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FOREWORD

In the late 1950s, state highway departments had a massive job of staffing to meet the planning, design, and construction of the Interstate Highway System. Today, highway departments are facing new and different problems.

The three papers in this RECORD address how manpower problems are being handled in three highway departments: Virginia, Utah, and Ontario, Canada.

The first paper, by Ira F. Doom and Wayne S. Ferguson, discusses the Virginia Department of Highways' approach to manpower planning. Manpower planning is carried out here by using a management-by-objectives approach. A pilot project using a rural and an urban area was used for the study with the objective of making manpower planning and personnel training a continuing activity. Initial results included the expansion of planning of maintenance activities from 40 to 80 percent, financial savings, and a permanent manpower planning organization. Currently about two-thirds of the department's employees are included in the manpower planning program.

Grant Fairbanks discusses the problem of field engineering management in the Utah State Department of Highways. The paper outlines the basic methods used for developing an integrated management system for field engineering personnel. The system was developed with the participation of the people who would be using it. It took into account such items as the need for performance standards and procedures, better defined job classification and skill requirements, better employee review and promotion procedures, and manpower planning at the project, district, and state levels.

The Ontario Department of Transportation and Communications has developed a supervisory training program. Arthur Gibson's paper discusses the procedures used in developing the program and examines the development of the program to its present form.

DEVELOPMENT AND IMPLEMENTATION OF MANPOWER PLANNING IN THE VIRGINIA DEPARTMENT OF HIGHWAYS

Ira F. Doom, Virginia Department of Highways; and
Wayne S. Ferguson, Virginia Highway Research Council

The conduct of the study and the initiation of the Virginia Department of Highways' manpower planning followed a management-by-objectives approach. Of particular importance was the proper blending of the conceptual ideas of personnel in staff positions with the practical expertise of those in line management. A pilot approach was used for one rural and one urban area; of particular concern was the training of employees in the personnel division to carry out manpower planning on a continual basis. Results cited include the expansion of the planning of maintenance activities from a previous level of 40 or 50 percent to roughly 80 percent, the institution of a permanent organizational unit to carry out manpower planning on a continual basis, and the fact that the department is now engaged in manpower planning for about 66 percent of its employees, an effort that has already resulted in more than $2 million annual savings. This manpower study was one of a series—and not the most important one—of studies that has helped to initiate a management-by-objectives philosophy in the department and to create the savings previously cited. In speculating about the future, the writers have suggested that manpower, equipment, financial, and materials planning will be more integrated but that the effectiveness of the system is no greater than that of its component parts; specifically, the conceptual aspects must not be greater than the understanding and cooperation of line management.

• PRIOR to 1967, the Virginia Department of Highways performed manpower planning—the selection, utilization, and development of employees—on an intuitive basis. In that year, it was decided that manpower planning should be formalized to provide for a more orderly and systematic program. Moreover, the increasing size of the organization had made it more and more difficult to deal with the manpower needs of the department without clear-cut plans.

The top management of the department recognized the need for comprehensive manpower plans and assigned the development and implementation of a manpower planning system to a task group composed of staff members from both the Virginia Highway Research Council and the personnel division of the Virginia Department of Highways.

The task group members realized that there were both tangible and intangible reasons for launching this effort. The tangible reasons were as follows:

1. The department had 12,000 employees, an annual payroll of $66 million, and employee assets that were viewed as at least equal to $132 million of capital investment; and
2. Annual losses to these assets were more than $2.8 million because of personnel turnover.

The intangible reasons for investigating manpower planning were as follows:

1. Ensure that the talents within the organization are used efficiently;
2. Ensure that employees feel that their interests and those of the highway department are compatible;
3. Ensure that the employees as well as the organization prosper; and
4. Ensure that the taxpayers receive an optimum return on their investment.

The objectives of the department's manpower planning efforts can be divided into three types: organizational, financial, and administrative.

METHODOLOGY

Close liaison between management and task group personnel is of primary importance in a task such as the development and implementation of manpower planning. Efforts that do not properly consider current methods or provide for resource inputs from the ultimate users of the system are likely to fail. As a general approach, it was concluded that manpower groupings would follow traditional lines: classifications (engineer, inspector, etc.), organizational units (divisions and sections), and/or geographical location (districts, residencies, and areas). The analysis of these groups was based on interviews with employees and statistical data.

A key factor in the methodology was the scheduling of frequent meetings between the study group and line management in order to blend the conceptual knowledge of the former with the practical knowledge of the latter.

Specific approaches were carried out on a pilot basis. The Staunton District (Appendix A), one of eight construction and maintenance districts of the highway department, and the Fairfax Residency (Appendix B), one of the department's 44 construction and maintenance residency areas, were used as pilot study areas. The Staunton District represented a rather large, primarily rural organizational unit, whereas the Fairfax Residency represented a highly urbanized unit.

In organizational terms, the specific assignment of the task group was to "institute systematic and improved manpower planning processes and to develop tools and techniques in an organizational framework to ensure continuity of these processes." In other words, this was to be an applied research project. The task group was asked to define the manpower planning needs of the highway department, institute a program (at least on a pilot basis) to meet those needs, and provide the ways and means by which the program could be implemented on a department-wide basis.

The financial objective was to reduce the payroll from the past average of more than 20 percent of total highway expenditures to no more than 18 percent. The objective would be achieved through greater productivity of employees and a reduction of the work force by normal attrition. It was reasoned that this would yield annual savings of $6 million based on current work loads.

The objectives in manpower administration included the following:

1. Improved utilization of current employees;
2. Integration of individual and organizational goals;
3. Anticipation of future employee requirements and of measures necessary to fulfill them; and
4. Training of personnel division staff to accomplish the preceding goals on a continual basis.

The specific approaches used in the pilot areas included the following:

1. Delineation of the objectives to be accomplished—a forecast work program.
2. Conduct of a manpower audit—the determination of the number of employees necessary to accomplish the program in terms of their skills and classifications.
3. A manpower inventory—an assessment of how many employees the pilot areas had on hand in terms of skills and classifications.
4. Identification and projection of loss factors—a projection of future employee improvable turnover (resignations and removals), retirement, and death;
5. Forecast of anticipated employee deficits or surpluses by employee class;
6. Designation and recommendation of remedial action to obtain the necessary number of employees for the objectives to be accomplished; and
7. Utilization of the findings from the pilot areas on a department-wide basis.

The key to the methodology was to apply a management-by-objectives approach to the two pilot areas and to ensure that this approach would, over a period of time, be adopted throughout the department. Included in the task, therefore, was the develop-

ment of an appropriate organizational framework that would facilitate department-wide implementation of the methodology developed in the pilot studies.

RESULTS

The results of the pilot studies of the Staunton District and the Fairfax Residency in terms of the maintenance work load of the department were as follows:

1. The management-by-objectives philosophy was introduced and applied in the areas both by the investigators and by the line management involved;
2. Manpower authorizations determined in relation to need were stated for the organizational units;
3. It was noted that personnel transfers from areas of surplus to areas of shortage would result in considerable benefits to the department;
4. Maintenance activities are now planned for roughly 80 percent of the objectives as opposed to only 40 to 50 percent at the time of study; and
5. Annual savings generated by these and subsequent studies have amounted to more than $2 million.

As a result of the study, specific recommendations were made with regard to the functions of individual management positions including authority, responsibility, and accountability for manpower management. These recommendations are the key to a successful manpower planning or management-by-objectives system. Employees must understand and approve of a system if it is to succeed.

Another result of the study in the pilot areas was an increased recognition on the part of the study group and other members of the department that money, men, materials, equipment, and planning are interrelated. Also, it was recognized that, when these items are planned separately, the plan is only as useful as its least useful component.

It is emphasized that the level of sophistication of an effective manpower planning system must not exceed the understanding of those who implement it.

A significant result of the study was the establishment of a manpower planning section within the personnel division of the department and the training of the section head in the processes of manpower planning and highway operations. This section is now operating as an independent unit.

In overall terms, the department's manpower planning efforts to date have resulted in extending manpower planning to all of its employees (on a fairly systematic basis); about 66 percent of its employees are presently covered.

Financial savings are beginning to appear in both the maintenance and construction operations as a result of this and other related studies. More specifically, it is estimated that $907,000 is being saved annually because of manpower planning for construction inspectors and that unit cost savings through the use of manpower planning and performance budgeting in maintenance are more than $1.5 million yearly (Appendix C). These figures represent $2.4 million of the $6 million target proposed by the researchers.

Subsequent to the manpower planning study, a study of Virginia's governmental units was ordered by the Governor and a self-study was conducted by the highway department. The results of these studies corroborate, in many instances, the manpower study findings.

As a result of the various studies, top and middle managements are adopting a management-by-objectives philosophy. When this philosophy is fully adopted, the term manpower planning will refer only to the personnel aspect of a management-by-objectives system.

FUTURE APPLICATION

The department is now engaged in performance budgeting for its maintenance system and in manpower planning for construction and materials personnel. In addition, the

department is studying equipment utilization and management. The equipment utilization and management study is a result of the emphasis on manpower and the obvious relationship between equipment and manpower delineated in the manpower study.

In further recognition of the management-by-objectives philosophy, the department has created a Management Services Division that is a direct result of the increased emphasis that has been placed on the discipline of management by the department. Finally, it should be noted that the authors are not implying that the manpower study described in this paper was responsible for the ultimate development of management into a divisional part of the department's organization. The research investigation was merely one of a series of studies that has led to the recognition of the need for increased emphasis on management by the department. It is presumed that this need exists in other highway departments as well.

APPENDIX A

SYNOPSIS OF THE STAUNTON DISTRICT PILOT AREA STUDY

The conclusions and recommendations of the manpower study of the Staunton District follow. They are in turn followed by discussions of the principal areas of concern in the study: improvable turnover, management training, employee classification, employee motivation, and district field employees.

Conclusions and Recommendations

1. To ensure continuity and effective growth of the manpower planning function, the manpower planning section within the personnel office should do the following: (a) implement the techniques developed in this study on a department-wide basis; (b) initiate a management-by-objectives training program for line managers as an integral part of the manpower planning function; (c) include extensive field involvement and participation of line managers as a functional part of the manpower planning process (such a cooperative relationship should promote the integration of line and staff in the manpower planning process); and (d) provide a framework from which financial and manpower planning can be carried out on a continual basis so that each department line manager understands management practice.
2. The data available in the maintenance management system should be utilized to develop effort, accomplishment, and fund allocation indexes for each residency and maintenance area within the state.
3. Analysis of personnel turnover should become a part of the personnel division's annual program, and the detailed findings of the analysis should be released to each division manager.
4. The problem of employee turnover (separations due to resignation and removals) should be viewed generally in terms of those employee classes that have a turnover rate of 10 percent or more and that are difficult to train and replace. If, however, training and replacement within a classification are exceptionally time-consuming and expensive, a turnover rate of less than 10 percent may be critical. If training and replacement are not a problem, or if a classification includes too few employees for statistics to be meaningful, a turnover rate of more than 10 percent may not be critical.
5. To solve the turnover problem, the department should use a selective approach in implementing the following actions: (a) increased attention to the supervisory skills of managers where turnover and poor morale are evident; (b) improved utilization of the existing classification system to provide promotions where vacancies exist or to give early promotions to within one step of the next higher grade; (c) more intensive recruiting efforts in the affected classes; and (d) salary evaluations of the affected classes.
6. The state personnel department should be requested to make periodic surveys of wages and benefits given by industry and other government agencies within Virginia

to ensure that department employees in the critical classifications receive comparable compensation.

7. Special goals for utilization of employees (field manpower levels) should be adopted in accordance with the effort, accomplishment, and productivity indexes to plan for future growth.

8. A priority objective that could be established with regard to manpower levels would be the accomplishment of more work without a proportional increase in the number of employees.

9. A 5 percent annual increase in productivity for 3 years would result in an annual savings of $480,000 for the Staunton District. It is estimated that department-wide application of this increased productivity concept would result in more than $3.5 million annual savings.

10. Increased needs for additional personnel can be partially offset through elimination of personnel surpluses—only through attrition, of course.

11. Uniform increases in manpower and funds are unwarranted.

12. It is believed that man-hour and manpower planning for district field forces should relate not only to planned and unplanned activities but also to planned maintenance, unplanned maintenance (no more than 25 percent of planned), maintenance replacement, and state force or incidental construction. If this is done, man-hours will be more than 80 percent planned and will be related to job objectives as compared to a 40 percent figure for net planning.

13. Consideration should be given to a detailed evaluation of the classification structure. Current disparities between engineering and administration divisions and construction and maintenance activities should be included in this evaluation.

Improvable Turnover

Separations from the department due to resignation and removal have been analyzed from the point of view of classes of employees. In examining employee classes, all classes with a turnover rate of 10 percent or more have been cited.

The summary data suggest that one-third of the department's employees account for two-thirds of the turnover rate. Because turnover is not uniform throughout the department, it is believed that it can be considerably improved.

The turnover problem is not critical generally because most classes of employees can be replaced and trained without great difficulty.

The employee turnover problem is critical when hard-to-replace job classifications are affected. Additional classes of professional employees that were deemed crucial (bridge, traffic, transportation, and urban planning engineers) represent only 83 employees. There are 26 classes of employees that fall in the critical or crucial categories. These 26 represent only 1,200 to 1,300 employees, or less than 15 percent of the department's labor force.

One or more of the following actions, depending on the circumstances of the employee class, is recommended for solving a turnover problem in a critical or crucial employee category:

1. Investigation of management and morale of the classes of employees involved and implementation of remedial action where decided on by line management and the personnel division;
2. Improved utilization of the existing classification system with regard to promotions, i.e., promote where vacancies exist or give early promotions within one step of the next higher grade;
3. More intensive recruiting efforts;
4. Salary evaluations; and
5. Support and follow-through of the preceding items by the personnel division.

The turnover problems of the department can be considerably reduced if implementation of the findings and recommendations of this report is carried out by line management, the personnel division, and the state personnel office.

Management Training

The line-staff management-by-objectives approach used in Staunton was most beneficial from the standpoint of the following:

1. The management training of line managers;
2. The acquaintance of staff with field operations and with how the staff's activities should be related to the improvement of line effectiveness; and
3. The effective integration and management development of line and staff as separate entities and as a management team.

Originally, the researchers felt that appropriate manning tables could be drawn up in an almost textbook fashion and be given to line management at Harrisonburg and Staunton to be filled out. Harrisonburg residency officials, however, requested an analysis of their manpower allocation and utilization practices before the development of a manpower plan. A combination of computer-stored maintenance data, principles of management by objectives, and the intuitions of line managers was used to perform the analysis. This was followed by the development of a 3-year manpower plan.

An eclectic method such as the one used in Harrisonburg is an excellent management training technique because, unlike the classroom, it is related directly to the line manager's area of interest. Development of such data generates maximum attention to and utilization of the principles of management by objectives and return-on-investment analysis.

The attempt is to combine academic management principles with operational management problems and solutions to forge a more effective (and less expensive) tool than classroom training.

Employee Classification

During the course of the study there were certain comments that were repeatedly encountered by the researchers. These related primarily to questions concerning knowledge, skill, and ability requirements and salary differentials that exist between employees associated with construction and maintenance activities and between employees of engineering and administrative divisions. No formal collection of such comments was made, and no documentation or analysis is provided. Nevertheless, the prevalence of the opinions seemed to suggest that the study would be incomplete without some reference to them.

Employee Motivation

The researchers spent little time on motivation aspects. It is suggested, however, that considerable effort will be directed toward motivation in the final phase of the study. It is further stated that two approaches considered at the June 1969 meeting of the Research Advisory Committee to the Economics, Finance, and Administration Section of the Virginia Highway Research Council may be used. These are (a) an audit and analysis of the exit interviews performed by the personnel division and (b) personal interviews with employees.

District Field Employees

The report discusses the objectives of work program accomplishment in relation to the utilization and allocation of district field employees.

Maintenance management records system data can be used as source data for effective man-hour and manpower planning. It is suggested, however, that these data should be used in terms more related to total management objectives such as planned maintenance, unplanned activities (no more than 25 percent of planned), maintenance replacement, and state force or incidental construction.

It is further suggested that, because of increased requirements (Route 64, rest areas, weighing stations, and chemical bins), there will be a need for more than 120 new employees in the Staunton District in the next 3 years if there is no increase in productivity. With improved management and employee effectiveness (a 5 percent

annual increase in productivity for 3 years), this need would be reduced by 80. If this figure is extrapolated department-wide, the anticipated increase of more than 1,300 personnel would be reduced to 500, which would mean an annual savings of more than $3.5 million.

The following findings were emphasized in the report:

1. Manpower and man-hour planning can best be accomplished by integration of staff concepts with line expertise;
2. Some locations have personnel surpluses, whereas others have personnel shortages; and
3. Uniform increases in personnel and money are viewed with disfavor because of widely disparate man-hour and employee needs in relation to the objectives to be accomplished.

APPENDIX B

SYNOPSIS OF THE FAIRFAX RESIDENCY PILOT AREA STUDY

The head of the personnel division and the Culpeper District Engineer requested the assistance of the Highway Research Council and the staff of the department's personnel division in conducting a manpower planning study of the maintenance activity within the Fairfax Residency.

The study was initiated in March 1970. The objectives of the study were (a) to develop realistic ways in which the maintenance work load could be anticipated in terms meaningful to manpower planning and (b) to determine the personnel needed to meet the work load.

In conducting the study, the researchers were given the opportunity to study manpower planning not only in terms of numbers but also in terms of the Fairfax management process. The suggestions for change are therefore greater in scope than those resulting from previous manpower studies.

Scope of Study and Recommendations

1. Because of the limited time allotted, the study was primarily restricted to manpower planning and management analysis of the maintenance functions of the Fairfax Residency and therefore should be viewed in that context.
2. Because recommendations beyond the residency level are viewed as beyond the scope of this study, considerations of the "districtization of Fairfax" have been omitted. It should be noted, however, that Fairfax's man-hours, expenditures, and equipment are approaching the levels of some of the department's districts and that any widespread area splitting will have a serious effect on the effectiveness of the traditional residency organization. The organization was altered prior to this study, and it will be altered further if the recommendations of this study are followed.
3. A truly complete manpower planning study covers and integrates manpower, equipment, and financial planning. This study has ignored financial planning because it involves the department's fund allocation process, which is beyond the purview of the researchers; when, however, manpower planning is implemented on a department-wide basis, manpower, equipment, and financial considerations will have to be integrated to achieve optimum solutions.
4. It is suggested that, in the future, the return on the department's invested dollar should serve as the criterion for the integration of manpower, equipment, and financial plans.

