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Foreword

With the substantial increase in maintenance and construction work loads since the inception of the Interstate Highway System, with the continued high turnover of personnel in many states, with the scarcity of qualified labor, with rapid technical innovation and its concomitant requirement for higher skill levels, there is a growing scarcity of trained personnel for state highway programs. This RECORD reports on the recent activities of a number of states in the area of manpower planning and personnel training.

The first paper by R. T. Soderburg reports on pre-appointment training for top level managers. The California Highway Department has attempted to assess the needs of persons about to be appointed to middle and top level management positions. For upper middle manager positions, the need was to direct the concern of managers to problems of planning, control, resource utilization, and program evaluation. For persons about to be appointed to top level management positions, the need was to broaden their time prospective from short-range to long-range goals and from their previous functional areas of concern to organization-wide concern. The training programs for manager training utilized small group workshops.

Barry L. Elkins and H. R. J. Walsh, Indiana State Highway Department, and Elden G. Spier and Gordon L. Bell, North Dakota Highway Department, report on manpower needs and training programs for state highway construction inspectors. In Indiana, inspector training was accomplished through on-the-job training programs in the highway districts. With the development of a new research and training center near Purdue University, inspector training courses are now being conducted on a more formal basis at the research and training center. In North Dakota, manpower needs for construction inspectors were related to standard types of construction activities. Manpower requirements were calculated for each of the standard construction activities. In this way, manpower needs may be directly tied to work-load forecasts.

Also included in manpower planning in North Dakota is the development of a new classification and salary plan for maintenance personnel, which is reported on by James O. Kyser. State highway department personnel were utilized to develop the plan under the direction of a consultant. In this manner, highway personnel were familiar with all phases of the plan and were ready to implement it and to provide for changes as new personnel problems arose. Committees were chosen to define the work performed by all maintenance employees and on completion of the analysis, maintenance employees were given an opportunity to discuss and dissent on the new classifications.

In 1957, the Illinois Division of Highways did not have sufficient technical staff to accomplish the projected Interstate Highway program. Therefore, to relieve engineers of the more repetitive task, the Highway Department began recruiting and training engineering technicians. R. L. McCracken reports on training programs for technical and maintenance

employees by the Illinois Division of Highways. Since 1957, more than 1500 engineering technicians have been added to the Highway Department staff. In addition to initial training programs, follow-up training programs have been devised for both engineering staff and technicians. These formalized programs insure that inspectors on construction projects have a thorough knowledge of inspection procedures and specifications and that maintenance employees are acquainted with the new and more sophisticated maintenance methods and equipment.

One technique receiving much attention for training of personnel is the use of programmed learning courses. Alfred Miller reports on the use of programmed learning for the training of highway construction inspectors in the Virginia Department of Highways. The paper demonstrates the efficiency of programmed learning and describes the limits of its potential as a teaching process. Using programmed learning courses, 90 percent of the new construction inspectors in Virginia have received training in mathematics, plan reading, specifications and standards, and fundamentals of leveling within six months of their initial employment.

Leonard H. Guilbeau of the Louisiana Department of Highways further identifies factors affecting the initiation of the formal training program for construction inspectors. The organizational structure of the highway training system is described and requisite characteristics of the training personnel along with duties and responsibilities of the different job positions are defined.

Mortenson, Kascak, and Noriega describe the training program being developed for maintenance personnel of the Louisiana Department of Highways. The four basic training methods that will be used are written programmed instructions, audio-visual programmed instruction, programmed workshops and group discussion.

Contents

Pre-Appointment Training for Top Level Managers

R.T. SODERBERG, Chief, Management Development and Training, California Division of Highways

This paper discusses the development of employees eligible for appointment to civil service positions as upper middle or lower top management in the California Division of Highways. It concludes that formal training immediately prior to appointment is desirable for the objective of changing the orientation of the appointee. For persons about to be appointed as upper middle managers, it was found that what was needed was a focus away from roles that had been predominately as supervisors and as technical experts, to roles which encompassed management planning, control, resource utilization and program evaluation. For persons about to be appointed as lower top management, what was needed was a broadening from short-range to long-range goals and from functional area to organization-wide concerns. Above all, complacencies needed dispelling and realization achieved that organizational improvements could and should be made. Findings were primarily through interviews with persons now at these levels and their supervisors. Interviews focused on problems, not on what training was needed.

The paper proposes that short small-group workshops, if properly designed, can meet the expressed objective. Proper design focuses on using actual problems in the training. At upper middle management levels this was accomplished through simulation of the problems within training groups, and careful evaluation and feedback of the results to the persons being trained. At lower top management levels, it was through assigning the trainees in small groups to analyze and report on assigned problems which were of current paramount interest to the organization, and to use the results to actually influence the course of action taken by the organization. These methods have proven effective with three upper middle management groups and two lower top management groups. The division intends to continue and expand this program.

•ON three separate occasions in 1965, 1966 and 1967, special teams of managers from the California Division of Highways sat down to operate a highway district. Each team had many of the major problems of a typical district—budgets to prepare, sizable program changes to master, claims to settle, routes to recommend, speeches to give—and each team was judged on its performance in competition with every other team. The districts existed only on paper. The performance and evaluation were a training exercise for people who were soon to be considered for promotion to positions where they would be expected to make the kinds of decisions required in the exercise.

Again, once in 1965 and again in 1967, other teams of managers began work on some of the most critical overall managerial and philosophical problems facing the California Division of Highways. Their objective was to report to the state highway engineer, giving him proposed guidelines and recommended courses of action. The problems were real, as were the requirements for reports. Yet again, this was primarily a training conference whose main reason for existence was the development of the conferees.

Paper sponsored by Department of Economics, Finance and Administration; Department of Urban Transportation Planning; and Department of Maintenance and presented at the 48th Annual Meeting.

These two types of workshops, the pre-appointment training of persons currently eligible to become the division's upper middle or lower top management, are a portion of the management development program of the California Division of Highways. These workshops, our Management Conference—Supervising Level, and our Management Conference—Principal Level, are given whenever circumstances require. The objective of this paper is to provide information about them that may help other organizations to design, develop or expand their own management development programs.

As our workshops are keyed to our organizational structure, promotional system and student group, we will first place them within the context. Also we will (a) briefly enumerate other phases of our management development program, as these are prerequisite to these workshops; (b) discuss how the needs for the workshops were determined, and what these needs are; (c) discuss workshop objectives and constraints, development and implementation, content, methods, and instructors; (d) give our conclusions as to how well the workshop objectives are met; and (e) discuss future workshop plans, including intended changes.

ORGANIZATIONAL CONTEXT

Organization

The Division of Highways is a relatively large, full-functioning organization within the California Department of Public Works. Its primary mission is the planning, design, construction and maintenance of the California State Highway System, including the appraisal and acquisition of required right-of-way. It has more than 17,000 employees and an annual budget of approximately one billion dollars.

The division is directed by the state highway engineer. Reporting directly to him are three headquarters staff deputies and 11 line district engineers each of whom is responsible for the entire program in a geopgraphic area of the state.

The district engineers are at the principal engineer level in the 7 smallest districts (350 to 1,000 employees) and above this level in the remaining 4 (1,200 to 4,000 employees). In the two largest districts, the district engineers have several principal engineer level subordinates. In headquarters (approximately 2,500 employees) the principal level bears the title of department head and generally reports to the immediate subordinates of the deputies. These department heads have divisionwide staff responsibilities for a program area (construction, design, right-of-way acquisition, etc.). In both districts and headquarters, the next level down is the supervising level.

Principal and supervising level positions are responsible management jobs. For example, a principal serving as a district engineer has up to 1,000 direct subordinates and a total annual budget of up to 52 million dollars. District supervisory level employees may have well over 200 employees and direct line supervision of several major district programs. In headquarters, the level of responsibility is comparable. The workshops discussed in this paper are for all persons eligible for promotion to positions at these two levels.

Merit System

All division employees are under the California State Civil Service, which is a merit system. Promotion is by competitive examination and is almost always from within. To qualify to compete, an employee must meet minimum educational or registration requirements and have a specified amount of experience in lower grades.

The examination includes a written test and an oral interview. Persons who pass both phases are given an overall score and assigned a position on an eligible list, which stays in effect for up to four years. The division may choose any one of the top three people on the appropriate list when it has a vacancy it wishes to fill.

Student Group

The promotional ladder narrows rapidly in the division. We have approximately 4,500 employees in professional and other positions requiring a college degree and extensive training. These are the people potentially eligible for positions at the super-

vising and principal levels. About 2,900, or 63 percent of the 4,500, are in entry and sub-journeyman level jobs. Another 1,100, or 24 percent, are full journeymen or first line supervisors. Four hundred, or 9 percent, are second level supervisors. Only 3 percent, or 150, of those potentially eligible are at the supervising level, and less than 1 percent, are at the principal level. The workshops are directed toward these 4 percent of the positions. The persons eligible to attend them are on the Civil Service lists for positions at the supervising or principal level.

As this is an engineering organization, a large proportion of these people are required to be engineers. The state highway engineer, his deputies and the district engineers are all registered civil engineers. In headquarters, 2 of 11 persons reporting to the deputies are from other disciplines—an accountant and a right-of-way agent. There is a similar percentage of non-engineers at the principal and supervisory levels in the districts and at headquarters. All positions at these levels, however, are in merit system classes that require either registration as an engineer or a college degree, plus special training and experience.

From our records, a picture may be drawn of the average candidate for the supervising and principal level. He is a college graduate with years of varied, meaningful division experience. He has been developed by carefully planned rotation and reassignment augmented by extensive in-service training in his occupational specialty, management and supervision. Generally, because of the broad base of the promotional pyramid, only those employees who have performed well and have shown considerable promise promote through the lower levels to qualify for the higher level positions.

The typical person appointed to the supervising level is a 42-year-old college graduate with 18 years of division service. The new principal averages 6 additional years at the supervising level, which makes him 48 years old with 24 years of experience. These factors must be considered in deciding whether additional training is necessary and desirable, and what kind of training should be given, if any.

MANAGEMENT DEVELOPMENT PROGRAM

For more than 10 years, the division has augmented the education and experience of potential management employees with an extensive in-service training program. Entry and sub-journeymen employees are given extensive, planned rotation through the major functions in which the division uses their occupational specialties—two years' rotation, for example, for junior engineers. Rotation is supplemented by evaluation and counseling, and by on-the-job and classroom training.

At the first line suprvisory level, these employees participate in basic supervisory management training—40 hours plus in small group seminars, 80 hours plus of outside reading and homework. At the second line supervisory level, most participate with their peers in small-group, team-training, leadership laboratories to sharpen their interpersonal/supervisory/communications/problem-solving skills. The 60 small group hours are supplemented by planned reading and homework assignments. These programs are mandatory for persons at the appropriate organizational levels.

Throughout these years of the employee's career, this basic training is reinforced with refresher and special purpose training courses as needed. Both the employee and his management are required to assess the employee's experience and potential at frequent intervals. The high-potential employee is frequently reassigned to constantly broaden his experience. Thus, persons qualifying by experience and examination for supervising and principal level positions should be well prepared.

NEED FOR ADDITIONAL DEVELOPMENT

Despite this extensive training and experience, top management had some feeling that many persons on supervising and principal level lists were not as well prepared as they should be. The impressions, somewhat vague and ill-defined, centered around a wish that new supervising level employees would adjust to their new management jobs a little faster and a little less hesitantly. For the principal level, the wish was for the newly appointed person to take a broader viewpoint of his job, be less inclined to suboptimize in his decisions, have a better sense of priorities, contribute more to overall division policy and plan formation.

How Need Was Determined

To find out what caused these impressions, the division undertook an extensive study. First, questionnaires were sent to supervising and principal level employees to determine what kinds of things had given them the biggest problems when they were first appointed. Second, other questionnaires were sent to the immediate superiors of principal and supervising level employees. These asked for a frank expression about problems they had with new employees at these two levels, and what kind of performance changes in these employees they would find desirable. Third, the results of both questionnaires were analyzed, and promising areas were identified. We then interviewed a sample of existing supervising and principal level employees and their superiors. The interviews, like the questionnaires, focused on problems and their causes, not on suggestions for training or development. Finally, desk audits were performed on a number of supervising and principal level jobs to determine what the jobs actually comprise, how the work time was spent, and what caused the most difficulty.

What the Need Was

Without going into the specific problems identified, it is possible to generalize about our findings. For both levels, it was found that the major requirements were to help the newly promoted employee change his orientation. For those promoting to the supervising level, the prior orientation had been that of the supervision of professional men and the performance of the role of the technical expert. The majority of the new positions required far more interest and skill in management planning, control, resource utilization and program evaluation. The problem was not a lack of knowledge; it was primarily an attitudinal and skill problem. The new supervisor had to recognize more rapidly what was expected of him and to gain confidence in his skills to meet these new requirements.

We found the new principal needed a better concept of what was important. This entailed long-range as opposed to short-range thinking; a divisionwide rather than a functional or geographic area viewpoint. The new principal had to concern himself more with divisionwide goals, objectives and problems.

This was the information we needed to develop in the people about to be appointed to these two levels. We chose to do this through the pre-appointment workshops. Their development and implementation is discussed in the following.

WORKSHOPS

Objectives and Constraints

With the type of need determination previously discussed, it was relatively easy to spell out objectives. For the supervising level, we wanted a training experience that would help the newly appointed supervisor understand and accept his new job responsibilities, recognize his current skills to perform these, and identify his skill and knowledge shortcomings so he could do something about them. It was all pointed toward helping the new supervisor perform more effectively on his new job from the start, thus shortening a costly learning period.

We wanted the new principal to accept that the division comprised more than his assigned area, and that his responsibilities extended to helping shape the division's overall course. We wanted to create anxieties and with them recognition that the division could be improved. This required that we dispel complacencies and raise questions about old, tested and true solutions to problems.

We recognized that these objectives were extensive and that we could only expect minimal achievement through any one development activity. On the other hand, even minimal accomplishment would be very worthwhile. It was, therefore, necessary to look at our constraints.

The Civil Service System and administrative expediency imposed one set of constraints. It would be unwise to select for special training some of the competitors for top positions and not others, as this would give an edge in the examinations. Yet, we

did not wish to spend the money required to train the entire competitive group. If we waited until after appointment to give the training, there would not be enough promotions at one time to make group methods feasible, and it would be hard on the division to release the promoted employee to attend the training. On the other hand, the training should be as close in time to promotion to the new job as possible.

An ideal solution was to limit participation to those people who had qualified by examination for positions at the two levels, to make the training mandatory for these employees, and to hold the training as soon after the lists were established as possible. As the supervising and principal highway engineer lists are ordinarily the largest and the most used lists at their respective levels, the workshops are keyed to the examinations for these classes. At the supervising level, the lists are long enough so that they can be divided into thirds and the workshops given as each one-third becomes reachable for promotion. This solution satisfied our first set of constraints. It perhaps should be said that even though all persons on the lists are eventually trained, not all are subsequently promoted. Appointment may take place as early as at the time of training, as late as two years after the list is out, or in some cases, not at all. Those who are trained and promoted are generally very stable in the organization; turnover at the principal and supervising level is very, very low, the primary reason for leaving being retirement.

Another set of constraints involved actual time to be used. This necessarily had to be limited so the persons in attendance would not be away from their jobs too long. We decided to make the most out of actual workshop time in three ways:

1. Knowledge inputs would be by pre-reading/correspondence courses. In this manner, we would know that all persons who attended were amply prepared, and valuable workshop time would be saved for activities that are best performed in groups.
2. The workshops would be live-in, and would encompass 12 to 14 hours per day. As the workshops were to be of a relatively short duration (4-5 days) and were of an active, participative type, we felt that the long hours would be advantageous and not excessively hard on the participants. These expectations proved to be true.
3. The workshops had to be well planned. Extensive staff time—more than ½ man-year each—was required for preparation, but this amount does not seem excessive in light of both the expense of having the workshops and the importance of the objectives.

A final set of constraints evolved from the amount of training and development the participants had completed in the past, and the direct tie between the workshop objectives and those of the division. It seemed unlikely that we could achieve our objectives through an academically developed, theoretically oriented approach. Rather, we felt that we needed real problems from the real world of the California Division. Hence, we decided that all workshop development and instruction should be done with our own staff resources, rather than relying on outside consultants, and that all content must be concerned directly with the operation of the division.

It was with these objectives and constraints that development of the two programs was begun. The workshop approaches outlined below are those that seem to fit our guidelines best.

METHOD, CONTENT AND INSTRUCTIONAL STAFF

For the supervising level our objective was to get better job performance as soon after appointment as possible, for the principal level our objective was to get better understanding of and meaningful involvement in overall broad-gauge division problems. Each set of objectives required a different approach and different content.

Supervising Level

For the supervising level we had discovered a number of pressing job problems when desk audits of the positions were performed. It was decided to use these problems as the basis for a simulation.

We constructed a paper highway district, complete with assigned territory, roads, deficiencies, budget, planning program, staff, and even telephone books. It was located within the real California Division of Highways with the existing management and headquarters staff.

At the supervising level conference, we divided the total number of conferees into five teams of five members each. These five represented the top staff of the artificial highway district. During the conference, each rotated through the roles of district engineer, assistant district engineers for administration, planning and operations, and district right-of-way agent. Each team was given office space, telephones, and all of the documents needed to run its district.

Problems were fed in by mail, by telephone, and by personal visits. It was the responsibility of each team to decide at any given moment what its most pressing problems were, to work out solutions to these problems, and to feed in answers to the workshop staff.

The staff was carefully selected from persons who held positions of the kinds that the participants were role-playing. Members were selected because of excellence of performance in their current jobs, and they had three functions at the workshop, as follows:

1. To play the roles of district subordinate staff, headquarters staff, and interested outsiders. In these roles they made and answered telephone calls to and from the teams, made personal visits to the teams, input information on the problems, and answered questions from the context of their role.
2. To evaluate the output of each team and to assign it a score.
3. At the conclusion of each time period, to feed back to each team an evaluation of how well it did, why, and how it could have done better.

The problems used at the supervising level workshops were in the following areas:

1. A major unexpected increase in the district right-of-way program.
2. An attempt to lower preliminary engineering costs.
3. A disputed contractor claim.
4. A billing problem with a county for maintenance work.
5. Revising procedures for a right-of-way relocation program.
6. To make a speech on Equal Opportunity Employment to a community group.
7. To rate their men for possible promotion.
8. Troubles with their junior engineer rotation program, and the development of improvements.
9. Preparation of an annual budget request.
10. Analysis of management reports and a plan to improve indicated weaknesses.
11. Planning a resident engineer's meeting.
12. Several public relations problems involving the Legislature.
13. Advice to the state highway engineer with respect to how to handle anticipated federal cutbacks.

On each problem, each team competed with every other team, and scores were posted. The spirit of competition was high, yet each group generally felt that the standards used by the evaluators were fair and were equitably applied. Learning came from both the problem-solving experience and from the feedback of the staff to the participants.

Principal Level

At the principal level a different format was used to meet the different objectives. The state highway engineer and his deputies are always concerned with a number of current problems facing the division. At the time of the last conference, for example, the following problems were among the most pressing:

1. The establishment of effective management controls.
2. The most efficient allocation of personnel in the face of changes in program size between districts.

3. The development of meaningful work norms and standards.
4. The extent of division involvement in and with other transportation modes.

For this workshop, extensive pre-reading on each of these problem areas was sent to the conferees. Also, they were given and expected to complete a brief correspondence course on problem solving.

At the workshop, the conferees were divided into three six-man groups. Each group, within allocated times, was asked by the state highway engineer to arrive at recommendations on each of the foregoing problem areas. While they worked on the problems, they were both assisted and evaluated by assigned resource people, again selected from within the division from among the experts in each problem area.

At the conference conclusion, one member from each group was assigned to a special task force for each problem. The task force's job was to arrive at a consolidated report on the assigned problem, and to submit it to the state highway engineer. Subsequently, these reports have been used along with other inputs to guide the division's course of action in these areas.

HOW WELL WERE OBJECTIVES MET

Our evaluations of the first three Supervising Level Management Conferences and the first two Principal Level Conferences are quite encouraging, although not scientific.

The first evaluation took place at the conferences themselves. It was universally evident at all five conferences that the participants performed much better on each succeeding problem. This was despite the fact that the level of difficulty of the problems also increased. Hence, there was some development of the skills and attitudes required for the conferees to function together effectively.

The second evaluation took place through interviews of the superiors of newly appointed supervising level employees who had attended the conference. They expressed satisfaction with how these people were performing on the new jobs, and indicated that performance seemed to improve faster than they would ordinarily expect.

A third evaluation took place through using some of the principal conference graduates on special management problem-solving task forces. Their performance evidenced they had learned through the training they had received.

Spin off, that is, the achievement of secondary objectives, is high. In the first place, there seems to be a better understanding between district and headquarters people and among the employees in various disciplines who were at the conferences together. Cooperation is good and there seems to be excellent rapport. In the second place, lasting, meaningful work relationships have developed between the conferees and the conference staff, and there has been much informal consultation and advice giving.

An unanticipated result is that the conference staff seems to have developed at least as much as the conferees did. The same rapport noted between conferees and staff has developed staff to staff. As the staff members are relatively high level division managers, this is a most meaningful development.

Conference participation by persons eligible for promotion has also allowed management to get another look at these employees' performance, which has aided us in determining additional individual training needs for the participants and recognizing other divisionwide needs. For example, a current training program for all division managers in "The Systems Approach to Problem Solving" has arisen directly from principal level workshop findings.

As a last benefit, the reports submitted to the state highway engineer from the principal level conference task force have been extremely useful to the division in planning its current management improvement programs.

From the foregoing, it is our conclusion that conference objectives for both programs were achieved to a degree greater than expected when the conferences were planned. Spin off has added to the value we are receiving and has resulted in a very favorable cost-benefit ratio.

FUTURE CHANGES

The changes that we will make in the workshop format are minimum. Of course, each time new workshops are held, new problems will be in the foreground and will be substituted for those used in past workshops.

Other changes involve the evaluation process. We find that an evaluator should be present with each team at all times to evaluate the group problem-solving process. This will entail additional expense, but the immediate feedback to the group will be worth it.

Also, longer periods than we have allowed in the past should be used to give more extensive evaluations of the end products. This will mean either lengthening the conferences, reducing the number of problems or increasing the number of people assigned as evaluators. We will probably attempt some of each.

With these minimum changes, we expect to continue the workshop program, as in the past, each time new lists are established at the principal or the supervising level.

Development of a Formal Highway Training Program in Indiana

BARRY L. ELKIN and H. R. J. WALSH, Research and Training Center, Indiana State Highway Commission

This report discusses the formal in-house training program that the Indiana State Highway Commission has developed within the last few years, concentrated on construction personnel. Originally, such training was done by the districts, or the immediate supervisor, principally in an on-the-job manner. In cooperation with Purdue University through the Joint Highway Research Project, some courses were developed and presented, and the activity rapidly developed into the establishment of a Research and Training Center within the Commission, with a number of varied courses.

A number of courses are described as they are now taught, and the teaching philosophy and techniques that brought them to their present form are illustrated.

•THIS report is primarily a discussion of certain courses as they are now taught at the Indiana State Highway Commission Research and Training Center. The training of highway personnel, such as inspectors, is not a standard educational situation, and the approach to be used deserves a little special consideration. The following information about our courses is that which seems best to illustrate the teaching philosophy and techniques that have seemed most efficient in Indiana.

The historical development of this program is not discussed, although it must be acknowledged that what is presented in this paper did not begin and develop in the last year. The efforts of many people over a long period of years, even prior to the establishment of the Research and Training Center of the Indiana State Highway Commission in 1966, led to the present program. Engineers from throughout the Commission and on the faculty of Purdue University, especially Professor Eldon Yoder who first served as Acting Director of the Research and Training Center, contributed to the development of the present courses.

The Center is now staffed entirely by Commission personnel who can concentrate on the problem of improving present courses and developing new ones, although each also works on applied research projects. It occupies a facility that was designed for its functions and has an arrangement and supply of equipment that has been adequate for the present. It is hoped that this report will illustrate the particular educational methods and techniques that have been applied to give the courses their present efficiency and effectiveness.

PRESENT PURPOSE AND GUIDING PHILOSOPHY

The formal training program for highway construction personnel in Indiana is primarily geared to the inspector. A principal criterion for such a program is a focus on the inherent lack of background and technical knowledge of the largest single group

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of individuals in the highway department. The purpose takes several forms as a result of the nature of the responsibilities and the varied ranges of experience of the men to be trained.

One of the main desires of the program is the orientation of the new employee to the general aspects of highway construction techniques, specifications, and procedures. From the beginning of the construction season in April until the middle of June when school ends for the summer, the highway department experiences its greatest influx of applicants interested in the field positions. Most are fresh out of high school and perhaps this is their first permanent job. A good number of these individuals are using the opportunity to make some money to continue their education. Some of this number are older men who have retired from their life's work but still have the vitality to continue as active wage earners.

The ages of this group range from the late teens to the early sixties. They are required by law to have an education equivalent to a high school diploma, as a minimum, but for some this was acquired years ago and essentially is of little value. There is no maximum limit on education—a few graduate civil engineers from foreign countries have worked as inspectors while learning the language. Many have never held a job. Some owned their own businesses. Some are retired school teachers. The remainder have worked in various other capacities. The one characteristic that most of these men have in common is the lack of a working knowledge of highway construction. This group must be taught in general terms that there is more to the inspection of building a highway than watching the equipment run back and forth.

Another purpose concerns the training of the experienced inspector with the emphasis on extending and rounding out his knowledge. Many inspectors with some time in the field have been assigned a single responsibility. If they perform well and are effective in this capacity, and if the need is over an extended period of time, they will probably remain in this position for the duration of this phase of work. Many engineers find this to be an efficient way to administer a project. But, when that phase is completed, the inspector must be reassigned to another type of work. This will require training so that he will be as effective in his new and different capacity as he was in the previous. If he has had some experience in this phase of work but has forgotten some of the specifications or problems, the course he will attend will refresh his memory and give him confidence. When necessary he will also be brought up to date on improved methods of testing, changes in the specifications, new construction procedures, specific problems that will require attention, etc.

The third direct purpose of an organized program of this nature is to train seasoned inspectors for positions that require more responsibility. Some individuals have the technical background, the experience, the potential, and the general intelligence to serve the project engineer as an assistant or even to assume the position of project supervisor on a small contract. The program includes courses that can aid the individual if he has the desire to accept more responsibility.

A highly desirous aspect to come out of this program is the standardization of testing procedures throughout the state. It is well known that each test designed to control a specific characteristic of a certain material has a definite procedure that must be followed in order to obtain information that can be related to similar information obtained by someone else on another sample taken in a different location. A purpose of Indiana's training program is to teach the proper testing techniques, as set down in the specifications, to all inspectors to provide a consistent basis of quality control from job to job.

There is also an indirect purpose for the development of a training program. Many inspectors see this as a means to develop and to work their way up the ladder. They can rapidly see the pattern that leads to job security. This aspect leads to interest in the work, which in turn benefits the employer. As a rough estimate, at least $75,000 per year is spent for inspection on an average road construction contract. This is a sizeable investment that can be tolerated if the inspection is competent and produces the quality expected. To insure this investment and the quality of a much greater investment, such as an Interstate highway, it is felt that a formal training program is a must.

IMPORTANT DEVELOPMENTS

The formal program had its beginning in 1963 with a four-day course, known as the General Insepctor's Course. The course was developed by a planning committee of Commission engineers and members of the Civil Engineering faculty at Purdue University, which also provided the instruction until after establishment of the Research and Training Center in 1966. Various highway commission engineers from construction and testing were called on to suggest particular requirements and to advise the planning committee. From these meetings a schedule for the course was established and a manual was written accordingly. The schedule for the course was divided into three general areas—soils, concrete and bituminous. Each of these areas was divided further into three sections—theory, field procedures, and laboratory sessions. Each of these areas was introduced with a lecture on the background and theory of the material. This was followed by a laboratory session where groups of students performed the specified tests used to control the material in the field. Finally, the area was completed with the instruction of general field procedures and specifications by the project engineer experienced in this area.

The trial course was quite successful and the basic format was continued even after the formal training program came under the complete administration of the Highway Commission. Then the engineers of the Center reviewed the comments of the various interested parties within the Commission, and also incorporated the teaching methods that had been found so efficient in the Specific Task Courses as discussed later. Thus, the course was reduced to three days.

The following discusses the major developments that resulted as the program expanded from the original General Inspector's Course. As an aid to the reader, the sections are listed in order of their importance as we see it: Specific Task Training, Organization and Operation, Surveyor's Course, and Project Engineer's Workshop.

Specific Task Training

Early in 1967, an aspect of training was considered that was new to Indiana, and development of appropriate courses was started. Reports from other states told of their satisfaction with Specific Task Training. In this case, a short course is designed specifically to teach the methods and procedures associated with a single task or particular area of job control. In essence this type of course is now the backbone of our entire program, because it provides a means of training an individual who has little or no knowledge of construction procedures and makes him useful in a specific area of inspection after one or two days of training.

Guided by course outlines, which had been generously furnished by other states, especially Illinois, the first courses of this type were tried in May and June 1967. From the experience gained in the first few courses, we developed some concepts of needs for changes in the course, which were new to us and worked well. These involved a way of teaching the material which is rapid enough so that the men do not ordinarily stay overnight, which can accommodate men with almost no prerequisities, and which still teaches them to do all the tests required of an inspector of this sort of work, and, even more important, to enter the results on the proper standard forms. Because of the impact these courses have had, this development will be traced in detail. We now schedule these courses for presentation at any time, at very short notice, and they are used almost as basic training for all employees in construction.

The Center was equipped and staffed sufficiently so that in May 1967, a trial two-day course was scheduled for Specific Task Training of Soil Density. Seventeen construction inspectors were trained by the staff of Highway Commission engineers of the Center. The course began with a complete demonstration of the determination of in-place soil density from the calibration of the standard sand density to the soil moisture content determination using a field stove. The demonstration is meant solely to give the trainee the total picture of the entire procedure with as little accompanying explanation as possible. If a question is asked by an individual during the demonstration, it is answered, but further explanation is held for the classroom. Each step shown to the men in the demonstration was actually done by each individual in the

teaching laboratory but not until the step was explained thoroughly by the instructor in the classroom prior to the laboratory session.

During the laboratory session, where each man performed each part of the task individually, staff engineers were available to answer questions and to help the student as much as was needed.

Supplementary data sheets were used along with the regular Highway Commission forms to aid the men in calculating the various parts. This served two functions. First, the data sheets provide a guide, step by step, through the testing procedure, which gives the student an organized method of setting up and computing the necessary information. This method is in an order that is meant to indicate to the student what he is actually doing at each step, and hopefully that will help him understand the procedure.

Upon completion of this course it was felt by all that this type of training must be continued. It was decided that a two-day course of Concrete Specific Task should be developed and presented as soon as possible. In two weeks, 27 men were on hand for the first concrete course. The class was divided into three groups, so that each of the smaller groups could be learning a particular part of the overall task at the same time. Each of these parts was taught repetitively by the same instructor at a particular location to which each of the groups reported in turn. The purpose of this was so that each individual could more easily follow the explanation of the specific test and then perform the test himself with close personal attention. Also, it allowed each instructor to concentrate on teaching the single test, and to try various changes and possible improvements. As in the Soil Density Specific Task Course, the instructor was always available in the laboratory area, to help the student if a question or problem arose.

From May 11, 1967, to June 20, 1967, three soil courses and two concrete courses were offered, which followed the original schedule. However, it was found that much difficulty developed in finding overnight accommodations for the men, so that courses could not be scheduled as often as desired. Also, it appeared that the teaching time might be cut drastically if certain approaches, which were working well in some parts

TABLE 1

SCHEDULE OF SPECIFIC TASK COURSE IN CONCRETE

Time	Task
9:00	Registration and orientation.
9:10	Lecture on concrete properties, mixing of small batch, and casting beams for the flexural test.
9:30	Each student adds water to a dry batch, mixes it with a hand trowel, and casts a 6 by 6 by 22-in. beam.
10:15	Coffee break and clean up.
10:30	Lecture on consistency and slump test demonstration.
10:45	Each student does slump test twice, using a dry batch that he mixed with water by hand to obtain what he guesses will be a proper slump.
11:15	Lecture on yield test, including setting up, leveling and balancing scales, use of specified forms, and calculations.
11:30	On concrete from a pre-mixed batch, each calibrates a yield bucket, does yield test, calculates results and enters on forms.
12:30	Lunch
1:30	Demonstration of the pressure air meter and Chace air indicator. Each then does these, on a pre-mixed batch, and records results.
2:00	Lecture and demonstration on the portable beam breaker. Each student will break a beam cast by a previous class and calculate flexural strength.
2:30	Final comments including questions and answers.
3:00	Close

TABLE 2

SCHEDULE OF SPECIFIC TASK COURSE ON SOILS

Time	Task
9:30	Registration and orientation.
9:35	Demonstration of a sand cone test, from calibration of the silica sand through recording of the data.
10:20	Lecture on calibration, and calibration by each student individually of the sand and of the sand cone apparatus.
11:00	Review the calibration results and discuss the in-place soil density test and the form for the data.
11:30	Each student runs a complete test on a prepared sample of fine-grained soil and records all of the data.
12:30	Lunch
1:15	Review previous laboratory calculations. Demonstrate Speedy Moisture Meter.
2:30	Lecture on testing a soil containing +¾-in. material, and special form used.
2:45	Each student performs a test on a prepared gravel sample.
3:15	Review the procedures and calculations for gravel soils. Explanation of the lab density curve. Each student calculates percent compaction from his data.
4:00	Comments and close.

of the courses, were applied to the whole course outline. On trial basis, one-day courses in soil and concrete specific task training were prepared. On June 23, 1967, the first one-day concrete course was presented according to the schedule in Table 1 and on June 27, 1967, a one-day soils course as in Table 2. Later larger classes were taught in smaller groups, by schedules, as in Table 3. These schedules appear to illustrate fairly well the preceding discussion of teaching methods, although close study may be needed.

From May to September 1967, nine soil density and nine concrete specific task courses were presented for a total of 182 inspectors. Unlike the original concept of the program, these sessions were held through the summer and could accept any man who needed training, regardless of his experience or education. From November 1967, to mid-January 1968, another set of specific task courses was offered and from

TABLE 3

SCHEDULE FOR SPECIFIC TASK COURSE ON CONCRETE FOR LARGER CLASS

Time	Task
9:00	Registration and orientation.
9:10	Lecture on concrete, and demonstration of mixing concrete and casting a test beam, by hand, from a dry batch.
9:30	Each student mixes and casts beam.
10:15	Coffee break and clean up; class split into two groups, A and B.
10:30	Group A is shown, and each does, slump and air tests, in garage. Group B is shown, and each does, yield test, in laboratory.
11:45	Clean up and lunch.
12:45	Group A, yield tests in laboratory. Group B, slump and air tests in garage.
2:00	Class re-combines. Lecture and demonstration on the portable beam breaker. Each student will break a beam cast by a previous class and calculate flexural strength.
2:30	Final comments including questions and answers.
3:00	Close

May to July 1968, a third group was held. This will be our future pattern for scheduling of this type of training—a set of one-day courses in May and June for the new employees, a set in August for the people who have just finished an eight-week highway technician program presented by state universities to high school graduates, and a set in the winter for those who require the special attention. Reaction and reports from field personnel on these courses is uniformly favorable.

The approaches to teaching the material that permitted these courses to be presented so rapidly are really quite simple. First, the subject was broken into a series of short laboratory periods, arranged in a logical sequence, so that the man started with a rather simple problem, and then progressed to more difficult and complex procedures. Discussion in the classroom before each step was closely limited to a quick review of the prior period, an explanation of the next period consisting only of what the man had to know to do the work and the calculations, and as much time as was required to permit the asking of questions bearing on the procedures. The second technique was to have enough equipment and sample material to have each man do every test entirely by himself with instructors circulating to answer questions and correct errors. It was found that the theoretical aspects of the test and of the material properties were learned by the men from handling the items, and from explanations of why tests had to be done in certain ways, and the closing summaries usually revealed a good grasp of these. Best of all, the men were never awed, as by a long mathematical explanation.

Organization and Operation

From experience with the specific task courses in particular, and from the problems encountered, certain things were learned about the type of organization necessary for such training programs, and the manner in which it should operate. Those of general importance include the class atmosphere, the method of selection of trainees, and the work of a training coordinator.

By trial and error it was found that a particular atmosphere seems important to a training course of this type for these students. It will not work if the instructors act as figures of authority delivering stiff and formal lectures. The introductory orientation period is normally delivered by the Director of the Center, if available, as an indication of the importance placed on the class and its training, but this discussion includes statements about the fact that this is a Commission facility staffed with Commission employees, to make the students feel at home. Also, much of this discussion covers matters peculiar to Commission employment, such as travel vouchers, locations of nearby projects and gas supplies, and inquiries about matters in the districts represented. All staff engineers, again including the Director, act as instructors and talk freely on such topics as well as on the technical course material. The objective is to produce a feeling that this is just another day of work and of freedom to ask questions and make comments.

To aid the districts in choosing construction personnel to attend specific task courses and others, a form was developed that is to be used by the project engineer or project supervisor to recommend an individual for training. It was felt that the project engineer was in the best position to evaluate an inspector's general knowledge and construction experience because he was in daily contact with the individual and would know his capabilities and shortcomings. However, the districts are free to send anyone they wish. Furthermore, the Center encourages this freedom because the variety of backgrounds stimulates class participation and discussion.

The addition of a man trained in education, whom we shall call training coordinator, solved many problems of Indiana's formal training program. While it is necessary for highway engineers, familiar with the problems and procedures of highway construction, to develop the various courses and use their knowledge and ability to perform the actual teaching duties, it was soon found that as the number of courses increased much more time was required of the engineers at the Center to maintain the training files and organize pending courses. It was felt that in order to maintain a balance between training and applied research, someone familiar with the administration of educational procedures must be added to the staff of the Center to relieve the

engineers of the extra burden and allow them time to work on highway research projects.

The duties of this man can be tedious and must be exacting. Many small items have to be assigned to others and someone has to be available at all times to see that these items are organized, ready for use when needed, and incorporated into the program. The main responsibilities involve constant contact with the district that will provide the trainees and to insure that all arrangements for these men such as boarding, transportation, and necessary information, are complete. During any particular course presentation, the training coordinator is responsible for every aspect of the course. The engineers are reminded of their teaching schedules, the class is registered, workbooks and supplementary handouts are distributed, visual aids are organized, laboratory samples are prepared, equipment is set up, and tests are ready. These are only the high points! After the course, tests must be graded, records completed, and letters sent to interested parties. There is no doubt that this is a job requiring the full time and energies of one man when the program is as extensive as that in Indiana.

In the courses where written tests or other means of evaluation are employed, a certificate of achievement is issued to the successful students. The standards for this evaluation are kept at a very high level and are not relaxed. It is common knowledge that every certificate issued is well earned. The certificate itself is perhaps more expensive or ornate than some might feel justified, as it is parchment, hand lettered in gold as well as other colors, and signed by the Executive Director of the Commission as well as the Center Director. However, they are much prized by the recipients, and should be something they are proud to display. Naturally, no certificate is given for the specific task courses, or others, in which no evaluation is possible.

Surveyor's Course

Another program of great importance to the Highway Commission was begun in late 1964. The need for more component and knowledgeable surveyors and assistants was great because of the heavy construction schedule and lack of experienced personnel. Indiana does sponsor a highway technician program, under which new employees fresh out of high school are given 8 weeks of intensive technical training before actually reporting for work, but it has never been large enough to meet the demand. Also, the new technician, although he did have some working knowledge of how to handle an instrument and had been exposed to trigonometry, needed some additional and specific work in highway surveying. Besides there already were men in the ranks with the background, desire, and potential who could accept more responsibility if the proper training were made available to them.

A two-week surveying course was developed by the Civil Engineering Department of Valparaiso University and offered to experienced highway inspectors. The first of these sessions was held in December 1964, and one other was held in December 1965. Even though there were some problems encountered, it was felt that a course of this nature should be continued and added to the formal program.

When the Research and Training Center was opened in April 1966, planning began immediately to develop the surveyor's course. The Highway Commission was fortunate to have the cooperation of the Purdue University Civil Engineering Department through the Joint Highway Research Project to plan to develop the initial two-week course and especially fortunate for the effort put forth by Professor William J. Kay. Professor Kay not only guided the development of the course content and schedule but worked with the Highway Commission engineers during the actual instruction of the first few presentations.

The initial course was offered in June 1966, and held at the Research and Training Center. The students were divided into four-man parties. This was established mainly for work in the field and maintained in the classroom so that the individual parties were together in order to organize and utilize the field information in an efficient office routine. The first week was spent in reviewing trigonometry, learning the fundamentals of taping, and becoming familiar with the use and care of the transit and level. The second week concentrated on actual highway surveying techniques and procedures. At the end of each week a written test was administered to measure the comprehension

and ability of the student. Part of the test required actual outdoor work with both transit and level.

The surveyor's course did not change appreciably in content, but the instruction did become the full responsibility of the Research and Training Center with the cooperation of the Construction Division of the Highway Commission. It has, however, been rearranged to become a series of logical progressive steps equivalent to a single construction situation. More frequent short periods of laboratory and field work were included so that long classroom sessions were broken up. This change greatly increased the level of interest.

Our experience with the surveyor's course has brought some important considerations to light. First, it was found that eight parties of three men is the most efficient combination for four instructors. In the field, each instructor is responsible for two parties. The parties are organized on the first day by looking over the information on the registration cards. Because none of the classes has been homogeneous with respect to experience and technical background, the men are divided so that the experienced and inexperienced are distributed as evenly as possible with the hope that all of the parties are fairly uniform. Also, an attempt is made to separate individuals from the same districts because, in many cases, all districts are represented. This is done not only to help the men get acquainted but also to give them an opportunity to learn some good methods that may not be practiced in their respective districts. A party chief is selected for each party, he is responsible for the equipment and the general performance of the group, but he need not be the most experienced member of the party nor is he to be considered as the so-called "boss."

A three-man party is thought to be the most efficient size independent of the type of field work. Everyone has a better chance to perform a part of all the various functions of a survey crew and no one has the time to stand around. The general speed of this course is geared to the slowest student and the experienced men are encouraged to help those who need special attention.

Until recently, there was just enough land immediately adjacent to the Center where eight surveying parties could perform the required field work associated with the course. However, the land is now being developed and will no longer be available to the Highway Commission. In the future the surveyors will be transported by special bus, owned by the Commission and kept at the Center, to an area suitable for surveying field practice.

Project Engineer/Project Supervisor's Workshop

In 1966, the Construction Division of the Indiana State Highway Commission began to develop a one-week workshop for the newly assigned engineers and project supervisors. This would be a concentrated effort to provide a seminar that would familiarize them with project organization and planning, documentation of records, quality control of materials, policies and procedures, and structure control. A workbook was prepared with the combined efforts of the major divisions of the Highway Commission, and the first workshop was held at the Center in January 1967. The comments of the engineers at the end of the workshop indicated that they wanted to concentrate more on construction problems and materials and less on record-keeping and project paperwork.

A year later, in February 1968, the second workshop was conducted at the Center with some changes in course content. This was more suitable, but some further refinements are contemplated for future presentations. It is obviously more difficult to develop a workshop for men at this level.

Other Schools

There have been other courses presented at the Center to train people in very specialized areas of highway construction. Generally, the course outline, content, and supplementary aids have been prepared by the particular division of the Highway Commission responsible for the area. The facilities and personnel at the Center are available to any branch of the Commission that has a need for training.

The Bureau of Materials and Tests has presented various courses to train its personnel in pipe inspection, bituminous plant inspection, steel fabrication plant inspection, prestressed concrete inspection, and field testing monitoring. Personnel from land acquisition and people responsible for landscaping and highway beautification have been trained at the Center. More than once there have been two schools going on at the same time.

FUTURE DEVELOPMENTS

In the immediate future it is planned that more courses of the Specific Task variety will be incorporated into the program, and the older courses revised to take more advantage of the specific task training techniques. For example, a one-day bituminous course has been developed and presented; however, too much time was spent in the classroom. It is hoped that the course can be revised to allow for more work in the teaching laboratory so the students can actually see how the various types of mixes behave. Also, a trial two-day course for project office managers was recently presented. This course was offered again with some minor changes and has become an accepted part of the program. Inasmuch as the content of this course is mostly administration, an indication of the broadening of the original technical function is clear.

A short course on small structures is being developed at this writing and planning is started on a course for bridge construction inspectors, which will deal with the special problems and procedures associated with this type of construction.

The Center is equipped with a very complete photographic laboratory and drafting room where movies and visual aids can be prepared for any type of course. We are now in the process of making various training films, which will be used in many of the courses. Also, work will continue on revising existing training manuals and developing new ones.

These are the major developments proposed for the near future. Additional developments will no doubt hinge on changes in construction procedures and testing methods. To keep up with these changes, the Center is prepared to study the situation and to provide a course of instruction. As an example, the Center does training and other activities required to put into field use such new devices as nuclear moisture-density apparatus and ultrasonic steel and concrete testers.

CLOSING

In 1962, there had been no formal training program in Indiana; in calendar year 1967, 1,764 student-days were spent in formal training at the Center, and in the first half of 1968, 1,316 student-days were recorded.

Another interesting finding is the cost of training. Although exact figures are not available, training costs average about $45 per day per man.

These data result from the fact that the training program is well supported, guided, and assisted by every responsible official in the Indiana State Highway Commission.

Determining Manpower Needs for Construction Inspection

ELDEN G. SPIER and GORDON L. BELL, North Dakota State Highway Department

A manpower management objective was adopted by the North Dakota Department of Highways to (a) relate manpower to work loads in the construction inspection and materials testing functions, (b) express those relationships in terms of standard staffing patterns for standard work activities, (c) develop ways of reducing the standard staffing complements insofar as possible in order to increase the salary levels of the persons employed, (d) predict future manpower needs, and (e) develop manpower plans, programs, and policies based on future needs. A research project was undertaken to accomplish the manpower management objective. The study approaches used and the results obtained are discussed in this paper.

•THE North Dakota State Highway Department recognized a need to improve its methods of construction manpower planning and undertook a study to meet this requirement. This report describes that study.

In the spring of 1967, the Department initiated the study. The objectives of the study were (a) to develop realistic ways in which the construction work load could be anticipated in terms meaningful to manpower planners, and (b) to determine the personnel needed to meet the work load. The questions to be answered by the study included the following: (a) How many men are needed? (b) Where are they needed? (c) When will they be needed? (d) What special skills are needed? and (e) Is there adequate lead time for training?

This study was one part of a personnel management study that included the development of a new classification and salary structure, implementation of improved personnel policies and procedures, and determination of the training needs of the construction and materials work forces. These phases of the study influenced the results reported herein; however, a discussion of the entire program is beyond the scope of this report.

STATEMENT OF THE PROBLEM

The first efforts of the study were directed toward the identification of four major problems: (a) nature and level of seasonal employment, (b) adequacy of programming, (c) adaptability of the organization, and (d) current manpower planning methods.

Seasonal Employment

The Department has relied on a relatively small and stable permanent construction inspection work force while employing a relatively large number of seasonal (temporary) personnel to meet its construction requirements. The primary source of its seasonal personnel has been students who were seeking summer employment.

Figure 1 shows the level of staffing by month since 1962. This number of employees used has varied considerably from month to month, and from year to year. These

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variations are greatly intensified when the work loads of the individual districts are analyzed.

The temporary work force is largely untrained. The same persons do not tend to return year after year. In 1966, 70 percent of the seasonal work force had total Department experience of three months or less. Only five percent of these persons had Department experience amounting to one year or more.

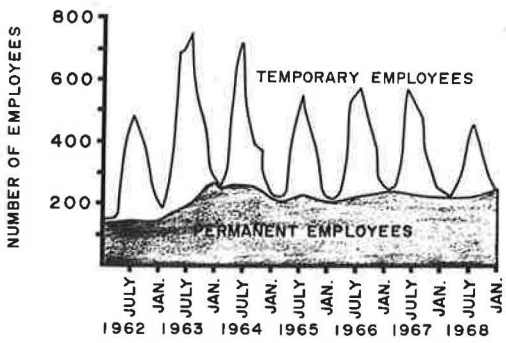

Figure 1. Monthly construction staffing.

At the peak of the 1967 construction period there was more than one seasonal employee for each permanent employee. This had been a relatively consistent ratio since 1965. Seasonal employees can be trained to perform only a few limited and routine assignments. They must be brought to a point where they can be productive rapidly. The amount of work they perform may be limited by the knowledge and skills they possess.

Programming

Construction programs are developed for a number of years in advance. The period being programmed now includes the year 2000. The program classifies the work to be undertaken into improvement types (types of projects). The program is based on highway needs and estimates of fund availability. The availability of construction inspection personnel is not a factor. Contract starting dates are scheduled for the coming three-year period. Expected completion dates are not scheduled.

Organization

The State of North Dakota is divided into seven districts. The districts are not officially divided into construction residencies. The flow of authority and responsibility is from the assistant district engineer directly to the project engineer, with functional control from headquarters.

Essentially two types of permanent construction inspection personnel are employed: (a) those permanently assigned to a district, and (b) a reserve "pool" of field personnel assigned to headquarters.

The headquarters "pool" is normally assigned to the various districts as needed for the duration of the construction period. These employees are usually returned to headquarters during the winter months. This procedure provides great flexibility in meeting shifting work loads, but demands the development of ways in which the work under way can be evaluated in terms of manpower requirements.

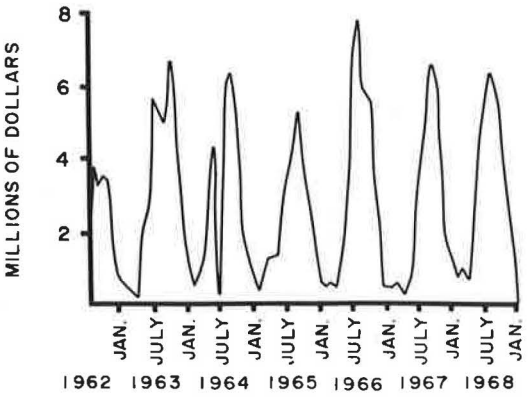

Figure 2. Monthly construction expenditures.

Manpower Planning Methods

The study staff reviewed current manpower planning methods. The primary method in use was the drawing of relationships between expenditures and manpower requirements.

Figure 2 shows the monthly construction expenditures since 1962. They vary widely and the level of each month's expenditure is difficult, if not impossible, to estimate.

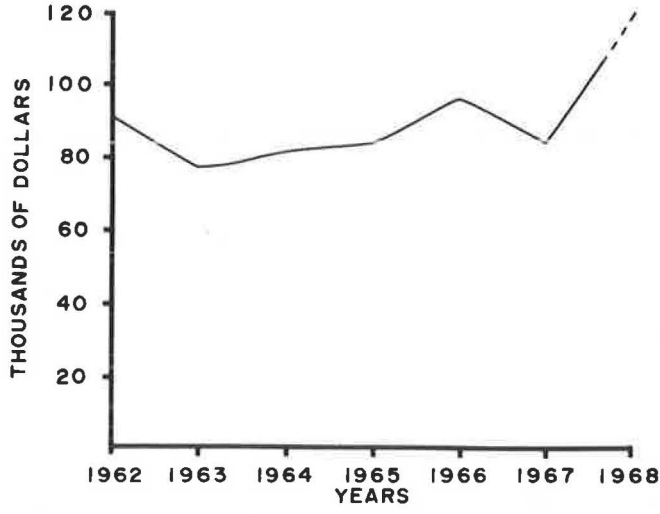

Figure 3. Annual dollars expended per man 1962 through 1968.

Figure 3 shows the relationships between expenditures and employment on an annual statewide basis since 1962. It varies more than 20 percent from the lowest level to the highest level. This variation is intensified as the management unit (districts and projects) becomes smaller and the time period analyzed becomes shorter. The variations are so large as to indicate that this is not a reliable method on which manpower needs may be based.

A similar analysis was done on miles constructed. The statewide results are shown in Figure 4. Again the variations are so large as to indicate that this guideline is ineffective as a manpower planning tool.

These relationships (manpower-expenditures-miles constructed) may be somewhat valid indicators of the overall effectiveness of manpower utilization, but they lack precision for manpower planning.

Figure 4. Miles constructed per man 1962 through 1968.

STUDY METHODS

The methods used in developing the construction manpower planning procedure involved three phases: (a) work identification, (b) work observations, and (c) historical analyses.

Work Identification

A Construction Manpower Committee composed of knowledgeable field personnel was formed. This Committee identified the principal elements involved in the construction inspection of roads and bridges and the significant tasks involved in each of these elements. The elements, which are called job elements, ranged from pre-construction inspection to

inspection management and included such items as road and bridge surveying, clearing and grubbing inspection, and excavation and embankment inspection. Twenty-seven job elements were defined in this manner.

Work Observations

A team of work observers was formed. This team was made up of four full-time men, with two other men filling in on a part-time basis.

Twenty-four different projects were selected throughout the state. These projects represented the major types of construction normally encountered in North Dakota and the various types of terrain that typify the area. One field trip was made into an adjoining state.

The work observers were furnished schedules that varied their time of arrival on the projects, and the routes of the observers were interchanged and varied. The objective was to provide as nearly a random observation pattern as travel distance and time would permit. The primary purpose of these observations were as follows:

1. A documentation of the number of men working on each project during the time of the observation and their physical location on the job.
2. The work being performed by each man at the time of the observation.
3. The type of construction under way, and the type and location of equipment being used by the contractor.

Historical Analyses

Construction records were compiled and analyzed. The primary purposes of these analyses were as follows:

1. Identification of the normal length of construction time (in calendar days) for the various types of projects.
2. An analysis of the numbers of personnel assigned to the various types of projects and the resultant effect of staffing variations on project costs.

In each instance, variables including unusual weather conditions, differences in terrain, inclusion or exclusion of structures, and variations in the contractor's procedures were isolated insofar as possible.

RESULTS

The results of the work observations were one of the principal findings of the study. These results were substantiated by the historical analyses.

Work Observations

The work observations substantiated that similar tasks and job elements are required for similar improvement types. However, in many instances one individual could perform several tasks included in two or more job elements over a short period of time. For example, one inspector could be involved in utilities relocation inspection, clearing and grubbing inspection, and excavation and embankment inspection on the same day. In fact, the more knowledgeable the inspector, the more likely he is to be involved in diverse activities.

Staffing variations were identified for similar projects. Figure 5 is an example of the variation between two projects that were very similar in every respect except staffing.

Subcontracting did not, in itself, change staffing requirements. The sequence of construction could alter the staffing requirements but not as greatly as previously anticipated. Primary impact was observed where essentially two projects were created. The doubling of contract forces, whether by subcontracting or by the addition of more personnel and equipment, did not double the requirement for inspection personnel.

Staffing variations were observed where two or more projects were close together. In this instance, the work on both could sometimes be staffed as though it were one project.

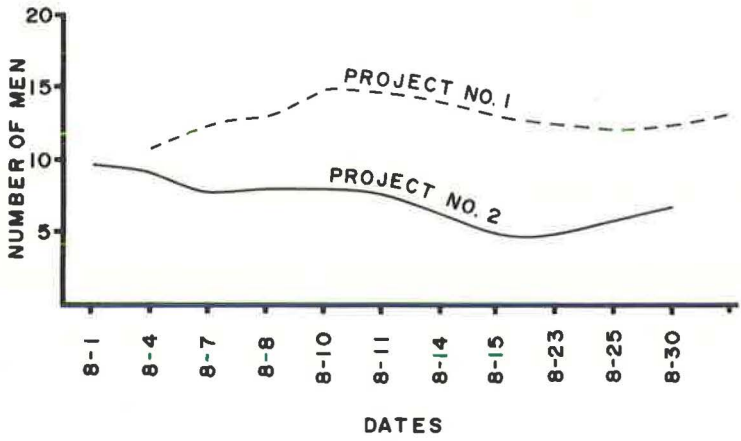

Figure 5. Variation in staffing construction projects.

Staffing variations did occur where more than one project was under the direct supervision of one man. The supervisor was then able to shift personnel from one job to the other to meet peak demand periods. This occurred only on projects where persons with the required knowledge and skills were available for shifting.

The number of persons assigned to particular jobs did tend to vary with the ratio of seasonal to permanent personnel, although this varied from project to project and supervisor to supervisor. In general, the more temporary personnel assigned to a project the greater the likelihood that the project would be staffed with more personnel.

In summary, the observed staffing variations were a result of:

1. The sequence of construction progress—where this sequence was altered to include the essential formation of more than one project.
2. The physical proximity of work to other work.
3. The detailed knowledge of, and responsibility for, more than one job by a senior project supervisor.
4. The level of seasonal personnel when compared to the number of permanent personnel assigned to the same job.

Other staffing variations occurred. These were often inexplicable and apparently grew from such things as a lack of useful work to be performed elsewhere and contractor scheduling problems.

Historical Analyses

The primary result of the historical analyses was the establishment of a normal allowable calendar day's construction time by type of improvement. As previously noted, programming procedures established a date for commencing contract work for the coming three-year period. Completion dates were not scheduled. This procedure prohibited the establishment of effective construction manpower scheduling procedures.

Table 1 gives the normal calendar time allowance for each improvement type. These allowances were the results of detailed analysis of several projects for each improvement type. Extraordinary circumstances were excluded from the data that were averaged to obtain the normal allowance.

Construction engineering and inspection cost variations were substantiated for similar jobs. Again, care was exercised to exclude projects that were constructed under unusual conditions and to insure that the projects were comparable. Figure 6 is an example of one of these analyses. As can be seen in this figure, construction engineering and inspection costs did vary for similar projects. Cost variations could not be attributed to construction time.

TABLE 1

TYPES OF IMPROVEMENTS AND CONSTRUCTION TIME

Code	Type of Improvement (project)	Calendar Days per Construction Mile
10	Grade and aggregate surface	16.5
11	Grade and bituminous-treated base	16.5
12	Bituminous-treated base and plant-mix base	8.5
13	Intermediate type surface	8.5
14	Widening	10.0
15	Widen and retread	12.0
16	Selective grading and widening	12.0
20	Surfacing all stages	8.2
30	Structural	
	Box culverts	40.0
	All other structures	100.0
31	Grading[a]	35.00
32	Surfacing[a]	
	Portland cement concrete	12.0
	Asphaltic concrete—shoulders, ramps, etc.	20.0
33	Signing[a]	5.0
35	Grading—4 lane added	16.5
36	Bituminous-treated base—4 lane added	8.5
37	Surfacing stage 1—4 lane added	8.2
38	Surfacing stage 2—4 lane added	8.2
39	Surfacing stage 3—4 lane added	8.2
40	Surfacing ultimate—4 lane added	8.2

[a]Normally used for Interstate projects only.

Staffing Standards

The work observations and historical analyses indicated that improvement types (projects) were sufficiently similar to make feasible the establishment of standard levels of staffing. Figure 7 is an example of one of these standards. It was developed by the project staff and Construction Manpower Committee. Similar standards were developed for each of the 18 improvement types and approved by top management.

The standard defines how many men are normally required by project type, and whether those men should be temporary or permanent employees.

Some work activities require less than full-time attention. In these cases, the minimum manpower requirement recognized in the standard was one-half time for one man. The less than full-time personnel requirements will be filled by trade-offs, that is, by one man performing two or more part-time activities, or by the temporary transfer of personnel from other projects.

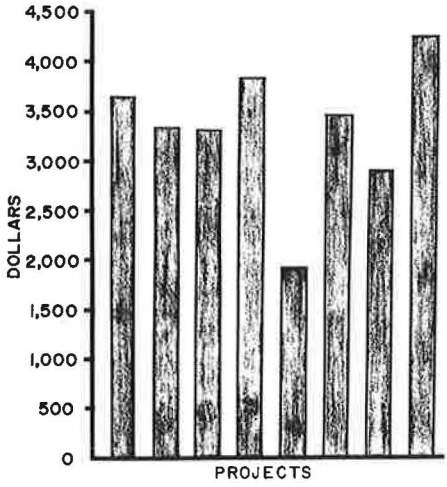

Figure 6. Grading construction engineering cost per mile 1965-1966.

The staffing standard presumes that each project stands alone. The physical proximity of projects will influence staffing requirements. These factors are weighed during scheduling of personnel; however, the standard provides a basis on which these decisions may be made.

The staffing standard provides definition of the "mix" of employees that will be required by personnel classification. This was accomplished by relating the knowledge, skills, and abilities required to fulfill effectively each of the major activities, together with the personnel classification structure now in effect in North Dakota. The classification plan is based on the same criteria as is the staffing standard. Emphasis in both was placed on employee flexibility and well-rounded knowledge of the jobs to be performed in construction inspection.

	Number of Personnel		
	Permanent	Temporary	Total
Supervisor	1		1
Survey Crew	2	2	4
Lab. Man	1		1
General Inspector-Compaction	1		1
Pipe and Structural Inspector		½	½
Water Checker		½	½
Scale Man		½	½
Gravel Checker		½	½
Office Man	1		1
Seeding-Sodding Inspector		½	½
	6	4½	10½
Permanent by Classification:			
Project Supervisor	1		
Technician III	1		
Technicians II	4		

Figure 7. Staffing standard, grade and aggregate surface.

Normal vehicle requirements were also anticipated in the staffing standard. Vehicle assignments were based on three primary factors: (a) the need to be able to transport personnel to the job, (b) the need for certain personnel to be mobile in the discharge of their duties, and (c) the size and vehicle specialization that is required to transport certain testing and measuring equipment. As with the manpower standard, the vehicle standard anticipates trade-offs and less than full-time vehicle utilization.

CONCLUSIONS

The principal conclusions of the study are as follows:

1. Adequately trained construction engineering and inspection personnel are a scarce, vital resource. Increases in the level of employment require lead time so that capable personnel may be recruited and trained. The job knowledges and skills that are required are extensive.
2. Relatively long-range manpower planning and short-range scheduling of personnel is as important as is the planning to meet highway needs. Each is dependent on the other.
3. Effective measures of control cannot be developed unless standards exist whereby day-to-day staffing levels may be evaluated.
4. Planning and scheduling of manpower must be continuous and flexible. Schedules and plans must be adjusted to meet changing field conditions and changes in priorities in the construction program.
5. Organizational structures do influence the level of construction inspection staffing. If personnel are not available on short notice to meet peak work loads, project supervisors tend to staff at peak levels each day.
6. Balanced manpower plans provide greater job stability. As such it contributes to employee morale and security, and may aid in the reduction of personnel turnover rates.
7. The manpower plan facilitates the preparation of a work-related budget. Budgetary changes may be rapidly evaluated in terms of related changes in the level of employment. This information is then readily available to provide detailed guides as to the numbers and locations of personnel who will need to be recruited.

IMPLEMENTATION

The North Dakota State Highway Department is implementing the results of this study.

Organization

The Department has created construction residencies. These residencies do not have fixed headquarters or fixed boundaries. The lines drawn between residencies, and the offices of senior personnel responsible for the residencies, are shifted to meet the workload.

The Department has appointed a full-time construction staffing officer assigned to the Construction Division. Among his duties are the preparation of manpower plans, the coordination of manpower needs between residencies and districts, the coordination of personnel recruiting and training, and the coordination of the budgetary materials.

Manpower Scheduling

Figure 8 is a map of a district. It shows the physical location of each project to be constructed in 1969. The district is divided by a line running north and south that corresponds to the authority of a senior engineer. The line is not fixed.

Figure 9 shows the project scheduling for each of the jobs to be under way in this district in 1969, together with the manpower requirements for those jobs. The first digit represents the number of permanent personnel required and the second defines the number of seasonal personnel that will be needed. (Note that personnel were not planned for projects 24-1, 7-052 and 48-2 for the West Residency in 1969. Personnel for these projects will be made available by transfers from projects completed within the residencies.)

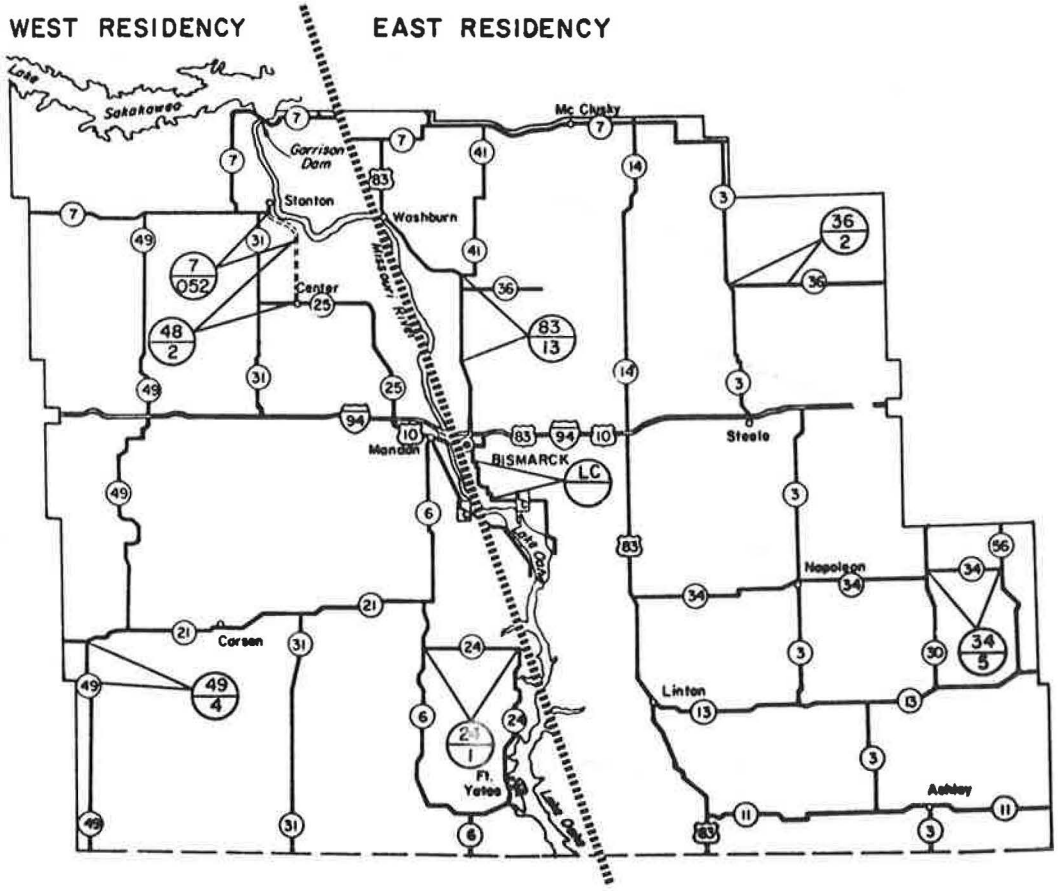

Figure 8. Map of highway district "A".

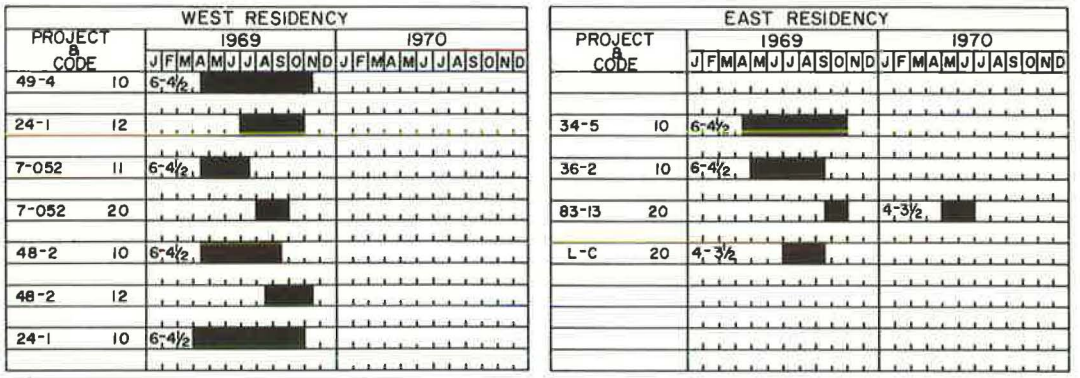

Figure 9. Scheduling projects and personnel.

Table 2 compiles the manpower and vehicle requirements to meet the construction work load planned in District A for 1969.

Statewide Application

In May 1968, the first trial manpower needs program was prepared on a statewide basis. This plan was based on a tentative 1969-1973 construction program that was not yet finalized.

The trial application covered a five-year period and showed an increase in permanent inspection personnel in 1969 that was equivalent to one-third of the existing permanent work force. This was the peak personnel demand for the coming five-year period. The application of the trial manpower needs to the tentative construction program indicated that the total field force requirement would drop from 520 employees in 1969 to 350 employees in 1973.

This information gave management a program evaluation tool that was not previously available. After re-programming, the manpower requirement leveled in total but continues to vary by district and residency.

TABLE 2

REQUIRED STAFFING OF HIGHWAY DISTRICT "A"
1969

(a) Manpower Requirements

Classification	East Residency	West Residency	District Total
Technician I	1	1	2
Technician II	8	15	25
Technician III	4	4	8
Project supervisor	3	4	7
Senior supervisor	1	1	2
Total permanent	17	25	44
Total temporary	13	18	31
Total manpower	30	43	75

(b) Vehicle Requirements

Type of Vehicle	East Residency	West Residency	District Total
Automobiles	3	4	7
Panel trucks	5	8	13
Six-passenger pickup	2	4	6
Three-passenger pickup	2	3	5
Total	12	19	31

Results to Date

As previously noted, this is but one portion of a personnel management study. Rather dramatic results have been achieved. It is not possible to say what results were obtained from each specific phase of the program. However, the following are the overall results.

The 1968 level of average monthly construction employment has been reduced by 80 employees (30 percent) from the 1967 level, whereas construction expenditures in 1968 were about 10 percent higher than 1967.

Because of the economies realized in this and other divisions, the Department has been able to implement a prevailing wage (going rate) plan while reducing the total labor expenditures.

Developing and Implementing New Classification And Salary Plans for Maintenance Personnel

JAMES O. KYSER, Maintenance Engineer,
North Dakota State Highway Department

A systematic plan was used in establishing a complete new salary plan for the North Dakota State Highway Department. Department personnel were used to develop all areas of the plan under the direction of a consultant who planned, controlled, and scheduled the work. Highway Department personnel must be familiar with all phases of the plan in order to continue its use and to provide for changes as new personnel problems develop.

Committees made up of highway maintenance personnel were chosen to define the work performed by all maintenance employees. When completed, the work descriptions were placed in numerical levels of difficulty for each classification.

District highway personnel were used to visit industrial firms and government agencies to determine prevailing salaries, fringe benefits, and working conditions for comparable work. The new rate structure was then established from these salaries. The hours worked by the Department were worked into the plan to arrive at an annual salary equivalent to prevailing rates as determined from the salary survey.

Maintenance employees were then evaluated at a meeting of representatives of the Department's personnel division and supervisors. The employee was evaluated according to the work he performs, the equipment he can effectively operate, the type he operates most of the time, how well he operates it, his potential for improvement, longevity, and other work factors. The initial evaluation was followed by a second evaluation to establish uniform ratings.

After salaries had been established for all employees, cost estimates were developed for comparison with budgetary restrictions. The plan was then implemented in three stages, due to limited funds, with an evaluation of employees before the implementation of each stage. Employees were given an opportunity to discuss any dissent with a member of the Department's personnel division. The plan appears to be developing increased employee incentive.

•THE North Dakota State Highway Department found that its maintenance employees' salaries needed review and adjustment. Numerous adjustments and rescheduling had been made in years past, but there still seemed to be salary difficulties. A straight across-the-board cost of living increase did not appear to be the correct solution. The Department then developed a new classification plan and a new salary plan for its maintenance forces.

STUDY APPROACH

Seven basic steps were taken in the development and implementation of the new classification and salary plans: (a) definition of the work, (b) definition of levels of

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difficulty, (c) completion of salary survey, (d) formulation of classification and salary plan, (e) initial classification of each maintenance employee, (f) development of cost estimates, and (g) development of plan of implementation.

Employee participation was considered essential to the success of the study. To this end, two committees were formed consisting of Department employees. They participated throughout the study and made some of the basic decisions in the program's development. It was felt that this approach would result in maximum employee participation and communication. Understandings of problems and solutions should enhance the probability of success and ensure proper administration in the future.

One of these committees was a Field Operations Committee, consisting of a district engineer, assistant district engineer, maintenance superintendent, and three foremen from different districts.

The other was an Equipment Maintenance Committee, consisting of an assistant district engineer (maintenance), three shop foremen, a stock clerk and a mechanic.

DEFINITION OF THE WORK

It was necessary to define the work that maintenance personnel perform in order to compare maintenance titles and work in relation to the titles and work defined by industry and other agencies.

Descriptions were made for all the types of work performed in the three major areas of operations: maintenance field operations, equipment maintenance, and sign fabrication. The work descriptions are brief (no more than that needed for understanding by field and office personnel). The Field Operations Committee evaluated and defined field operations with the following job descriptions:

1. Operate rubber-tired tractor with tractor-mounted mower;
2. Operate rubber-tired tractor with trailer-mounted mower;
3. Operate trailer or truck-mounted distributor, less than 1,000-gallon capacity—where truck driver controls the operation and where distributor operator controls the operation;
4. Operate motor grader on gravel surface operations;
5. Operate motor grader for snow and ice control;
6. Operate motor grader for patching with oil mix; and
7. Operate motor grader for continuous mix laydown.

The Equipment Maintenance Committee evaluated and defined the shop and sign operations as follows:

1. Shop—Install generator or alternator, repair brake bands, adjust clutch in manual transmission, adjust band in automatic transmission, minor tune-up on diesel engines, and overhall torque converter.
2. Sign—deface used Interstate signs, mount face on primary-secondary signs, and lay out Interstate signs from blueprint.

DEFINITION OF LEVELS OF DIFFICULTY

In the field maintenance classification there are three titles: equipment operator, foreman, and maintenance superintendent. Of these, the largest number of employees is in the equipment operator title, with only one title listed for all equipment operators. All levels of equipment operation difficulty under this title assume that the piece of equipment is operating at its maximum output for each type of work the machine performs. There can be several levels of difficulty for one machine. This includes only the performance of work for which the vehicle is intended. Minor operations, such as driving the unit in the yard, are incidental and are not considered equipment operations. The operators are also required to be able to perform their own field maintenance for the type of equipment they are operating.

In defining the work that is done, it is necessary to determine how it is done and the degrees of difficulty. The level of supervision that is required in the performance of an operation would have an effect on its level of difficulty. The complexity of operation

TABLE 1

EQUIPMENT OPERATOR LEVELS OF DIFFICULTY

Level of Difficulty	Typical Job Description
3	Operate rubber-tired tractor with tractor-mounted mower
4	Operate rubber-tired tractor with trailer-mounted mower
	Operate trailer or truck-mounted distributor, less than 1,000-gallon 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 laydown

for each machine was compared to others, and when all were rated, they were again reviewed and checked by the committee.

The levels of difficulty for maintenance field operations were then established, and numbered from 1 to 16, with each type of work or equipment operation assigned a number or level of difficulty (Table 1). The next step was the grouping of these 16 levels of difficulty into four ranges of pay, which were slightly overlapping (Table 2). Where there was an overlapping of pay range, a further breakdown of a level of difficulty was made to differentiate between the two pay ranges for that level of difficulty. Table 3 indicates typical types of operation in the progression through the first five levels of difficulty, with the further breakdown for the two pay ranges in level 5.

The level of difficulty in a range can be terminal for an employee if he does not move to a higher range. For instance, in level 5 the operation of three additional types of equipment was added in range 2. This would develop incentive to try to move from range 1 to range 2 for advancement when a person had attained the No. 5 level of difficulty in range 1. The same procedure was used for establishing levels of difficulty in the shop and sign operation classifications.

COMPLETION OF SALARY SURVEY

The objectives of this survey are to: (a) identify the prevailing salaries paid by industrial firms and government agencies competing in the labor markets for the same kinds of personnel as are needed by the Department; (b) analyze the relative standing of the Department in those labor markets in terms of the salaries paid; and (c) develop conclusions and recommendations based on the findings of the survey. The survey would include businesses within and surrounding the state.

TABLE 2

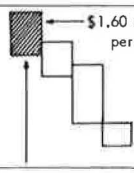
RANGE OF PAY FOR LEVEL OF DIFFICULTY

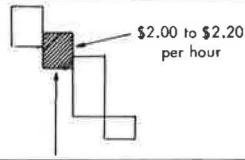
Level of Difficulty	Range of Pay			
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	$1.60 to $1.95	$2.00 to $2.20	$2.25 to $2.70	$2.75 to $3.10

Salary surveys are normally made through a written questionnaire, but the answers are usually poor, with a poor percent of return, making them difficult to evaluate. There is always the question of whether or not they compared the various levels of skill within each area of operation. For this reason it was decided to do the maintenance employee survey through personal contact with local employers

TABLE 3

OVERLAPPING OF PAY RANGES





Level of Difficulty	Types of Equipment Operation	Level of Difficulty	Types of Equipment Operation
1	Hand work		
2	Field painting equipment Pickup		
3	Tractor-mounted mower Pickup with trailer		
4	RWD tractor loader Pull-type tractor mower 1½ to 2-ton truck		
5	Sand & salt spreader Power winch Earth auger, truck-mounted	5	3 to 4-ton truck with box Backup man for rotary or V-Plow on 5 to 7-ton truck Tandem-axle truck

and employees. The firms contacted would, of course, need to be in the same type employee market area as the Department.

State Highway Department personnel were again used in all areas of the study. Two administrative personnel from each of the seven districts in the state were chosen to act as salary interviewers. These personnel were trained for the work necessary in salary interviews to be sure we obtained proper salary information from other employers. The two persons from each district were then given a list of employers to contact. This list was selected by drawing a random sample from available employers in the area as follows: 5 road contractors, 5 building and mechanical contractors, 1 heavy equipment dealer, 3 manufacturing firms, 1 service station, 1 utilities company, 1 life insurance company, 1 city, and 3 counties.

In addition, these personnel would contact the following employers:

1. Three of the largest ranchers or farmers in the district.
2. Six to ten employers in each district headquarters in the following categories, selecting two or three employers in each classification rather than taking the entire six to ten of one type: (a) public garages, (b) specialty shops, and (c) miscellaneous businesses in the retail or wholesale trade.
3. Six to eight employers in the outlying parts of the district in these same categories, again selecting them from all three classifications rather than concentrating on one. In neither case should any special attention be given to the size of the business in making the selection.

In all, a total of 156 employers in the state were contacted in the survey—104 commercial and 52 governmental—as follows: 9 utilities companies, 16 public garages, 8 specialty repair shops, 6 light building contractors, 19 heavy construction contractors, 12 farmers and ranchers, 34 other industrial, 3 federal agencies, 4 state agencies, 33 county government, and 12 city government.

The interviewer presented a letter of introduction to each employer, which explained the purpose of the survey. We needed quite elaborate and accurate data, as the entire Maintenance Division salary structure would be based on these prevailing scales, fringe benefits, and employment practices. If the business had a personnel officer, he was contacted; if not, someone was contacted who knew the salary and classification structure of the business. The more knowledge the individual has, the more rapidly the interview can be completed and the more accurate the information

EMPLOYER QUESTIONNAIRE

Date Interviewer Company Name & Address

Official Interviewed (Name & Title) Telephone No. Business Type

Is employment seasonal? If so, indicate period in which seasonal personnel are employed.

Jan. Feb. Mar. Apr. May June July Aug. Sep. Oct. Nov. Dec.

Company-wide fringe benefits for PERMANENT employees:

Vacation	Health Insurance	Bonus
Sick Leave	Retirement Plan	Other

Company-wide fringe benefits for TEMPORARY employees (if any).

Figure 1.

will be. Figures 1 and 2 indicate the type of information obtained from the employers in these interviews.

To avoid inadvertent disclosure of confidential information, steps were taken to use code numbers for the name of the employee and employer wherever salary data were shown.

If the employer was willing, the interviewer obtained the names of three to five employees in one or more of the classifications covered. Permission was requested for an interview with each of these employees during working hours; if this was inconvenient or not possible, the contact was made at home. Figure 3 indicates the type of information obtained in the employee interviews.

Particular care was taken so that information gained from employees and employers was not exchanged. A total of 3,685 employees of various organizations throughout the state were contacted as follows: 272 supervisors, 1,803 equipment operators, 377 shop

EMPLOYER
JOB CLASSIFICATION STATEMENTS

Company Trade Classification — Description of Duties
Salary Basis and Rates — Normal Work Period
Under what condition is compensation stopped?
Minimum show-up time allowance?
Guaranteed minimum wage?
Overtime premium? Overtime frequency?
Fringe benefits?
Special Characteristics: Hazardous Duty — Incentive Pay
Shift Differential — Adverse Weather
Turnover Rate?
Are persons hired and layed off to accommodate workload periods?
Are layed off persons: Guaranteed re-employment?
Paid subsistence?
Drawing unemployment compensation?

Figure 2.

EMPLOYEE QUESTIONNAIRE

Age Education Previous Work Experience

Principal Employment: Current Classification
Describe the Work
If job is seasonal, indicate work period
Total Earnings, including Overtime:
Amount and Period (Estimate or Actual)
Base Pay Rate
How long employed in this job?
Why did you select this job?

Secondary Employment: Same as above, plus information on fringe benefits

Are you looking for new work?

Figure 3.

personnel, 297 tradesmen, 879 laborers, and 57 janitors and watchmen. All interview results were mailed to the consultant daily for evaluation.

FORMULATION OF CLASSIFICATION AND SALARY PLANS

The classification of pay plan is based on the levels of difficulty as previously determined by the two operations committees and the salary survery, which identified what other employers were paying for work similar to that being done in our highway maintenance operations. The need was to develop and adopt salary and wage plans that would be reasonably consistent with the salary and wage plans of local major industry. This was necessary in order to place the Department in an honorable position as compared to industrial firms with regard to recruiting and retaining competent employees. To accomplish this, the hours worked for the Department were backed into an annual salary level that had been established to provide a scale adequate to retain highway

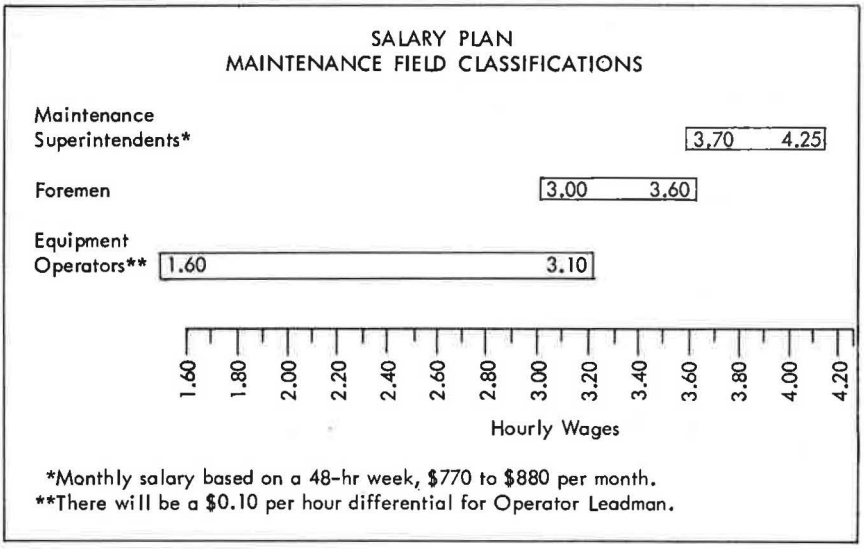


Figure 4.

maintenance employees. Figure 4 shows the salary scale established for the three titles in the maintenance field classification.

The leadman title is used for employees who supervise rural maintenance sections consisting of two to six men, but who actually operate machinery along with the rest of the section equipment operators. Their evaluation procedure is the same as for equipment operators, with ten cents per hour added for the supervisory responsibility.

In adopting the prevailing wage philosophy, there are arguments that a salary survey does not adequately compensate for cost-of-living increases. This would be true only if other employers are not keeping up with cost-of-living increases. In that event, employees would move to other employers, causing a high turnover rate. Normal expected turnover rates are in the 10 to 15 percent range; this is total turnover from death, retirement, quits, etc. A quit rate of 10 to 15 percent would be high. Turnover rates were identified in the salary survey, and those employers who had high turnover rates were not included in the analysis.

A close study of employees and jobs was necessary to establish the rate range. It was necessary to check whether or not the employee had a second job for additional income. Seasonal jobs and working conditions were evaluated.

In setting up the new plan, consideration had to be given to a comparison of the proposed rates with the present rate structure. A few areas of deviation were found, which required close analysis in establishing the new rates to be sure these discrepancies were totally eliminated in the new rate structure.

Fringe benefits, such as expense allowance when away from home, hazardous duty pay, vacation, sick leave, retirement contribution by employer, and health insurance, were considered in establishing the rates for the various levels of difficulty.

INITIAL CLASSIFICATION OF EACH MAINTENANCE EMPLOYEE

The evaluation of each employee was done in a meeting with the individual's supervisors. In most cases these consisted of the district engineer or assistant district engineer, maintenance superintendent, administrative supervisor, and foreman. With the district engineers, superintendents and foremen a part of the evaluation, the employees accepted the plan with less altercation.

The rate of pay for each employee covered by the plan was determined by the following factors:

1. The types of equipment the employee can operate effectively;
2. The type of equipment that the employee operates most of the time;
3. How well the employee operates and maintains the equipment;
4. An evaluation of the employee's potential for improvement;
5. The length of Departmental service the employee has; and
6. Other general considerations, such as work attitude, attendance, loyalty, dependability, and ability to work with others.

In some cases an employee will spend most of his time operating equipment listed in the lower levels of difficulty, with some of his time spent on more complex operations, such as operating motor graders for snow and ice removal. In these instances, the rate of pay is established by what the person normally does plus an addition for the more complex operations. In no case was the newly established rate below the employee's current rate.

After the initial evaluation, the same personnel were given an opportunity to review the employee's evaluation a second time. The first evaluation was a single evaluation comparing the man's work and work habits to the level of difficulty he performed. The second evaluation was the same, except that it also gave the opportunity to compare individuals and rates in order to eliminate any minor errors.

DECENTRALIZATION

After the plan has been fully implemented, district and immediate supervisory evaluation on a continuing basis is necessary. Employee production is geared to motivation. There can be no greater motivation for a person than to know that his immediate

foreman or supervisor has a continuing duty, responsibility and opportunity to evaluate the employees under his supervision.

DEVELOPMENT OF COST ESTIMATES

When the salaries had been established for all personnel, the total yearly salary cost for the Department could be computed and compared to the budgeted salary amounts.

Because of legislative salary limitations, the budget was inadequate to fully implement the plan at one time, and it was necessary to develop our program in three stages, at approximately six-month intervals.

DEVELOPMENT OF PLAN OF IMPLEMENTATION

The employees were mailed a notification of Stage I. We did not inform the employee at what level of difficulty he had presently been rated, but we did show him in which of the four ranges he would fall at the final stage of implementation. The employees were told they would be evaluated again before the implementation of Stages II and III. This would provide for possible increase or decrease where the level of difficulty for the employee had changed, or where other qualifications and abilities were developed.

The employees were given an opportunity to discuss any dissent with a member of the Department's personnel division. The personnel representative explained the program to the appealing individual alone, with the reasons why the employee had been rated as he was, and listened to his complaints. If the interviewer felt there was an error, it was discussed with other members of the implementing team for adjustment. If the employee was still dissatisfied, he could file a written appeal to the state highway commissioner for a personal interview. All in all, there were very few changes, and most employees agreed with their evaluation after explanation.

CONCLUSION

We believe the plan has increased incentive. The employees understand the evaluation system, along with the level of difficulty schedule, and try harder to raise themselves to a higher level of difficulty. Employees compare their own salaries to those that they are aware of in industry, and realize that they will be paid prevailing scales at the full implementation of the plan. An equipment operator can also see what machines he must operate and what type of work he must do to increase his pay rate. There could be the assumption that an employee would use larger equipment than necessary to accomplish a job in order to raise his rate; the foreman must supervise this, and it would be controlled by the fact that most of the outlying sections have only one size equipment.

The plan is working out extremely well to date. If it is to be a continuing plan, the market would have to be surveyed periodically, with salaries adjusted accordingly, to keep the plan in line with industry and other agency salary levels.

REFERENCES

1. Roy Jorgensen and Associates. North Dakota State Highway Department Salary Survey Report. Bismarck, N. Dak.
2. Roy Jorgensen and Associates. Maintenance Salary Survey. North Dakota State Highway Department, Bismarck, N. Dak.
3. Roy Jorgensen and Associates. Salary Survey Data Tabulation for Maintenance and Truck Regulatory Personnel. North Dakota State Highway Department, Bismack, N. Dak.

Training Programs for Construction and Maintenance Employees of the Illinois Division of Highways

R. L. McCRACKEN, Engineer of Training and Assignment,
Illinois Division of Highways

THE "good roads" concept has been with us for four generations. Its goal was an all-weather road between every town, village and city. Highway construction organizations began near the turn of the century and have since developed at all governmental levels. Over the years, we have seen constant change and expansion.

Following World War II, the entire national economy began to expand at an ever-quickening pace. Competition for tax revenue and manpower became a new and real problem. Technological advancements were showing more sophistication, thus increasing the need for skilled, well-trained personnel. While the need for competence increased, greater numbers were not finishing their education. Thus, in an era with more jobs for the skilled, there were fewer skilled people available. Simply stated, muscles were and are yet becoming more and more unemployable. Those having skills are much better trained today than in the past and have many more opportunities. Competition for their services has produced higher and higher salaries.

Both the highway industry and the auto manufacturers have bettered their products, making it easier to move about. World War II taught millions of Americans that the world away from their home communities was not such an awesome place. Working forces today are less likely to endure personal discomforts, real or imagined, in one job when their skills are marketable elsewhere. All industries are experiencing higher turnover rates. During the first five months of 1968, the Illinois Division of Highways employed 102 college graduates and lost 101 others who had been employed.

The conditions making it necessary to train employees are not unique to our organization. They apparently exist in all private and public sectors. You must train your personnel to efficiently accomplish your responsibilities or find, in the case of a governmental agency, that there are not enough available tax dollars or, in the case of private industry, you are not competitive.

The advent of the Interstate Highway System forced a decision to recruit and train technical personnel although our chief maintenance engineer had been exploring the need for formally training maintenance field forces since 1948.

In 1956, our technical staff numbered approximately 1,700. Most were civil engineers. Many more were needed to construct the 1,640 miles of Interstate Highway allotted to the State of Illinois for construction in 15 years and, at the same time, continue to improve and maintain our 15,000-mile Primary System.

TECHNICIAN TRAINING

Immediately following the signing of the act creating the National System of Interstate and Defense Highways, plans were formulated to recruit 1957 high school graduates who did not intend entering college that fall. The recruits were, first, to have already completed high school Algebra and Plane Geometry. Second, they were required to pass an aptitude test administered by the University of Illinois. This was a standard test consisting of four parts: School and College Ability Tests (SCAT); Scat Verbal and Scat

Paper sponsored by Department of Economics, Finance and Administration; Department of Urban Transportation Planning; and Department of Maintenance and presented at the 48th Annual Meeting.

TABLE 1
RETENTION OF TECHNICIAN TRAINEES

Year	No. in Class	No. Still Employed	Percent Still Employed	Percent Receiving Additional Education	Percent Obtaining Degrees
1957	183	85	46.5	36.4	9.4
1958	133	50	37.6	42	14
1961	136	49	36	53	8.1
1962	139	70	50.4	41.5	5.7
1963	177	92	52	43.5	0
1964	168	104	62	30.4	0
1965	162	132	81.5	14.4	0
1966	168	136	81	19.1	0
1967	227	209	92	1.9	0
1968	172	164	95.3	0	0

Quantitative Sections; Mathematics; and Mechanical Comprehension. After a personal interview, those found acceptable were signed to a one-year contract ensuring that they would stay in our employ for one year following their training.

A special 11-week course was developed in cooperation with the University of Illinois for the 200 trainees recruited. The course, which was specifically tailored to our needs, consisted of College Algebra, Trigonometry, Surveying, Highway Drafting and Highway Materials Inspection. Thirty-three class hours per week were scheduled between 8:00 a.m. and 5:00 p.m., Monday through Friday. Required, monitored study hall was conducted on the first four nights of each week from 7:00 to 10:00 p.m.

The first class produced 183 graduates, of which 85 remain in our employ. Of those 85, 36 percent have obtained additional college-level education and 9 percent have obtained degrees. The course has been continued each year except for 1959 and 1960. Totally, there have been 1,668 graduates, of which 62 percent are still in our employ. Those presently on military leave will bring the number retained to 74 percent when they return. Table 1 gives a year-by-year retention score and the percentage of those obtaining additional education. These men are considered permanent employees. They are given an educational leave when they enter college and are welcomed back each summer to assist during the construction season. Upon graduation, each is reclassified to a technical title and his salary adjusted accordingly.

Presently, technician trainees are paid $350 per month while enrolled in the course. Their tuition is paid but they must buy their own books and supplies and pay for room and board in regular University housing facilities. Upon completion of the course, salaries are adjusted to $375 or $400 per month, depending on scholastic record. The trainees are then integrated into district construction activities.

SPECIFIC TASK CONSTRUCTION TRAINING

Several years ago, in-depth inspections, in cooperation with the Bureau of Public Roads, revealed the need for corrective action in many minor facets of construction inspection. It had always been the responsibility of the resident engineer on each project to ensure that inspectors had a basic knowledge of specification requirements for the particular task being inspected. In years past, this approach proved satisfactory, but the large turnover today in engineering technician classifications makes training an almost impossible task for the resident engineer. Such things as specification requirements, proper testing methods, and record-keeping are considered so fundamental that many older resident engineers may not look upon them as important. But, these are the very kinds of things that appear as problems during in-depth inspections. Most of the problems were found to be simple errors or omissions, each of little consequence by itself. However, it became apparent that the same error or omission occurred over and over again when the inspection task was performed by the same individual. A lack of training appeared then to be the root of our problem.

In light of these findings, the decision was made to train our technicians to perform the specific tasks involved in each construction inspection area. Thus was formulated our Illinois Program for Specific Task Training. As the name implies, classes are set up that in one day will teach an employee to perform the tests required in a specific construction operation. Among others, our program provides training in such items as bituminous concrete lay down, portland cement concrete paving, pipe culvert installation, earth density determination, and concrete testing.

TABLE 2

SPECIFIC TASK CONSTRUCTION TRAINING
LIST OF COURSES

Portland Cement Concrete Paving Field Inspection
I-11 Bituminous Concrete Field Inspection
Pipe Culvert Installation
Earth Density Determination
Portland Cement Concrete Testing
Portland Cement Concrete Proportioning and Testing
Bituminous Concrete Proportioning
Earth Excavation and Embankment
Stabilized Subbase and Shoulders (BAM)
Concrete Structures (Including Bridge Decks)
Erosion Control
Piling
Pavement Patching
Storm Sewer
Documentation

If one of our district engineers needs an inspector for portland cement paving and finds he does not have an experienced man available, he can send a technician to our classroom in Springfield where in one day he can be taught the basics necessary to perform this specific inspection task.

A program of this type is particularly of value in summer when many temporary inspectors are employed to meet our construction needs. The majority of our temporary employees are undergraduate college engineering students. It would not be economical to give them a long period of training. Each student can be trained in one specific task and then kept at that task all summer. The greatest booster of this program is the resident engineer. He is now relieved of the former on-the-job training he provided in the field. Also eliminated is the possibility that little or no instruction will be given because the resident engineer is too busy or does not have the ability to convey properly the necessary information.

The first of the specific task classes was held in late April 1966. Classes are limited to 30 students and are provided three days each week, three weeks out of every month. The instructors use the intervening time to update their class outlines, keeping them current with changes in specifications, material changes, and construction methods. Examinations are given at the close of each class.

A list of the classes being periodically taught is given in Table 2. Most of these classes are of one-day duration, but a few are comprehensive enough to require two or three days. Currently under development are a series of classes that will teach our project and resident engineers the "why" of construction inspection. