

## IMPORTANCE OF EMPLOYEE INVOLVEMENT

Agency experience indicates that the importance of employee involvement at all levels simply cannot be stressed enough. Unless there is a commitment on the part of the people responsible for making the necessary improvements, any program, but especially one of this magnitude, will fail. This commitment is not easy to come by; rather, it must be earned. It must be proven to engineers and field laborers alike that the new priority should become an operational habit and not simply a temporary exercise in paperwork. This can be done through direct employee involvement in decision making and by repeated evidence from top management through obvious changes in top-level decisions. The committee process, although cumbersome at times, provides a mechanism for such employee involvement. If the committees are charged with developing recommendations within time constraints and many of those recommendations are implemented, the commitment is reinforced.

Another mechanism is to make individuals more directly responsible for failures in the system. This approach is being tried by the Oakland County Road Commission through the assignment of liability claim losses against appropriate departmental budgets. Department heads thus become directly accountable for financial losses in areas where they have some degree of control.

Even the employee-survey process, such as the analysis of procedures described above, can be useful. It allows the seldom-heard-from employee to vent frustrations and at least feel that he or she has had a chance to be heard. There may also be fringe benefits that are not necessarily reflected in the original instrument. For example, although more than 700 road-hazard-report forms have been turned in by road commission employees, there has also been a notable increase in radio and oral notification of problems. Thus, the forms themselves may not reflect the actual increase in employee awareness of problems and corresponding reporting. Again, through follow-up confirmation of suggested improvements, the commitment toward con-

tinued reporting is reinforced.

Repeated educational and training programs are also mandatory. The messages of priorities and duties relating to those priorities must be repeated again and again so that there is little question that the new program is here to stay. Finally, there must be continued reinforcement from top management. Commitment from the top must be the most evident.

## FUTURE DIRECTIONS

Many of the programs and activities described in this paper are in the form of in-house demonstrations, and staff will be analyzing and improving them. Eventually, the staff hopes to develop a system for the allocation of all road commission resources in the interest of safety. But, although determining the priorities of link and inter-section improvements is not always an easy and clear-cut process, the allocation of resources among the numerous construction and maintenance activity alternatives is even more difficult.

Through the adoption of safety as its number-one priority and the implementation of the highway risk-management program, it is believed that the Oakland County Road Commission has taken a more significant step toward improving highway safety than any other road agency in the nation.

An informal survey of approximately 70 public agencies responsible for streets and highways indicated that major safety improvement programs generally correspond directly with available federal safety funds. The Oakland County Road Commission's program far exceeds the federal program limitations. It is believed that the road commission's program will demonstrate that substantial improvements can be made in highway safety at existing levels of funding and that road agencies need not wait for new federal programs. There is no question that additional funding is warranted at all levels, but progress can be made in highway safety without waiting.

*Publication of this paper sponsored by Committee on Transportation Programming, Planning, and Evaluation.*

*Abridgment*

# Matrix Project Management in Transportation: New York State Experience

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The topic of matrix project management in transportation is explored, and the results obtained after two years of experience by the New York State Department of Transportation are described. The major problems of increased complexity of the transportation-project development process and the effects of inflation on project delays led to the creation of the program planning and management group in the fall of 1976. This new organizational structure, of which the program-project management section is a part, allows primary units that interact during critical stages of the project development process to be located within the same major

unit. The organizational structure of the program-project management section and the duties of its members are discussed. An analysis of the first two years of operation, 1977 and 1978, is presented based on decreased project slippage and dollar value of projects let. The average project slippage on 100 sample projects in the period January-December 1976 was 5.11 months and that on projects monitored in 1977 and 1978 was 2.45 months. By applying this slippage reduction against the 1977-1978 average inflation rate of 10 percent per year on a total letting of monitored projects for the same period of \$1.364 million,

a cost saving of \$30 million can be calculated. During the period 1977-1978, the 91 monitored let projects represented only 14 percent of the total projects let but composed 68 percent of the total dollar value of the program. The average value of these projects was in excess of \$10 million. These relatively simple findings indicate a great amount of success at a minimal investment of staff and resources.

Following the completion of a study by the Management Improvement Bureau in the summer of 1976, the New York State Department of Transportation (NYSDOT) formed a new group called the Program Planning and Management Bureau.

