Abridgment

Programmed Project Management in Pennsylvania: Statewide Data Access

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One aspect of the Pennsylvania Department of Transportation's commitment to provide a vastly improved transportation program to the commonwealth is the implementation of responsible and practical management systems. One of these systems, the project management system (PMS), is making major contributions in the area of planning and scheduling the use of dwindling resources that must be used efficiently to maintain and restore an extremely large highway system. PMS is a computerized information management system that integrates project-related data from the engineering and planning communities with accounting data from the financial community. These data are stored in a common data base and are accessed by users located in the department's central office and the 11 engineering districts. PMS has enabled people in various branches of the department to obtain consistent information on all projects because everyone has access to the same data base. The project-related and accounting-related data maintained in PMS enable it to track the physical and fiscal progress of the projects on the department's program. PMS employs on-line updating to make changes in the project data. It also serves, therefore, as a powerful communications tool because a change made anywhere in the state is instantly available to all other system users.

At the beginning of the current administration, Pennsylvania's transportation program was so far behind that of other states that extraordinary measures were required to gain control of program management. On a system that includes 45 000 miles of highway and 27 000 bridges, deferred maintenance and lack of good management controls had created a crisis situation. In addition, the revenues and buying power of the department of transportation were cut severely by the combined effects of inflation and reduced fuel consumption.

One of the many new management initiatives introduced to address these difficulties was the development of a project management system (PMS). PMS is a computerized information management system that integrates project-related data from the engineering and planning communities with accounting data from the financial community. It employs a centralized data base and data can be updated on-line by users in the department's central office and in its 11 engineering district offices statewide. As such, PMS is essentially an electronic filing cabinet that contains the equivalent of an electronic manila folder for each project on the state's program.

The storage of project data in a common data base for the entire state has, for the first time, enabled people in various branches of the department to obtain consistent information on all projects. The classic problem of getting different answers to the same question has been virtually eliminated.

The on-line updating also permits PMS to serve as a powerful communications tool because a change made from anywhere in the state is instantly available to all system users. Many time-consuming manual tasks are being automated through the use of PMS data, which results in significant savings of staff time.

SYSTEM OBJECTIVES AND CONCEPTS

PMS has the following objectives:

1. Identify projects on the department's program and monitor the status of their federal funding;
2. Track the physical and fiscal progress of each project by maintaining information concerning previous activity, current status, and future estimates;

3. Eliminate confusion that could result from multiple lists of project-related information by maintaining a common data base for statewide use;
4. Provide a communications tool that will provide instant transmission of project information to all system users; and
5. Enable information requests to be met by inquiring into the data base (maintained as part of daily operations) instead of short-fuse telephone inquiries to the engineering district offices.

System Concepts

The programmed project managed by PMS is the aggregate of all phases (design, utilities, right-of-way, and construction) and incorporates all federal agreements that are used across the phases. The relation between a project and the federal agreements for its phases is depicted in Figure 1. At the state level, the federal agreements are essentially charge numbers in the department's accounting system. The preparation of management-level information on any particular project requires that PMS reach into the entire population of accounting charge numbers, extract only those that relate to the project in question, summarize the detailed information (costs incurred and future cost estimates) contained with each of these charge numbers, and report the aggregated information.

Data Integration

To accomplish the above summary function, PMS integrates data that historically has been separate—that maintained by the engineering and planning communities and that maintained by the financial community. This integration is demonstrated by the links in Figure 1 and the diagrams in Figures 2 and 3. Figure 2 shows the situation in which there are two distinct communities of data: the engineering and planning community (big picture) and the financial community (detailed picture). By using the linkages shown in Figure 1, PMS provides the means for integrating these data (Figure 3). As shown in Figure 3, someone in the engineering and planning community can inquire about the item that is familiar (a programmed project) and, without knowledge of the specifics of accounting data, he or she receives summarized data selectively extracted from the accounting system. Similarly, a person in the financial community can inquire about the item most familiar (accounting charge number) and, without knowledge of the specifics about programming projects, he or she receives information about the programmed project to which the accounting charge number relates. The ability to traverse the links in either direction and move, selectively, from detail to aggregate or aggregate to detail gives PMS its power as an extremely useful management tool.

