Renaissance for the State Transportation Needs Study

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State transportation agencies are faced with continued public expectations of improved transportation services. The interrelated issues of projecting revenues and inflation, anticipating the effectiveness of alternative investment maintenance programs, assigning priorities for future service level requirements, ensuring equity, and preserving the benefits from past investments affect the ability of the states to formulate responsive policy. An historic framework for planning has been the periodic state transportation needs study. This process, however, has fallen into disfavor as the disparity between increasing needs and the ability to retire deficiencies has grown. The Michigan Department of Transportation has restructured the needs study through a procedure for disaggregating, stratifying, and assigning priority transportation needs as input to the preparation of the state's first transportation plan. The Michigan process is basically zero-base budgeting done for each mode for each year of a study period—in this case, 1982 to 1990. Each defined deficiency is examined to see whether its cost is avoidable; if it is avoidable, the deficiency is placed into a hierarchy of classification. A set of priority rules defined by each mode is then applied. This results in the ranked decision packages needed in order to evaluate the implications of a particular fiscal policy or monetary reality on the ability to retire transportation deficiencies. This approach enables analysts to disaggregate needs into deficiencies, assign priorities, and stratify needs by planning objectives. With this new approach, the needs study process is reaffirmed as a valuable element in transportation planning and a vital component in evaluating alternative policy options.

Toward the end of the 1970s, warning signs began to emerge as to the cumulative impacts of the world's energy economy on increased inflation in the transportation field, reduced levels of transportation funding, and the problems in matching federal aid. The interests of special groups, such as the elderly, the handicapped, and those with limited mobility, shared attention with the traditional issues of public transportation, freight movements, and personal mobility. Together, these realities led to confusion in policy at the national and state levels and a recognition that a massive reassessment of traditional planning and analysis structures was required. In essence, it became clear that a restructured approach to planning and policy formulation was required to support the difficult choices and decisions that would have to be made throughout the rest of the century.

The initial reaction in the state of Michigan to the need for more comprehensive information was to expand the traditional highway needs study (required every 4 years) to a multimodal assessment of all transportation needs that require public assistance. This first restructured data collection and analysis process, which extended over 2 years, produced more than future transportation requirements stated in terms of dollars. The process produced

1. State transportation goals;
2. Modal goals for (a) aviation, (b) highways, roads, and streets, (c) nonmotorized transportation, (d) ports and harbors, (e) public transportation, and (f) railroad freight;
3. Identification of critical issues;
4. Specific service levels and design standards for each mode;
5. An analysis of the magnitude and growth of fixed-expenditure needs; and
6. A financial projection of available funds and fixed expenditures under varied inflation-rate assumptions.

This expanded format for needs assessment produced a number of startling observations and set the stage for the restructured planning process that produced the first Michigan State Transportation Plan (STP). It also established a framework for modal plans and regional plans and is currently serving as one of the benchmarks for the refined multimodal needs study, which will be completed in 1984. The recommendations in the first multimodal needs study report formed the basis of a mandate to produce the first STP (both of these reports are available today in their executive formats).

Of the many findings and observations, the most distressing included

1. The magnitude of the total needs (see Figure 1), even within strict service-level targets;
2. An imminent inability to fund fixed expenditure requirements;
3. The impending jeopardy to past investments in transportation;
4. The inability to assign priorities to competing needs within and among modes;
5. Problems of categorizing and linking federal, state, and local issues to alternative policy options;
6. The need for automated methods of examining fixed expenditures; and
7. The need for methods of disaggregating and stratifying transportation deficiencies into building blocks that permit iterative policy analysis.

These issues, which were addressed in the recent STP, are currently serving as a backdrop for modal and regional plan development and as a frame of reference for refinements to be included in the state's second multimodal needs study.

In this paper, an overview is presented of the role of the first Michigan multimodal needs study data and information in the STP process (see Figure 2), the restructured Michigan planning process, and future directions of the Michigan DOT.

RESULTS OF NEEDS STUDY PROCESS

The expanded needs study approach and process have much to recommend them. Because all modes were considered and both avoidable and nonavoidable costs were included, decision makers were reasonably sure that they were being presented with the entire universe of demands on future revenues. Because needs were assessed by comparing projected demand with independently determined target service levels, planners had a potentially powerful tool for examining "what if" contingency planning and policy questions, such as the resource requirements associated with varied service levels.

Several major problems with the results of the expanded multimodal needs study process had to be overcome, however, before the results could be used in the STP. First, needs were referenced primarily by what must be done--resurface, widen, and so on--rather than by how the improvement related to departmental or societal goals or the priority of the improvement. This made it difficult to assess the effectiveness of a proposed revenue package. A method had to be developed in the STP to relate improvements to goals and issues and to assign a priority to the needs identified in the needs study.

A second problem was that needs were stored in various forms by mode, from disk files to manila folders. To make the system responsive to the requirements of decision makers, all the needs had to

Figure 1. Michigan transportation needs identified in 1977 multimodal needs study.

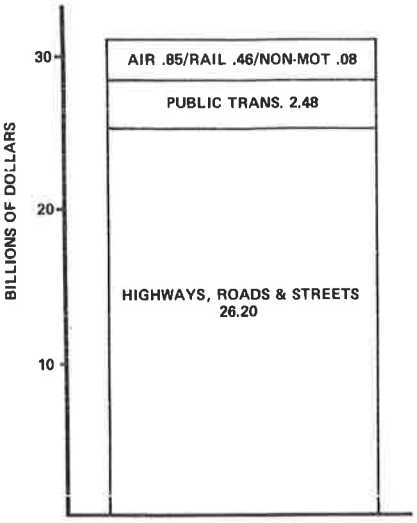
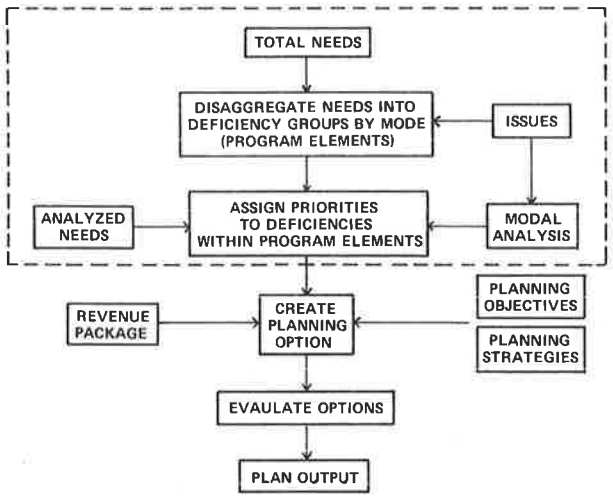


Figure 2. Analysis process.



be put into computer-readable form in compatible formats. This constituted a significant task because the final needs universe comprised several hundred thousand records on computer disk.

In addition, after a period of declining revenues, needs studies report a huge backlog of needs that were never retired. In Michigan the 1977 needs study identified $30 billion ($46.5 billion in 1980 dollars) of transportation needs that required public assistance. Department attempts to use the total dollar needs as justification for revenue restructuring would be likely to encounter a "what's-the-use" attitude from legislators because there are no realistic tax packages that could possibly address all needs. A process for disaggregating the universe of needs into strategies had to be designed as part of the STP process to identify what specific needs could and could not be met under various revenue options.

FACTORS THAT AFFECTED THE STP

Four additional factors affected the design of the first Michigan STP process and the use of the needs study results:

1. Inflation,
2. Shrinking revenues,
3. The emergence of fixed costs as a significant proportion of transportation needs, and
4. The need to be able to explain to legislators and the public the effect of any proposed tax increase on the performance of the transportation system.

Double-digit inflation in the late 1970s affected the cost of providing transportation more harshly than most other sectors of the economy (see Figure 3). Whereas food costs increased 33 percent and new-car costs increased 25 percent between 1977 and 1980, the cost of transit operations increased 38 percent and the cost in Michigan of a typical mile of rural road construction increased 54.7 percent. The phenomenon of transportation inflation required the analysis of inflation forecasts, the selection of inflation rates, and the design of a procedure for isolating the opportunity cost of capital. If a required improvement is deferred, its cost continues to escalate and in some cases may become prohibitive in comparison with available resources.

Shrinking revenues are largely a sustained response to the high fuel prices and occasional shortfalls that have persisted since 1974. Automobiles are becoming more fuel efficient at the same time that people are making fewer automobile trips. This causes fuel-tax revenues to drop. Passenger vehicles are also becoming lighter, which decreases weight-based registration fees. Because these are the two principal components of revenue for the Michigan Transportation Fund (MTF) under the tax structure in effect during the STP, funds available to retire transportation needs exhibit a downward trend that could probably be reversed only through tax restructuring (see Figure 4).

During the past 30 years, the public demand for improving transportation systems has resulted in a tremendous investment in transportation's physical plant. Transportation departments must now find ways of preserving the value of that investment. This preservation is reflected in part in a costly program of regular system maintenance, system administration, and servicing debts incurred through bond issues years before. As these nonavoidable fixed costs consume an increasing share of available revenues, the money left over to retire deficiencies decreases and the backlog of deficiencies mounts. The Michigan State Trunkline Fund (which is spent on state highways and nonmotorized transportation) was expected to have insufficient discretionary funds to match federal aid by fiscal year 1984 and would not meet fixed-cost requirements by fiscal 1985 under the tax structure in place during the STP (see Figure 5).

These factors and issues made it necessary to devise a means of explaining to the state legislature and the taxpayers the impact of existing and alternative revenue packages--in effect, which deficiencies can be retired and which may have to be foregone. This type of information should assist the public in understanding the future of transportation services and the explicit role of tax structures in that future. Fortunately a mechanism for developing this information is well known and needed only to be adapted to the restructured planning process in the STP. This mechanism is zero-base budgeting (ZBB).

ADAPTATION OF ZBB

Classical ZBB requires that activities and their potential expenditures be categorized by major area of emphasis [program element (PE)] and by subdivi-

Figure 3. Effect of inflation on costs: 1977-1980.

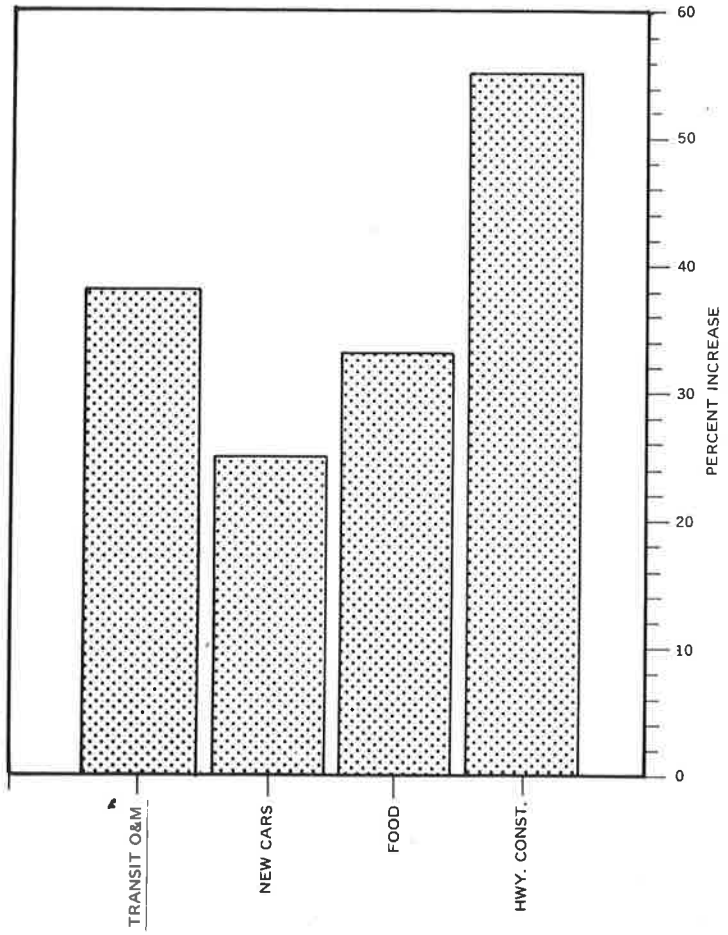


Figure 4. Forecast of revenues to MTF before December 1982 tax restructuring.

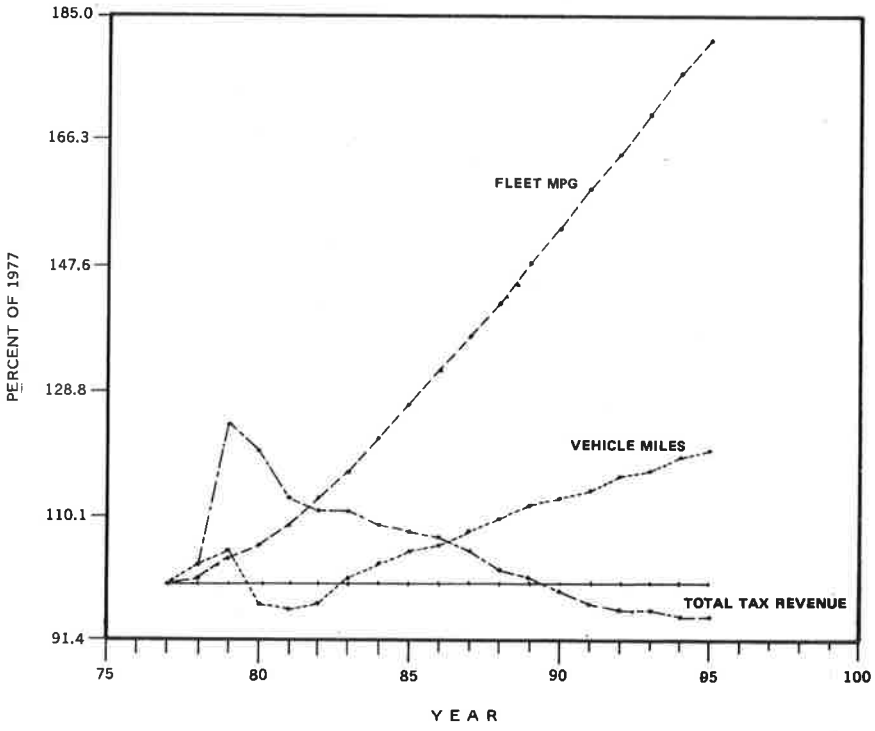
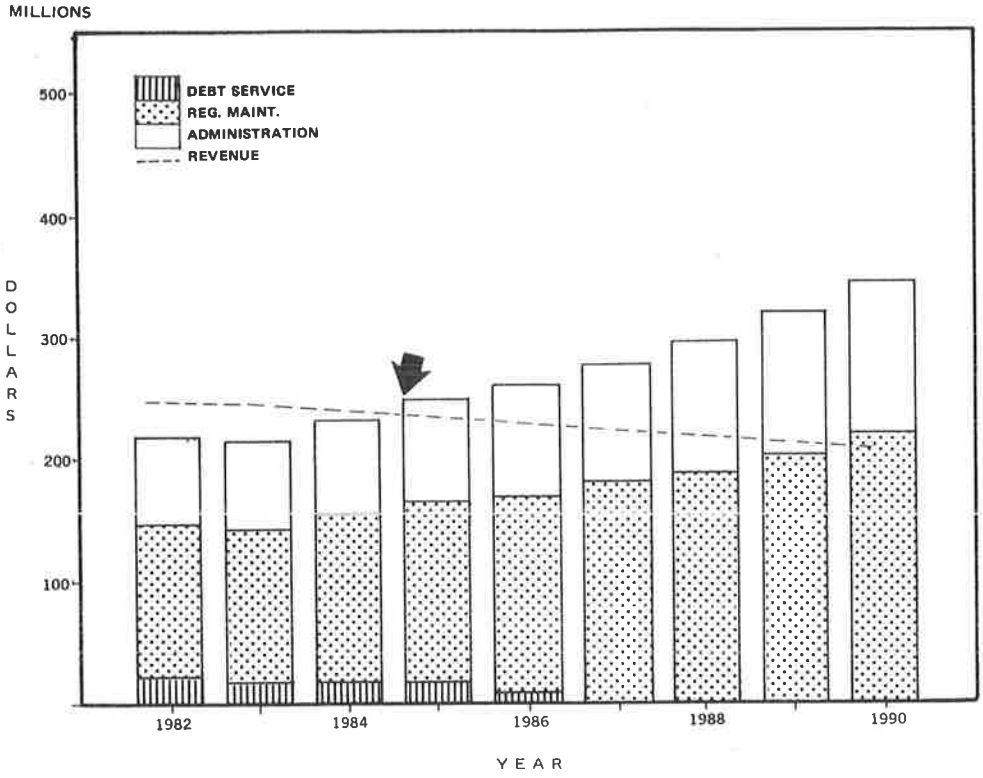


Figure 5. Comparison of STF revenues with fixed costs before December 1982 tax restructuring: present tax package, 1982-1990.



sions of program elements [subprogram elements (SPEs)] that address specific objectives. These activities are then grouped into logical units called decision packages. The decision packages are ranked within each PE and projected funds are assigned to each PE according to its relative importance in achieving the organization's goals. The allocation to each PE is then spent on each package in order until the money runs out. Thus, the universe of activities in a PE is divided into those that can and those that cannot be met under a particular funding allocation.

Conceptually, one might think of a PE as a stack of several sponges of varying thicknesses. A measured amount of water is poured onto the topmost sponge and trickles down until a certain number of sponges are saturated and all the rest are dry. The sponges are thus divided into two groups, and it is easy to see whether the one used for washing the car is going to get any water.

In adapting ZBB to the needs study, several liberties had to be taken with the classical ZBB process. First, it was necessary to apply the technique by mode. In Michigan, three separate transportation funds receive revenue to finance the eight state modes: the State Trunkline Fund (STF), the Comprehensive Transportation Fund (CTF), and the Aeronautics Fund. State law specifies which fund finances which mode.

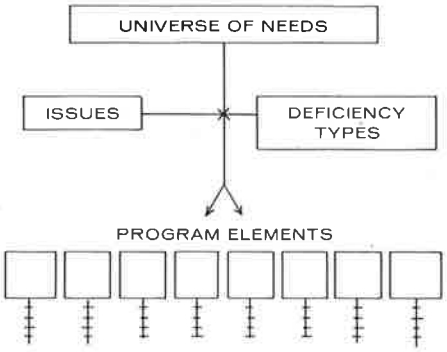
Second, each of the three funds is confronted with a base level of nonavoidable costs that must be met before any money is distributed by mode. These are the so-called fixed costs: regular maintenance, administration, and debt service. These three categories of fixed costs are not applicable to all of the transportation funds. State highways and nonmotorized facilities owned and maintained by the state through the STF have all three elements of fixed costs. The CTF provides capital and operation and maintenance subsidies to all non-STF modes except air; debt service and administration are considered fixed costs, whereas the subsidized companies or transit authorities define and perform their own routine maintenance. Because the Aeronautics Fund provides no direct maintenance and does not bond, its fixed costs are limited to administration.

Third, because the STP dealt with a forecast revenue stream from 1982 through 1990, the ZBB process had to be designed to apply each year's revenue forecast sequentially. Modal rules dictate whether a deficiency that cannot be retired in one year because of insufficient funds is "unmet" or becomes part of the backlog and therefore eligible to be retired later at an inflated price. A mode such as highways allows the backlogging of capital requirements, whereas a mode such as intercity bus, for which the state provides only operating subsidies, does not.

After fixed costs have been identified and forecast by year, the remaining deficiencies must be categorized and disaggregated into PEs (see Figure 6). The first Michigan STP used eight PEs:

1. Service continuation--Preservation of already existing service, such as 4R-type (resurfacing, restoration, rehabilitation, and reconstruction) work in highways or operating subsidies in public transit;
2. Service relocation--Relocation of an existing facility or system;
3. Service improvement--Expansion of capacity, frequency, speed, or other quality of an existing facility or service;
4. New service--Establishment of a completely new facility or a service not currently offered;
5. Mobility-disadvantaged--Establishment of a program or project specifically designed to provide or improve service to a mobility-disadvantaged group (a countywide demand-response bus system in a county

Figure 6. Assignment of needs to program elements.



with many rural poor or elderly persons might fall under this category);

6. Economic development--Promoting private investment and job creation or complementing a particular public or private venture, such as widening an access road or providing a rail siding to accommodate a new automobile assembly plant;

7. Safety--Elimination of an existing hazardous situation, either by improving the existing facility or by establishing a new facility specifically designed to mitigate the hazards of the first;

8. Energy conservation--Establishment or expansion of a facility designed to reduce the amount of fuel used for transportation, such as a carpool lot.

The final step was to use the rules defined for assigning a priority by each mode in order to establish the priorities for the projects within each PE. The criteria for assigning priorities for a mode may vary within a PE. For example, aviation planners may rank service improvements by the airport's existing activity but use the population within 30-min driving time of the airport to assign a priority to new service. The only overriding criterion for defining rules for assigning priorities is that they be simple and understandable and satisfy existing legal requirements. The criteria that were used to assign priorities to deficiencies in the STP are summarized in the following paragraphs

In keeping with the ZBB approach, priorities were assigned within each PE of each mode. The rules for assigning priorities for a given mode were developed by the planning section that has responsibility for that mode. Because modal trade-offs were outside the scope of the first STP, no attempt was made to totally balance the system. Modal trade-offs will be considered in the next STP.

The criteria for assigning priorities by mode are as follows:

1. Aviation--The major criterion for assigning priorities for the aviation mode is the year in which a deficiency is projected to occur. Because in Michigan projects are typically initiated by the airport authority that governs each airport, aviation planners must consider projects as they come up. Within any given year, however, new airports or new services can be ranked by service area (population within 30-min driving time); existing service deficiencies can be ordered by the level of activity of the airport at which they occur.

2. Highways--Day-to-day project programming for state trunkline improvements reflects a complete set of legal requirements that overlay rule-of-thumb judgments about the order in which deficiencies should be addressed. The STP attempted to approximate this decision-making process by a scoring system that considered three factors: (a) the level of significance or importance to the overall system; (b) the year in which the first deficiency is projected to occur (a road could, for example, be projected to develop surface problems in 1984 and capacity deficiency in 1987); and (c) the type of deficiency. Figures 7 and 8 show the highway process for assigning priorities.

3. Intercity bus--The state's role in the intercity bus mode consists of providing subsidies to retire operating deficits. They must be addressed in the year in which they occur and cannot be backlogged. Therefore, the deficiencies are ranked (within PE) first on their year of occurrence and then on the functional classification of the route on which they occur.

4. Intercity rail passenger (Amtrak)--Within each year priorities are assigned for rail track improvements by operating speed, and the lowest existing operating speed is given the highest priority. If two existing tracks have identical speeds, the tie is broken by assigning the higher priority to the track used by more daily trains. Priorities for service improvements are based on the ridership potential of the respective routes. Balancing is attempted among the state's four classes of routes to ensure that each receives some high-priority projects each year.

5. Local mass transit--Priorities are assigned for local mass transit projects first by year and then by expected demand on the local system. Demand is approximated by the percentage of carless households in the local planning area. Balancing is attempted among the four types of planning areas (metropolitan, small metropolitan, urban/small urban, and rural) so that an equal proportion of the needs of each will be met in each year. No balanc-

Figure 7. First-cut priorities by level of significance for highway mode.

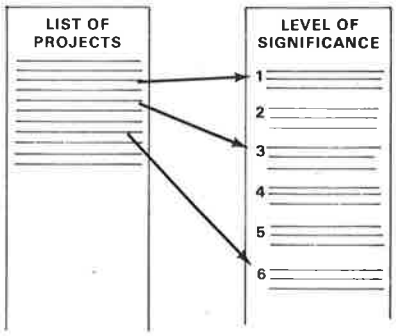
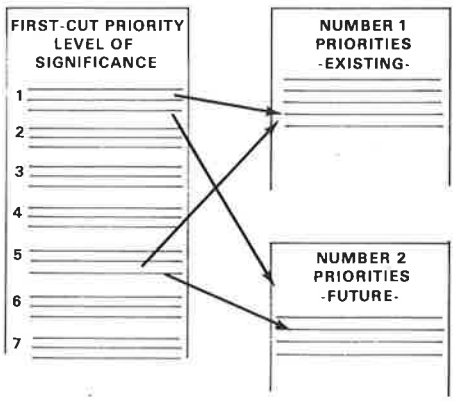


Figure 8. Second-cut priorities by time frame for highway mode.



ing between the systems within each type of planning area is attempted.

6. Ports and harbors--Michigan's Great Lakes ports serve a wide range of traffic, from international vessels to local pleasure boats. Allowing a port to accumulate silt not only restricts the class of vessel that can be accommodated but also greatly increases dredging costs. Therefore, the primary concept in the ports and harbors mode is keeping the existing system in operation. Priorities are determined by year of deficiency, whether the deficiency affects passenger or freight vessels (freight is ranked higher because freight vessels tend to be deep-draft), type of deficiency (emphasis is placed on maintenance dredging), and the functional classification of the port. In addition, funding for port authorities is legally obligated and therefore must be ranked high within its PE in each year.

7. Nonmotorized transportation--By law, at least 1 percent of construction money available to the STF must be spent on facilities that benefit nonmotorized transportation. Because bicyclists also use state highways, assigning priorities to nonmotorized facilities is closely tied to highway deficiency analysis. Highway segments that need a nonmotorized improvement and are also scheduled for improvement under the highway construction program rank high because of the possibility of significant cost savings through, for example, adding extra-wide shoulders when a highway is widened. Highways without shoulders are given first priority. Within that group, they are ranked in order of traffic level.

8. Rail freight--For the rail freight mode, for improvements to or maintenance of existing segments priority is based on annual carloads per mile, the higher-density segments receiving higher priority. In the case of new service, because there is no existing traffic to evaluate, priorities are established by looking at the place classification (importance) of the goods production centers served by the segment. The more important centers a segment serves, the higher is its priority.

After priorities were assigned within PE by mode, the deficiencies were reviewed by the planning teams responsible for each of Michigan's 14 planning regions to ensure compatibility with local and regional objectives. After that review, final priorities were assigned to individual projects (see Figure 9).

USING STRATEGIES TO RESTRICT ATTENTION

As the STP process evolved, it became evident that shrinking revenues could only retire a small fraction of the deficiencies in most modes no matter how the priorities were assigned. To provide an adequate framework for decision making, it was necessary to propose a series of policy decisions for the consideration of the Transportation Commission. A strategy for meeting the objectives of each policy was defined, and this strategy was then translated into a particular subset of deficiencies.

If a policy decision were chosen for implementation, a certain subset of each mode's deficiencies would have to be concentrated on. All other deficiencies for that mode would automatically be neglected in order to satisfy as many of the strategy deficiencies as possible. A conscious decision would thus be made as to which opportunities would have to be foregone in order to strive toward a particular strategy.

A range of possible strategies was considered in the formulation of the STP. These strategies ranged from attempting to satisfy all needs to concentrating on preserving existing facilities and systems while providing no new or improved service of any sort. In the latter case, although system preservation seems to be worthwhile in the face of shrinking revenues, increasing demand guarantees that service levels will decline.

Six strategies were developed for the draft STP (see Figure 10). They ranged from a strategy that included the total universe of identified needs to one that included only those deficiencies needed to preserve the existing transportation system. The universe of needs was updated from the 1977 study by considering more recent levels of demand and by deleting retired needs satisfied by projects completed since 1977. In Figure 10, each of the six strategies is described and the amount of money that would be needed to retire all deficiencies in the strategy for the eight state-supported modes is given. Figure 11 shows conceptually how a simple set of strategies might be built.

After review of the analyses of the effect of present funding and a proposed tax package on the strategy deficiency sets presented in the draft STP, the Transportation Commission defined a seventh strategy that more closely addressed present pres-

Figure 9. Setting final priorities.

Figure 10. Planning strategy packages.

		INFLATED $
STRATEGY 1 =	1980 Target Service Levels	19.3
STRATEGY 2 =	1980 service levels will be retained in all modes. New demand will be met with new or improved services to the same extent demand was met in 1980.	14.1
STRATEGY 3 =	Some 1980 services levels will be allowed to degrade. Some demand generated deficiencies will be met through service improvements and new facility and services.	
3A =	This sub-set addresses some of the mandated functions of MDOT. It does not involve expansion of Department activities into portions of the state where they do not currently exist.	
3B =	The philosphy of this sub-set is to fulfill MDOT mandated functions in the full spirit of the law. It addressed all the requirements of Act 51 as amended. It does not necessarily expand or improve upon those services beyond minimum requirements.	11.4
3C =	This sub-set address all of the elements and requirements included in 3A and 3B and fulfills commitments previously made or elements considered primary to the existance of certain modes.	12.8
STRATEGY 4 =	Present service levels will be allowed to degrade. No new facilities, services, or service improvements will be initiated to meet new demand.	8.7

Figure 11. Building strategy packages.

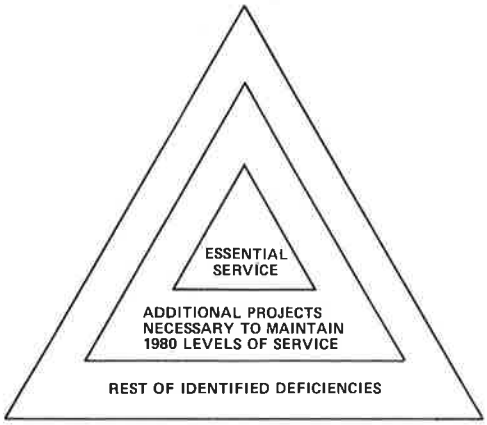
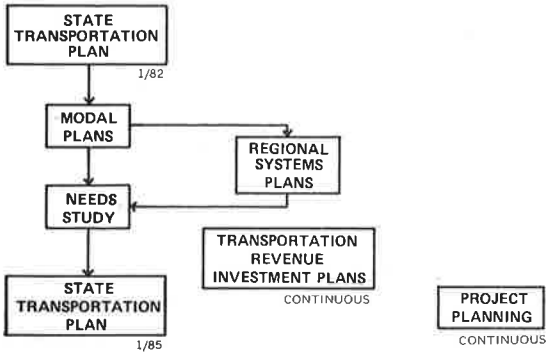


Figure 12. Michigan's restructured planning process.



sures. Called strategy 3d, it was a hybrid formed by substituting a significant number of economic development projects for projects in other program elements in strategy 3a (Figure 10). The new strategy was designed to preserve the existing system, stimulate Michigan's weak economic climate, satisfy such legal commitments as funding port authorities, and finish major projects to which the Commission has committed itself (completion of the Interstate system and the Detroit Central Automated Transit System).

FUTURE DIRECTIONS

At the conclusion of the STP, the lessons learned from the needs assessment and establishment of priorities and from the STP process were analyzed. This continued the evolution of Michigan's restructured planning process (see Figure 12). The current phase of the restructured process includes the production of the modal plans, the regional plans, and the refined multimodal needs study. The observations generated from the STP process, appreciation of the significance of fixed costs throughout the rest of the century, and ongoing testing and analysis of the effects of new revenue measures will affect the current 1984 multimodal needs study.

The second phase of the multimodal needs study process is being developed to allow dimension strategy options, to provide a concise and responsive data format, and to serve as a primary vehicle in forming public awareness of the potential problems in the Michigan transportation system. The results of the second multimodal needs study will serve not only as the foundation of the next STP but also as a backdrop for discussions of modal goals, regional and local service levels, and revenue requirements. The intention is to use the refined needs study processes to address the issues of essential services for each mode, ways to improve priority assignment, the concepts of backlog, design standards, and a reexamination of the role of the state in local transportation. Throughout the current process, a great effort is being made to ensure the validity of the needs data base. Analyses of the impacts of various service levels and design standards and refinements in the estimates of fixed cost needs are now under way. All needs data will be developed and assigned within the restructured needs assessment format. This requires PE and SPE project identification, programmatic assignment of priorities, and financial analysis.

Recent and current experience in Michigan clarifies one point. The criticisms of historic needs studies are valid--not because of a lack of dedication in producing such studies but because the process was not adapted to the critical issues of realistic service and financial constraints.

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