This paper will explore the management theories of matrix project management as used by one part of this group—the program-project management group—and the results achieved in its first two years, 1977 and 1978, in reducing project slippage and, consequently, in reducing added costs due to inflation.

## MANAGEMENT THEORY

To understand the development of project management, it is necessary to explore the customary view of the matrix organization. This is a structure in which authority flows both horizontally and vertically, and there is a key person who is the focus of activity and has the capability of cutting across lines of authority to accomplish the ends of the project. Matrix organization, as an advanced concept of organization structure, is typically associated with complex technologies, in particular the aerospace and computer industries.

Matrix project management is a form of project management in which the actual work on a given project is performed within the functional departments but the flow between functional areas of assigned programs and priority projects is overseen by a project manager assigned to bring it to a successful completion.

Although the key person, called the project manager, has some formal authority, much of his or her success comes from the ability to influence functional managers and reach understandings with them. The effective project manager exercises power outside of that formally granted by the formal organization.

The role of the project manager is to see that the time, quality, and cost standards for the project are met. He or she acts as the advocate for the project in each of the functional departments that do work on it. This is in contrast with the functional managers who are responsible for the project only while it is under progress within their own functional areas. The functional manager handles the more specific tasks of assigning staff and facilities and ensuring that requirements are fulfilled according to deadlines, technical accuracy, and other criteria as needed within the functional area. Only recently have project managers shifted their attention to the problems of lateral relationships and the corresponding problems of coordination and integration. Perhaps the reason for the rapid growth of this organizational development is that observant managers have recognized that the most crucial problems concern improving cooperation and coordination between departments, managers, and subsystems.

## TRANSPORTATION FACILITY PROJECTS AND MATRIX PROJECT MANAGEMENT

The time required to develop a transportation project varies considerably by the type of project. Planning, designing, and constructing a new facility may take many years, but resurfacing an existing highway may take only a few months.

Every proposed project results in social, environ-

mental, and economic effects that must be assessed in the development process. To ensure that such effects are consistently and systematically considered, each state has been required to develop an environmental action plan, a formal document that serves as the organizational framework for considering those effects throughout the project development process. To comply with the provisions of the National Environmental Policy Act of 1969, the environmental impacts of each individual project must be assessed so that final project decisions are made in the best overall public interest.

The complexity of this procedure and the added state and local requirements have caused lengthy delays and added costs to projects. In 1971-1972, these delays became so pronounced that the U.S. Congress held committee hearings to explore the causes of a near halt to road construction nationwide.

At the average inflation rate of 9 percent of the early 1970s, the average increase of design time (44 months) meant increases in the costs of projects of more than 30 percent. These increased costs became a matter of great concern to the states as highway costs escalated at a rapid rate while local available tax dollars receded at an equal rate.

Due to the complexity of the project development process found in the environmental action plan and the need for detailed coordination among the various functional areas, it became difficult for the functional managers to keep the various projects on a set schedule, which made it apparent that changes in the management system were necessary. The complexity of the process of managing a project through the various functional areas justified the consideration of matrix project management.

Four criteria can be cited as guidelines for the use of the matrix approach:

1. A time schedule must be met.
2. Cost constraints are critical.
3. Coordination of specialized skills is required for completion of the project.
4. The required actions are in some way new or unfamiliar to the personnel involved.

Thus, NYSDOT management decided to establish a management mode based on matrix project management. There were two reasons for this: (a) the process through which a project must travel is very time-consuming and complicated and requires the interaction of many bureaus and (b) the large number of projects makes it impossible to have one project manager assigned to each project. Matrix project management is conducive to the multiple approach.

## MATRIX PROJECT MANAGEMENT IN NYSDOT

### The Organization

The centralized program planning and management group created in the fall of 1976, which reports to the office of the commissioner, consists of

1. The Program Planning Section (previously located in the Planning Division),
2. The Capital Projects Coordination Bureau (previously assigned to the Finance Division),
3. The Environmental Analysis Section (previously assigned to the Development Division), and
4. The Program-Project Management Section (which oversees critical projects).

This staff organization was established to limit the im-

pacts of outside changes on the delivery of systems and to provide a bridge for the functional organizations when new or significantly different programs are introduced. The new group brought together three existing functions having departmentwide responsibility for project advancement and created a small group of problem solvers to assist in advancing programs and high-priority projects. This new organizational structure allows primary units that interact during critical stages of the project development process to be located within the same major unit. It also allows a closer working relationship between the units involved in project advancement, which provides shorter, simplified lines of communication.