Any single project can have many related accounting charge numbers (federal agreements) across its phases. To accommodate this one-to-many situation, PMS employs two separate data bases (linked by pointers shown in Figure 1): one for programmed projects and one for accounting charge numbers. The

Figure 1. Relation between projects and federal agreements.
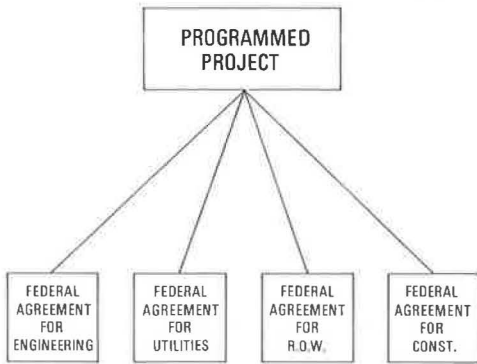

Figure 4. PMS communications network.

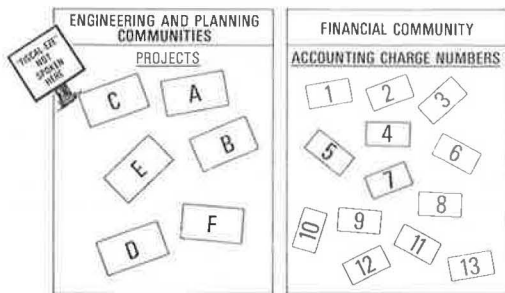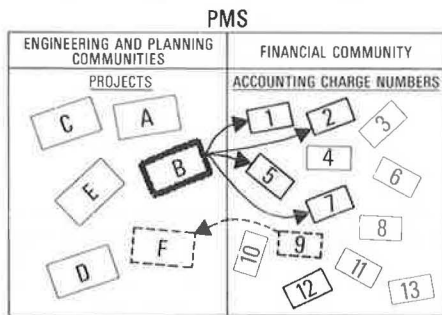Figure 2. Two communities of project-related data.

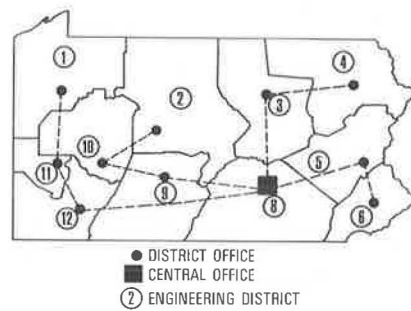Figure 3. Data integration and retrieval supported by PMS linkages.

general data categories contained in the programmed project data base are basic project information, narrative, project location, related accounting charge numbers (links), overall project costs, milestone achievement dates (physical progress), and senatorial and legislative districts. The general data categories for the accounting charge numbers are basic accounting information, narrative description, related programmed projects (links), prior costs, current costs, and estimated future costs.

PMS IMPLEMENTATION

PMS was designed, coded, and implemented by using department personnel and computer resources. System development started in June 1979 and the extraordinary transportation situation described in the introduction to this paper required that the system be designed and implemented within six to seven months. By overlapping the raw data collection and the beginning of the data entry with the development of the test system, implementation of the production

system was possible in January 1980. The initial user's training was conducted during January and early February 1980. At the same time, a communications network was installed that connected all engineering district offices and the central office bureaus to the main computing facilities in Harrisburg (Figure 4). In February 1980, the engineering district offices began updating their respective portions of the data base. Since that time, system users have been involved daily with data entry, update, and extraction, and the PMS staff has been working on system maintenance and enhancement.

System Structure and Report Preparation

The PMS operational flowchart is shown in Figure 5. The focal point is the two data bases: one for programmed project data and one for accounting charge number (SPN) data. The upper portion of Figure 5 shows that data enters the data bases either through on-line data entry from system users or from an interface with the department's accounting system. The lower portion of the flowchart shows that reports are extracted either directly from the data bases or from fixed-length records written to a separate storage device. These records contain data merged from both data bases and were developed to meet special reporting requirements. The significant point is that, although some data manipulation is accomplished with conventional programming languages (PL/I), all reports generated for system users are created by using a standard report-generating package. One of the main selling points for PMS is that it is flexible enough to meet almost any reporting need (within the limitation of available data). Seldom will two system users need exactly the same report (differences would occur in selection criteria, sort sequences, output formats, and time period covered) and the use of the standard report-generating package has enabled the preparation of literally hundreds of different reports in response to user requests.

System Users

PMS is a lot of things--data bases, reports, computers, display terminals, printers, and telephone lines. But most of all, it is people. The computerized information system is not an end in itself but, rather, what the people who use the system do with the information it stores determines the success or failure of the system. Producing a user-oriented system has been a continuing goal throughout the development of PMS.

