Abridgment

Preconstruction Engineering Management in Virginia

Frank E. Tracy

The Virginia Department of Highways and Transportation has implemented a project-monitoring system and a limited staffing planning system. These systems are automated to the extent that computer files have been developed that output a large number of specially formatted listings designed to assist middle- and high-level management in the administration of the annual construction program. All technical areas of the department were involved in defining the specifications for the project-monitoring system and are involved in its daily operation. A single large operating division was selected as the pilot area for the staffing planning system. A task force approach was used in each case to define the system details. In the future, the systems will be combined and expanded to other engineering areas of the department. On-line capabilities and statistical techniques will be used in this expansion. The staffing planning programs are written in COBOL, and the project-monitoring system is written in COBOL and FORTRAN.

The present-day Virginia Department of Highways and Transportation has major responsibilities in each of several modes of public transportation. For many years, however, the agency's basic responsibilities were confined to highway systems and, even today, the 88 000-km (55 000-mile) highway network and its attendant planning, design, construction, and maintenance remains as the largest area of concentration for the engineering staff. The scheduling and monitoring of the preconstruction stages of the thousands of highway development projects and the assignment of staff, as needed, to the hundreds of engineering and other tasks involved in each of these is a continuing voluminous undertaking that involves almost every unit and every technical discipline in the organization.

PROJECT MONITORING

Several years ago, the department began the development of a methodology designed to outline the steps involved in a construction project and to monitor the progress of a project in relation to meeting a realistic bid-advertisement date. An internal task force representing all affected divisions of the department was appointed and assigned the task of specifying the system requirements. The system, as defined and as developed, is best described as semiautomated. Computer-maintained files have been built and can be accessed to produce reports and to indicate schedule variances, but the scheduling itself remains largely manual. The system, therefore, can be considered a project-monitoring-and-status system but not a project-scheduling system.

The first action consisted of manually defining the identifiable activities involved in two theoretical most-complex projects. These projects included each known step in a project having one public hearing (combined location and design) and in a project having two public hearings (separate location and design hearings).

Basic data consisting of such information as route, county, project number, description, and length are collected for each construction project and entered into the system. These data, grouped by projects that are expected to be advertised in one contract, are entered into a computer file. A tentative date for advertisement-for-construction bidding, which has previously been determined, is used as the control by which target dates for other steps in the development of the project are based.

The dates are furnished individually by division or district representatives in lieu of a computer calculation. It was found that this approach was more accurate and more flexible for the initial period (although automated calculation is being considered for the future). A project turnaround sheet, which includes the proposed advertisement date, is circulated among the affected divisions. Each division representative determines the activities within his or her area of responsibility and produces one or more target dates. This information is entered into the computer system and a resultant target-date report is produced for each project. This report shows the bid-advertisement date together with dates for other critical phases of work as required to keep a project on schedule. The computer system evaluates the effectiveness of each date when compared with an actual date and produces other reports to alert the affected divisions and management area(s) of critical steps, deadlines, and such.

A number of critical points in the development cycle for a project, such as environmental-impact-statement approvals, holding of public hearing(s), and such, are identified as permanent checkpoints. Other critical stages of various preconstruction operations are isolated, and specially formatted listings are produced, by district and by advertisement date, of the critical dates involving road design, bridge design, right-of-way acquisition, district operations, and other factors. Figure 1 illustrates the type of data reported for bridges in a particular construction district.

Many other computer-output formats have been developed for specific use by a particular division or district. One of these is an output that indicates the chronological sequence in which various work elements must be performed to allow projects in a construction district to remain on schedule. This type of advance information is of extreme importance in scheduling staffing requirements. Other specially formatted listings are prepared for the various units of the department involved in preconstruction activities.

When a project fails to advance on schedule, reports produced by the automated system alert the affected administrative areas. This allows corrective action, if possible, within the remaining time frame or, alternatively, setting the project aside to apply concentrated attention to other projects.