The only new group introduced into the organization was the Program-Project Management Section. Because this group reports directly to the office of the commissioner, the following benefits can be anticipated:

1. Provision of a central focal point for the early detection and prompt resolution of potentially significant problems,
2. Availability to the executive staff of better and more current information on the status of programs and projects and the impacts of various options involved,
3. Capability for quicker actions and decisions on new programs,
4. More efficient use of department resources and a decrease in the time needed to bring a project to completion, and
5. Integration of programming and scheduling factors.

The Program-Project Management Section consists of a small group of problem solvers whose task is to assist in advancing programs and high-priority projects. This section implements the program-management concepts and is responsible for obtaining the management decisions necessary to complete programs and related projects on schedule and within budgeted costs.

Duties are broken down so that a project manager has responsibility for various regional offices and specific programs. The chief program manager has similar responsibility for regions and programs, along with overall direction of the group, and represents the section at staff meetings and assigns projects and program duties to the four project managers. The principal project managers handle larger and more complicated projects and program areas. They also act in a supervisory, advisory capacity to the associate project managers.

Each program manager is assigned specific programs and high-priority projects for which he or she accepts responsibility. The duties of the program-project manager in this system can be broken down into several major areas, the most comprehensive of which is the directive to manage the flow between functional areas of assigned programs and priority projects and bring them to a successful conclusion. In meeting this responsibility, the project manager has the duties of directing overall implementation efforts; the preparation of program plans, schedules, and necessary instructional materials; and the formulation and implementation of revised plans and of providing clarification where necessary. Other functions that are performed by the project manager include establishing and maintaining liaison with other state and federal agencies, performing continual review of assigned projects to ensure that schedules are being met, resolving issues and problems beyond the scope of the functional managers (which includes identifying problem areas), and recommending remedial courses of action.

Currently, NYSDOT must coordinate more than 30 programs. These are constantly in flux as some programs are added, some are combined, and others are

eliminated. The program management group assists the functional managers in coping with these changes and in enlisting the timely support of others whose actions are critical to advancing the programs. There are also a relatively small number of projects that require individual and concentrated attention to bring them to completion. Those projects in which there is a great deal of public interest and those that were previously assigned to outside consultants have lost large amounts of time due to coordination problems. In addition, the program managers are assigned projects that have routinely fallen behind schedule, as shown on the exception reports produced by the Capital Projects Coordination Bureau, and that the bureau is unable to return to schedule. It is estimated that more than 100-150 projects will receive this detailed review each year.

It should be emphasized that the project managers are not responsible for substantive aspects of the programs or projects and therefore are not substitutes for the functional managers, who have the responsibility for controlling activities and the performance of work. Project managers should have full knowledge of all aspects and requirements of programs and assigned projects and serve as a bridge across functional lines. For new or significantly changed programs, the project manager ensures that responsibility is assigned, that all involved parties are kept informed, that plans are prepared, and that proper priorities are assigned. Once a program is running smoothly, project management personnel will withdraw and rely on the basic monitoring system to identify new problems. For individual projects, the project manager will uncover problems caused by lack of policy or delays in decision making and bring these to the attention of the appropriate functional manager. The group will also ensure that higher-level management is informed of delays that are beyond the control of department personnel so that administrative action can be taken.

#### Results: 1977 and 1978

Two measures were used in the evaluation of the first two years of operation of the program: (a) project slippage and (b) percentage of dollar value of projects let. These measures were chosen because they are major items set forth as goals and objectives for the Program-Project Management Section and because the data they require are easily obtainable.

Those projects identified for detailed monitoring were those that had engendered a great deal of public interest and also those projects that had routinely fallen behind schedule and could not be returned to schedule.

In 1977, some 100 projects were monitored in detail and, in 1978, 116 projects had the same detailed monitoring. Sixty of the 100 projects monitored in 1977 were let in that year, and 31 of the 116 projects monitored in 1978 were let in that year. The average value of the projects was in excess of \$10 million. During the two years, the 91 let monitored projects, although representing only 14 percent of the program, composed 68 percent of the total dollar value of the program. Thus, the Program-Project Management Section monitored the larger, more complicated projects.

A major factor in the success of the matrix-project-management concept is its effect on slippage or time delays, that is, its efficiency in holding projects within time constraints. The 100 projects monitored January-December 1977 represent a high percentage of projects in the later part of the project development stage. The 116 projects monitored January-December 1978 offer a more-representative cross section of the total project development process. The analysis of the average slip-

page is based on the total time span, i.e., January 1977 to December 1978.

Using the 100 projects monitored January-December 1977 as a base, an examination of the slippage experience by these same projects January-December 1978 shows an average of 5.11 months and a high for 12 projects in one regional office of 10.33 months. During the period January 1977-December 1978, the average slippage per project monitored was reduced to 2.45 months, a reduction of 53 percent.

If this slippage reduction is applied against the average inflation rate for January 1977-December 1978 of 10 percent per year on a total letting of monitored projects for the same period of \$1364 million, the cost saving calculated is \$30.0 million.

Another success factor is the support shown by higher-level management in the efforts of the Program-Project Management Section. Monthly status reports on the monitored projects were developed by the section and reviewed at regular monthly meetings with this management. At these meetings, decisions are made on those problems beyond the control of the project manager and action is taken to correct the situation. Although many other factors are involved in the measured success, without this visible follow-up to major delays, it is doubtful that the section would have achieved such results in the first two years.

### Future Years

The future course of the matrix-project-management concept is dependent on recognition of the possible failings of the system: inability to identify the responsible person, the fostering of power struggles, being considered redundant during economic recession, and fear of high costs associated with the matrix organization. Recognizing and dealing with these and other problems associated with the matrix approach can improve the group's chance of future success. Continuing on course without acknowledging some of the possible failings of the matrix organization would be shortsighted.

Over the past two years, the major area of concentration of the Program-Project Management Section has been on the highway mode; there has been only minor emphasis on other modes of transportation. From projected trends, however, it is apparent that, in the future, more of the activity of the section will be given to the various other modes.

*Publication of this paper sponsored by Committee on Transportation Programming, Planning, and Evaluation.*

### *Abridgment*

## Suggested Criteria and Procedures for Setting Highway Priorities

David Curry and Guillaume Shearin

A practical system for setting the priorities of highway projects for the California Department of Transportation has been developed. This includes formula and rating instructions for setting priorities based on project merits for 12 of the 15 highway capital-outlay programs and guidelines for the remaining three maintenance programs. The general technique for rating projects consists of calculating a benefit/cost ratio or a cost-effectiveness index closely related to project objectives. The numerator of the ratio or index represents the benefits of the project, measured either in dollars or in weighted rating scales; the denominator is the project cost. This ratio or index is then used to rank projects within each program area. The project ranking is then subject to technical, financial, legal, scheduling, and political considerations that are not addressed by the formula. This priority-setting system, which has been used for a year with only minor adjustments to formulas and weights, is a major step toward rational spending of highway monies that are projected to cover only 25 percent of the anticipated need for improvement over the next six years.

In the study described in this paper, a practical system for rating and ranking improvement projects in each of the 15 components of the highway capital-outlay program of the California Department of Transportation (Caltrans) was developed. The capital-outlay program has a budget of \$2.4 billion over the next six years, an expenditure rate that will meet only 25 percent of the anticipated need for highway improvements. New highway construction is the largest of the program components, constituting 53 percent of the total budget. Seven maintenance and rehabilitation components constitute

about 20 percent of the budget, and six operational-improvement components and a very small (0.4 percent) bicycle facilities component constitute the remaining 27 percent. Even among the maintenance programs, the available funds will meet less than half the anticipated need, which thus emphasizes the need for careful project selection.

The technique for rating projects varies by program component, but the general approach is that intensity-of-impact variables [such as highway-user time saving per vehicle or decibels of noise reduction (each derived from project objectives)] are multiplied by breadth-of-impact variables (vehicle kilometers or number of affected housing units) to give impact ratings. Different impacts can be weighted if they are not all measurable in dollars. (A typical weighting and scoring system is described below for the HB33—safety roadside rest areas—program component.) The sum of the project impacts or ratings is then divided by the project costs to give either a benefit/cost ratio (when impacts are measured in dollars) or a cost-effectiveness index. This ratio or index serves as the criterion by which projects are ranked to determine their formula priority.

The formula priorities are only advisory, because additional considerations (such as financial, legal, scheduling, and political) are introduced in the process of developing the annual state transportation improvement plan (STIP). Also, there are some types of projects