Restructure of the Maintenance Management System

1. The department's maintenance management system in Fairfax was restructured to more adequately meet the management analysis and planning needs of Fairfax (and other urban areas).

2. The system restructuring included the addition of many important functions, such as the cleaning and repair of minor drainage, curb and gutter maintenance, litter patrol activities, sidewalk maintenance, and maintenance replacement, to the planning process. The restructuring has resulted in planned man-hours for approximately 80 percent of the residency's activities as opposed to current man-hour plans that account for only 45 percent of the man-hours expended. All residency crews were included in the man-hour planning.

3. The restructuring was performed primarily by the Fairfax Residency staff. This has resulted in the management-by-objectives training of the staff and the acceptance and active use of the maintenance management system—a situation that did not exist at the time the study was initiated.

4. The manpower plan developed by Fairfax calls for a manning level of 472 persons (including convicts) to meet current needs. The researchers consider this level reasonable, providing that current productivity standards continue.

Effective Manpower Management

1. It is recommended that, with increased productivity, Fairfax's current manning need and authorization should not be 472 but rather 415 (35 more than the 380 on the residency payroll as of April 15, 1970). The Fairfax labor force as of October 1970 was approximately 415.

2. The residency thought that personnel increases should be achieved through the use of additional highway employees rather than convicts because convict labor already represented more than 25 percent of the work force. The researchers agree with the residency on this point.

3. It is suggested that the increased productivity called for can be accomplished through the following: (a) More effective delegation of authority, responsibility, and accountability in the residency than currently exists; (b) continuous efforts toward utilizing as effectively as possible equipment such as graders, loaders, rollers, sweepers, and tractors; (c) further automation of residency maintenance functions where feasible; (d) the provision of 2 additional maintenance management positions (1 residency maintenance supervisor and 1 residency equipment supervisor) to help ensure that the previous steps are accomplished effectively (the need is for more and better management but less labor than had been anticipated); and (e) the possible addition of 2 high-level maintenance positions (2 assistant resident engineers for maintenance) that the residency feels are needed (the researchers are inclined to agree that additional assistants may be needed, but it is suggested that, prior to final action, the requirements of these positions be examined in greater detail).

4. Because of the great urban demands on the Fairfax area, a management-by-crisis situation has been created and not yet resolved. This situation has resulted in each level of management performing 1 or 2 levels below its position; therefore, the functions of the highest level either have not been accomplished or have been performed on an unsystematic basis.

5. It is recommended that all area superintendents report to their residency maintenance supervisors only and that these supervisors have the authority to plan, execute, and implement the maintenance functions of the areas or the crews for which they are responsible. Because of this increase in informal authority, supervisors should be held more accountable than they have in the past for the results achieved in their areas.

6. It is suggested that, along with increased quality and quantity of management, more attention be paid to the higher level maintenance activities of long-range planning, development of improved management techniques, more effective ways of implementing public relations activities as they affect operations, and examination of questions such as the utilization of equipment on hand as well as possibilities for future automation.

7. Area superintendents appear to have sufficient authority, but it is felt they are not held as accountable for the results of their operations as might be desirable.

8. The Fairfax effort toward encouraging highway foremen to assume responsibility for subareas is commendable and should be applied on a residency basis. It is also suggested that the question of optimum numbers of man-hours per foreman should be

examined in some detail by residency management. Currently, Fairfax annually expends an average of 19,800 hours per foreman. There is a wide range of hours expended among areas.

9. In order for manpower planning to be implemented on a continuous basis in the residency, the personnel supervisor must take an active part in manpower planning.

Equipment Utilization, Automation, and Manpower Planning

1. Because maintenance needs will continue to grow (particularly in urban areas), efforts should be made to evaluate the possibilities of maximum use of automation to carry out the maintenance functions of the department.

2. These possibilities should be viewed in terms of the following: (a) effective utilization of equipment such as graders, loaders, rollers, sweepers, and tractors, and (b) the introduction of new equipment (where technically and economically feasible) that can perform functions that are now performed solely by men, e.g., the cleaning of catch basins and the conduct of litter patrols. The modification of old equipment might also achieve this.

3. Currently, on the basis of hours used only, rental equipment does not appear to be used as effectively as it might be; however, this can be caused by equipment obsolescence, breakdowns, delay in delivery of parts, and information needs as well as equipment management at the residency level. Residency equipment, therefore, should not be called in nor should residency requests for additional equipment be held up. It is suggested, however, that Fairfax and other residencies be provided with information relating to hours used, hours broken down, and equipment profitability on a quarterly basis so that the residency can schedule usage and repair of equipment as effectively as is possible.

4. Another measure that should provide incentive for effective equipment management would be to charge in some form an "availability" fee on equipment. (District equipment rental rates have since been instituted along with utilization standards by equipment class. Estimated annual savings since implementation of these recommendations are $466,000.)

5. Optimum equipment utilization and manpower planning trade-offs (automation versus people) should be given primary emphasis by the assistant resident engineer for maintenance, the residency maintenance supervisors, and the equipment and maintenance divisions. The trade-offs should be designed under the supervision of a person or committee that possesses the authority of implementation because they will dictate the future effectiveness of the department's maintenance operations.

6. The introduction of new equipment to automate additional maintenance functions should be viewed by the department and Fairfax in terms of an offensive strategy. The strategy could be the responsibility of the purchasing committee referred to in the department's self-study and could include a separate study on automation possibilities by the research council. In any event, it should receive emphasis by high-level maintenance managers of the residency.

Residency Organization

1. As has been stated, it is suggested that additional management positions should be established in the Fairfax Residency. If the 4 new organizational positions are established, the Fairfax Residency should be held accountable for the elimination of much of the management-by-crisis situation that currently exists in maintenance work.

2. Currently, the Fairfax Residency has 9 maintenance areas and 4 crews; residency maintenance supervisors pay little attention to these crews. It is suggested that this inattention is justified because of the present responsibilities of the 2 supervisors (1 has 4 areas and the other has 5); however, management planning and direction (at the lowest possible level) should be given to the maintenance superintendents of these crews.

3. In addition to the need for increased management of residency crews, there is a need for the scheduling of maintenance contract work ($1.5 million annually) and supervisory inspection of the same and for the supervision and quality control of the activities of the equipment shop.

4. It is suggested that the needs outlined in the previous two recommendations can be met by (a) the addition of a residency maintenance supervisor who would have authority, responsibility, and accountability to the assistant resident engineer for maintenance in the performance of the electrical, sign, construction, and bridge crews and the scheduling and inspection of maintenance contract work and (b) the addition of a residency equipment supervisor responsible for the operations of the equipment shop.

5. It is also suggested that Area 8 (Van Dorn) be split into 2 areas because current plans for this area call for expenditures of more than 137,000 man-hours. This is nearly twice that of any other area in the Fairfax Residency and, for example, more than twice that of any area in the Staunton District. All of the foregoing findings and recommendations relate to the current situation (with implications for the future, of course), but possibilities of additional areas of interest exist for the future—particularly those approaching annual requirements of 100,000 man-hours.

APPENDIX C

DESCRIPTIONS OF THE METHODS OF ESTIMATION OF SAVINGS GENERATED BY MANPOWER PLANNING STUDIES IN THE VIRGINIA DEPARTMENT OF HIGHWAYS

1. The revision of established guidelines for determining the number of inspectors that are assigned a given construction project.

Action required: Executive

Status: Fully implemented

Comments: The manpower planning section of the personnel division in cooperation with the construction division and field personnel has developed an analysis of inspector needs and requirements. Staffing analysis will be a continuing program; the management-by-objectives approach has led to a reduction of 108 inspectors. This reduction has been or will be accomplished through normal attrition and/or transfer—no employee will be dismissed for manpower reduction purposes.

Fiscal effect:

Fiscal Year	Estimated Savings
1971-72	$ 907,200
1972-73	907,200
1973-74	907,200
1974-75	907,200
4-year total	$3,628,800

Documentation of savings: The reduction of 108 inspectors (who earn an average annual salary of $8,400) will result in an estimated annual savings of $907,200.

2. The reduction of the number of employees normally assigned to miscellaneous unmeasured highway maintenance.

Action required: Executive

Status: Fully implemented

Comments: The thrust of this recommendation calls for better utilization of an improved maintenance standards system. On May 19, 1971, a 3-man committee appointed by the Highway Commissioner (2 members of the Highway Commission and the Management Services Officer of the Virginia Department of Highways) issued its report to the Commissioner stating that "The Department has reviewed and expanded man-hour work standards as recommended by the Governor's Management Study team. For the coming fiscal year there will be 45 activities covered by work standards as compared to the 12 in

existence at the time the Governor's Management Study team made its comparison . . . the specific activities for which man-hour standards have now been developed will account for more than 90 percent of the total expenditures for ordinary maintenance."

Fiscal effect:

Fiscal Year	Estimated Savings
1971-72	$1,650,000
1972-73	1,650,000
1973-74	1,650,000
1974-75	1,650,000
4-year total	$6,600,000

Documentation of savings: Any reduction of costs below a normal 5 percent increase as well as the percentage increase of lane miles were counted as unit-cost savings.

Exhibit I: An analysis of estimated unit-cost savings on total ordinary maintenance allocations.

1970-71 allocations (5 percent)	$2,433,268
Actual increase in allocations from 1970-71 to 1971-72	1,154,469
Difference	$1,278,799
1 percent primary 1970-71 budget (as 1 percent increase primary lane miles)	161,484
4 percent interstate 1970-71 budget (as 4 percent increase interstate lane miles)	205,802
Total estimated maintenance unit-cost savings	$1,646,085

FIELD ENGINEERING MANAGEMENT

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This paper outlines the basic methods used to develop an integrated management system for field engineering personnel. The major objective of the study was to provide management with tools that would aid in improving field operations, developing personnel, and planning manpower requirements. The system was developed through full participation of the people who would be using the system. The study takes into account the need for standards of performance; standard work procedures; reporting system that would offer timely and pertinent information to both worker and manager; better definition of skills and abilities necessary to perform particular functions; means to help ensure that promotions would come as a result of individual accomplishment; method of reviewing employees based on their own objectives with the sole purpose of the development of the employee; and means of planning manpower needs on a project level and on a district or statewide level.

•THE Utah State Department of Highways decided to help line personnel become aware of and solve their management problems at the working level. It was evident that, if line personnel were going to be held accountable for management problems, they needed management tools to help them. In order to provide tools, the department had to define the problem areas. A review of the operations was made, and it was determined that improvement in the following areas would contribute to improved operations in the field:

1. Standards of performance—Employees and supervisors did not have a way of measuring performance. Often, accomplishment was equated with amount of work, which is not always a true measure. A crew may work hard and accomplish little because of improper procedures or errors.
2. Standard work procedures—The necessity for standardizing the many field procedures used by different engineers was evident. When employees were transferred, they could not be used effectively until they learned the method used by their new engineer. It was difficult to provide training aids because no standard method was employed. It is believed that, by using a standardized methods system, manpower utilization can be increased and training opportunity can be enhanced.
3. Reporting system—A method for measuring accomplishment or productivity did not exist; the worker did not have a yardstick with which to measure his performance or to establish objectives.
4. Skill level requirements—There were job descriptions available that could be used in evaluating the level of work that should be expected of an employee; however, the descriptions were too general to be useful. Useful guidelines of what should be expected of employees did not exist.
5. Method for manpower planning—There was no system for planning manpower. Each engineer had his own method based on his experience. Little had been done on long-term manpower planning.
6. Promotion program—There was a need to assure employees that promotions would come as a result of individual accomplishment.
7. Employee review—Self-development is partially dependent on the proper environment; the worker must be challenged and motivated. Who can blame a worker for neglecting to make the effort of development if it is not rewarded or acknowledged? Performance review is a good tool to use to promote the development of employees. The current performance review is essentially quantitative and only incidentally directed toward performance improvement. When we evaluate an employee's performance using

the present system, we try to attach a score to his workday activities. We are interested in rating him with respect to other employees for the purpose, primarily, of administrative decision-making. We may be interested in giving him a raise, promoting him, or, perhaps, firing him. It is necessary to have a system that has as its major goal the development of the employee rather than the collection of data.

Approach

One principle was felt to be foremost in the development and eventual acceptance of a management system: The system should be developed with the full participation of the people who will work within it. A committee was organized exclusively from project and resident engineers. Participants from higher management levels were purposely omitted so that the engineers would be assured that it was truly their program. Two project or resident engineers from each of the six districts throughout the state were chosen to serve on the committee.

The initial objectives of the committee were as follows:

1. Investigate work activities with a view toward systematizing project engineering crew methods, and
2. Establish standards that will (a) provide management with a means of measuring quantitative performance, (b) provide the individual worker with a yardstick with which to measure his performance, and (c) provide guidelines for staffing project engineering crews and projecting manpower requirements.

The committee chose a chairman from among the members, and the project coordinator, who was the only member of the committee that was not a resident or project engineer, served as the secretary for the committee. The engineers on the committee varied with regard to background, age, and experience with the department.

At first, the problems encountered in accomplishing the goals of the committee seemed to some to be insurmountable. As the committee worked together, however, a good rapport developed, and decisions were made through a consensus of the group. When matters were not agreed on, additional information was gained through special studies. The results of the studies were then analyzed and evaluated by the committee, and a consensus was reached. This procedure helped to maintain the solidarity of the committee.

As a public organization, the goal of the highway department is to provide the best possible services at a cost that is nominal to the taxpayer. This means that department work must meet the needs of the public.

It was decided that efforts could not be aimed at improving results without developing an integrated program including personnel development. For a supervisor to simply tell his subordinates to work harder was not the answer. There was a need to provide tools for workers as well as for managers to aid in accomplishing the objectives. It was necessary to show respect for the workers and to give them an opportunity to work in a climate conducive to personal development. The system would need to be a developmental system; i.e., the organization must make continuing, purposeful change and cast aside values that are no longer meaningful. The goal was to relate work to objectives as much as possible and to give line supervisors management responsibilities.

FINDINGS

Standards and Procedures

The functions of a project engineering crew were divided into three major areas: survey, inspection (including laboratory work), and administration. These were subdivided into activities such as preparation of books, grade staking, and inspection of roadway excavation. These were the basic activities for which the standards and procedures were to be developed.

Standards of performance, method, and crew size were established by the committee. The establishment of the standards and procedures were based on experience, judgment, and actual time analysis.

Standards are generally viewed as being rigid and restrictive; however, because of variables such as weather and types of terrain, standards cannot represent rigid bounds but must stand as guidelines from which a relative value of performance can be determined. In some cases, a crew can be meeting standards but be doing substandard work. The reverse can also be true. It must be remembered that standards are based on an average project, and awareness of the specific conditions of a project must be present when evaluating performance against standards. Standards are to be used as a basis for establishing work objectives; they are not necessarily the objective itself. Standards are a guide from which objectives should be established by the employee and the supervisor according to circumstances.

It is believed that standards of performance provide an opportunity to stimulate analytical thinking. If a person has a standard to measure his performance against, he is able to analyze his work and determine why his performance is what it is. It also points out weaknesses.

Standards can be used by an engineer as a guide to staffing in accomplishing a job economically. Standards are not, however, intended to replace field staffing judgment, although they will provide a basis to evaluate that judgment.

Standards and procedures will be regularly compared on a statewide basis with actual performance. If it is found that there is substantial statewide deviation from a standard, the standard will be reviewed as well as the methods employed and the means of reporting. If the standard is found to be unrealistic, then it will be revised. Employees at all levels will be encouraged to offer suggestions to improve procedures. Their recommendations will be reviewed by the field engineering management (FEM) committee and, if acceptable, the procedure will be revised.

It is anticipated that standardized methods and procedures will help to fully utilize the manpower in the department and to allow greater employee mobility. In the event of transfers, an engineer would be assured that the person who is being transferred to him would be familiar with the method of operation.

Skill Levels

Skill levels were developed by the committee in order to describe the knowledge and ability that would be required to perform different functions on a field engineering crew.

After the committee identified the activities that are involved in field engineering, they arranged them by particular functions, e.g., chaining and running instrument. The skill level necessary to perform each of the functions was determined on the basis of a 5-point scale. The parameters were established by skill levels 1 and 5. Skill level 1 requires no previous experience; the duties could be performed under supervision in a very short time. Level 5 requires the knowledge and ability of a person who could act as an assistant project engineer. After the activities and functions were identified and skill levels were assigned, the knowledge and ability requirements for the skill levels were defined. The committee reviewed the functions assigned to a particular skill level and then described the knowledge and ability needed to perform them satisfactorily. Skill levels were not equated with pay grades or job titles initially so as to avoid any possible bias by associating a function with a job that may have typically performed that function. References to job titles such as chainman, rodman, and instrumentman were avoided. It is considered that these are functions that may be performed by various skill levels depending on the activity or situation. After skill levels were assigned knowledge and ability requirements, they were then matched to current pay grades.

Skill-level requirements will provide a basis for the employee and supervisor to solve some of their differences. Frequently, employees and supervisors disagree about work activities. Defined skill levels help to bring the supervisor and the subordinate closer together. The skill-level requirements are designed to increase the employee's awareness of his own job responsibilities and serve as a guide to self-development and training.

Skill-level requirements will be the basis for determining an employee's eligibility for promotion. He will be required to go through an examining process to evaluate his ability to perform at a particular skill level. The examination will be composed of a supervisor's recommendation, a written test, and an oral review and evaluation of the employee by a board.

Reporting

The reporting system is set up primarily for control, evaluation, and planning purposes. The following objectives were kept in mind in developing a reporting system:

1. Paper work and time spent in recording the data is to be kept at a minimum;
2. Involve the people who are doing the work; and
3. The reporting system should serve as a tool for the line supervisor with which he can (a) compare actual productivity with a standard, (b) use past performance to evaluate present performance and plan future performance, (c) compare actual and planned performance, (d) determine the need for corrective action, (e) determine where corrective action is necessary, (f) use as a guide to evaluate daily performance, and (g) use as a basis to set group and individual goals.

One of the important functions of the record-keeping process is that it provides the supervisor with an opportunity to make daily evaluations of the activities of his men. As he makes the labor and accomplishment form out each day, he is able to determine if the productivity for that day is within an acceptable range of performance. The supervisor is also able to perform an informal evaluation of his crew as he observes the methods and procedures they use and the quality of their work. This form of analysis gives a supervisor an opportunity to determine the type of instruction his employees may need to improve their performance, and, therefore, it may become an aid in identifying training needs.

The project engineer will review the labor and accomplishment form at the end of each 2-week period. This gives him an opportunity to get some short-term feedback and to evaluate the performance of his crews. It should be remembered, however, that the reported data will only give general indications and will not positively identify specific problems. The project engineer should discuss the significance of a possible problem with his subordinate. Through this discussion, the engineer can determine the proper course of action to take.

The project engineer will also review the summary report, which will show the combined activities and accomplishment of his crew on a project. He can compare total payroll hours with the number of hours reported on the labor and accomplishment forms to determine if all the hours are being reported and where the time is being spent and to determine the productivity of the crew's operations.

Evaluation of individual crews from the reporting system cannot be made beyond the project engineer level. The reason is that positive identification of problems, causes, and solutions cannot be made solely on the basis of the reported data. There are many variables influencing the data; therefore, only a person who is close to the situation and who can evaluate the variables can use the data to evaluate individual production.

This type of reporting system gives the line supervisor an information base from which he can better plan, evaluate, and control his work. Adequate and accurate reporting provides a regular feedback of the man-hours expended in relation to the quantities of work completed. Later refinements and expansion of the program are dependent on the accumulation of satisfactory records.

The project engineer will regularly receive a report that informs him of the status of his project. He will also receive other cost data charged to his project, such as the following:

1. Total salaries—including salaries from other divisions that have been charged to his project;
2. Travel time charged against the project;
3. Subsistence charged against the project;
4. Supplies charged against the project;
5. Computer time charged against the project; and
6. Any special consultant time charged against the project.

By using this type of information, the project engineer will be better able to evaluate productivity and to control his budget.

The district construction engineers will also be given summary information of all the projects in their districts. This will give them information concerning the utilization of manpower at the project levels as well as the progress of projects.

Employee Review

Employee review, as a part of the FEM system, was developed to stimulate improvement through a combined effort of the employee and the supervisor. It involves a joint effort in setting objectives and evaluating progress toward those objectives. It is important to keep in mind the objective of the evaluation—to help the employee with self-development. The supervisor can use it to learn what he can do to help develop the employee. The supervisor and subordinate will examine and reach agreement on such items as the requirements of the job, current performance on the job, need for and method of improving job performance, and employee's objectives.

The program of employee review is an ongoing, self-correcting, active process. When it is planned well and executed without haste or coercion, employee review can do much to encourage and reinforce those actions that are necessary for the achievement of individual and organizational goals.

A few days prior to the interview, the supervisor asks the employee to jot down areas of his responsibility and how he feels his performance should be measured. The subordinate should be asked to start formulating objectives related to job performance and self-development. The supervisor, also, needs to prepare for the review by asking himself what he can contribute toward the employee's improved performance; for example:

1. Can he clarify the work assignments so that the employee fully understands what is expected of him?
2. Does he have knowledge or skill that he could pass along to the employee?
3. Is he able to foresee obstacles or roadblocks that he can warn the employee about?
4. Can he do some advance "road paving" with or without the employee's knowledge that may smooth the way or add to the likelihood of getting results?

The supervisor must acquaint himself as much as possible with the employee and his work. He might begin by listing the major work expected of the employee for an appropriate period of time. In doing this, the supervisor might list the areas of work that will be assigned to an employee, or he might take from the skill-level requirements the major responsibilities for which he is holding an employee accountable. The supervisor should keep in mind that the employee should be encouraged to participate in developing the list of tasks and objectives; in fact, the employee should have the most responsibility in defining his own objectives.

The discussion between the subordinate and supervisor should be held in private in an atmosphere conducive to open discussion. At this joint meeting, they should fill out the employee review form (Fig. 1) and discuss the following:

1. The subordinate's responsibility. Tasks and activities required of the person should be reviewed.
2. Guidelines of performance. These should be put into specific terms if at all possible. Here there may exist the opportunity for developing crew standards. The supervisor should use the standards developed in field engineering management guides for crew production standards.
3. Individual objectives or goals. The goals should be quite specific. For example, an objective such as "improve in mathematics" is less likely to spark constructive suggestions and action than is a specific objective such as "be able to figure a catch point." The first wording is so general and covers such a broad area that it does not offer a starting place or an identifiable completion point. The second focuses on a particular area and serves to remind the employee of a particular problem or a specific area of importance. The use of more specific wording also opens the door to more accurate measurement of performance, thus giving both the employee and the supervisor a way of knowing how successfully the objective has been accomplished. The established ob-

Figure 1. Employee review form.

NAME_____ POSITION_____ DISTRICT_____

PROJECT ENGINEER_____ LOCATION_____

REVIEWER_____ POSITION_____ DATE_____
NEXT REVIEW

SITUATIONAL FACTORS

OBJECTIVES	RESULTS

Employee's Signature

Supervisor's Signature

Figure 2. Supervisor's action sheet.

EMPLOYEE_____ POSITION_____

SUPERVISOR_____ POSITION_____

DATE OF REVIEW	
	AREAS OF EMPLOYEE'S PERFORMANCE MOST IN NEED OF IMPROVEMENT
	EMPLOYEE'S GOALS TO BE GIVEN MOST SUPERVISORY ATTENTION.
	EMPLOYEE'S ACTIONS TO IMPROVE HIS OWN PERFORMANCE AND ACCOMPLISH OBJECTIVES.
	SUPERVISORY ACTION AIMED AT HELPING EMPLOYEE TO ACHIEVE RESULTS.

jectives should be within the employee's capabilities. It is necessary that the employee set the objective or goal and commit himself to its achievement. Setting a great many goals is not as effective as setting one or two vital goals. The goals should represent improvement or development in something actually required and used in the employee's job.

4. The subordinate's current performance. It should be weighed in light of previously agreed on standards and objectives and the objectives of the department.

5. What needs attention? What factors have been observed that might help in identifying areas needing attention? How do all the facts seem to fit in with the conclusions reached?

After the interview, the supervisor should fill out a supervisor's action sheet (Fig. 2). This has been designed so that the supervisor will have to think beyond the interview of what he can do to help the employee accomplish his objectives. The supervisor will be required to review the supervisor's action sheet with his supervisor so that the project engineer will be aware of the essential information about the employee's goals and of the action the supervisor will take to help the employee accomplish his goals.

Between formal meetings of the employee and supervisor, it is vital that the employee receive timely and useful feedback as to how well he is succeeding. Also of major importance is the necessity for the employee to feel rewarded for his improvement attempts. If he accepts an improvement objective and finds himself achieving it, he experiences internal feelings of satisfaction that spur him on to further attainment. The supervisor will increase the desire for improvement by letting the employee know his efforts to improve are recognized and, if he is successful, by giving him additional recognition or reward. Natural opportunities that occur on a day-to-day basis should be taken advantage of for discussing job performance with the subordinate. Between interviews, the supervisor should make notes of important performance incidents, both favorable and unfavorable, in enough detail to recall not only what happened but also the conditions under which it happened. The supervisor should compliment or correct the employee at the time the incident occurs. Notes provide an excellent input for the supervisor's thinking at the time of the next performance review and may support disciplinary action if it is necessary.

At the end of the 6-month period, the supervisor and subordinate should meet and jointly evaluate the results toward the accomplishment of previously established objectives. They, then, initiate a new cycle in employee review.

Manpower Planning

The ability to anticipate future manpower requirements is an essential element in planning for effective utilization of manpower. It serves as a tool in ensuring manpower program development and implementation of manpower control. It can be used as a factor in determining the programming of projects to maintain a balance in manpower.

In this study, two means of estimating manpower requirements have been suggested. One is used by project engineers for anticipating the size and characteristics of the work force necessary to complete a specific project. The goal here is to ensure that the right number and kind of people will be at the right places doing the things for which they are most economically useful.

The project engineer will make an estimate of his manpower requirements for the duration of a project by using a project manpower chart. All of the anticipated activities are listed on this chart. Then, through the use of manpower standards, project plans, and contractor work plans the engineer plots the estimated time to complete the activity and the number of men required. After completing this, he is able to chart his staffing requirements, determine the type of personnel needed, and estimate when he will need them.

A copy of this information is submitted to the district construction engineer. This will enable him to see the anticipated manpower requirements for each of his project engineers in relation to time. If there is a difference in the manpower requirements and actual staffing, the shortage areas are balanced by utilizing personnel from areas where a manpower surplus exists.

It is realized that the work is such that some underutilization of manpower is unavoidable because of variations in the work load and the contractor's operation; however, this system will provide a tool to aid the construction engineer in planning his manpower needs and distributing his manpower to obtain optimum utilization.

The second method is designed to project manpower requirements on a statewide or district basis and would be used by the construction management engineer or a district construction engineer.

The first step in this method requires that we obtain a productivity index. This was obtained by using the following formula:

$$\frac{\text{Total man-hours}}{\text{Dollars of construction}} = \text{Productivity index}$$

A means of forecasting the time necessary to complete a project was the next step. This was done by plotting on a graph the amount of time taken for completion of a project against the dollar value of the project. A line of best fit was drawn. In the example (Fig. 3), we observed three levels at which definite break points occurred: projects costing up to $350,000, projects costing from $350,000 to $1,900,000, and projects costing $2,000,000 or more. These three points represent the average construction time taken for projects costing less than $400,000, from $400,000 to $2,000,000, and more than $2,000,000.

By using the figure, we can estimate the length of contract time. It should be noted that lead time, where the project engineer gets the plans prior to the contractor's starting, is not included in the figure. The time that the project engineer spends on the project after the completion of the contractor's work is also not included.

With this information, it is possible to use the program schedule to estimate the total future work load for a state or district. It should be noted that in using this method we are working with averages and that reliability will increase with the number of projects. It follows, then, that reliability will decrease as the number of projects decreases; therefore, this method may not be adequate for determining the time for a specific project.

The amount of work that can be done each quarter varies because of many variables. We estimated quarterly work amounts by computing an average production index for each of the four quarters in a year. The production index (man-hours per $1.00 of construction) for the first quarter in the calendar year for our example was 9; the second quarter was 3; the third quarter was 2; and the final quarter was 2.5. From this, we were able to determine what percentage of the total year's construction work is done in each quarter.

It was then necessary to identify all the projects in the district or state for the year we were projecting manpower. The method we used to estimate the duration of the projects was explained earlier (Fig. 3). The total construction dollars to be spent during the year was computed. Then the amount of work to be accomplished (based on construction dollars) was figured for each quarter.

The amount of estimated construction for each quarter was multiplied by a production index of 2.5 (man-hours per dollar of construction) to give the number of man-hours needed in each quarter. A production index of 2.5 was used because it was demonstrated that this could be met or exceeded in the majority of work quarters.

Our permanent staffing would be based on the second quarter of the year. Training and other activities are planned for the first quarter when there are excess man-hours. In the third and fourth quarters, the additional man-hours required beyond normal staffing are made up by employing temporary help and giving overtime (Fig. 4).

Evaluation of Procedures (Pilot Study)

A pilot project was started to introduce the new standards, to clarify procedures, and to test the methods that had been established for reporting. The pilot project was limited at first to committee members to avoid confusion and possible resistance from workers. There was an attempt to acquaint other personnel with the project, and some of these were asked to participate and offer their suggestions later. Those participating were able to advise and make suggestions for refinements. Not enough data were col-

Figure 3. Project completion time versus cost of project.

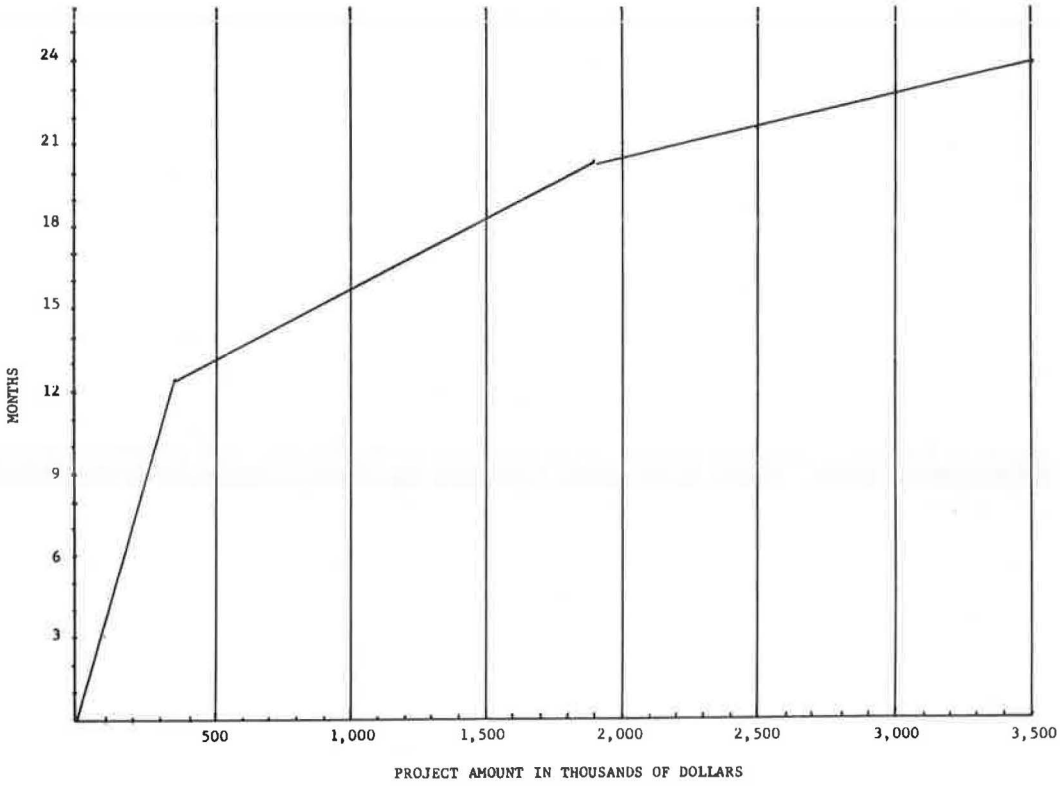
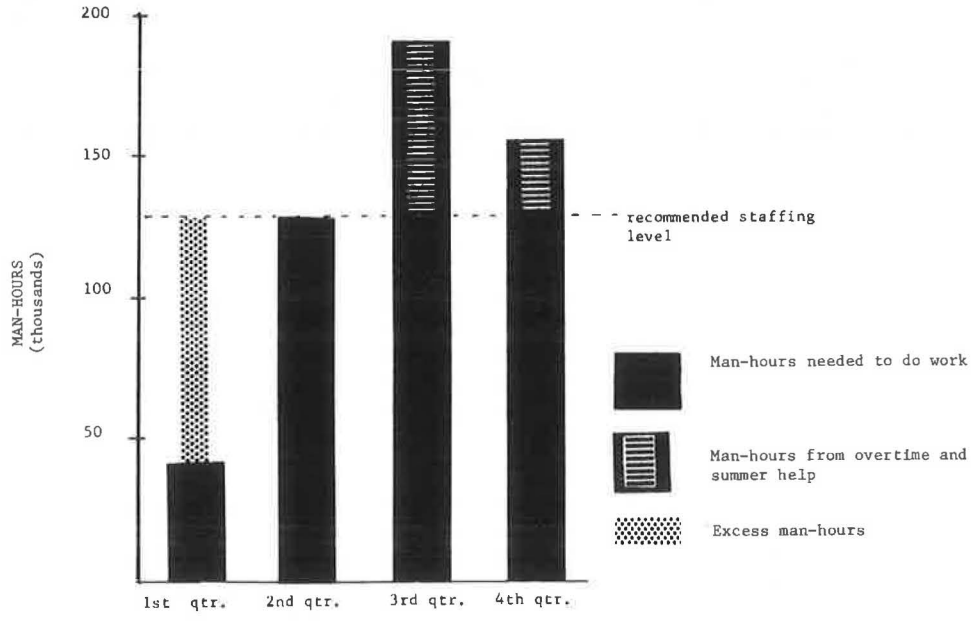


Figure 4. Example of manpower projection.



lected to make a sound decision with regard to changing the standards that had been adopted. However, the statistics on the standards were reviewed carefully, and they did indicate areas in which some of the standards may need revision.

The pilot project was most helpful in finding weaknesses in our reporting system and in gathering information concerning the acceptance of the program by line personnel. One of the major problems we had was the feeling on the part of the employees that the reports would not be detailed enough and would lead to false evaluation of their abilities. This created a negative feeling about reporting. It was necessary to conduct a campaign to educate the working force to the fact that they would not be judged individually beyond their project engineer.

There was a general tendency for all of the records to go to the project engineers; the line supervisors acted primarily as record-gathering agents. The line supervisors were relieved of the duty to analyze the records. When the project engineer allowed this, he lost a way to stimulate the responsibility, loyalty, and understanding of the line supervisor.

Short-range objectives can overshadow the total long-range goals of a project. As an example, the short-range objectives of a crew may be to increase productivity in a certain activity. The crew may make a special drive to do this but neglect some other important aspect that will lead to future problems. It is necessary to tie the employees and supervisors to the long-range goal of a project as well as to their own short-range goals.

Frequently, an engineer's reaction to this program is that the standards do not fit their particular situation and that the means of measuring is not accurate. It is not necessary, however, to have perfection at the outset. Standards and measurements that are not completely accurate are usable in getting a program started. Experience will later prove where they are in error, and adjustments can be made.

At first, the records system did not seem particularly well adapted to our total program. Parts of the job were very hard to measure. An example of this is the project administration area, where there was a tendency to retreat from establishing standards because the whole position could not be covered. It was decided that it did not have to be. We worked on the areas where measurement was readily available. It was not expected that we would cover every facet during the first year. Although everything in the FEM program cannot be geared to objectives, we are becoming accustomed to working with standards and are developing a better understanding of objectives. As more information and experience are gained, it will be possible to refine standards and expand them.

Implementation

The FEM program had the total acceptance and endorsement of top management, who agreed on implementation with only a few minor suggestions.

A position of construction management engineer was established. One of the members of the FEM committee was promoted to this position. His duties are to provide overall surveillance for the FEM system and to identify the need for system adjustments. He works with the committee in revising and updating performance standards, evaluates the total construction work load and determines overall manpower allocations, and participates in investigation and research in improving managerial and technological methods.

The FEM committee has been continued beyond implementation and is to be a permanent part of the program so that project engineers can have a voice in the management of its system.

At the time of implementation, the makeup of the committee was altered to include a representative from the district construction engineers and district engineers. This was done to provide the point of view of other management levels. Also one representative each from the design, materials, and maintenance departments was added to the committee. These personnel act as a formal liaison between the area they represent and the FEM committee. They will be the means by which mutual problems will be carried to the other divisions and will be responsible for investigating and helping in the develop-

ment of practical solutions. The committee will meet at least every 3 months for the purpose of reviewing performance standards, methods, and problems. This committee is responsible for soliciting, evaluating, and acknowledging suggestions submitted by department personnel. They will aid in providing overall surveillance for the system and in identifying the need for system adjustments.

ESTIMATE OF SAVINGS FROM THE FEM PROGRAM

The FEM program provides a variety of means for improving overall productivity in the construction area of the Utah State Department of Highways.

It has been determined that current yearly productivity is approximately 0.027 to 0.030 or 2.7 to 3 man-hours per $100 of construction. At an average wage of $4.00 per hour, this is $10.80 to $12.00 of engineering costs per $100 construction.

It is felt that, with hard work and with proper backing of the program, productivity can be improved by at least 10 percent. This then is 0.27 to 0.30 man-hours per $100 of construction. After applying the $4.00 wage average to this, we save from $1.08 to $1.20 per $100 of construction. At current average yearly construction costs of $50,000,000, this amounts to from $540,000 to $600,000 in savings ($50,000,000 ÷ $100 x $1.08 = $540,000; $50,000,000 ÷ $100 x $1.20 = $600,000).

It is improbable that the goal of 10 percent improvement will be reached within 1 year, but if improvement were only 10 percent of the desired 10 percent, that is, a savings of $54,000 to $60,000, the cost of establishing the program would be exceeded.

We can apply a present value approach (cost of money at 10 percent) for 5 years by using the low figure and by assuming that 2 years will pass before any savings are realized. [The present value approach is a method by which future dollars can be shown at current value when discounted by the cost of money (time). The factors used in the following calculations are taken from a table that gives such factors for r cost of money (time) for n periods, but the values can be determined by using the following formula: $1/(1 + r)n$.] Further, the third year would show just 10 percent of the goal. The fourth and fifth years, however, would be 50 percent and 100 percent respectively of the desired 10 percent improvement.

The following calculations show that the program would pay for itself in the fourth year ($519,204 - $84,700 = $434,504 net present value).

Year	Cost (dollars)	Savings (dollars)
0	50,000 x 1.000 = 50,000	—
1	20,000 x 0.909 = 18,180	—
2	20,000 x 0.826 = 16,520	—
3	—	34,000 x 0.751 = 25,534
4	—	250,000 x 0.683 = 170,750
5	—	520,000 x 0.621 = 322,920

On the assumption that productivity improvement is valid only in three of the four quarters, we multiply the possible savings by 0.75, which gives us $405,000 to $450,000 savings on $50,000,000 of construction. Present value application on these figures (again using the low figure and the same savings rate) gives a net present value at 5 years of $295,429, and the program would still be paid for in the fourth year as shown in the following calculation.

Year	Cost (dollars)	Savings (dollars)
0	50,000 x 1.000 = 50,000	—
1	20,000 x 0.909 = 18,180	—
2	20,000 x 0.826 = 16,520	—
3	—	20,500 x 0.751 = 15,396
4	—	182,500 x 0.683 = 125,648
5	—	385,000 x 0.621 = 239,085

If annual operating costs are $20,000, we get a net savings from $520,000 to $580,000. If we apply this estimate of costs to the preceding figures, the net savings is from $385,000 to $430,000.

A 10 percent improvement in productivity mey be a conservative expectation from a program with so much potential. For every additional 0.10 man-hour improvement, there is $40,000 savings per $1,000,000 of construction.

SUPERVISORY TRAINING IN THE ONTARIO DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

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•THIS paper briefly outlines the development, implementation, and evaluation of a training program that is being undertaken to improve the supervisory skills of managers and supervisors of the Ontario Department of Transportation and Communications. The project, started in 1970, is being developed by the staff development section of the department with some assistance from a consulting company, the Sterling Institute of Canada. The development of the program is summarized under the following general headings.

1. Research—Research was undertaken in which more than 200 separate interviews of supervisory staff were conducted. The purpose of the interviews was to establish training needs of supervisory and managerial staff, gather and catalog information and incidents for use in role plays and case studies, and give staff development officers the opportunity to establish rapport with trainee supervisors.
2. Development—An analysis of the research data resulted in a statement of training needs. A program specification was developed that outlined the priorities among the needs and defined the objectives of each part of the program. During this time, the department's staff development section worked closely with the consultant and with the Ontario Government Central Agency Staff Development Unit. Program development continued during implementation with two basic purposes in mind: (a) make the program more effective and (b) instrument the program and make it possible for line managers and supervisors to run the program with only minimal input by the staff development group.
3. Implementation—During the implementation phase, the program was attended by 180 supervisors (first to fourth line) who were drawn from all parts of the organization. Each participant attended two 3½-day seminars that were held approximately 1 month apart. Each seminar accommodated 25 to 30 participants. The program was implemented over a period of about 6 months.
4. Evaluation—This is being carried out in three different stages: (a) an immediate post-seminar evaluation by the participants, (b) a short-term (6 months after the seminar) evaluation of the effects and achievements of the program, and (c) a long-term evaluation of the program in terms of performance and/or behavioral changes.

BACKGROUND

In June 1969, the Sterling Institute of Canada submitted a preliminary report on department-wide supervisory and management needs. The main findings of this report were as follows:

> 1. Managers and supervisors tend not to think and act as managers but rather as technical experts. This has produced a general imbalance in the performance of the managerial role.
> 2. Resources could be used more effectively in some areas by the introduction of a different managerial approach.
> 3. The department tends to be reactive rather than initiative in the performance of its role.

As a result of the study, the Institute made a number of recommendations, among which were the formation of a full-time staff development group and the inception of a supervisory training program to cover both newly appointed and long-term supervisors. Both recommendations were accepted. With the help of the consultant, the newly formed staff development section undertook an extensive program of interviews with supervisors across the province. The purposes of the interviews were to establish training needs, validate the consultant's findings, gather and catalog information and incidents for use in role plays and case studies, and give the staff development officers the opportunity to develop rapport with the potential trainees.

The interview program achieved its objectives. Analysis of the data revealed the following major areas of concern:

1. Most supervisors tend to act and think as technical experts rather than as managers.
2. Many supervisors tend to be reactive rather than initiative in the performance of their roles.
3. Many supervisors feel frustrated by a perceived lack of opportunity for growth and advancement. In some cases, this feeling is magnified by a perceived loss in personal responsibility and status.
4. Most supervisors have an inadequate understanding of the role and function of other department branches and sections. This applies even to the members of sections with common interests.
5. Most supervisors are highly task-oriented and do not have a clear understanding of their responsibilities to train and develop their subordinates.
6. Employees generally expressed dissatisfaction with their knowledge of how well they were performing.
7. The role of a supervisor as seen by his boss is dramatically different from the same role seen by those he supervises. The training needs study results suggested that the supervisors were faced with a conflict between the expectations of their bosses and the expectations of their staff and, further, that the supervisors had a very clear understanding of the extent of the conflict.

PROGRAM DEVELOPMENT

A specification for the program was formulated based on the data obtained from the interviews. The program was named Encounter.

Each seminar was divided into two 3½-day sessions with approximately 1 month between sessions. The first session was referred to as Encounter I and the second as Encounter II. The adoption of a code name helped to draw attention to the program and provided a means of communication that avoided confusion with other programs.

The necessary materials, instructors' guides, films, games, and simulations were selected from various sources; some were developed in the department, whereas others were taken from commercial and government sources. All of the role plays and some of the case studies were taken from commercial and government sources. All of the role plays and some of the case studies were taken directly from incidents revealed in the interview data. A theory-simulation-practical application sequence was followed in each module.

The program was closely timed with sessions scheduled every evening. Seventy-five percent of the trainees in the first three seminars were from the construction branch. In the later programs, the trainees were a completely heterogeneous mix with one candidate selected from each branch and section. The employee level of the participants was mixed at all sessions. First, second, and third line supervisors were at every session, and fourth line supervisors attended some sessions. All of the sessions were held in a motor hotel. In some cases, the location was remote from all departmental headquarters, and all of the participants lived in. Other sessions were held in the hometown of most of the participants. At these sessions only 30 to 45 percent of the participants lived in. The locations of the accommodations did not affect the results of the sessions. Participation in evening sessions was almost 100 percent throughout. The early programs were carried out by a staff of four: two trainers and two audiovisual technicians. This number was reduced at the later sessions to a single trainer.

DESCRIPTION OF MODULES

Appraisal Module

Need—The original investigation showed that employees were not satisfied with the review process. The current appraisal system was perceived to be inadequate, and it was used at the discretion of the local manager. Many employees had not had a formal, or perhaps any, appraisal for 10 years or more.

Objective—The objective of the module was to change the negative attitude of the supervisor toward the appraisal process.

Methods—As part of the pre-course material, the trainee was provided with a duplicate set of three forms: job responsibility rating, job performance rating, and learning objectives. A set of the forms was made out by both the trainee and his supervisor. They then met to reach an agreement about the ratings.

Each trainee took part in an appraisal role play. The role plays were video-taped and were replayed and critiqued by the entire group. This took place during the three evening sessions.

A classroom session on appraisal was conducted using a case study. The session examined appraisals in the light of (a) what they were at the moment, (b) what they should be, and (c) how to change them.

Between Encounter I and Encounter II, participants were encouraged to develop an appraisal form, or part of a form, or a method and to use it on their own staff.

Observations—This portion of the program was well received. All of the participants completed their own pre-course forms. Approximately 80 percent of the participants completed the entire exercise, including reaching a consensus with their supervisors. In performance, employees learned that they were more highly rated by their bosses than by themselves. In achieving consensus, most participants found their bosses to be reasonable and flexible. Most participants were willing to have the results of the consensus displayed on a screen for discussion by the group. All those who participated fully stated that they had achieved a better understanding with their supervisor in both the performance and responsibility areas. The last part of the module, that is, the on-job attempt to develop an appraisal form and to use it, was only carried out by 5 percent of the participants. Approximately 15 percent of the participants did develop an appraisal form or some part of a form without actually testing it. All of the information obtained through this exercise is being accumulated and will be considered when revision of the current appraisal system is undertaken.

Communications Module

Need—The following needs were considered when the module was developed. Supervisors find themselves in dead-end jobs and fail to perceive or consider promotional opportunities that exist outside of their sections. Employees of certain sections do not have an adequate understanding of the functions of other sections within the department, especially in cases where the sections involved have interests in common.

Objectives—The objective of the module was to measurably increase the participants' general knowledge of the department. Each participant gained an in-depth knowledge of one section.

Method—A classroom session involving a film, games, and role plays was used to introduce various theories of communication and to give participants the opportunity to test the theories and their own normal practices in simulated situations.

In the second phase of the module, the group was divided into five work groups with five to six participants in each group. Each work group was made up of participants who had expressed an interest in learning more about a particular section. Each group was assigned the task of preparing a 20- to 30-minute presentation concerning the department section it had chosen to study. The groups were provided with the necessary equipment and assistance. Each group was also provided with a resource person from the appropriate section. Only 3 hours of seminar time were allowed for the preparation of the presentation.

Observations—Most groups spent many hours of their own time preparing their presentation. The final presentations appeared to be interesting, informative, and quite

imaginative. The resource people seemed enthusiastic. Most of the groups tended to identify strongly with the section that they discussed. This was especially evident during question periods. On one occasion, several observers sat through all five presentations under the illusion that the members of the groups were from the sections being presented.

EVALUATION

The purpose of the immediate post-seminar evaluation was to obtain the initial reactions of the participants in terms of preseminar information, general arrangements during the seminar, and the quality and content of the presentations. Most participants expressed general satisfaction with these aspects of the program.

After the completion of the first phase of the program, 10 participants representing a cross section of geographic location, function, and level were invited to take part in a 1-day feedback workshop. The group tended to be unexpectedly positive in its opinion of the seminar and suggested that the seminars be extended to all supervisors and that each seminar have participants from a broad cross section of function and level. These, plus other minor suggestions, were implemented in subsequent seminars.

Short-Term Evaluation

This part of the evaluation is still in progress and will continue for all future seminars. To ensure objectivity, the Government Central Agency is coordinating the evaluation process. To measure the impact of the program on the work situation, we developed a specific questionnaire. Approximately 6 months after the seminar, the questionnaire was sent to all 51 participants from two of the five regions. Forty-three participants responded. The results of the structured items in the questionnaire are briefly summarized in the Appendix.

The results indicate that the seminars were perceived as being relevant to the participants' work areas specifically and to the department generally. Seventy-eight percent of the respondents who had had specific expectations felt that their expectations had been met to different degrees. Fifty-six percent felt that their expectations had been met to a moderate extent. Only 58 percent of the respondents felt that the most important problems facing their units had been discussed more than slightly.

It seems that the major benefits of the program occurred in the area of department information exchange and communication. This information has apparently been useful to the participants as well as to the department as a whole.

Eighty-two percent of the respondents felt that they had gained new, "implementable" ideas from the seminar. Specifically, the contents of the communications module seem to have been implemented to a greater degree than the contents of the appraisal module. This may be a result of the problems associated with introducing new concepts into an existing system, that is, the problem of introducing change. The greater acceptance of the communication module may well reflect the nonspecific nature of its contents and implementation.

Sixty-six percent of the respondents reported that they had made either slight modifications or none at all in their operations as a result of the seminar. With regard to changes in productivity, 44 percent perceived signs of improved productivity in their own unit, and 23 percent felt the efficiency of the department had improved. Thirty-five percent of the respondents did not answer the question related to departmental productivity. The main indicator given for the increase in unit productivity is better supervisory performance. The increase in departmental productivity seems to be the result of increased communication among its members.

Most participants expressed a desire to attend more seminars. This indicates that the seminars have been successful in creating a climate of acceptance, support, and concern for training and development as a formalized activity. Many respondents expressed the opinion that additional and more extensive seminars would lead to useful change in the department.

Long-Term Evaluation

The next step in the evaluation process will be to obtain the opinions of the participants' supervisors, peers, and subordinates. Attempts will be made to measure job satisfaction and, where appropriate criteria exist, changes in performance. This should become increasingly possible with the implementation of the planning-programming-budgeting system and, in a few areas, the management-by-objectives system.

CONCLUSIONS

It would seem that the greatest achievements of the seminars have been in areas such as improved communications among the members of the seminar. The implementation of ideas in the more concrete areas, such as performance appraisals, has been unspecific and limited. It is obvious that any change in the current performance appraisal system will require a great change in the supervisory behavior of managers and strong organizational support. Such an effort must start at the top.

APPENDIX

Table 1.

QUESTIONS		RESPONSE PERCENTAGE					
1.	Relevance of seminar contents:	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree	No Response
	a) immediate work situation	5%	12%	16%	65%	2%	2%
	b) department generally		12%	19%	58%	9%	2%
2.	Expected to gain from seminar	Yes	No				
		77%	19%				
3.	Extent the most important problems were discussed.	Not At All	Slight Extent	Moderate Extent	Great Extent	V.Great Extent	No Response
		12%	30%	30%	12%	7%	9%
4.	As a result of the seminar:	Strongly Agree	Agree	Uncertain	Dis-Agree	Strongly Disagree	
	a) better idea of the overall goals, direction of the department	5%	19%	26%	49%	2%	
	b) better appreciation for others' problems and difficulties	17%	65%	9%	7%	2%	
	c) greater knowledge of functions and people	9%	73%	9%	9%		
5.	Utility of the information gained:	Not at All Useful	Slightly Useful	Moderately Useful	Greatly Useful	Completely Useful	No Response
	a) to the participant	2%	9%	47%	33%	9%	2%
	b) to the department	5%	16%	35%	35%	7%	2%

Table 1. (Continued)

QUESTIONS	RESPONSE PERCENTAGE					
6. Gaining of new implementable ideas.	None	A few	Some	Many	Very Many	No Response
	9%	33%	47%	7%	2%	2%
7. Modification of operations	Not At All	Slight Extent	Moderate Extent	Great Extent	V.Great Extent	No Response
	26%	40%	27%	2%	5%	
8. Implementation of modules	Not At All	Slight Extent	Moderate Extent	Great Extent	V.Great Extent	No Response
a) performance evaluation modules	26%	36%	21%	5%	-	12%
b) theories of motivation and leadership	2%	40%	37%	7%	2%	12%
c) Group process and behaviour	12%	40%	27%	7%	-	14%
d) Communications module	5%	33%	36%	7%	5%	14%
9. Increased productivity	Yes	No				No Response
a) immediate work unit	44%	49%				7%
b) the department	23%	42%				35%
10. Interested in further seminars	No	Undecided	Probably	Yes		
	5%	12%	18%	65%		
11. Recommend such seminars to others	No	Undecided	Probably	Yes		No Response
	2%		21%	74%		3%
12. Holding more seminars would lead to useful change	No	Doubtful	Probably	Yes		No Response
	5%	5%	39%	49%		2%
13. Overall opinion of the seminar	Very Poor	Poor	Average	Good	Very Good	
		2%	19%	65%	14%	

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