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**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE**

10

RECRUITING, TRAINING, AND RETAINING MAINTENANCE AND EQUIPMENT PERSONNEL

RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION
OF STATE HIGHWAY OFFICIALS IN COOPERATION
WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
PERSONNEL MANAGEMENT
MAINTENANCE, GENERAL

**HIGHWAY RESEARCH BOARD
DIVISION OF ENGINEERING NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING 1972**

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NCHRP Synthesis 10

Project 20-5 FY '72
ISBN 0-309-02012-3
L. C. Card No. 72-87290

Price: \$2.80

This report is one of a series of reports issued from a continuing research program conducted under a three-way agreement entered into in June 1962 by and among the National Academy of Sciences-National Research Council, the American Association of State Highway Officials, and the Federal Highway Administration. Individual fiscal agreements are executed annually by the Academy-Research Council, the Federal Highway Administration, and participating state highway departments, members of the American Association of State Highway Officials.

The study reported herein was undertaken under the aegis of the National Academy of Sciences—National Research Council. The National Cooperative Highway Research Program, under which this study was made, is conducted by the Highway Research Board with the express approval of the Governing Board of the NRC. Such approval indicated that the Board considered that the problems studied in this program are of national significance; that solution of the problems requires scientific or technical competence, and that the resources of NRC are particularly suitable for the oversight of these studies. The institutional responsibilities of the NRC are discharged in the following manner: each specific problem, before it is accepted for study in the program, is approved as appropriate for the NRC by the NCHRP Program Advisory Committee and the Chairman of the Division of Engineering of the National Research Council.

Topics for synthesis are selected and defined by an advisory committee that monitors the work and reviews the final report. Members of the advisory committees are appointed by the Chairman of the Division of Engineering of the National Research Council. They are selected for their individual scholarly competence and judgment, with due consideration for the balance and breadth of disciplines. Responsibility for the definition of this study and for the publication of this report rests with the advisory committee.

Although reports in this category are not submitted for approval to the Academy membership nor to the Council, each report is reviewed and processed according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine *inter alia*, whether the major questions and relevant points of view have been addressed, and whether the reported findings, conclusions and recommendations arose from the available data and information. Distribution of the report is permitted only after satisfactory completion of this review process.

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bringing such useful information together and making it available to the entire highway fraternity, the American Association of State Highway Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Highway Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices without in fact making specific recommendations as would be found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available concerning those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

FOREWORD

By Staff

Highway Research Board

This report should be of special interest to administrators responsible for highway personnel management, maintenance operations, and highway needs. The report offers information on policies and practices affecting economic security, practices affecting job content, innovative training practices, recruiting, and trends in maintenance personnel administration.

Administrators, engineers, and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. In an effort to resolve this situation, a continuing NCHRP project, carried out by the Highway Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems—a synthesis being identified as a composition or combination of separate parts or elements so as to form a whole greater than the sum of the separate parts. Reports from this endeavor constitute an NCHRP report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems. This is the tenth report in the series.

Highway organizations came into being near the turn of the century and have since developed at all governmental levels as a response to the “good roads” concept of four generations ago. Constant change and expansion have occurred over the years; however, only since World War II has the national economy expanded at a rapid pace, with the subsequent competition for manpower becoming a new and real problem. Technological advancements have become more sophisticated and have resulted in a need for highly skilled, well-trained personnel. This increasing need for more competence, coupled with a reduction of those not completing their training and education, generated increasing competition for the fewer highly skilled workers and, in turn, resulted in higher salary levels.

The mobility of the American worker has permitted him to seek the best market for his skills. This has resulted in internal training programs by both the private and public sectors to improve the available labor market. The significant aspect of the state highway department practices in the recruitment, training, and retention of maintenance personnel is the emphasis on the importance of first-line supervisors. The Highway Research Board has attempted in this project to set down those practices found to be most effective. The report discusses these innovative practices from the standpoint of motivation, retention, and performance.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from many highway departments and agencies responsible for highway planning, design, construction, operations, and maintenance. A topic advisory panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report.

As a follow-up, the Board will attempt to evaluate the effectiveness of this synthesis after it has been in the hands of its users for a period of time. Meanwhile, the search for better methods is a continuing activity and should not be diminished. An updating of this document is ultimately intended so as to reflect improvements that may be discovered through research and practice.

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ACKNOWLEDGMENTS

This synthesis was completed by the Highway Research Board under the supervision of Paul E. Irick, Assistant Director for Special Projects. The Principal Investigators responsible for conduct of the synthesis were Thomas L. Copas and Herbert A. Pennock, Special Projects Engineers.

Special appreciation is expressed to O. D. Turner, Dean, School of Business, Auburn University, who, as special consultant to the Advisory Panel, was responsible for the collection of data and the preparation of the report.

Valuable assistance in the preparation of this synthesis was provided by the Topic Advisory Panel, consisting of Jack F. Andrews, Director, Division of Economic and Environmental Analysis, New Jersey Department of Transportation; Kermit Bergstralh, Vice President, Roy Jorgensen Associates; George

A. Brinkley, Assistant Chief Engineer, North Carolina State Highway Department; Ira F. Doom, Assistant Management Services Officer, Virginia Department of Highways; J. H. Drake, Chief Maintenance and Operations Engineer, Louisiana Department of Highways; and William N. Records, Highway Research Engineer, Field Testing Division, Office of Development, Federal Highway Administration.

A. G. Clary, Engineer of Maintenance of the Highway Research Board, assisted the Special Projects staff and the Advisory Panel.

Information on current practice and ongoing research was provided by many highway agencies. Their cooperation and assistance were most helpful.

RECRUITING, TRAINING, AND RETAINING MAINTENANCE AND EQUIPMENT PERSONNEL

SUMMARY *Retention and Performance*

The identification of innovative practices affecting retention and performance is based on the notion that these are characteristics that result from the behavior of individual members of the work force; i.e., a high proportion of maintenance employees may perform well, or may perform poorly, and a high proportion of them may remain in the work force, or may leave voluntarily. Further, the kind of behavior prevalent in the work force is motivated, to a considerable degree, by factors in the total work situation—as perceived and reacted to by individual employees. Maintenance managers cannot initiate high retention and high performance per se—they can only create those conditions, or do those things, calculated to motivate employee behavior so that high retention and high performance result.

The technique used to identify innovative practices affecting retention and performance relates practices to a conceptual model that includes those factors that findings of behavioral research strongly suggest influence employee retention and performance behavior. The model is based on the findings of research conducted by Herzberg. The fundamental concept is that work is a powerful determinant of the retention and performance behavior of individual employees. In the model, the total work situation is comprised of two major parts: (1) the job environment, and (2) the job, or work, itself.

The job environment contains causal factors extrinsic to the actual work the employee does. Chief among these are: the policies and administration of the organization; the kind of supervision the employee receives; the interpersonal relationships of the employee; working conditions; wage and salary administration; and job security. These are called hygiene factors—an analogy to medical hygiene in that they are preventive in nature. They prevent poor performance and, to some extent, high turnover. But they do not result in high retention and high performance behavior.

The job, or work, itself contains factors intrinsic to the actual work the employee performs. These are called motivator factors in that research findings strongly suggest that if they lead to attitudes of satisfaction, high performance and high retention are much more likely to result than if they lead to attitudes of lack of satisfaction. Major motivator factors are: a feeling of achievement on the part of the employee as a result of performing his job; recognition of achievement by superiors, peers, and subordinates; a feeling that the work is interesting, challenging, and enjoyable; a feeling of responsibility; and a feeling by the employee that he is growing.

The decade of the 1960's saw many changes in the ways maintenance work is performed—most of these resulting from the massive maintenance research and implementation program initiated during the late 1950's. Many of these changes introduced powerful motivator factors at the operating level and, hence, resulted in improved retention and performance.

Possibly the most significant innovation, in terms of potential for improving

employee retention and performance, was the development and implementation of maintenance management systems by several highway agencies. Technical and operating aspects of such a system require major changes in work structure and job content at the operating level—changes that should inject motivator factors into the jobs of first-line foremen and operator personnel. The operating aspects that are particularly motivator in nature are:

1. The creation of strong supportive relationships among the various hierarchical levels of the maintenance organization—from top management to first-level supervisors.
2. The enrichment of jobs of first-line supervisors and operators by increasing responsibilities in a vertical fashion that provides opportunities for growth and development.
3. Great improvement in communications related to all aspects of the job—and among all levels of management.

Another area in which significant innovations have occurred is that of wage and salary administration. The North Dakota State Highway Department has developed and implemented a classification and salary plan that relates wages and salaries directly (1) to the level of difficulty of work performed, and (2) to the level of skill and ability of employees. Fundamental to successful operation of the plan is the Department's philosophy that each supervisor has a continuing duty, responsibility, and opportunity to evaluate performance of employees under his supervision—and to encourage them to develop skills and abilities necessary to advance. Great emphasis is placed on communications to employees regarding all aspects of the plan.

Maintenance organizations in the United Kingdom have developed and implemented incentive pay systems with considerable success. The systems are based on measured work and productivity standards with bonus payments made to those whose productivity exceeds the standards established. Emphasis is placed on strong and continuing communications to assure that employees understand the plan, how it works, and its administration.

Several states have made innovative changes in operating-level organization structure and procedures that appear to have introduced greater motivator factors into the work. The Illinois Division of Highways has established a gang—or labor pool—system based on Team Sections. The gang is, in effect, a pool of labor assigned to a Team Section and contains the number of individuals necessary to perform the work load of the Section. The supervisor is able to optimize manpower utilization in relation to operational requirements.

Louisiana also has moved toward the establishment of a labor pool in each of its parishes. Kansas has taken a similar approach. The motivational aspects of the labor pool result from the wider range of skills required of operators. These enrich the jobs of operators.

The single most striking feature of all the innovative practices described—from the standpoint of motivation, retention, and performance—is the consistency with which departments have recognized the major importance of first-line supervisors. Without exception, the changes resulted in increasing their responsibilities and involvement in planning and organizing work, assigning and directing personnel, and evaluating performance on a more realistic basis than was previously possible. Perhaps even more important is the fact that first-line supervisors are

provided more supportive assistance by way of policies, guidelines, standards, and communications. These combine to accord supervisors managerial status and treatment—a motivator factor of great significance.

Supervisory Training

The move to science-based maintenance management during the past decade has been accompanied by increasing emphasis on training of all kinds. Recognition of the importance of first-line supervision led to intensive attention to developing effective means for training supervisors. Possibly the most striking of the new approaches was the development (by California, Nevada, and New Jersey) of Maintenance Academies in which the curriculum focuses on training of first-level supervisors. These courses are similar in several respects:

1. They are extended in time—the California and Nevada Academies are one week in length and the New Jersey Academy is two weeks in length.
2. The courses are conducted at training facilities that serve to remove students from demands of daily work during the training period.
3. All are designed to assure a high degree of participation and involvement of students in the learning process.
4. Great efforts are made to assure that subject matter is related to actual work situations through use of cases, simulations, incidents, and other techniques.

The Port of New York Authority has developed a Maintenance Foreman Simulation Program. Small groups of students placed in a realistically simulated situation actually perform all the routine tasks normally assigned to foremen—from scheduling actual work to analysis of feedback reports. They are also exposed to nonroutine occurrences of an emergency nature, such as situations involving human relations and safety deficiencies, and others that require analysis, judgment, and decisions. Senior Maintenance Foremen serve as instructors, and there are scheduled critiques of student performance.

California conducts a continuous program to develop supervisory skills of maintenance crew chiefs. It is built around reading units that provide a basis for class sessions conducted by district instructors on a scheduled basis.

Highway agencies that have implemented maintenance management systems have emphasized training of supervisors and operators. They have, in general, developed courses that teach first-level superintendents and foremen (1) how to plan, schedule, and organize their work in the context of the system, (2) the key elements in reporting work and the operation of the information system, and (3) how major specific work activities should be performed.

Operator Training

North Carolina has initiated a simple, straightforward program to train equipment operators. Primary responsibility for training is on Area Foremen. Each foreman is initially responsible for selecting at least one trainee and for following his progress until the trainee is fully qualified or it is determined that he cannot qualify. Record-keeping is minimized.

Maine initiated and refined a driver selection and training program. Instruction is by two full-time driver trainers. There is provision for certification of drivers to operate various types of vehicles and/or equipment.

The California correspondence course is designed to augment on-the-job

training of Maintenance Man I, II, and III. The course treats a wide variety of subjects and is administered in each district.

Several agencies have made systematic analyses to determine training needs of maintenance employees. The approach includes the following elements:

1. Analysis of characteristics of maintenance work.
2. Analysis of characteristics of the maintenance work force.
3. Determination of the extent to which the present work force possesses, or lacks, the knowledge, skills, and abilities required to perform the work adequately.
4. Determination of the learning characteristics of the work force.
5. Providing needed training.

Recruiting

Innovative practices identified in relation to recruiting are limited to apprentice training, entrance-level training, and orientation programs.

Minnesota operates an Apprentice Training Program to train equipment mechanics. The apprenticeship standards are formulated by a joint highway-union committee. Those who successfully complete the 8,000-hr program are guaranteed a journeyman's job.

New Jersey initiated a Maintenance Man II Program that is conducted on a continuous basis for entrance-level employees. Instructors are department personnel; the program is 17 days in length. Classes are limited to 12 students. The training involves classroom work, and performance by trainees under supervision of instructors.

California continuously conducts a New Employee Orientation Program. The program time is approximately 3 hr. The lesson plan includes a slide presentation of the Department organization and functions; handout materials (including the most recent Annual Report, a map showing district boundaries and mailing addresses, and a Safety Booklet); small-group discussions to answer questions; and explanation of personnel matters.

Trends

Several trends in maintenance, including the following, will affect maintenance personnel administration in the future:

1. The trend toward systematic maintenance management will definitely improve possibilities for positive motivation and, hence, improved performance and retention.
2. There is a definite trend toward development of comprehensive and continuing maintenance training programs.
3. There will be increasing emphasis on development of training techniques.
4. There is a definite trend toward the "labor pool" concept of organization at the operating levels of maintenance organizations.
5. There is a strong trend toward unionism in maintenance organizations.

INTRODUCTION

The objective of this synthesis is to identify innovative practices that affect retention, performance, training, and recruiting of maintenance personnel. The focus is on practices at the operating levels of maintenance organizations. Major emphasis is on retention and performance subject areas, based on the following premises:

1. The primary function and responsibility of maintenance personnel administration is to develop a maintenance work force characterized by high retention and high performance.
2. It is undesirable, and wasteful, to expend the considerable monies and efforts required to recruit and train maintenance personnel effectively unless there is reasonable expectation that a large proportion of these can be retained in the maintenance work force.

THE CHALLENGING MAINTENANCE SITUATION

State highway agencies are confronted by an extremely complex and challenging situation—one that has been developing since the mid-1950's. Major forces and factors responsible are:

1. A steadily increasing total maintenance work load. This is largely due to constantly increasing traffic volumes, demands by users for ever-higher levels of maintenance service, and increasing mileage to be maintained.
2. Increasing complexity of maintenance work. This results from the fact that maintenance forces are required to perform many more kinds of activities, in greater volume than ever before, often under heavy traffic conditions, and at odd hours.
3. Steeply rising unit costs and total expenditures. The increasing magnitude of the maintenance work load, combined with the fact that maintenance unit costs rose 100 percent from 1950 to 1967 (compared to a 50 percent increase in unit construction costs), accounts for a significant increase in total expenditures for maintenance during the last two decades. Significant increases in needs and expenditures are projected.
4. Increasing concern for traffic safety. This is a pervasive factor that affects, and complicates, each of the conditions previously enumerated.

The total situation is complicated by the fact that maintenance needs are expected to grow by about 60 percent during the period 1973-1985, and average annual expenditures are expected to be \$5.8 billion during the same period (1). When it is considered that projected construction needs are great, and that competition for available funds (at federal, state, county, and municipal levels) will probably intensify, it is apparent that real challenges are posed.

The great amount of applied maintenance research undertaken since the late 1950's indicates that maintenance man-

agers recognize the challenges. The direction taken in many research projects indicates the conviction that the fundamental approach to meet these challenges must be to improve the efficiency of maintenance operations. This conclusion suggests that innovative practices that affect retention, performance, and training of maintenance personnel are of primary importance—because the efficiency with which any organization can operate depends more on effective utilization of human resources than on any other single factor.

Maintenance Research and Implementation

The major emphasis of an unprecedentedly large maintenance research and implementation program initiated in the late 1950's was on management improvement. The general approach taken in most of the management research and implementation projects was to adapt and apply industrial management concepts and techniques—particularly work measurement techniques—to maintenance operations. The aim was to exploit opportunities for improving efficiency offered by two interrelated and interdependent characteristics: (1) the fact that maintenance operations are conducted under variable conditions of considerable uncertainty; and (2) the fact that highway maintenance is characterized by a high labor cost structure. These two characteristics, and factors related to them, merit further explanation.

Variables and Their Effects

The conditions of uncertainty under which maintenance operations are conducted stem from the many variables inherent in maintenance work: These include: (1) climate; (2) terrain and soils features; (3) kinds and volumes of traffic; (4) design features and characteristics of roads and roadsides; and (5) ages, conditions, and composition of roads.

The major over-all effect of these variables is to complicate long-range planning and work planning, scheduling, and staffing. These, in turn, complicate financial planning and control. A pervasive, complicating factor is that many states are subject to seasonal climatic variations of such magnitude that the annual work load is extremely unbalanced.

The Maintenance Cost Structure

The high labor cost structure of maintenance may be attributed, in considerable part, to the effects of the many variable conditions affecting operations. These conditions have led to a tendency, in some instances, to staff to meet peak seasonal work loads. This practice makes optimum year-round utilization of personnel difficult.

The high labor cost structure may also be partly attributed to some conditions that have combined to create an "image" of maintenance that has made it less attractive to highly qualified personnel than other operational areas—until recent years, at least. These include:

1. A traditional tendency to place less emphasis on maintenance—in both management improvement and research efforts—than on construction. A relatively neglected operational area is always less attractive to highly qualified personnel.

2. Low wages and salaries. The wages and salaries paid maintenance personnel have tended to be lower than those in other operating areas, and less than those paid for comparable work in other industries.

3. Patronage. Although political patronage has not been limited to maintenance, its effects have been greater there than in other operational areas of highway departments.

The practice of patronage has diminished considerably since World War II. There are still some states, however, in which a large and abrupt turnover of maintenance personnel occurs when the political administration changes. In such instances it simply is not realistic to expect full potential benefits from practices calculated to improve retention and performance. Training is important in these states in that it is necessary to train large numbers of new employees quickly to perform essential activities. Training in these circumstances is likely to be costly and benefits are likely to be of short duration. A more stable work force permits training from which compounding benefit effects are realized.

Progress Resulting from Research

Probably more innovative maintenance practices were initiated during the past decade than were initiated during the entire 40-year period preceding 1960. Most of these resulted from maintenance research-implementation projects. The major research breakthrough was successful adaptation and application of industrial management work measurement techniques. Initial efforts were to define and measure specific maintenance work activities and to establish standards of quality, quantities of work, and productivity. These standards include definition of the man-materials-machine "mix" for each measured activity, and the most efficient work procedures.

The standards provide quantitative values essential to:

1. Effective balancing of the annual work load.
2. Efficient planning and scheduling of work.
3. Realistic allocation of resources (labor, materials, equipment) to perform work once it is planned and scheduled.
4. Design and implementation of management information systems to provide a sound basis for control.
5. Development of effective performance budgeting systems.
6. Organizing (or reorganizing) for more effective decision-making.

In terms of the objectives of this synthesis, the successful application of industrial management concepts and techniques to maintenance operations is of paramount importance. The reason is that it led to a considerable number of changes in work structure at the operating level—and the structure of maintenance work is the primary factor affecting retention, performance, and training of maintenance personnel. These ideas are explained in the following sections.

DEFINITION OF THE SUBJECT AREAS

The specific subject of the synthesis—retention, performance, training, and recruiting of maintenance personnel—is directly related to two broad fundamental responsibilities of personnel administration in any organization. These are: (1) to develop a highly capable work force, and (2) to maintain that work force.

Recruiting and training are major activities required to develop a highly capable work force. High retention and high performance are desired characteristics. In the final analysis, the retention and performance characteristics of the maintenance work force are the results of the behavior of its individual members.

The basic difference in the nature of training and recruiting on the one hand, and retention and performance on the other, is significant from the standpoint of the directness of the actions that management may take. For example, management may initiate training and recruiting activities at its will. But it cannot initiate high performance and high retention at its will—it can only create conditions, or do those things, calculated to motivate behavior of its employees so that high performance and high retention characteristics result.

APPROACH TO THE SYNTHESIS

The fact that high retention and high performance are behavioral characteristics requires an approach to identification and analysis of innovative practices based on motivation theory. The specific approach taken here is to develop a conceptual model composed of factors that behavioral research findings strongly suggest influence employee retention and performance behavior—and then relate maintenance practices to the model. The motivation concepts that provide the foundation for the model are generalized here.

Employee Behavior and Needs

For some years there has been general acceptance of the idea that employee work behavior is related to individual needs; i.e., employees have needs, they (consciously or unconsciously) view their total work situation as a primary source of satisfaction of these needs, and their work behavior is motivated by their desire to satisfy these needs. McGregor (2) describes the process as follows:

Man is a wanting animal—as soon as one of his needs is satisfied, another appears in its place. This process is unending. It continues from birth to death. Man continuously puts forth effort—works, if you please—to satisfy his needs.

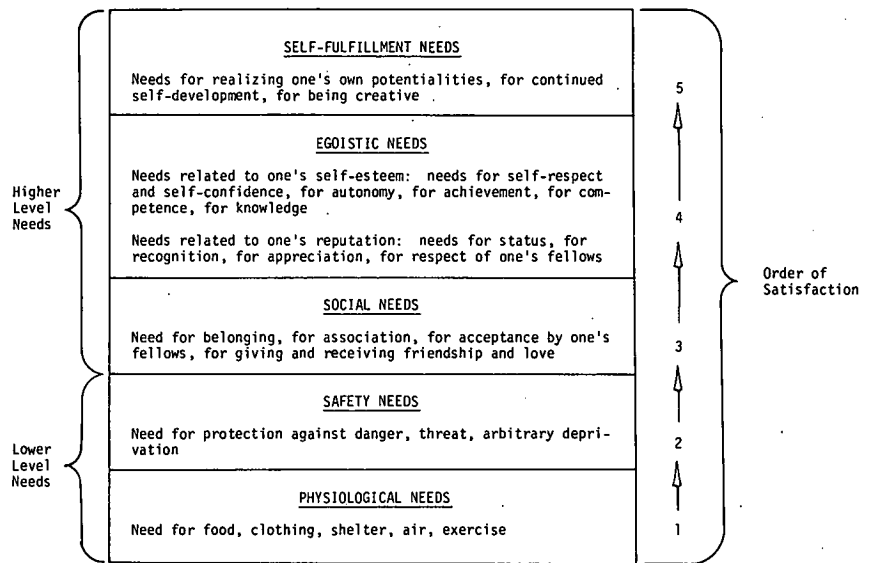


Figure 1. Hierarchy of human needs and order of satisfaction. Based on McGregor (2).

McGregor describes human needs as being organized in a series of levels in a hierarchy of importance (Fig. 1). He emphasizes that lower-level needs are of primary importance as motivators of behavior until they are satisfied or, if satisfied, when they are threatened. He also concludes that a "satisfied need is not a motivator of behavior" (2).

Satisfaction of physiological and safety needs is relatively well provided for today. The material standard of living of most employees is higher than ever before and most employees rarely suffer major deprivation of their physiological needs. Even in periods of marked unemployment, social legislation (much of it enacted during the past quarter century) minimizes the shock (2).

McGregor's conclusion that satisfied needs are not motivators of behavior is especially significant here. For example, an employee who is well satisfied with his material standard of living (a standard afforded by his salary or wage) generally will not respond to a raise in pay, or an improvement in some fringe benefit, with greatly improved performance. But he may become dissatisfied, and perform at a lower level, if some of his fellow workers receive greater raises than he does (particularly if he feels their performance does not warrant it). His dissatisfaction may even cause him to resign if an alternative opportunity exists. Although he may verbally complain about the actual amount of money involved, the real cause of his dissatisfaction is more likely to be the loss of status he feels he suffered—and status is a higher-level need.

The fact that lower-level needs are relatively well satisfied—and the fact that satisfied needs are not motivators of behavior—means that motivational emphasis must be placed on satisfying higher-level needs. There is growing acceptance of the idea that the only effective approach to satisfaction of these needs is through the work structure and job content.

Work as a Motivator

Traditionally, work has been viewed more as an unpleasant necessity than as a potential positive motivator of behavior. Until recent years, the approach to employee motivation was largely directed to: (1) conditions in the job environment, and (2) the things the employee received for working.

The viewpoint that work is an unpleasant necessity often leads management to feel that employees must be enticed to work by various rewards, or coerced by threats, or both—an approach McGregor (2) called the "carrot and stick" theory of motivation. He asserts that it works reasonably well so long as employees are struggling for subsistence, but does not work at all once they reach an adequate subsistence level and are motivated primarily by higher-level needs. McGregor says (2):

Management cannot provide a man with self-respect, or with the respect of his fellows, or with the satisfaction of needs for self-fulfillment. We can create conditions such that he is encouraged and enabled to seek such satisfactions for himself, or we can thwart him by failing to create these conditions.

The findings of behavioral researches conducted by Herzberg strongly suggest that work can be a powerful motivator of behavior (3). To be so, jobs must be designed so that they provide opportunities for employees to satisfy higher-level needs. The findings suggest that the potential motivational power of work has not been apparent in the past because most jobs have been designed primarily from the standpoint of efficiency and costs. The result has been jobs that are not stimulating or challenging and provide little opportunity for creativity (4).

The conceptual model to identify and evaluate innovative maintenance practices that affect performance and retention is based largely on Herzberg's research and contains the essential elements of his findings (4). The model is summarized here:

1. The retention and performance characteristics of any work force are the results of the behavior of individual members of the work force; i.e., if an individual voluntarily leaves the work force it is a behavioral act, as is the act of remaining in the work force; and good performance is a behavioral characteristic, as is poor performance.

2. Work behavior is largely motivated by some factors, or combinations of factors, in the total job situation of the employee.

3. High retention (low turnover) and high performance result from causal factors in the total work situation of individual members of the work force. The total work situation consists of two major parts:

- a. The job environment.
- b. The job, or work, itself.

4. Each of these parts contains causal factors that affect the individual employee's work behavior—but in different ways:

- a. The job environment contains causal factors *extrinsic* to the job, or actual work, performed by the employee. Herzberg calls these hygiene, or maintenance, factors. Major hygiene factors are: (1) the policies and administration of the organization, (2) supervision, and relationships with supervisors, (3) interpersonal relationships with peers and subordinates, (4) work conditions, (5) wage and salary administration, and (6) job security.
- b. The individual perceives the factors in the work environment. His perception determines his attitude toward the factors. His attitude affects his work behavior.

- (1) If his attitude is one of *dissatisfaction* with the factors in the environment, he is more likely to leave the work force (provided he has alternative opportunities) than if he is not dissatisfied. Even if he does not leave, it is likely that his work performance will suffer.
- (2) On the other hand, it is unlikely that *absence of dissatisfaction* with factors in the job environment will result in greatly improved work performance. For this reason causal factors in the work environment are called hygiene, or maintenance, factors—they serve primarily to prevent dissatisfaction.

5. The job, or work itself, contains causal factors—called motivator factors. Research findings strongly suggest that if they are such that the individual receives satisfaction from them he will be motivated to high performance, and will be more likely to remain in the work force than if such satisfactions are not received.

- a. Absence of satisfaction with the job probably will

result in (1) worse performance than the individual is capable of, and (2) a greater likelihood that he will leave the work force for more satisfying work (if the opportunity presents itself).

- b. Major motivator factors for the individual employee are: (1) a feeling of achievement, (2) a feeling that his achievements are recognized and considered worthwhile by his supervisors, peers, and subordinates, (3) a feeling that his work is interesting and enjoyable, (4) a feeling of responsibility, and (5) a feeling of growth and advancement.

The major elements of the model, and relationships among them, are shown in schematic flow form in Figure 2. In essence, the model shows that:

1. High retention and high performance characteristics result from a combination of employee attitudes that result from employee perception of (1) factors in the work environment (hygiene factors), and (2) factors in the work, or job (motivator factors). Specifically, an attitude of *lack of dissatisfaction* with hygiene factors, combined with an attitude of *satisfaction* with motivator factors, results in the best possible combination to achieve high performance and high retention.

2. Combinations of an *attitude of dissatisfaction* with hygiene factors with an attitude of *lack of satisfaction* with motivator factors in the work is the worst possible combination of attitudes—and leads to probable low performance and high turnover.

Herzberg's findings are consistent with the idea that employees desire satisfaction of the needs shown in Figure 1. In fact, his findings define the nature of these needs more clearly in that (1) the lower-level physiological and safety needs are "hygienic" in nature, and (2) the higher-level needs (social, egoistic, and self-fulfillment) are "motivator" in nature.

ORGANIZATION OF THE SYNTHESIS

Chapter Two describes briefly the trends in job environment (hygiene) factors in highway departments during the post-World War II period. Chapter Three describes a number of innovative maintenance practices. All of these involved significant changes in work structure at the operating level and, consequently, changes in job content. These changes are "motivator" in nature. Innovative maintenance training practices are treated in Chapter Four, and recruiting practices are treated in Chapter Five. Chapter Six is a resume of some trends in maintenance personnel administration.

Appendix A is the result of an HRB Subcommittee questionnaire on training of operating personnel in 45 states.

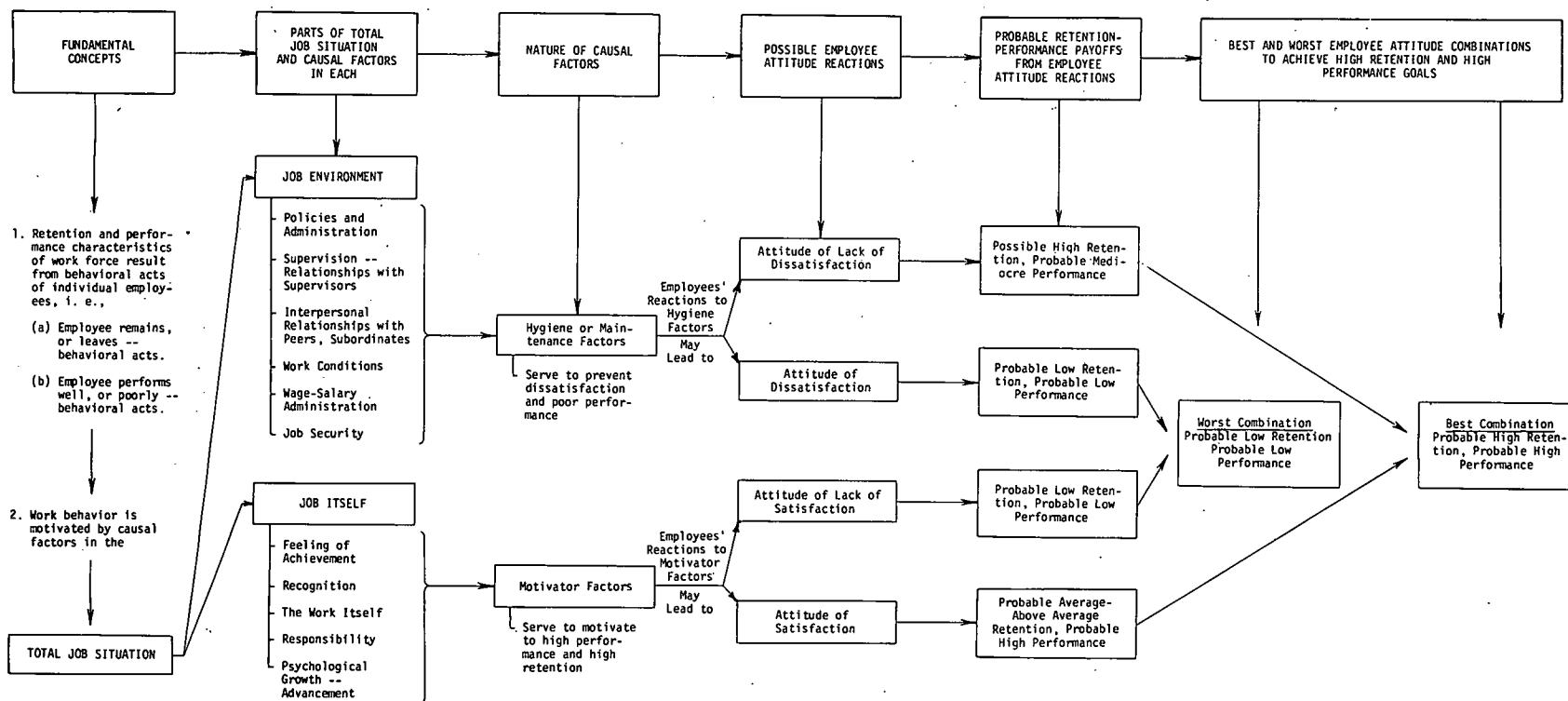


Figure 2. Conceptual model for evaluating innovative retention-performance practices. Based on Herzberg, Mausner, and Snyderman (3).

RETENTION AND PERFORMANCE— TRENDS IN JOB ENVIRONMENT FACTORS

Research findings suggest that factors extrinsic to the actual work of employees affect their attitudes and, hence, performance and retention. Herzberg calls these hygiene factors—an analogy to medical hygiene—because they are preventive, not curative, in nature. They serve to prevent dissatisfaction and poor performance. But satisfaction of hygiene needs will not result in high performance and high retention (4).

Since 1945, highway departments have directed considerable attention to policies and practices that are hygienic in nature. Trends in practices affecting (1) economic security, (2) working conditions, and (3) wages and salaries are summarized here.

POLICIES AND PRACTICES AFFECTING ECONOMIC SECURITY

The need for highway departments to provide “a fair chance for economic security” for their maintenance employees was emphasized as early as 1945 by the Committee on Maintenance Personnel (now the HRB-AASHO Joint Committee on Maintenance and Operating Personnel). Although it is difficult to assess the effects, if any, of the Committee's report, certainly there have been significant changes in policies and practices related to economic security (5, 6).

Continuity of Employment

Probably no single factor affects attitudes of maintenance employees as much as the department's policies and practices relating to continuity of employment, or job security. In this time of increasing competition for capable employees it simply is not realistic for highway maintenance organizations to expect to develop a work force characterized by high performance and high retention unless it rewards good performance with job security—irrespective of political changes.

Traditionally, highway departments have sought to provide job security through civil service systems, merit systems, or comparable plans. Table 1 gives trends in the number of states that provide such plans. In 1970, only eight departments had no formal civil service, merit, or similar system covering maintenance employees, compared to 31 states in 1945.

This is not intended to imply that statutory civil service or merit systems are absolutely essential in order to provide continuity of employment. If a department operates in an environment in which it is able to establish and administer its employee policies effectively without a statutory system, there is no reason that continuity of employment may not be achieved.

Financial Security

Policies and practices that assure some protection for the employee and his family when he is temporarily ill, when he dies prematurely, and when he retires are important determinants of attitudes.

Trends in Sick Leave Provisions

Provision for sick leave with pay was an almost universal practice in highway departments in 1945. At that time all but three states had such a provision. In 1970, all states provided for sick leave with pay—25 provided it for all maintenance employees, 24 provided it for all but temporary maintenance employees, and 1 provided it for all salaried maintenance personnel.

The most noticeable trend in sick leave practices has been toward increasing (1) the number of days allowed, and (2) the number of days that may be accumulated. The trends are given in Table 2.

Trends in Hospitalization and Life Insurance

Hospitalization insurance is an increasingly important hygiene factor in view of skyrocketing costs of hospitalization and medical treatment. No data are available for 1945, but in 1970, 6 states provided hospitalization plans paid for by the state, 31 provided such plans on a contributory basis, and 13 had no such provisions for maintenance employees.

No data are available regarding life insurance plans for maintenance employees in 1945. In 1970, 8 states provided state-financed life insurance plans, 19 provided such plans on a contributory basis, and 19 had no life insurance provisions.

TABLE 1

NUMBER OF STATES WITH CIVIL SERVICE,
MERIT SYSTEM, OR SIMILAR PLANS
AND MAINTENANCE CLASSIFICATIONS COVERED,
1945 AND 1970

EMPLOYEE CLASSIFICATIONS COVERED	NO. OF STATES	
	1945	1970
All maintenance employees	10	21
No maintenance employees	31	8
Salaried maintenance employees	2	6
All but labor	3	0
All but temporary employees	NA	13
Indefinite	NA	2

NA = data not available.

Trends in Retirement Plans

A major characteristic of the population is increasing longevity. This fact, combined with a general tendency toward mandatory retirement, makes a retirement plan important to most employees. During the past 25 years the number of states that provide state-sponsored retirement plans for maintenance employees has increased considerably.

Table 3 gives the number of states that provided retirement plans in 1945 and 1970. Whereas only 21 states had state-sponsored plans in 1945, all 50 states had them in 1970. Maintenance employees in most states also have the benefit of Federal Social Security coverage.

Trends Toward Liability Insurance

Protection against public liability has assumed increasing importance in recent years. In 1970, 34 states provided state-financed (in whole or part) public liability insurance for maintenance employees.

WAGES, SALARIES, EXPENSES

Wages and salaries are treated separately in that they are both hygienic and motivator in nature. Herzberg concluded: "As an affector of job attitudes, salary has more potency as a job dissatisfier than as a job satisfier" (3).

The Committee on Maintenance Personnel made a strong case for improvement in wage and salary administration in its 1945 report (5) when it said:

Equally important with assurance of continuity of service is the payment of fair wages and salaries. Fair wages and salaries imply, not only that the wage or salary is equal to that paid by other organizations for the same type of work, but also that a fair relationship must exist between the wages or salaries paid to various jobs within the entire highway organization.

Relative Wage and Salary Rates

It is recognized that salaries and wages in maintenance have traditionally tended to be lower in relation to (1) those paid for comparable jobs in industry, and (2) those paid for comparable jobs in other operational areas of highway departments. This tendency is probably attributable, to some degree at least, to the tradition of placing less emphasis on maintenance than on construction in management improvement efforts and research.

Table 4 gives percentage increases in average salaries and wages paid various positions and classifications during the period 1945-1970. These data suggest that the wages and salaries paid maintenance personnel generally did not increase at a greater rate than did those for personnel in other operational areas during the past 25 years.

Pay for Overtime Work

In 1945, 21 states made an allowance or adjustment for overtime work, and 25 did not. In 1970, 48 states made some allowance or adjustment for overtime work (data for 2 states were not available). Of these, 21 paid straight

TABLE 2

SICK LEAVE FOR MAINTENANCE EMPLOYEES, 1945 AND 1970

SICK LEAVE ALLOWED WORKING DAYS PER YEAR	NO. OF STATES		SICK LEAVE ACCUMULATED WORKING DAYS	NO. OF STATES	
	1945	1970		1945	1970
10-15	37	31	None	1	0
16-30	5	8	1-20	17	0
>30	0	0	21-60	8	5
Discretionary, or data unavailable	3	11	61-150	15	22
			Unlimited	4	23

time, 18 paid time and one-half, 8 had compensatory plans, and in one the amount paid is dependent on the salary.

Portal-to-Portal Pay

Performance of many maintenance activities requires time to travel from a central location to the place of work. Data available for 1945 do not show the practices with regard to portal-to-portal pay. The 1970 data indicate that 40 states pay both ways for foremen, 44 pay both ways for operators, and 43 pay both ways for laborers. Three states pay only one way for all employees.

Expenses

A majority of states pay all or part of work-related expenses (Table 5).

POLICIES AND PRACTICES AFFECTING WORKING CONDITIONS

The major changes in policies and practices affecting working conditions of maintenance employees occurred in relation to hours of work and annual leave provisions.

TABLE 3

NUMBER OF STATES WITH RETIREMENT PLANS FOR MAINTENANCE EMPLOYEES, 1945 AND 1970

TYPE OF PLAN	NO. OF STATES	
	1945	1970
State-sponsored plan covering:		
All maintenance employees	21	19
Salaried maintenance employees	NA	4
All but temporary maintenance employees	NA	27
No maintenance employees	27	0
Federal Social Security covering:		
All maintenance employees	NA	41
All but temporary maintenance employees	NA	2
No maintenance employees	NA	7

NA = data not available.

TABLE 4
CHANGES IN SALARIES AND WAGES PAID
SELECTED POSITIONS AND CLASSIFICATIONS—
ALL HIGHWAY DEPARTMENTS, 1945 TO 1970

POSITION/CLASSIFICATION	AVERAGE MONTHLY WAGE OR SALARY (\$)		INCREASE (%)
	1945 ^a	1970 ^b	
Maintenance position/classification:			
State Maintenance Engineer	446	1611	261
Asst. State Maintenance Engineer	356	1390	290
Division Maintenance Engineer	307	1249	307
Asst. Division Maintenance Engineer	273	1138	317
Gang Foreman	184	670	264
Section Man	162	612	378
Common Laborer	126	429	240
Skilled Laborer	162	566	349
Shop Foreman	218	742	240
Mechanic	184	612	333
Mechanic Helper	145	501	346
Equipment Operator	165	538	226
Clerk/Timekeeper	158	492	211
Key position in other areas:			
Project Engineer	256	1072	319
Chief—Survey Party	241	837	247
Plans Designer	243	995	309
Bridge Designer	267	1048	293
Chief Clerk	233	802	244

^a Data from Whitton (5).

^b Data from HRB-AASHO (6).

Hours of Work

There has been a clear trend toward a shorter standard work week. Table 6 gives the patterns that existed in 1945 and 1970. In 1945, only 6 states had a work pattern requiring 40 hours, or less, of work. In 1970, 45 states required 40 hours, or less, of work. These data show a strong trend to a shorter work week since 1945.

TABLE 6
STANDARD DAILY AND WEEKLY WORK PATTERNS
FOR MAINTENANCE EMPLOYEES, 1945 AND 1970

STANDARD WORK PATTERN (HR)		NO. OF STATES	
DAILY	WEEKLY	1945	1970
10	55-60	6	0
10	50	2	0
9	49-54	7	0
9	44-45	3	5
8	48	16	0
8	44-45	4	0
8	39-40	6	40
7½	37½	0	4
7	35	0	1

TABLE 5
PROVISION FOR PAYMENT OF TRAVEL
AND MOVING EXPENSES, 1945 AND 1970

TRAVEL EXPENSES	NO. OF STATES		MOVING EXPENSES WHEN TRANSFERRED	
	1945	1970	PORTION PAID BY AGENCY	NO. OF STATES
PAYMENT METHOD				
Reimbursement of actual expenses	25	18	All	NA
Per diem allowance	16	28	Part	NA
Increase in salary	4	0	None	NA

NA = data not available.

Annual Leave

Table 7 gives trends in provisions for annual leave. There has been only a slight tendency to increase the minimum number of days of annual leave allowed. However, 40 states now provide for additional days related to length of service.

There has been a marked increase in the number of states that allow accumulation of annual leave and the number of days that may be accumulated. In 1945, 31 states did not allow accumulation; in 1970, only one did not.

SUPERVISION AND INTERPERSONAL RELATIONS

The kind of supervision employees receive and the kinds of interpersonal relationships experienced at work are important affectors of attitudes—and are hygienic in nature. The scope of this report is such that it does not allow the intensive kinds of analyses necessary to fully document trends in these two areas—analyses that would require extensive interviews with personnel.

It is possible, however, to point to some activities that strongly suggest that a great deal of progress has been made in these two areas. Foremost among these is the fact that most highway agencies have continuously participated in the National Highway Management Conference (a one-week course, twice a year) and the Highway Management Course (an annual five-week course). Both of these are under the joint sponsorship of the American Association of State Highway Officials and the Highway Users Federation for Safety and Mobility and are available for highway officials at all levels. The curricula include, among others, principles of supervision, human relations, and motivation concepts.

One purpose of these programs is to encourage highway agencies to initiate management training and development activities. The fact that a considerable number of highway agencies have regularly organized and conducted similar seminars during the past decade attests that there is considerable emphasis on these areas. Some agencies conduct ongoing supervisory training activities that emphasize ways to improve supervision and supervisor-subordinate relations. These are discussed in Chapter Four.

TABLE 7
ANNUAL LEAVE FOR MAINTENANCE EMPLOYEES, 1945 AND 1970

ANNUAL LEAVE ALLOWED			ANNUAL LEAVE ACCUMULATED		
WORKING DAYS PER YEAR	NO. OF STATES		WORKING DAYS	NO. OF STATES	
	1945	1970		1945	1970
10-12	32	27	None	31	1
13-15	12	22	Up to 18	2	0
18-22	4	1	Up to 20	0	1
Additional days for long service	NA	40	Up to 28	7	5
			Up to 30	5	19
			Up to 39	1	3
			Up to 60	1	7
			Up to 90	0	1
			Up to 120	0	1
			Twice annual limit	0	6
			No limit	0	2

NA = data not available.

This brief analysis indicates that highway agencies have made significant progress in policies and practices related to the job environment. Changes in practices related to job security are particularly apparent, as are those related to working conditions.

The satisfaction of hygiene needs is essential to high retention and high performance in that it serves to prevent dissatisfaction and poor performance. The practices treated herein are largely hygienic in nature. Practices that are motivator in nature are treated next.

CHAPTER THREE

RETENTION AND PERFORMANCE— PRACTICES AFFECTING JOB CONTENT

There is constantly increasing evidence that high performance and high retention are affected more by the job content than by any other single factor in the total job situation. The aim here is to direct attention to innovative maintenance practices already initiated that required significant changes in work structure and job content at the operating level—changes from which positive motivational effects should follow if the work environment thus created is used to produce employee attitude reactions. More specifically, the thesis is that the nature of the resulting job content offers first-line supervisors and operator personnel greater opportunities for (7):

1. Achievement and recognition for achievement.
2. Increased responsibility.
3. Growth of the job and growth of employees—thus providing opportunities for creativity.
4. Advancement (with or without change in formal rank) because the job is of higher order.

5. Greater direct interest in the work—thus fostering a sense of personal worth and individuality.

The evaluation is "after the fact" and in relation to criteria somewhat different from those that led to the original change. Most of the practices described here were developed and initiated as the result of research-implementation projects in which the primary aim was to increase efficiency as measured in terms of costs and levels of service. But, although it cannot be said that the changes were designed in relation to a specific motivational model (such as that shown in Fig. 2), it can be said that (1) there was general recognition that changes in technical structure would affect employee attitudes and performance, and (2) a conscious effort was made in most instances to design and implement technical changes in such a manner that they would complement the human system of the organization.

ROLE OF FIRST-LINE SUPERVISORS

Because emphasis is on practices that affect operations at the operating level, it is essential to examine the role of first-line supervisors. Although it has long been recognized that theirs is a key role in retention and performance of employees, it has been only in relatively recent years that great attention has been concentrated on the specifications of their job. In this connection, Herzberg's studies led him to say (3):

Our conclusion is that the single most important goal in the progress of supervision is the development of new insights into the role of the supervisor so that he may effectively *plan and organize work* . . . He will have to acquire increasingly greater skills in the organization and distribution of work so that the possibility for successful achievement on the part of his subordinates will be increased . . . He will have to learn . . . to recognize good work, to reward the good work appropriately. This emphasis does not reduce the necessity for the maintenance of optimum personal relationship between supervisor and subordinate.

Drucker also emphasizes the planning and organizing aspects of the supervisor's job (8):

. . . the first-line supervisor (whether called "foreman," "chief clerk," or "section manager") alone can bring to management what the worker needs for peak performance. On his ability to *plan and schedule* depends the worker's ability to work. His performance in training and placing makes the difference between superior and mediocre performance of the work.

There is little question that over-all policies, procedures, and organization for maintenance must be established by higher levels of management—they usually are not determined, or even greatly influenced, by first-level foremen. But, when all these are done, the first-line supervisor must, within that supportive framework, operate in such a manner that his employees are motivated. The areas in which he can be most effective are (3, 8):

1. Planning, organizing, and scheduling work activities so that employees can experience a sense of achievement.
2. Recognizing achievement of employees—recognition related as closely as possible to reliable and valid measures of performance.
3. Placing and training employees so that opportunities for growth, development, and advancement are enhanced.
4. Directing the work of his unit so that it contributes to accomplishment of objectives of the department.

Before the supervisor can perform these activities well, a supportive management structure must be established that includes:

1. Clear-cut objectives, policies, and procedures that provide a framework within which a supervisor can make daily decisions to direct his unit's efforts.
2. Ready availability of resources—men, materials, equipment—required to perform the work expected of his unit.
3. Information necessary to do the job required of him and to evaluate performance.
4. Managerial status for first-line supervisors.

MAINTENANCE MANAGEMENT SYSTEMS

Possibly the most significant innovation in maintenance operations—in terms of potential for improving employee retention and performance as well as efficiency—has been the development and implementation, by several highway agencies, of maintenance management systems. Although there are some differences in structure and operating procedures among the systems now operational, the basic elements are essentially the same. They include (9):

1. Clear identification and definition of major, specific, maintenance work activities (e.g., mowing, grading shoulders, ditching, patching, mudjacking).
2. Appropriate measuring units for each specific work activity to provide a basis for measuring the quantity of work to be done. Examples of measuring units are acres of grass mowed, miles of shoulder graded and tons of patching materials placed.
3. Development of standards of performance for each major work activity—standards related to quality; quantity; productivity; the size of crew, the equipment to be used, the materials required, and the recommended work procedure for each activity; and a time standard for performance when recommended procedures are used.

These elements are technical in nature and were developed by adaptation and application of industrial work measurement techniques.

Operational aspects of the typical maintenance management system are designed to facilitate (1) planning and scheduling, (2) allocation of resources, (3) performance feedback, and (4) financial planning, budgeting, and control. They generally include (9):

1. An over-all planning and scheduling system that features an annual plan that balances seasonal workloads and provides a basis for allocating resources in relation to defined needs.
2. A system for short-term work planning and scheduling (biweekly, weekly, and/or daily) at the operating level. Periodic field inspections are scheduled to identify specific needs. The scheduling system provides for routine activities, winter activities, garage activities, minor work activities, and alternative schedules for inclement weather.
3. A reporting system that reports actual work accomplished, and productivity, in relation to that planned and scheduled. The reports provide a basis for evaluation of performance, evaluation of standards, and corrective action, and for summaries to appropriate managers and supervisors.
4. A financial planning and control system that features performance budgeting directly related to work planned for the budget period.

The operating cycle of the typical maintenance management system is a continuous one—built around interrelated procedures for planning work to be done, allocating resources to perform work planned, scheduling specific work activities, directing work performance, comparing and evaluating work performed and productivity in relation to standards, and taking appropriate managerial action. The cycle is shown in Figure 3.

MOTIVATIONAL ASPECTS OF MAINTENANCE MANAGEMENT SYSTEMS

Implementation of the maintenance management system requires major changes in work structure and job content at the operating level. These changes are of a nature that "motivator" factors shown in the conceptual motivational model (Fig. 2) should be injected into the job itself. According to the model, these factors should result in attitudes of job satisfaction and, hence, improved performance and retention. Broadly, the potential for increased motivation lies in three major areas: (1) strengthening of supportive relationships; (2) job enrichment; and (3) improved communications.

Supportive Relationships

Likert has stated a generalized theory of organization based on extensive research of management practices of managers with the best records of performance in U.S. industry—managers who are achieving highest productivity, lowest cost, least turnover and absence, and the highest levels of motivation. The general, over-all principle used by these managers is the principle of supportive relationships, stated as follows (10):

The leadership and other processes of the organization must be such as to ensure a maximum probability that in all interactions and all relationships with the organization each member will, in the light of his background, values, and expectations, view the experience as supportive and one which builds and maintains his sense of personal worth and importance.

The operation of the maintenance management system requires strong supportive relationships among the hierarchical levels of the maintenance organization—from the top management level to the middle management level and thence to the operating management level. The organizational and procedural arrangements create a management framework that emphasizes the interdependence of these levels of management and includes:

1. Clearly defined policies that provide a basis for supervisors to plan work in their units in such a manner that accomplishment will contribute to the department's maintenance objectives.
2. An annual plan that provides supervisors with a guideline framework within which to plan and organize activities in their units.
3. Allocation of resources on the basis of needs defined as a result of inspections in which supervisors have participated.
4. Performance standards that provide useful guidelines to supervisors in planning, scheduling, and directing work.
5. Feedback data that show actual accomplishment and performance related to that planned—essential information if supervisors are to fulfill their managerial responsibilities.
6. Continuous support of higher levels in terms of training of supervisors and operators—and positive guidance, support, and assistance in operations.

All the technical methods of industrial production management (work measurement, time and motion study, performance standards, budgeting, and financial controls) were

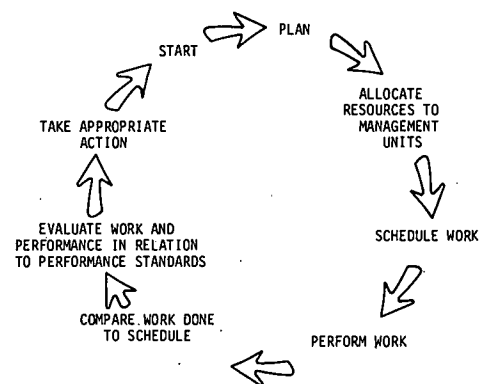


Figure 3. Continuous functional operating cycle of typical maintenance management system.

used in developing and implementing the system. However, agencies that have implemented the system generally did not design it and then impose it on first-line supervisors and operator personnel. Rather, they exerted major efforts to assure that operating-level supervisors and operators understood the system, and provided opportunities for them to participate in the development and implementation phases. These efforts included:

1. Orientation of union representatives (where unions existed) prior to initiation of the research and development program.
2. Explanation of program objectives and methods to operators, first-level supervisors, and higher-level maintenance manager personnel.
3. Heavy involvement of departmental personnel (including operators) at all levels in various research, development, and pilot-testing activities.
4. Orientation of first-level supervisors and operator personnel in all aspects of the system; pilot-testing of new procedures and methods in selected organizational units; and provision for continuous training.

In actual operation of the system, department managers generally have not taken an approach that seeks compliance with standards, work methods, and procedures through heavy exercise of authority and economic pressures. Rather, they have taken an approach that seeks to guide, assist, train, and support operating-level supervisors and employees in doing their work—and have given first-line supervisors leeway to exercise considerable managerial judgment with respect to operations within their units. This approach is in full accord with Likert's principle of supportive relationships and with Herzberg's idea of self-esteem and individual growth.

Enrichment of Supervisors' and Employees' Jobs

As the result of his studies, Herzberg concluded that organizations desiring to increase motivation should take a systematic approach to inject motivator factors into employees' jobs—a process he called job enrichment (4). Job enrichment increases the responsibilities of the job incum-

bent in a vertical fashion and provides opportunities for growth. Herzberg's principles of vertical loading (job enrichment) are shown in Figure 4.

The operation of the typical maintenance management system emphasizes the role of first-line supervisors and, in fact, "loads" their jobs in a vertical fashion. They are expected to assume major responsibility for:

1. Identification of existing maintenance needs and deficiencies in their assigned areas (this may be done in conjunction with higher-level managers).
2. Preparation of short-term work schedules—generally within the framework of an annual plan prepared at higher levels.
3. Assignment of personnel and equipment to accomplish the work scheduled—usually within a framework of guidelines as to crew sizes and work methods contained in performance standards.
4. Assuring that work accomplished is accurately reported.
5. Evaluation of feedback information as to work actually accomplished and productivity—in relation to work planned and scheduled and in relation to performance standards.
6. Taking appropriate action to bring performance into line with standards, and to assure desired quality and levels of service.

The jobs of operator personnel also have been "loaded" vertically in that:

1. The operator works as a member of a crew that is designed (so far as crew size is concerned) so that each crew member makes an important contribution to work accomplishment.
2. The work method used by crews is generally in accordance with guidelines, but the typical system encourages experimentation and innovation to determine better ways of doing work.

3. Operator personnel generally are expected to work on crews performing a variety of activities—thus increasing the range of job skills.

4. Most departments that operate management systems provide for continuous training and development of operator personnel (as well as supervisory personnel).

5. Operator personnel generally receive performance information through the reporting system.

Improved Communications

Without a good communication system within the organization, operating level personnel are in an insecure position from both a motivational and work performance viewpoint. According to Haire (11):

One of the major responsibilities of a leader (manager) is the establishment and utilization of a communication system. His communications with his subordinates are the medium through which he directs their efforts. By means of these communications the leader defines the goals of the organization and the subgroup; he tells the subordinate what is expected of him, what resources are available, how well he is doing, and the like. The communications from the superior are the things on the basis of which the subordinate is able to form a stable organization of his work world. . . . Without a rich flow of communications from the superior, the subordinate cannot know what the situation is, which direction he should be going, how well he is doing, and the like.

On the other hand, the communication from the subordinate to the superior is a real necessity to the successful leader. It is on the basis of these communications that the superior knows his subordinates. It is on the basis of these communications that the superior can diagnose misperceptions on the part of his subordinates of the goals of the group, of their own role and what is expected of them, of their degree of success, and the like. . . . A sensitivity to the movement of communications is one of the prime requisites of a successful leader, and the utilization of communications both to and from the leader can be one of his greatest assets.

The formal structure of the maintenance management system is built around an information system that is an integral part of the total system. This information system transmits to various levels of management appropriate information such as basic department policies concerning long-range planning, the objectives of maintenance, and the utilization of performance standards; procedural guides such as the annual maintenance plan; procedures for periodic inspections to define needs; and procedures for short-term scheduling. It also transmits, to all levels, appropriate reports and summaries of work accomplished to facilitate evaluation of accomplishment and performance.

In addition to the formal information system integrated into the management system, most agencies that have implemented such a system have entered into intensive and extensive training of supervisors and operators on a continuing basis. The development of the system provides information for performance-oriented training because it requires clear definition of work activities, work methods, and standards.

Some of the results of operation of the system are as follows.

PRINCIPLE	MOTIVATORS INVOLVED
1. Removing some controls while retaining accountability.	Responsibility and personal achievement.
2. Increasing the accountability of individuals for own work.	Responsibility and recognition.
3. Giving a person a complete natural unit of work (module, division, area, and so on).	Responsibility, achievement, recognition.
4. Granting additional authority to an employee in his activity; job freedom.	Responsibility, achievement, recognition.
5. Making periodic reports directly available to the worker himself rather than to the supervisor.	Internal recognition.
6. Introducing new and more difficult tasks not previously handled.	Growth and learning.
7. Assigning individuals specific or specialized tasks, enabling them to become experts.	Responsibility, growth, and advancement.

Figure 4. Herzberg's principles of vertical loading. Adapted from Herzberg (4).

RESULTS OF OPERATIONS

At this time most agencies consider the maintenance system so new that benefits realized to date are considerably less than those expected in the future. Following are some results of operations as reported by management personnel in the organizations cited.

Washington Department of Highways

In the Washington Department of Highways, the retention rate for maintenance personnel is significantly higher than for employees in other categories. The data given in Table 8 are for the fiscal year 1969-70.

Attitudes of foremen and operators toward the system are favorable. There has been a significant savings in man-hours expended to perform maintenance work, and more consistent levels of service have been attained.

Michigan Department of State Highways

Implementation of the maintenance system by the Michigan Department of State Highways has had a positive motivational effect on first-line foremen and operators. This is manifested by:

1. Receipt of an increasing number of suggestions from field personnel with regard to improving methods, equipment, procedures, policies.
2. Performance that exceeds standards by a significant amount in many instances and, in some instances, by twice the standard amount.
3. An obviously increasing cognizance of the importance of good performance and an increasing interest in it by foremen and operators.
4. Expressions of enthusiasm for the systematic approach by many first-level supervisors and operator personnel—particularly younger men.
5. Maintenance of a high retention rate that has prevailed for a number of years.
6. An expressed feeling by department personnel that the system will result in a better basis for evaluation of performance of supervisors and operators.

The Department has experienced a significant savings in dollar amounts expended and has attained greater consistency in levels of service.

Louisiana Department of Highways

Sampling techniques were used to determine turnover rates for the years 1962-1970 (the maintenance system was initiated on a statewide basis on July 1, 1969). The data are given in Table 9.

Although it cannot be said that the higher retention rate achieved in 1970 can be ascribed solely to the maintenance management system, it is believed that the system has had a favorable effect on retention of good employees. Operation of the system resulted in need for fewer maintenance employees. Transfers and attrition allowed a reduction of the number of maintenance employees by 677 persons from July 1968 to August 1970. A further reduction of 1,118 additional employees is planned by 1972.

Net savings in dollars expended for the first three quar-

ters of the first fiscal year of operation of the system amounted to \$2,628,099. Man-hours saved amounted to 676,374.

Utah Department of Highways

The retention rate of good maintenance employees by the Utah Department of Highways has been high. There is a significant improvement in consistency of levels of service throughout the state, accompanied by significant reductions in costs for performing various operations. There has been a significant reduction in the rate of annual increase in costs per lane-mile—from a historical rate of increase of 7½ percent to one of approximately 3½ percent. The attitudes of foremen and operator personnel toward the system are positive.

Ontario Department of Highways

The Ontario Department of Highways has not as yet quantified precisely the economic benefits derived from the system. It has, however, established an order of magnitude. It attributes a reduction in the winter maintenance complement of approximately 10 percent, and a similar reduction in the summer maintenance complement, partly to the information system. Further efficiencies are expected as the system is refined.

The Department has found that over-all response of employees to the demands of the system is generally good and anticipates that interest will increase as new standards of maintenance are achieved.

Virginia Department of Highways

Comparisons of data collected by the Virginia Department of Highways in 1963-64 (at the time the study was undertaken) and in 1967-68 (after the system was partially operative) indicate significant savings in man-hours due to improvements in efficiency, as well as benefits from improved planning and scheduling. Field personnel have become more familiar with the system and evidence considerable interest in developing ways to further improve efficiency. A most important aspect of the system is that managers at all levels are furnished feedback information necessary for adequate control of maintenance operations.

County of San Diego, California

Immediate qualitative benefits were realized from implementation of the system by the County of San Diego. These benefits were in the form of increased effort on the part of maintenance personnel to recognize and use methods improvements, priority ratings, and over-all planning and scheduling. Significant dollar savings are anticipated.

City of Los Angeles

The installation of the system by the City of Los Angeles has resulted in significant dollar savings. These are attributable to reductions in the number of employees, emphasis on improved planning and scheduling by foremen, use of improved methods, and increased productivity of crews.

TABLE 8
PERSONNEL SEPARATIONS, WASHINGTON, 1969-70

EMPL. CATEGORY	AV. EMPL.	SEPARATIONS			
		NO.		%	
		TOTAL	VOLUNTARY	TOTAL	VOLUNTARY
Department-wide	5068	450	309	8.87	6.09
Technicians	1488	118	93	7.93	6.25
Engineers	909	50	31	5.50	3.41
Maintenance	1435	63	18	4.39	1.33
Other	1234	219	167	17.74	13.45

TABLE 9
PERSONNEL SEPARATIONS, LOUISIANA, 1962-1970

YEAR	VOLUNTARY SEPARATIONS (%)
1962	7.38
1963	10.07
1964	10.74
1965	10.40
1966	11.58
1967	16.95
1968	13.09
1969	16.28
1970	3.02

Comment

The preceding analysis of major elements of typical maintenance management systems shows that implementation requires radical changes in structure and content of jobs of first-line supervisors and operators. These changes are of a nature that, according to the motivation model in Figure 2, they should result in attitudes of satisfaction toward the work and, hence, improved performance and retention. The experience of agencies that have initiated maintenance systems to date indicates that there has, indeed, been considerable improvement in performance. Available data in regard to retention indicate positive effects.

INNOVATIVE WAGE AND SALARY PLANS

Herzberg concluded that wage and salary payments are generally more hygienic than motivator in nature (7). He did, however, point out that money earned as a direct reward for outstanding individual performance is a reinforcement of the motivator factors of recognition and achievement, and is not hygienic as is money given in across-the-board increases. The plans described here are motivator in nature.

North Dakota State Highway Department

The North Dakota State Highway Department has developed and implemented a classification and salary plan for

maintenance employees that relates wages and salaries directly to: (1) the level of difficulty of normal work performed, and (2) the level of skill and ability of the employees. Development and implementation required several steps (12):

1. Definition of the work. Description of all work activities in three major areas of operations—maintenance field operation, equipment maintenance, sign fabrication—by employee committees.

2. Definition of levels of difficulty of work activities. The definition was made by employee committees, and was designed to relate pay to difficulty of work performed and knowledge, skills, and abilities required to perform it. An example of levels established for equipment operators is given in Table 10 (there is only one title for all field employees below the foreman level—Equipment Operator). Table 11 gives pay ranges related to levels of difficulty.

3. Establish pay ranges. Wage rate ranges are directly related to levels of difficulty, and actual rates are related to salary and wage rates prevailing in industrial and governmental organizations in the area. Figure 5 shows wage and salary rates for maintenance superintendents, foremen, and equipment operators.

4. Initial classification of employees. Each employee was evaluated by his organizational supervisors (in most cases the foreman, administrative supervisor, maintenance superintendent, and either the district engineer or assistant district engineer). The rate of pay was based on the following factors: (1) the types of equipment the employee could operate efficiently, (2) the type of equipment the employee operated most of the time, (3) how well the employee operated and maintained the equipment, (4) the employee's potential for improvement, (5) the employee's length of service, and (6) general considerations such as attitude, attendance, loyalty, dependability, ability to work with others. The same supervisory personnel reviewed the evaluations a second time, and in no case was the newly established rate below the employee's existing rate.

Because of legislative salary and budget limitations, the plan had to be implemented in three stages at approximately six-month intervals. Each employee was notified of the implementation of Stage One, and told in which of the four ranges he would be classified at the final stage. Provision

TABLE 10
EXAMPLE OF EQUIPMENT OPERATOR LEVELS
OF DIFFICULTY, NORTH DAKOTA

LEVEL OF DIFFICULTY	TYPICAL JOB DESCRIPTION
3	Operate rubber-tired tractor with tractor-mounted mower.
4	Operate rubber-tired tractor with trailer-mounted mower.
4	Operate trailer- or truck-mounted distributor, less than 1,000-gal capacity.
5	Where truck driver controls the operation.
6	Where distributor operator controls the operation.
10	Operate motor grader on gravel surface operations.
11	Operate motor grader for snow and ice control.
15	Operate motor grader for patching with oil mix.
16	Operate motor grader for continuous-mix lay-down.

was made for any dissenting employee to discuss complaints with a member of the Personnel Division. The employee could appeal to the State Highway Commissioner. There were few changes, and most employees agreed with their classifications.

Fundamental to the operation of the plan is the Department's basic philosophy that each supervisor has a continuing duty, responsibility, and opportunity to evaluate performance of employees under his supervision—and to encourage them to develop the skills and abilities necessary for their advancement. Great emphasis is placed on communication of the plan so that each employee knows what machine he must operate, and what work he must do to increase his pay rate.

The Department has been highly successful in maintaining a high retention rate. The turnover rate in 1969—considering only those who resigned for other employment—was slightly greater than 2 percent of the total maintenance work force.

The Department believes that it is able to recruit and retain younger persons with high potential to fill vacancies, and that this is possibly due to the fact that applicants can be shown a plan that clearly indicates positions they can advance to, the capabilities required to advance, and the wage scales.

Incentive Pay System

During the past decade, highway organizations in the United Kingdom have developed and implemented incentive pay systems with considerable success. Major elements of the systems are (13):

1. Various maintenance work activities must be measured (the MTM, or method-time-measurement, system is almost universally used in the United Kingdom).
2. A "performance value," representing "ideal" performance, must be determined for each measured activity.
3. Performance that is better than a fixed percentage of

TABLE 11
RANGE OF PAY FOR LEVEL OF DIFFICULTY,
NORTH DAKOTA

LEVEL OF DIFFICULTY	RANGE OF PAY (\$)			
1				
2	1.60			
3	to			
4	1.95			
5		2.00		
6		to		
7		2.20		
8				
9				
10			2.25	
11			to	
12			2.70	
13				
14				
15				
16				2.75 to 3.10

the established "performance value" earns a financial bonus on a rising scale.

4. There is a cutoff point (established for health and safety reasons) beyond which no bonus is paid.

5. The plan is geared so that the value of increased productivity is greater than the expenditure in bonus payments and for operation of the plan.

The success of the incentive system depends on three factors: (1) work and productivity standards must be accurate and so accepted by employees, (2) employees must understand the system and the reasoning behind it, and (3) administration of the system must be efficient. United Kingdom organizations that have successfully implemented and operated incentive systems have taken great pains to attempt to establish a complementary technical-human system. Steps taken include:

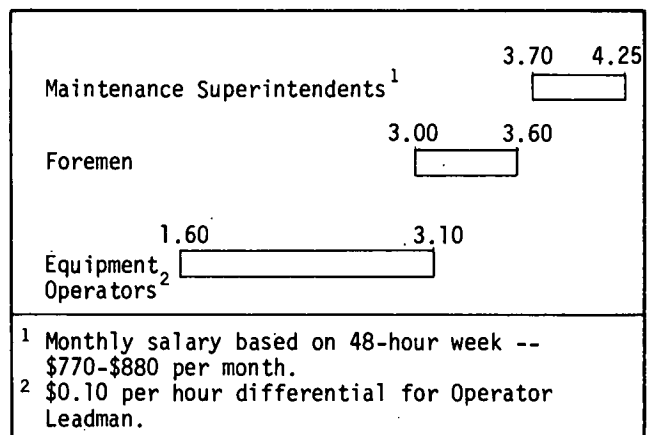


Figure 5. Salary plan, maintenance field classification; North Dakota.

1. Continuous communication with labor union representatives (labor organizations support the system).

2. Participation by employees in development and implementation phases.

3. Written information about the system made available to employees to study at leisure, supported by meetings and verbal communications.

4. Training of employees in all aspects of the system, particularly work reporting.

5. Continuous contact by "work checkers" (persons with practical experience in road maintenance) with work operations and those performing work.

6. Maintenance of management-employee cooperation and involvement through a Consultative Committee consisting of representatives of each divisional work force, the staff, and the maintenance engineer. This committee deals with any problems affecting values, current methods, and updating to take advantage of changes in methods, plant and equipment, and materials.

The system has been effective in retaining employees, and in attracting good employees. Productivity has increased significantly.

Comment

Both of the foregoing approaches to wage and salary payments apparently have introduced motivator factors into the job. These appear to have resulted in positive job attitudes and improved performance and retention. Moreover, it appears that each plan has increased the ability of the organization to recruit good employees.

Of great significance is the fact that operating-level employees (supervisors and operators) were fully informed and involved in development and implementation of these plans. Of equal significance is the fact that there is continuing emphasis on communications about the plans and on training to develop a wider range of skills, thus providing opportunities for achievement, growth, and advancement.

In the case of the United Kingdom incentive plan, the reaction of one employee to the bonus payment appears to support the idea that it reinforces the motivator factors of achievement and recognition. He said, "If I've got more bonus than Joe, I know I'm worth more than Joe" (13).

OPERATING LEVEL ORGANIZATION STRUCTURE

Several departments have analyzed maintenance work requirements and have modified organization structure and procedures to facilitate improved performance. These changes have affected work structure and job content at the operating level.

Illinois Division of Highways

In 1969, the Illinois Division of Highways established a "gang" system based on Team Sections. Prior to that time the Division had employed a patrol system in which individual supervisors had under their jurisdiction 250 to 300 miles of road and as many as 15 three-man patrols on 20-mile sections, each section with its own storage site. The major elements of the new organizational arrangement are:

1. The gang is a pool of labor formed of operators, maintenance workers, and laborers as necessary to perform the maintenance activities required in a designated Team Section area. The organizational structure is shown in Figure 6.

2. Team Section boundaries follow county lines where possible because nontechnical personnel are patronage employees. Where the work load is low, two or three counties may form a Team Section. Highly urbanized and dense counties are subdivided into two or more Team Sections.

3. The number of employees assigned to each Team Section depends on the work load. The Team Section includes 100 to 200 centerline miles of state highways, with the greatest travel distance being 25 miles. Where this distance must be exceeded, subheadquarters are established.

4. Staffing is determined by mathematical models that include such variables as miles of pavement, number of lanes, type of system, environment, and traffic volumes. Manpower complements are adjusted by snowfall factors to accommodate varying snow removal loads. Mathematical models are used to determine equipment requirements for each Team Section.

5. Each supervisor usually has three to six foremen. The number of equipment operators, maintenance workers, and laborers varies with work schedule requirements.

Fundamentally, the aim of the Team Section and labor pool arrangement is to allocate and utilize labor, materials, and equipment resources in direct relation to work loads. The supervisor is able to adapt his organization to operational requirements because crew sizes are flexible to allow efficient man-equipment utilization.

Patrolling and regularly scheduled inspections are responsibilities of the supervisor or those designated by him. He counsels with the field engineer in establishing priorities.

In snow removal operations the Division now assigns one man to a truck that has controls easily accessible to the operator. Formerly, all trucks were operated with two-man crews. All trucks are equipped with mobile radios to assure adequate communications.

Results of the new organization include:

1. Supervisors and foremen are increasingly enthusiastic about the system. Management feels that the system has resulted in greater positive motivation of field force personnel, improved performance, and higher retention of better people.

2. A significant reduction in the amount of contractual maintenance services—directly attributed to higher productivity.

3. The work force has been reduced by several hundred men, with significant salary savings and no lowering of service levels.

4. There is greater consistency in levels of service throughout the state.

Louisiana Department of Highways

The Louisiana Department of Highways has reorganized its work forces at the parish level—moving to a single gang, or labor pool, in each parish (15). The men are scheduled to specific jobs as needed. Schedule boards are set up in

each parish maintenance office so that employees can know their day-to-day work assignments.

The reorganization was effected in connection with implementation of a maintenance management system—a fact that accounts for the Department's ability to accurately define manpower needs in relation to work load. Training has been emphasized to assure effective performance of various activities.

The reorganization has (in conjunction with the operation of the maintenance management system) resulted in:

1. An increase in over-all productivity and greater consistency in levels of service.
2. Improved retention rates and more positive job attitudes.
3. Reduction in the number of maintenance employees required.

State Highway Commission of Kansas

In 1964, the State Highway Commission of Kansas initiated a general maintenance plan of operation aimed at accomplishing (1) total mechanization of operations, thereby eliminating all handwork, and (2) a well-balanced program with full productivity of personnel in summer and winter (16).

The program included a major reorganization at the operating level. This included establishment of larger sub-districts as the basic operating management unit. A major goal was to provide improved supervision with subdistrict foremen as key managers. To accomplish this aim, the Commission:

1. Initiated the program by developing and conducting a series of management training seminars. These programs emphasized the role, functions, and responsibilities of first-line supervisors.
2. Informed all first-line supervisors and higher-level managers of the timetable, and provided for involvement of first-level supervisors in the research, development, and implementation phases.
3. Established operating procedures that involved foremen in all phases of planning and scheduling work, estimating materials and equipment needs, and evaluating work performance.

The system anticipates that the subdistrict size be determined by the number of two-lane miles to be maintained by a crew and equipment sufficient to handle a measured and balanced work load year. The number of miles varies among subdistricts, depending on traffic volumes and other characteristics affecting amounts of work. Staffing is geared to winter maintenance. Consequently, during the peak summer season the excess of work over work-force capacity is contracted.

Operational aspects of the Kansas system include:

1. Clear definition of maintenance activities to be performed in each subdistrict and measurable work units for each activity (such as cubic yards of materials placed, gallons of sealant used, lineal feet of guardrail installed).
2. Quantity and quality standards to provide guidelines for supervisors and crews.

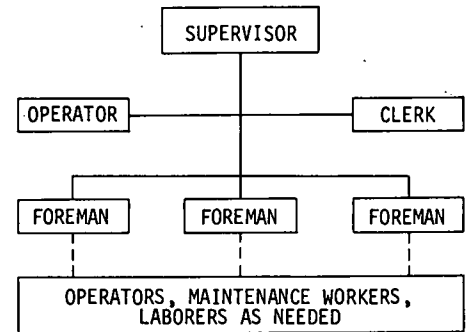


Figure 6. "Gang" system organization, Illinois.

3. Measurement of productivity in terms of work units per man-hour and work units per equipment-hour.

4. Assignment of major responsibility for planning and scheduling work to foremen, as well as responsibility for assigning crews, reporting accomplishment, and evaluating performance.

Although the foremen are key managers, the Commission has reorganized higher levels of management to give them strong support, guidance, and assistance to accomplish the work expected of them.

The reorganization and subsequent operation have been accomplished with great enthusiasm on the part of foremen and operators, who apparently have been pleased and motivated by the sense of direction, guidance, and assistance provided them. The Commission has maintained a high retention rate with approximately 2 to 3 percent turnover, most of it due to retirements.

The Commission has been able to accomplish more work than previously with approximately 300 fewer operator personnel than were employed 10 years ago. The amount of contractual work has remained stable.

Comment

The organizational changes in Illinois, Louisiana, and Kansas have some common characteristics that are in accordance with the conceptual motivation model (Fig. 2). Motivator factors are introduced by:

1. Enrichment of first-line supervisors' jobs in a vertical fashion, with considerably increased emphasis on responsibilities for determining needs and planning and scheduling work, assigning work crews, and receiving and evaluating feedback performance data.

2. Enrichment of operators' jobs by establishing an organizational system that provides opportunities for significantly increasing the range of activities performed and the skills required.

3. Establishment of strong supportive relationships among all levels of the maintenance organization, all geared to provide support, guidance, and assistance to operating crews.

4. Establishment of a communications system that emphasizes information related to work and work performance.

There is strong indication that these changes have resulted in positive job attitudes and improved performance and retention.

SUMMARY

The intent in this chapter is to identify innovative practices that required significant changes in work structure and job content at the operating level of maintenance organizations. In effect, the chapter is an effort to test the hypothesis (shown in Fig. 2) that high performance and high retention are affected by job content, and that they result from motivational factors in the job itself.

The data and information relative to results of operation of the innovations described here are taken from published reports, telephone conversations with agency personnel, or both. Although they are not extensive, and are not the result of in-depth studies to test the hypothesis, they are expressions by operating maintenance officials who are familiar with the innovations and who have first-hand knowledge of results. These data strongly suggest that (1) changes of the nature required by the innovations do, indeed, inject motivator factors into the jobs of first-line supervisors and operators, and (2) the result is greater satisfaction and improved performance and retention.

The maintenance management system appears to contain greater potential for increased motivation than any other innovation described in this chapter. The reason is that the systematic approach is one that, by definition, requires development of procedures that emphasize interrelationships and interdependencies of various hierarchical levels of the organization and the various organizational units, or parts, of the system. Conformance to this notion appears to have resulted in considerable enrichment of jobs of first-line supervisors and operator personnel, and has introduced reinforcing motivational factors of strong supportive relationships and effective communications systems.

The wage and salary innovations represent motivator

types of changes (rather than hygienic) in that they both allow money to be earned as a direct reward for outstanding individual performance. They reinforce the motivator factors of recognition and achievement.

The innovations in organization structure in Illinois, Louisiana, and Kansas illustrate a trend toward a labor pool concept that is motivator in nature. The motivation results from the wider range of skills required of operators—a job enrichment factor. These changes involved use of a considerable number of the elements of the maintenance management system, particularly the development of quality, quantity, and productivity standards; emphasis on planning and scheduling work; and heavy enrichment of first-line supervisors' jobs.

The single most striking feature of the innovations described here—from the viewpoint of motivation and improved performance and retention—is the consistency with which departments have recognized the importance of first-line supervisors. Without exception, the restructuring of jobs resulted in increasing the supervisors' responsibilities and involvement in planning and organizing work, assigning and directing crews, and evaluating performance on a more realistic basis than was previously possible. More importantly, supportive relationships have been established to assure supervisors of adequate guidelines and assistance.

Although major efforts of departments were, of necessity, directed to solution of the many technical problems with which they were confronted in initiating the innovations, it is particularly noteworthy that conscious efforts were made to assure complementary technical-human systems. The results cited indicate a considerable degree of success. There is every indication that formal, conscious introduction of motivation concepts and practices in maintenance operations would probably result in even more positive effects on already improving retention-performance behavior. Certainly, results cited here suggest that in-depth research along these lines is warranted.

INNOVATIVE TRAINING PRACTICES

SUPERVISORY TRAINING

The past decade has witnessed a growing recognition of the primary importance of effective operating-level supervision—a factor emphasized in Chapter Three. Many of the innovative training practices reflect awareness of the need for developing first-line supervisors and higher-level managers who must provide support for them. California, Nevada, and New Jersey have established Maintenance Academies that function to develop and improve the abilities of operating-level maintenance supervisors.

California Maintenance Academy

The California Department of Public Works initiated the Maintenance Academy in 1966—a program designed to impart managerial training to maintenance superintendents and foremen (17). In the program:

1. The course is one week in length—students register on Sunday afternoon and complete the prescribed curriculum at noon on the following Saturday.
2. The course is conducted at a training station where students are completely out of touch with daily operating responsibilities.
3. Each day's activities are highly structured from 7:00 AM until 4:00 PM.
4. Instructor personnel include (1) members of the Management Development and Training Section of the Department, (2) members of the maintenance organization, and (3) invited personnel from other state agencies.

A major feature of the course is that each student is required to report to the Academy prepared to participate as the Superintendent of a hypothetical Superintendent's Territory in a hypothetical district in the state. Prior to reporting, each student is given a packet of materials designed to provide all information necessary for him to become completely familiar with major aspects of the hypothetical district. The packet includes:

1. Information about sources of funds for maintenance operations.
2. Information about procedures for preparation of maintenance budgets.
3. A copy of the *Service and Supply Manual* of the Department.
4. A map of the hypothetical district and proposed routes and routes under construction.
5. A list of personnel assigned to the hypothetical Superintendent's Territory and a summary of the equipment allocated there; and the same information for each Maintenance Foreman's Territory within the Superintendent's Territory.
6. Copies of Circular Letters related to cooperation and

coordination of activities with other state agencies such as the Game and Fish Department.

7. Copies of policies and other documents related to requisitioning equipment, public relations, personnel procedures, landscape maintenance, procedures for issuance of encroachment and transportation permits of various kinds.

8. Materials related to basic maintenance engineering concepts and specifications and materials testing and control.

Teaching techniques include some lecture sessions, but great emphasis is placed on active participation by teams and individuals in role-playing situations, followed by critiques. The schedule is structured to include handling (by teams) of realistic case problems related to personnel, public relations, budgeting, costing, service and supply, equipment management, equipment department-maintenance department relationships, and landscape management. Sessions are also scheduled to familiarize students with operations and functions of the Signals Section and the Materials and Research Laboratory. Legal Division personnel discuss tort liability.

According to maintenance officials, job efficiency and performance at the operating level have increased appreciably as a result of the training.

Nevada Department of Highways Maintenance Academy

The Nevada Maintenance Academy (18) is patterned after the California Academy. The course format and length are similar, and the same kind of preparation is required. Participants are maintenance foremen and supervisors. The students are placed in realistic simulated situations.

The Academy is conducted twice each year on the Stead Campus of the University of Nevada. Approximately 24 students, chosen by District Engineers under a quota system, attend each Academy term.

A significant increase in efficiency and consistency of service levels throughout the state is attributed to the Academy program. Students have reacted favorably to the training experience and many apparently consider it the highlight of their career with the Department.

New Jersey Maintenance Academies

In 1964 the New Jersey State Highway Department (now New Jersey Department of Transportation) recognized the need for a formalized training program for its employees, and in 1965 the Division of Maintenance and Equipment developed a list of training needs based on submissions by members of the Department (19). A result was the development of two Academies—the Foreman's Academy for foremen and assistant foremen, and the Supervisor's Academy aimed at a slightly higher level of management and supervision.

The Foreman's Academy is designed to develop first-level management personnel and to help prepare them for promotion to middle management positions. The course is 10 days in length (Monday through Friday for two consecutive weeks) and is conducted at a training facility that allows students to be completely away from regular work routines. Classes are scheduled from 9:00 AM to 4:00 PM each day, and four evening sessions are scheduled for guided discussions of Civil Service rules and regulations, personnel relationships, legal obligations, and organizational relationships and procedures. The class is limited to 40 students divided into two groups of 20 each. Instruction is by consultant instructors, supplemented and complemented by instructors from the Department.

The subject matter in the Foreman's Academy emphasizes the roles of foremen and assistant foremen in:

1. Planning, organizing, and scheduling work.
2. Providing positive leadership to their employees.
3. Interdepartmental cooperation and coordination.
4. Providing on-the-job training to employees.
5. Communications, performance appraisal, and other personnel functions.

The Supervisor's Academy is similar in format to the Foreman's Academy, but aims to develop skills in managing managers rather than managing nonsupervisory employees.

The Department conducts pre-Academy and post-Academy attitude surveys, which indicate significant improvement in attitudes attributable to the training. Results are shown in Figure 7. A major positive accomplishment of the two Academies has been to develop a feeling of

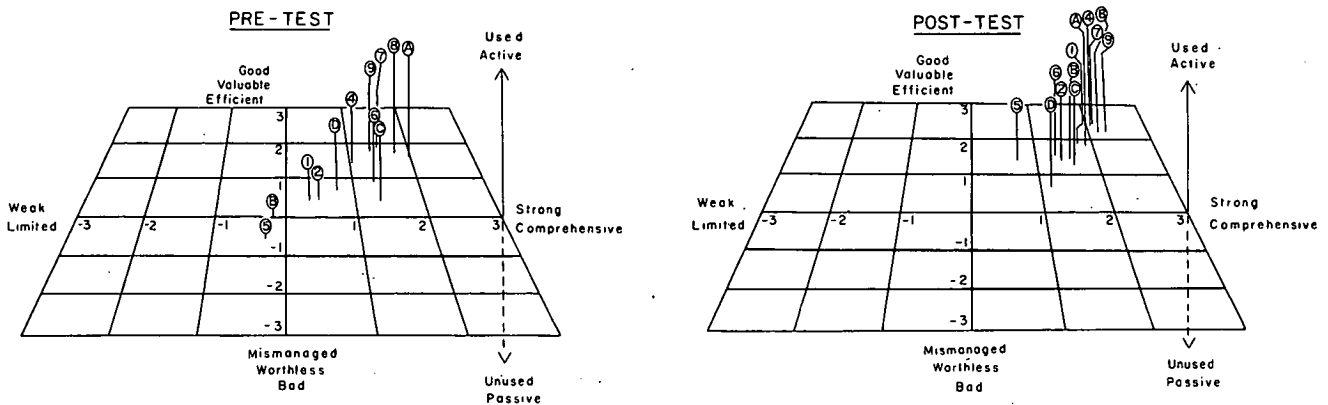
closeness among students. The exchange of information and viewpoints relative to similar problems has resulted in significantly improved attitudes.

Port of New York Authority

The Port of New York Authority has developed and regularly conducts a Maintenance Foreman Simulation Program (20). Fourteen foremen-in-training are divided into seven different Maintenance Foreman II positions at two identical facilities. Each foreman is assigned 12 to 15 maintenance personnel, a list of routine maintenance requirements, and a backlog of nonroutine maintenance work load in addition to other "tools" and materials a Foreman II has available. The trainees are grouped into teams representing the maintenance supervisors of a facility, and are able to make the same kinds of operating and administrative decisions as would Foreman II's in real working conditions.

Features of the simulation program are:

1. Trainees actually perform all the routine tasks normally assigned to foremen, from the scheduling of actual work to the work force to analysis of feedback reports on the quality of performance.
2. Trainees are exposed to nonroutine occurrences of an emergency nature such as situations involving human relations, safety deficiencies, and others that require analysis, judgment, and decision.
3. Senior maintenance foremen serve as instructors.
4. An intercom system is used to simulate telephones and introduces additional realism.
5. There are scheduled critiques of activities.



- 1 Highway Department
- 2 Division of Maint. & Equip.
- 3 ABCD Maint. & Equip. Districts
- 4 Division of Personnel
- 5 Bureau of Industrial Engineering

- 6 Union
- 7 Technical knowledge, foremen
- 8 Leadership, foremen
- 9 Communication, foreman

The three-dimensional sketches show a relative improvement in attitude after completion of the course.

Figure 7. The Foremen's Academy attitude survey, New Jersey.

The Authority has found that response from students, is enthusiastic, and that simulation is a highly effective technique for this kind of training. The Authority plans to refine and expand the program.

California Maintenance Supervision Course

The California Department of Public Works conducts a continuous program, called the Maintenance Supervision Course, to develop supervisory skills of maintenance crew chiefs. The course was developed by the Management Development and Training Section, which trained instructors in each district.

The course is built around seven reading units that provide a basis for class sessions conducted by district instructors on a scheduled basis. The units are:

1. Your Organization and Your Job.
2. Your Responsibility as a Supervisor—Delegation and Training.
3. Your Responsibility as a Supervisor—Discipline.
4. The Supervisor's Responsibility for Evaluation and Developing Employees.
5. How to Work with People through Human Relations.
6. How to Work with People through Communications.
7. How to Prepare for Supervision.

The Management Development and Training Section provides district instructors with materials as well as consultation services.

Maintenance Management Systems and Supervisory Training

It is noteworthy that development, implementation, and operation of maintenance management systems (described in Chapter Three) have been accompanied by considerable emphasis on supervisor and operator training. One reason for this is that training is essential because the systematic operation has generally required radical changes in management procedures and work methods affecting first-line supervisors. A second reason is that the systematic approach is conducive to development of effective, performance-oriented training materials.

Much of the supervisory training associated with the development, implementation, and ongoing operation of the system has concentrated on:

1. Orientation and familiarization of first-line supervisors with the major elements of the system; the management principles and concepts on which the system is based; and over-all relationships with higher managerial levels and procedures related to these.
2. Basic principles and concepts of supervisory management and the responsibilities of first-line supervisors regarding planning and organizing work, scheduling, directing work, and control actions, and procedures related to these.
3. Training in work reporting, the procedures and forms related to it, and analysis of feedback information and action alternatives.
4. Training in work methods.

The Federal Highway Administration supported a training research project by the Louisiana Department of Highways associated with the development and implementation of the maintenance management system in that state. The project objectives included determination of what as well as how to teach supervisors. The results indicated clearly that an audio-visual programmed instruction technique was most effective for training supervisors. Consequently, five courses were developed (21):

1. Maintenance Management System—directed to superintendents and district-wide foremen. It teaches them how to plan, schedule, and organize their work. It uses tapes, slides, and a workbook. There are about 248 slides and 5 tapes. Total course time is approximately 12 hr.

2. Work Reporting System—a companion course to the Maintenance Management System course. It is directed to foremen and clerks. It is audio-visual and includes a workbook for references and problems. The basic aim of the course is to improve the level of accuracy in reporting work planned, scheduled, and performed. There are approximately 125 slides and 3 tapes.

3. Bituminous Surface Care—a technical training course emphasizing procedures for repairing defects in bituminous surface roads. It is directed to maintenance superintendents and foremen. It includes determination of extent of defects and methods and standards for repair. The course is audio-visual with approximately 200 slides and 6 tapes.

4. Mowing—a technical course showing procedures for mowing in the most economical manner. It is designed for superintendents and foremen. It is audio-visual and uses tapes, slides, and workbooks.

5. Slurry Seal—presented in two different training mediums: audio-visual (tapes and slides) and videotape. The purpose of the dual presentation is to determine effectiveness of both mediums. The course is planned for maintenance superintendents and slurry seal crews across the state.

The Virginia Department of Highways has developed a series of training manuals dealing with a variety of procedures and specific work activities. These include (22):

MT-1-66	Maintenance Planning Procedures
MT-1A-66	Maintenance Planning Procedures Workbook
MT-2-66	Productivity Tables
MT-3-66	Performance Standards
MT-8-66	Instructions for Motor Grader Operators
MT-9-66	Mowing Methods
MT-10-66	Mowing Requirements for Interstate Highways
MT-12-66	Spreading Chemicals (Salt and Calcium Chloride)
MT-14-66	Introduction to Maintenance Management System
MT-15-66	Instructions for Maintenance Activities with Accomplishment (Work Units)
MT-66	Training Guide—Chemical Spreaders (Use and Maintenance)

MT-11-67	Planning Chemical and Plowing Routes
MT-4-69	Training Guide—Bridge Maintenance (Instructor's Guide)
MT-5-70	Bituminous Surface Maintenance: (a) Types of Surface Failures (b) Skin Patching
MT-6-70	Bridge Maintenance—Bridge Repair Handbook Timekeeper's Handbook Box Culvert Plan Reading Course

Training materials under development (Feb. 1972) include:

1. Drainage Maintenance.
2. Bituminous Surface Maintenance:
(a) Premix Patching.
3. Concrete Pavement Maintenance.
4. Orientation.
5. Snow Removal and Ice Control.

Research and Development in Progress

A national project, supported by the Federal Highway Administration, is presently being conducted to research and develop a training curriculum for operational maintenance managers—foremen, superintendents, and field maintenance engineers. The primary aim of the project is to develop a curriculum that can be used as a basis for implementing maintenance management training programs in state, county, and city agencies.

Major elements of the curriculum development project include: (1) identification of training needs, (2) the design of a framework for training, and (3) the preparation of specific units of training. The project provides for pilot-testing in highway agencies and evaluation and refinements. The final curriculum will be designed so that highway agencies may select units of training that will best meet their needs and preferences.

The support of this comprehensive major project reflects awareness of the importance of training at the operating level. The project is scheduled for completion late in 1972.

OPERATOR TRAINING

During the past few years there has been an increasing emphasis on training of operator personnel. Descriptions of some innovations in this area follow.

State Highway Commission of North Carolina

In 1966 the State Highway Commission of North Carolina initiated a statewide program of operator training designed to qualify as many employees as possible to fill future vacancies (23). The expressed intention was that the program be kept simple, uncomplicated, and on-the-job if possible.

Primary responsibility for training was placed on first-line Area Foremen. Each began by selecting at least one man from the lower ranks for on-the-job operator training. Each Area Foreman follows the progress of his trainee until the latter is fully qualified, or until it is determined that he cannot qualify.

Instruction periods are scheduled during which 16-mm color film presentations are made to illustrate both good and bad methods of operation of various pieces of equipment. These methods are discussed during the training sessions.

Record-keeping is kept to a minimum by using a simple form, kept in the District Maintenance Supervisor's office. The form simply lists the division, district, and county to which the trainee is assigned, and his name and classification. It lists all the types of equipment used by the Commission and has spaces for entering the date training started and the date completed. The Area Foremen are directly responsible for training, maintaining the record, and judging when the trainee is qualified.

The program has proved successful in that the Commission now has a sufficient number of trained operators to assure continuous operation through peak work periods, and to assure that trained operators are available to fill vacancies as they occur. The program has stimulated Area Foremen's interest and enthusiasm.

Maine State Highway Commission Driver Training

The Maine State Highway Commission initiated a driver selection and training program in 1963 and has refined and maintained it since that time (24). The goals are to: (1) decrease accident frequency, (2) improve performance and production, (3) extend equipment life, (4) increase equipment dependability, and (5) reduce operating costs.

A number of procedures were formalized and followed to assure uniformity. These include:

1. Completion of an employment application on which is recorded information as to driver experience and personal data.
2. Personal interview with applicant and reference checks with former employers.
3. Check of applicant's court and accident records.
4. Training is requested by division engineer or supervisor.
5. Written and oral traffic and driver knowledge tests, and road driving test.

Field training includes operation of specialized equipment such as snowplows, sand spreaders, bituminous distributors, and hydraulic cranes. There is thorough indoctrination in all aspects of the preventive maintenance program, and the operator is given a copy of the inspection, lubrication, and maintenance schedule for his assigned vehicle.

There is provision for certification of drivers to operate types of vehicles and/or equipment. A white certification is for operation of trucks up to certain maximum gross vehicle weight. Blue is for operating autos (including pickups) and suburbans and station wagons. Yellow is for operating specialized equipment such as motor graders, tractor-loaders, and power shovels.

Driver instruction is by two full-time driver trainers—each assigned one-half of the state. Trainees are chosen on the basis of their experience as drivers, skills as mechanics, and ability to communicate.

The Commission sponsors subsidiary activities that are a

part of the Driver Training and Safety Program. These include: recognition safety banquets for crews that operate a full year without a lost-time accident; safe driving pins for those who operate ten years without an accident; and plaques to divisions with fewest lost-time accidents during a full year. These activities are widely publicized.

Standard operating procedures call for meetings before each winter of all drivers, foremen, supervisors, and division engineers. The agenda covers safety, preventive maintenance, driving practices, deicing and plowing procedures, and a review of recurring problems based on past experience.

The Commission believes that accidents have decreased as a result of this program and that morale has improved. There is reasonable assurance that every driver will be safety conscious and that he will perform satisfactorily.

California Maintenance Correspondence Course

In 1971 the California Department of Public Works initiated a correspondence course designed to augment on-the-job training of Maintenance Man I, II, and III (17). The course treats the following subjects, each of which is covered in an individual section: aggregate bases and sub-bases, asphaltic concrete and liquid asphalts, blasting, bridges, concrete, guardrail, median barrier and right-of-way fence, painting, personnel, pollution control, public relations, safety, signs and pavement delineation, snow removal, traveled way, shoulders, and drainage structures.

The course is administered in each district, and preparation of course content is by district personnel familiar with technical aspects of the subject matter. Over-all coordination is by the Management Development and Training Section.

There is provision, at the outset, for test and control groups to establish a basis for determining effectiveness of training. The groups are selected on a random basis. The job performance of the test group is measured before and after taking the course; the same procedures are followed for the control group.

COMPREHENSIVE MAINTENANCE TRAINING PROGRAMS

During the 1960's, a number of state highway agencies determined that rapidly changing conditions and increasing complexity of maintenance operations made it imperative that comprehensive and continuing maintenance training programs be initiated. The major elements of two of these programs are described here.

New Jersey Program

New Jersey initiated development of a comprehensive maintenance training program in 1965 (19). All operating managers and staff specialists were asked to submit areas in which they felt performance could be improved through training. The resulting compilation was organized around three broad fields: (1) Administration and Management, (2) Personnel, and (3) Methods, Materials, and Equipment. The final result was a definition of training needs for eight groups of maintenance employees (Fig. 8). It was

recognized that the training necessary to satisfy existing needs called for a comprehensive program that would require continuous training over the years.

Administration and Management Training

The compilation of training needs revealed that supervisors and foremen had the greatest number of district training needs. The starting point for satisfying these was the development of the Foreman's Academy and the Supervisor's Academy (both described earlier in this chapter).

The number of persons at the upper levels of the organization was so small that it was decided to use out-service facilities. Personnel at these levels attended one or more of the following programs: (1) management development programs offered by the New Jersey Department of Civil Service, (2) the "Management of Managers" training program offered by the University of Michigan, (3) selected programs offered by the American Management Association, and (4) executive development programs offered by Rutgers University.

The Department is planning a management development program for middle managers so they can be developed and trained as they are promoted into executive positions. The level of training will be aimed at present positions and the next higher position.

Training in Administration and Clerical Skills.—A Department Training Officer was appointed and each division in the Department appointed a man to work with him to develop divisional training programs. The Training Officer is responsible for providing programs to improve administration and clerical skills (including typing, shorthand, basic management, advanced management, performance evaluation, statistics, speedwriting, and general administration).

Equipment Operation Training

The study of training needs of nonsupervisory employees indicated need for training equipment operators, mechanics, and mechanics' supervisors in operation, maintenance, and repair of all types of equipment.

Training in equipment operation is organized into two principal programs: (1) the Maintenance Equipment Program, and (2) the Specialized Equipment Program. Both of these are scheduled on a five-year basis.

A major feature of these and other programs is that departmental persons are trained as instructors. It was determined that the best instructors were those who were peers, or nearly peers, of the students and talked the same language.

To train instructors, the Department established a program based on the Job Instructor Training Program (JIT) developed by the federal government in World War II. It is planned that all foremen will eventually be trained as instructors so that operator skills training will be done by local foremen.

Maintenance Equipment Program.—This program includes operation and care of the dump truck, front-end loader, tractor, mower, compressor, light grader, and small tandem loaders. The maintenance methods used in this

program were pavement patching, replacement of steel guardrail, grass mowing, and grading.

Specialized Equipment Program.—This program includes training in operation of the large grader, backhoe, bulldozer, rollers, paving machine, oil distributor, crane, mud jack, tractor trailer, sweepers, and others.

This program is divided into four phases: (1) classroom training, (2) field training, (3) equipment operation under guidance, and (4) equipment operation under general

supervision only. These phases and the hours devoted to them are given in Table 12. Students are examined and certified at the end of each phase. After completing Phase IV, the student is issued a certificate that certifies that he is competent to operate indicated types of equipment and to train others.

Winter Equipment Program.—This program was developed before the Maintenance Equipment Program and the Specialized Equipment Program. The need arose as the result of the introduction of new spreader equipment.

Equipment Maintenance and Repair

The Winter Equipment Program revealed early that there was great need for training of mechanics and mechanics' foremen. The first program for mechanics and supervisors was developed in conjunction with the Winter Equipment Program. Subsequently, the program came to depend primarily on manufacturers' and vendors' training programs. The Department does present programs on general topics, such as fluid power and its applications. Also, mechanics are regularly scheduled in the Maintenance Equipment Training Programs so they can become more familiar with methods of operation used by maintenance forces.

Training for Entrance-Level Employees

The entrance-level position in the Department is the Maintenance Man II position. A training program was developed for new employees and is operated on a continuous basis. The program was initiated, in part at least, to reduce personnel losses. It is described in Chapter Five.

Managerial Planning and Scheduling

The Department is in the process of developing managerial planning and scheduling training for three levels of management in regions and/or districts: (1) administrative managers at the district level, (2) area supervisors, and (3) foremen and assistant foremen. It is anticipated that the programs will focus on the kinds of planning and scheduling that must be performed at each of these levels in a systematic approach.

California Department of Public Works

The California Department of Public Works has emphasized development and training for a number of years (17). It has established a Management Development and Training Section that works closely with the maintenance organization and others in developing and conducting a comprehensive and continuing program of training of maintenance personnel. This unit's activities in connection with the development of the Maintenance Academy are described earlier in this chapter, as are the Supervisor Training Course and the Correspondence Course. A major undertaking now under way is the orientation and training program necessary to develop and implement a maintenance management system. This program will include:

1. Orientation of district management to major elements of the proposed system.

	Division, Bureau and District Heads	Supervisors	Foremen	Equipment Operators	Mechanics	Maintenance Men	Engineers	Administrative Clerical
ADMINISTRATION AND MANAGEMENT								
Administrative Policies and Procedures	x	x	x	x	x	x	x	x
Management Principles	x	x	x				x	x
Work Programming	x	x	x		x		x	x
Fundamentals of Supervision		x	x				x	
Communications	x	x	x	x	x	x	x	x
Public Relations	x	x	x	x	x	x	x	x
PERSONNEL								
Personnel Procedures		x	x	x	x	x	x	x
Employee Relations	x	x	x	x	x	x	x	x
Job Training	x	x	x	x	x	x	x	x
Safety	x	x	x	x	x	x	x	x
Introduction to Supervision				x	x			x
How do I fit in?		x	x	x	x	x	x	x
Information Only			x	x	x	x		x
METHODS, MATERIALS, EQUIPMENT								
Fundamentals of Equipment Usage		x	x					
Fundamentals of Material Usage		x	x					
Materials		x	x	x	x			
Equipment Operation and Maintenance		x	x	x	x	x		
Methods		x	x	x	x			

x indicates training required
Blank indicates training not needed

Figure 8. Training needs of Division of Maintenance and Equipment, New Jersey.

TABLE 12
TRAINING DURATION, NEW JERSEY

EQUIPMENT	TRAINING DURATION (HR)			
	PHASE I, CLASSROOM	PHASE II, FIELD CLASS	PHASE III, EQUIPMENT OPERATION UNDER GUIDANCE	PHASE IV, EQUIPMENT OPERATION UNDER GENERAL SUPER- VISION ONLY
Grader	15	15	150	150
Backhoe	10	10	32	80
Tar pot	5	10	24	40
Scavenger	6	15	24	40
Bulldozer	10	15	40	80
Rollers	15	15	40	40
Paver	15	15	80	80
Oil distributor	3	15	24	40
Crane	20	20	400	400
Mudjack	6	18	16	40
Tractor trailer	6	6	100	100
Sweeper	15	15	40	80
Tailgate paver	5	14	16	40
Concrete saw	3	6	16	40
Pulvi-mixer	5	14	40	40

2. Training of foremen in reporting work accomplishments in accordance with the information system.

3. Training of analysts who will have responsibilities directly related to the Maintenance Management System.

4. Proposed training for managers in systems concepts; foremen training in planning, scheduling, and production reports; management training in budgeting; and supervisor training in reports.

DETERMINING TRAINING NEEDS

Several departments have made extensive analyses to determine training needs of the maintenance work force by using a systematic-analytical technique. This approach was used by the Louisiana Department of Highways as a part of a training research project supported by the Federal Highway Administration. The techniques used in that state are the basis for this description (25).

Major Elements of the Systematic-Analytical Techniques

The major elements of the systematic-analytical techniques for determining training needs of maintenance employees include:

1. *Analysis of characteristics of maintenance work.* This step is based on the notion that (1) the objective of training is improved work performance, (2) it is necessary to analyze the work to identify the knowledge, skills, and abilities required to perform work satisfactorily, and (3) any lack of required knowledge, skills, and abilities constitutes a training need.

2. *Analysis of characteristics of the maintenance work force.* This step is based on the notion that several charac-

teristics bear on development and administration of training. These characteristics are: size of the work force; its age, education, and experience levels; any unique language characteristics; and geographical location of persons to be trained.

3. *Determination of the extent to which the present work force possesses the knowledge, skills, and abilities required to perform work adequately.* This determination is made by administering tests to a statistically reliable and valid sample of the work force. The tests are designed to determine the extent to which the individual knows and is able to do that which the analysis of the work (Step 1, above) indicates that he should know and be able to do.

4. *Determination of learning characteristics of the work force.* This step is essential in that training is not effective unless learning actually occurs and results in changed work behavior. To devise effective training there must be knowledge of (1) capacity to learn, and (2) willingness to learn. These are determined by tests and interviews.

Completion of these four processes provides the basis for developing training to meet defined needs—and use of media determined to be most effective in the particular situation.

SUMMARY

The number and comprehensiveness of the training innovations described in this chapter indicate that there is increasing recognition by many highway agencies of the major importance of training—particularly when initiating major changes in the ways of performing maintenance. Also, there is increasing recognition of the importance of first-

line supervisors in efficient operations—and the necessity for training them to perform well in planning and organizing work, scheduling operations, directing operations, and evaluating performance and taking corrective action.

It seems clear that the systematic approach to maintenance operations is, in and of itself, a generator of training innovations. As one maintenance engineer stated, "I cannot overemphasize the importance of training in conducting the undertaking [implementing a maintenance manage-

ment system]. We find training new concepts the biggest single endeavor. We still have a long way to go before our people really understand what we are attempting to do and report accurately" (26).

The two comprehensive maintenance training programs described are indicative of an important trend toward continuous, comprehensive training. The systematic-analytical approach to definition of training needs is one that shows much promise.

CHAPTER FIVE

RECRUITING

The innovative recruiting practices described in this chapter relate to efforts of some agencies to attract and retain employees through apprenticeship programs, entrance-level training, and orientation programs.

THE MINNESOTA MECHANIC APPRENTICESHIP PROGRAM

The Minnesota Mechanic Apprenticeship Program's aim is to train equipment mechanics. The apprenticeship standards are formulated by the Minnesota State Highway Equipment Mechanic Joint Apprenticeship Committee. This group represents the Minnesota Department of Highways and the Highway Policy Committee of Council 6 of the American Federation of State, County, and Municipal Employees. It is composed of six appointed members—three representing the Department and three representing the union.

Features of the training program are (27):

1. The apprenticeship term is for 8,000 hr, with the first 500 hr considered a period of probationary apprenticeship. During the first six months the Department may terminate employment and the apprenticeship contract without appeal by the apprentice.

2. Apprentices work under competent supervision, receive instruction, and acquire experience, knowledge, and skills required to qualify them as journeymen mechanics. The training includes:

AREA OF TRAINING	HR
Engines—gas and diesel	1000
Clutch assemblies	300
Transmissions (manual)	600
Transmissions (automatic)	400
Drive shaft, rear axle assembly	500
Brakes	500
Front suspension—steering geometry	600

3. Apprentices are selected by the Joint Committee on the basis of their applications, are between the ages of 18 and 30 years, and are required to achieve a passing grade in the examination for "Automotive Mechanic Apprentice."

4. Apprentices are assigned to operating shops and work under a Local Supervisor, usually a shop foreman, who is appointed by the Joint Committee. The Local Supervisor is responsible for immediate supervision and movement of apprentices through the training process.

5. The apprentice is placed in a mechanic apprentice classification during training, and he may advance from the minimum rate during training, in accordance with the Department's merit increase policies and procedures.

6. Upon successful completion of the apprenticeship training, and achievement of a passing grade in the examination for "Highway Equipment Mechanic," the apprentice is guaranteed a position as journeyman in the classification for which he trained. Assignment location is determined by the Department.

The apprenticeship standards are clearly defined and are closely adhered to. The program is well-known in Minnesota and competition is keen. There are usually 250 applicants for a dozen openings. The screening process is the responsibility of the Minnesota Department of Civil Service.

The guarantee of a journeyman's job on completion of the Apprenticeship Program is, in the judgment of the

Engine tune-up	1200
Electrical system (primary)	600
Hydraulic system	600
Welding (gas and electrical)	800
Operation of shop machines and special parts fabrication	500
Miscellaneous	400
Total	8000

Department, the single most important feature of the program. Turnover has been slight during training and after completion. At present, approximately 85 percent of the Department's mechanics are developed through the Apprentice Program.

NEW JERSEY MAINTENANCE MAN II PROGRAM

The New Jersey Department of Transportation has developed, and operates on a continuing basis, a training program for entrance-level employees (Maintenance Man II) (19). This program includes training in methods of pavement patching; joint crack maintenance; drainage; guardrail maintenance; mowing; and winter maintenance. It also includes training in operation of trucks, mowers, loaders, small rollers, compressors, two-way radios, and joint-pouring machines; and proper use of shovels, rakes, sledge hammers, and various small tools.

Features of the program include:

1. Instructors are departmental personnel trained in the Instructor Training Program, and are divided into teams.
2. The program time is 17 days. Classes are generally limited to 12 students.
3. The training involves classroom work, observation by trainee of correct techniques, and actual performance by trainees under supervision of instructors.
4. A follow-up report, made by the trainee's supervisor, shows hours he spent in using hand tools or operating equipment. This information is useful in evaluating the program as well as how effectively new employees are utilized.

The program was originally initiated as a means of reducing the heavy turnover at the entrance level.

CALIFORNIA ORIENTATION PROGRAM

The California Department of Public Works continuously conducts the Departmental New Employee Orientation Program for new employees (17). The program time is approximately 3 hr. The lesson plan includes:

1. A slide presentation with a tape-recorded narration outlining the organization and functions of the Department.
2. Handout materials, including the most recent Annual Report of the Department; a map showing the district boundaries and mailing addresses; and a Safety Booklet.
3. Small group discussions to discuss organization and policies and to list any questions employees may have, and full group discussion of answers to questions.
4. Discussion by representatives of the Personnel Department of such matters as salary, sick leave, vacation, and health benefits.
5. A reaction sheet to be completed by each employee and returned to the Department for analysis and evaluation.

The person conducting the orientation must see that all questions are discussed and answered. If answers cannot be given during the session, participants are assured that the answer will be obtained and that they will be informed.

COMMENT

This study did not reveal as many innovative practices in recruiting as in other areas. However, it should be recognized that increasing emphasis on training and administration probably will have a marked positive effect on the "image" of maintenance and will result in attracting more applicants.

A second factor that probably has affected recruiting practices is that a number of departments have reduced the number of maintenance employees in the work complement as the result of innovations in work practices.

TRENDS IN MAINTENANCE PERSONNEL ADMINISTRATION

The subject areas of this synthesis—recruiting, training, retention, and performance—constitute major responsibilities of personnel administration. This study revealed several major trends that now affect, and will probably continue to affect, maintenance personnel administration.

TREND: MAINTENANCE MANAGEMENT SYSTEMS

There is a definite trend toward systematic maintenance management and this will definitely result in improved performance and retention of maintenance personnel.

The 1970 report of the Committee on Maintenance and Operations Personnel indicates that 8 highway departments have already changed their maintenance operations to a unit cost basis, and that 21 contemplate changing to that basis. The unit costing basis (cubic yard, linear foot, gallon, ton, etc.) is a fundamental first step toward systematic operations. The reporting system associated with the change to the unit basis will yield the kind of information that will lead to increasing emphasis on the responsibilities of first-line supervisors to plan and organize operations, schedule work, and evaluate performance. These, in turn, probably will lead to establishment of stronger supportive relationships among all levels of management and improved communications. All these will result in an improved motivational environment for operating-level personnel.

TREND: COMPREHENSIVE MAINTENANCE TRAINING PROGRAMS

There is a definite trend toward development of comprehensive, continuing maintenance training programs that emphasize appropriate training at all levels of the maintenance organization.

The trend toward comprehensive, continuing maintenance training is probably due largely to the influence of "systems thinking" that leads to recognition that such training is essential if adequate supportive relationships are to exist among the various levels of management. The training will, of necessity, emphasize planning and organizing work, scheduling of work, work methods and procedures, and controlling activities.

TREND: MORE EFFECTIVE TRAINING

There is increasing emphasis on development of techniques for effective definition of training needs, techniques for effective satisfaction of these needs, and techniques for measuring results of training.

The many changes that are now occurring in mainte-

nance virtually dictate an increasing amount of training. Training is expensive and time consuming, but benefits from effective training generally far outweigh costs. But the cost-benefit situation requires effective definition of training needs and development of techniques that provide reasonable assurance that training aims are accomplished.

TREND: STAFFING FOR MAINTENANCE TRAINING

There is increasing emphasis on staffing maintenance training sections with a "core" of personnel specialists, augmented by generalists who have experience and knowledge of maintenance operations.

The kinds of maintenance training developing in maintenance organizations require a combination of knowledge, skills, and abilities. In the first instance, the development of performance-oriented training materials requires persons who have first-hand knowledge and experience of maintenance operations and the "language" of operations. Secondly, specialists with background and training in personnel functions and activities are valuable to act in advisory, coordinative, and consultative capacities.

TREND: "LABOR POOL" CONCEPT

There is a definite trend toward the "labor pool" concept of organization at the operating levels of maintenance organizations.

The fundamental reason for the trend toward the labor pool concept is to assure efficient use of personnel and equipment. The trend represents a departure from traditional organizational concepts that have tended to revolve about the idea of specialization. The labor pool concept appears to have two major advantages: (1) it creates organizational flexibility that results in reduced labor costs, and (2) it appears to result in greater motivation (and, hence, improved performance and retention) because it increases the range of knowledge, skills, and abilities required of personnel.

TREND: EMPHASIS ON LABOR ORGANIZATIONS

There will be, of necessity, increasing emphasis on personnel administration activities related to labor and labor organizations—an emphasis brought about by increasing unionism.

The 1945 report of the Committee on Maintenance Personnel showed that some, or all, maintenance employees of eight state highway departments were organized by a national union (5). The 1970 report indicates that maintenance employees of 11 agencies are organized by a national union, and that membership is optional in 5 other

states (6). Furthermore, the 1970 report indicates that the maintenance employees of 15 other states are organized by local unions or employee associations, with optional membership possible in 5 other departments. Only 13 states indicated no organization of employees by national or local unions, or employee associations.

There is indication that a strong trend toward organization exists among public employees. Perlman (28) in June 1971 stated:

In less than a decade, union membership has at least tripled among employees of federal, state, and local governments. . . . A mere chronology of this phenomenal growth of union organization in the public sector would make an impressive chapter in any labor history. But it is too soon for the book to go to press; we are only midway through the chapter.

The rules of procedure for public employee collective bargaining are in an evolutionary state and probably will not be firmly set for some time, but it appears to behoove maintenance managers to direct special attention to this developing situation.

TREND: MANAGEMENT AND ORGANIZATION DEVELOPMENT

There will be increasingly strong emphasis on management and organization development.

In effect, this last trend sums up the message of this synthesis. It is perhaps best illustrated by the words of one maintenance engineer, who stated (29):

Only through good management procedures can we provide the desired standard of maintenance with less available funds. When I say less available funds, we might as well face the fact that maintenance costs cannot increase in the future as they have in the past if we expect to see any modernization of our present highway system.

We have heard a lot in the past few days on "performance standards," "quality and quantity standards," and "performance budgeting." While we may not like the sound of these terms and what they imply, they are the immediate "future" of tomorrow for which we must adapt our thinking if we expect to continue as maintenance engineers—otherwise the accountants will replace us.

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APPENDIX A

RESULTS OF QUESTIONNAIRE ON TRAINING

RESULTS OF HRB A3C03 SUBCOMMITTEE QUESTIONNAIRE ON TRAINING OF OPERATING PERSONNEL 1971										
Personnel Classi- fication	Type of Course	Department Degree of Interest in Training Program			Method of Instruction Used			Success of Program		
		Have Course	Need Course	Do Not Need Course	Formal Class Room	Self Instruc- tional	Formal on the Job	Poor	Fair	Good
Laborer	Safety	28	17	2	17	1	19	2	11	15
	Orientation	12	11	13	5	1	8	2	7	5
	Motor Vehicle License	7	3	22	5		4		2	4
	Educational Upgrading	12	7	15	6	7	1		5	7
	Equipment Operation	13	17	9	3	2	12	1	5	8
	Other	5	3	1	4		2		1	4
Equipment Operator	Safety	27	17	2	19	1	17	1	10	15
	Motor Vehicle License	9	3	24	6	1	4		3	6
	Operating Techniques	20	18	5	7	2	16	2	8	9
	Equip. Maint. Skills	18	17	5	10	2	14	1	5	12
	Basic Supervisory Training	7	13	14	6	2	2		3	3
	Educational Upgrading	11	10	13	5	7		1	4	6
	Other	8	2	1	6	1	2		1	7
Working Foremen	Safety	29	17	1	21	2	15	2	7	19
	Supervisory Skills	19	21	1	18	1	3	2	4	11
	Simple Work Planning & Scheduling	14	22	3	10	1	9		7	7
	Introd. to Depts. Procedures & Forms	10	18	7	5	1	6	1	6	4
	Execution	12	9	13	6	6	1	1	5	7
	Educational Upgrading	8	2	1	6	2	2			6
General Foremen or Supervisor	Safety	28	17	1	19	2	13	2	8	17
	Supervisory Skills	25	16	1	19	2	2	1	6	13
	Work Planning & Scheduling	17	23	1	12	2	10		7	10
	Educational Upgrading	11	11	12	7	5		1	3	8
	Tech. Skills (Blue Print Reading Const. Tech.)	11	15	10	6	4	2		3	7
	Basic Budgeting	6	13	18	5	3	5	3	1	4
	Utilization of Information Systems	6	15	14	5	2	5	2	2	3
	Other	9	3	1	8	1	1			6

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