels or vehicle power units prompted by environmental consideration may change traditional revenue sources in dramatic ways.

*Inferences for RCHS*

- Fiscal projections on which to base highway capital programs will be short term and unstable.
- Gaining program consensus may become increasingly demanding as local government and private sources join in the financing and so in the management of RCHS.

**Management**

- Highway agency CAOs are increasingly from outside the highway engineering profession and serve for increasingly shorter terms.
- Management focus for capital investment has been shifted from maintaining an "inventory of system capacity" to facing local but highly visible capacity shortfalls.
- Manpower shortages, especially in key technical areas, are likely for the future.

*Inferences for RCHS*

- A focus on rapid orientation of CAOs new to RCHS to all the elements involved will be required.
- A strong, high-level, central program management function can assist in keeping the new breed of CAO close to this important activity.



- Options for system improvements must be as wide ranging as possible, with capacity additions viewed as only one of several available.
- Private-sector support in measuring system condition and assembling data for management purposes and for designing and constructing projects will be more common in the future.

Arriving at the "bottom line," there is, in 1989, a persuasive and current body of evidence supporting the need for an accelerated program of highway capital improvements. Among the several states, there exists a wealth of knowledge concerning how to select and implement such improvements.

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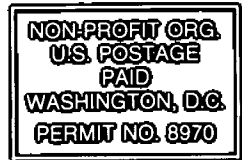
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