Most of the more than 200 system users have never encountered a computerized system before and, as might be expected, many of them had a great deal of apprehension about getting started. PMS was designed for easy use and this, combined with hands-on
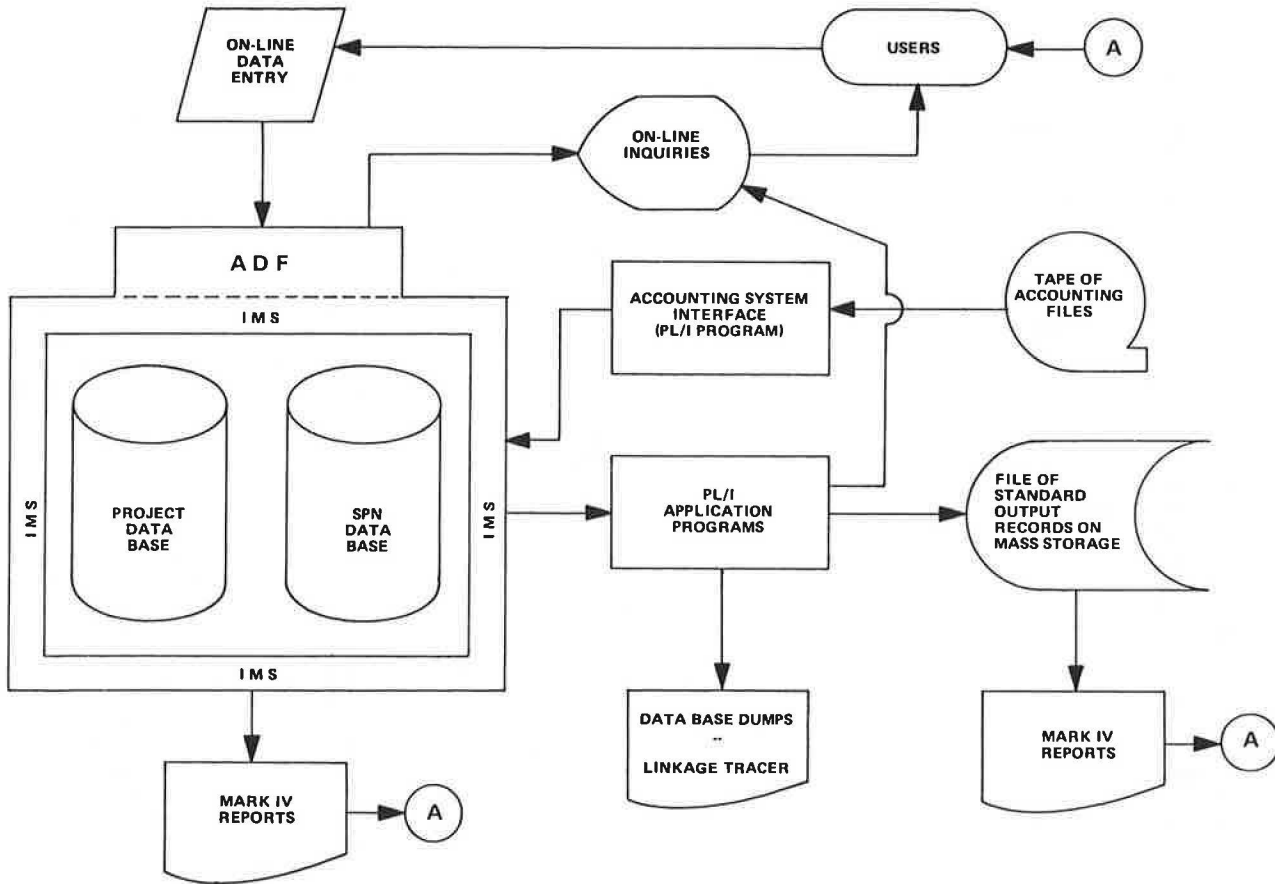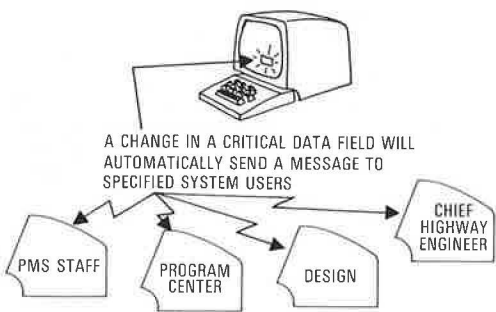
Figure 5. PMS operational flowchart.

Figure 6. Automatic message sending.

A CHANGE IN A CRITICAL DATA FIELD WILL AUTOMATICALLY SEND A MESSAGE TO SPECIFIED SYSTEM USERS

PMS STAFF PROGRAM CENTER DESIGN CHIEF HIGHWAY ENGINEER

training and a comprehensive user's manual, has enabled most people to become proficient without a great deal of difficulty. The list of users includes the secretary, district engineers, most of the executive staff, fiscal personnel, engineering and programming personnel, and support staff.