When it is necessary to significantly revise a portion of a project, a listing by district is produced showing descriptive data, a statement concerning the revision, and the next step in the anticipated development of the project. This alerts the affected unit(s) and allows them to make proper adjustments, if necessary, in the dates of subsequent operations.

A district project file is produced on a regular basis showing in summary, by district, the status of all projects in the system. This basic information is of particular benefit in scheduling the individual demands on the staff of the department and gives a concise overall look at all projects in the system.

Figure 1. Critical stage report: bridges.

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION

M25-1805-01 PROJECT DEVELOPMENT MONITORING SYSTEM 11/09/79
BRIDGE DIVISION
CRITICAL STAGES IN PROJECT DEVELOPMENT PAGE 8

XXX DISTRICT

PROJECT	DSG	< - - - - - - - DESCRIPTION - - - - - - - ->	BRIDGE DESIGN REQUESTED TAR	BRIDGE DESIGN REQUESTED ACT	FOUNDATION DATA RECEIVED TAR	FOUNDATION DATA RECEIVED ACT	PRELIM BRIDGE PLANS APP TAR	PRELIM BRIDGE PLANS APP ACT	COAST GUARD PERMIT RECEIVED TAR	COAST GUARD PERMIT RECEIVED ACT	FINAL BRIDGE PLANS TAR	FINAL BRIDGE PLANS ACT
		ADVERTISEMENT DATE 0180										
0081-080-105,B647		BRIDGE - NBL OVER RTE 311	0	676	0	0	778	778	0	0	1179	1079
0081-080-105,B648		BRIDGE - SBL OVER RTE 311	0	676	0	0	778	778	0	0	1179	1079
		ADVERTISEMENT DATE 0280										
U000-126-103,B601		BRIDGE - N & W RAILWAY	0	978	0	0	0	1278	0	0	1279	0
0697-033-160,B628		BRIDGE OVER MILL CREEK	0	678	0	0	379	379	0	0	1279	0
		ADVERTISEMENT DATE 0480										
0081-962-101,B609		WIDEN BRIDGE RTE 100 INTERCHANGE	0	0	0	0	1079	0	0	0	280	0
0081-962-101,B610		WIDEN BRIDGE RTE 100 INTERCHANGE	0	0	0	0	1079	0	0	0	280	0
		ADVERTISEMENT DATE 0580										
0501-009-103,B604		BRIDGE CABIN CREEK	0	0	0	0	0	0	0	0	380	0
0501-009-103,B605		BRIDGE LONG BRANCH	0	0	0	0	0	0	0	0	380	0
		ADVERTISEMENT DATE 0680										
0614-011-158,B639		ROUTE 614 OVER MIDDLE CREEK	0	776	0	0	479	479	0	0	480	0
0614-011-158,B640		ROUTE 614 OVER JENNINGS CREEK	0	776	0	0	479	479	0	0	480	0
0614-011-158,B641		ROUTE 614 OVER JENNINGS CREEK	0	776	0	0	479	479	0	0	480	0
		ADVERTISEMENT DATE 0780										
0081-962-102,B627		BRIDGE REPAIRS RTE 608 OVER RTE 81	0	0	0	0	0	0	0	0	0	0
0639-080-143,B628		BRIDGE ROANOKE RIVER	0	474	0	0	1179	0	580	0	580	0
0646-033-153,B622		BRIDGE PIGG RIVER	0	1177	0	0	0	179	0	0	580	0

A listing showing those projects scheduled for advertisement on a statewide basis for a particular future month can be produced. The successful meeting of such a schedule is the end product of the entire preconstruction effort. The successful operation of a highway construction program is tied to the ability of the many units within the department to maintain a scheduled rate of progress. The overall system continues to monitor this progress and contributes significantly to the department's ability to efficiently obligate construction funds and to maintain an effective program.

Summary sheets for the entire system are produced quarterly. These show the number of projects by year of bid advertisement and by road system and indicate their status in the project-development monitoring system.

Project monitoring is currently being used throughout the agency by all affected central and field offices. More than 20 individual reports, some with many variations, are being produced and distributed on a monthly basis. The system is an effective and useful tool for following the progress of the hundreds of individual projects under way at any time and thus measurably increases productivity at every level.

STAFFING PLANNING

Project scheduling and monitoring is a major portion of any highway and transportation agency's administrative work that to be of practical use must be fully coordinated with staffing planning efforts. The department has not, as yet, combined the project-monitoring and the staffing planning programs into a single interactive system. This will be done in the future. Staffing planning programs were relatively new concepts when the Virginia Department of Highways and Transportation began to investigate their use. Other highway and transportation agencies had taken steps in the field but most were still modifying and adjusting their systems to fit their needs and requirements. In Virginia, it was administratively determined that a detailed, but limited, study would be made to determine the effectiveness and anticipated advantages of such a system. It was also determined that the study would center about the demands and requirements of a single division and that the location and design division, with its broad involvement in almost every preconstruction phase of a project and its large personnel complement, would provide the best test.

The study was undertaken by another internal task force. The basic intent of the group was to outline a plan for

1. Budgeting staffing programs and costs for individual projects per unit of work,
2. Comparing the budgeted values with actual performance on actual projects, and
3. Developing a workable set of procedures that would allow the various design units to take advantage of the benefits of the system without letting input to the system become too time-consuming.

This required the development of procedures for forecasting work efforts and, at a subsequent date, determining the actual efforts and comparing them with the estimated or budgeted values. It was necessary to first break down each item of work into its basic ele-

Figure 2. Monthly project report.

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
LOCATION & DESIGN PROJECT REPORT
PRIMARY SYSTEM - URBAN

INITIAL BUDGET 6/07/77
LATEST REVISION 7/01/79

PROJECT XXXX-XXX
ENGINEER NO. 03 DIST. XXX
NOV. 30, 1979

	EL. NO.	MILES	MANHOURS BUDGETED	MANHOURS EXPENDED	DOLLARS BUDGETED	DOLLARS EXPENDED	PERCENT USED HOURS	PERCENT USED DOLLARS	FISCAL YEAR EXPEND. MANHOURS	FISCAL YEAR EXPEND. DOLLARS	% PART	% TOTAL
1. PRELIMINARY ENGINEERING	FIRST EXPENDITURE 06/77											
PRELIM SURVEY	02	P	195	195	1,057	1,057	100%	100%				1%
RECON-PROJECTIONS	03	P	90	90	488	488	100%	100%			7%	2%
PRELIM DEVELOP	04	6:00 AM	780	780	5,226	5,226	100%	100%			66%	8%
REVIEW-RECOMM	05	P	150	150	1,125	1,125	100%	100%			77%	9%
LOCATION HEARING	06	P	85	85	595	595	100%	100%			84%	10%
LOCATION SURVEY	07	6:00 AM	7,800	7,800	49,920	49,920	100%	100%	1,250	8,010		69%
PLAN BASE PREP	08	6:00 AM	3,768	3,500	22,796	21,850	93%	96%	2,570	1,560		98%
IN-DEPTH REVIEW	09	P	213	200	1,420	1,650	94%	116%	200	1,650	100%	100%
TOTALS W/O ELS	02,07,08		1,318	1,305	8,854	9,084	99%	103%	200	1,650		
TOTALS			13,081	12,800	82,627	81,911	98%	99%	4,020	11,220		
2. PRELIMINARY DESIGN	FIRST EXPENDITURE - 09/78											
PRELIM DESIGN	32	6.00 AM	540	540	2,662	2,662	100%	100%	225	1,110	11%	9%
HYDRAULIC DESIGN	33	6.00 AM	1,080	1,080	6,221	6,221	100%	100%	550	3,170		26%
COMPL PRELIM DES	34	6.00 AM	1,290	1,290	6,360	6,360	100%	100%	1,290	6,360	36%	47%
FIELD INSPECTION	35	P	85	85	419	419	100%	100%			37%	48%
RW PLANS	36	6.00 AM	1,440	725	7,099	3,445	50%	48%	725	3,445	65%	71%
PUBLIC HEARING	37		60		296		0%	0%			67%	72%
TOTALS			4,495	3,720	23,057	19,107	83%	83%	2,790	14,085		
3. FINAL DESIGN												
FINAL DESIGN	62	6.00 AM	1,110		5,472		0%	0%			88%	90%
SUMMARIZE	63	P	250		1,233		0%	0%			93%	94%
CHECK-DISTRIB	64	6.00 AM	360		1,775		0%	0%			100%	100%
TOTALS II & III W/O EL 33			5,135	2,640	25,316	12,886	51%	51%				
TOTALS			6,215	3,720	31,537	19,107	60%	61%	2,790	14,085		
4. CONSTRUCTION												
CONSTR SURVEY	82	6.00 AM	6,240		26,650		0%	0%				
FINAL SURVEY	83	6.00 AM	960		4,100		0%	0%				
TOTALS			7,200		30,750			0%				
5. FINALS												
FINAL ESTIMATE	92	6.00 AM	265		1,185		0%	0%				
TOTAL			265		1,185		0%	0%				
PROJECT TOTALS			26,761	16,520	146,099	101,018	62%	69%	6,310	25,305		

ments. The task force developed a series of element person-hour norms. Basically, a proposed construction project was broken into five general categories or phases: location, preliminary design, final design, construction preparation, and final estimate. The last step (final estimate) is a postconstruction operation in lieu of preconstruction. It is, however, a distinct phase that requires significant field and office engineering personnel involvement and is an integral part of the staffing planning programs.

Within the five categories, elements of work were identified and person hours per project or per unit length of highway were determined for rural and urban locations within each type of road system. These values or norms were determined by the task force members based on their considerable experience in this field. Employee time-sheet records, when available, were studied to determine person-hour expenditures on various work elements. After implementation and testing, certain of the values were adjusted and their review and detailed calibration will be continued.

The person-hour norms were established for alignment length, i.e., the length that will require the basic engineering functions of alignment and gradient calculations. Thus, dual-lane facilities having independently designed lanes for opposing traffic will have double alignment lengths. Interchange ramps, intersections, and such will also increase the alignment length.

The person-hour norms per project are for tasks that must be accomplished for a particular construction project but are not a function of its length. An example of this would be the efforts involved in the scheduling of, preparation for, and conducting of a public hearing.

The sum of the total person hours for each of the five phases is the total overall staff time estimated for the entire project. A pass against a person-hour cost file is made by the automated system to produce dollar budget values.

Figure 2 is an example of a monthly project report of budgeted versus expended costs. This report allows the design units and their management to monitor both the progress of an individual project and the cost and effectiveness of their staffing expenditures. These are available on a monthly basis and on a year-to-date basis. The percentage of available funds and the percentage of available person hours are calculated and furnished on the project report. This allows close review and control of projects by all management levels.

The accurate preparation of staffing-requirement projections is the backbone of the system. It is necessary to determine nonproductive time and nonproject time, and considerable study was expended by the task force in defining these elements. The basic time distribution consists of 2080 hours/year (52 weeks x 40 hours/week) from which is subtracted holiday, vacation, and average anticipated sick-leave time. This available time is further adjusted by design unit supervisors in preparing their person-hour budgets by separating productive time from nonproductive and nonproject time.

The monthly summary sheets produced by the system show monthly person-hour expenditures by design unit and by road system. As is the case throughout the system, the purpose of this report is to allow management to be fully advised of the status of one or more preconstruction activities—in this case, the expendi-

tures of the actual person hours and funding compared with the budgeted values.

The staffing planning system is currently under detailed study as to its place and utilization within the department. It is designed so that certain segments of the organization may use it permanently without others using it at all. Its future lies in its practicality. In some areas of the department, it will be implemented and fully utilized and, in others, it will not be used at all. A management study of the department's organization and reporting procedures is now under way. It is anticipated that this study will have a direct bearing on the expanded use of the staffing planning system.

This approach by the Virginia Department of Highways and Transportation to the overall areas of preconstruction engineering management is still in an early stage. A significant degree of automation is included in the system as now developed, but additional methods and procedures will be included in the future as the system is further developed. Particular future attention is required in the scheduling areas of project development and in the person-hour projection areas of the staffing planning portion. The obvious next major step will involve combining the two systems into a single system. Greater use of statistical concepts will be evident as the system is expanded. On-line capabilities, particularly for the project-monitoring portion, are being reviewed and studied and will be incorporated into future versions of the system. Critical-path methods and program evaluation and review techniques are being evaluated as to their practicality for inclusion in the system. The expansion of the staffing planning concept into other engineering disciplines is another obvious step (although different units may have different requirements).

The advantages of even a limited approach as currently used in Virginia are that management has a much closer grasp of the overall system, can recognize problem areas at a much earlier date, and can make necessary administrative adjustments at a stage that will not disturb construction schedules. These are substantial and immediate benefits.

In these times of restricted budgets and uncertain levels of transportation income, approaches such as these for project monitoring and staffing planning are of both intermediate- and long-range importance. All areas of government must take advantage of every possible means of accurately forecasting money and staffing requirements in order to provide the public with expected services efficiently, on time, and within funding restrictions.

The automated portions of the systems described in this paper consist of approximately 35 computer programs. The project-monitoring programs are written partly in FORTRAN and partly in COBOL. The staffing planning programs are written entirely in COBOL.

Publication of this paper sponsored by Committee on Manpower Management and Productivity.

Abridgment

Changing Criteria for Project Evaluation and Priority Setting

Kumares C. Sinha

Five topics relevant to changing criteria for transportation project evaluation and priority setting were discussed in a conference session. Types of criteria were defined, their limitations were identified, and a list of guidelines that can be used to deal with changing criteria was presented. The relationships between national goals and state and local planning and the various mechanisms that can be pursued at the federal level to ensure that national goals are addressed in transportation programming were described. Some of the analytical and graphical methods used in transportation priority setting were reviewed. The unique problems of transportation programming in metropolitan areas—particularly the mismatch caused by the fact that, although historically most of the programming function has occurred at the state level, this function is assigned by the 1975 joint Federal Highway Administration-Urban Mass Transportation Administration guidelines to the metropolitan planning organization—were considered. The role of minimum standards (threshold criteria) was examined, and it was suggested that potential improvements to the transportation system should be reviewed from a complete perspective of the condition of the existing service and the utility and feasibility of the proposed services.

In recent years, the task of programming transportation projects has become increasingly complex. Caught in the crunch between decreasing revenues and increasing costs, it has become necessary for transportation agencies to defer many needed improvements and to attempt to select only those projects that are optimally cost-effective. The need for a multimodal approach to transportation programming has steadily become more important. At the same time, the forms of federal, state, and local government responsibilities in transportation financing are in a state of change. In addition, public concerns about energy conservation, environmental preservation, social equity, and economic feasibility have added a new dimension to the transportation programming process, particularly in metropolitan areas. This paper describes a conference session in which the changing criteria for the evaluation of transportation projects and for the determination of priorities for their implementation were identified.

PROBLEM OF DEFINITION AND MEASUREMENT

Before one can discuss the changing criteria for project evaluation and priority setting, it is important to define the types of criteria commonly used and to identify their limitations due to changes in the transportation decision-making environment. Bruce Campbell of Fay, Spofford, and Thorndike, Inc., presented an overview of the programming process, including project evaluation and priority setting.