Security

The commitment of the department to PMS in terms of personnel, time, and resources, makes security of the system a major consideration. This includes both physical security of the data and necessary security measures to prevent invalid data from entering the data base.

In the area of physical security, daily data base backup copies are made and stored on computer tape.

The tape copies are first migrated to a fireproof vault and eventually to an off-site storage location to ensure that a means of recovering the data bases will always be available.

Protection of the data bases during normal operation involves control of system access and data quality. Each user has a unique identification code that must be used to gain access to PMS. Within that authorization, each user has a profile that defines his or her capabilities (retrieve, update, add, or delete) for each data entry screen (transaction). Each engineering district only has access to its own projects for update. In addition, individual data fields are checked for validity. Invalid data are rejected and must be corrected prior to being accepted by the system.

Automatic Message Sending

One of the objectives of PMS is to serve as a communications tool. A typical problem is that a change in a project schedule or estimated cost occurs, but only a few people find out about it. Automatic message sending facilitates the dissemination of this critical information, as shown in Figure 6. Any change in a specified data field causes a message to automatically be sent to any number of users on the message's mailing list. Typically, these messages are used for notification of project additions or changes in a project's schedule or estimated costs. Users may access their messages through the computer terminals and are also given a daily printed listing of these messages for a permanent record.

On-Line Inquiry Capabilities

More than 3700 individual programmed projects are in PMS and any single district office has between 250 and 650 projects. It would be difficult and time consuming to sequentially search through all the projects every time a list of projects that have some common characteristics was needed. The PMS inquiry system was developed to permit users to selectively interrogate their portions of the data base. The inquiry capabilities are in three areas:

1. Select all projects that meet criteria specified by the user;
2. Select all projects that will achieve a certain milestone date (physical progress) within a specified time frame; and
3. Select all projects that have missed specified milestone dates by more than a tolerance specified by the user.

The PMS inquiry has proved to be an effective tool for enabling managers to focus their attention on a subset of the projects within their responsibility instead of having to contend with large listings of projects. A hard copy of the inquiry results can be obtained on printers located with the computer terminals. In this regard, the PMS inquiry also functions as an on-line report generator.

PMS APPLICATIONS

Physical progress of the programmed projects is tracked by using a series of milestone achievement dates that range through preliminary design, right-of-way acquisition, utilities, final design, letting, award, and the construction phase. The milestone dates are posted into the PMS as either estimated dates, actual dates, or not applicable (for a particular project). For the most part, engineering district offices enter the estimated dates but many of the actual dates may only be entered by central office bureaus. The prime concern here is to capture a data element at its source and have it input there. For example, the Bureau of Highway Design receives notification of federal approval of funds for a specific project phase so it enters the actual approval date.

Scheduling the Obligation of Federal Funds

In addition to the milestone dates, project cost data (broken into federal, state, and other shares) is available in the PMS. PMS accesses the estimated costs and estimated federal obligation dates simultaneously to place the federal fund requirements into the appropriate federal fiscal year (or month

within the year) based on the estimated obligation date. These data, summarized across all projects, result in the obligation plan.

Developing the Letting Schedule

An important document prepared by the department is the letting schedule, which shows the bid dates for various projects. The ability to meet letting schedules will have a significant impact on the department's ability to manage its cash flow and accomplish the needed physical work on the highway system. By using a processing mode similar to that described above for the obligation plan, projects available for letting in a specified time frame are evaluated in light of established criteria (achievement of required approvals) and, if all criteria are met, placed on the schedule for letting within a specified month. The letting schedule is prepared every three months for the following six-month period.

Planned Applications

Several other applications can be implemented from PMS data. The department is developing techniques for producing a 12-month forecast of cash needs for payments to contractors for both construction and maintenance projects. Plans are also under way for using estimated data on future expenditures to identify sources of accrued unbilled costs before these costs actually occur. Early identification will permit timely corrective action. Another tedious process that can be aided by PMS is the development of the annual Title 23, Section 105 of the U.S. Code program. This program requires submission of all federal-aid projects for which federal obligation will be requested within a given fiscal year. This can be prepared by combining narrative, cost, and scheduling data for the individual projects.

CONCLUSIONS

The implementation of PMS is one of many steps taken by the Pennsylvania Department of Transportation to address the difficulties created by the current tight fiscal constraints, the effects of poor management in the past, and the pressing maintenance needs of one of the largest highway systems in the nation. PMS is making major contributions in the areas of scheduling the efficient use of dwindling resources and managing the department's overall program.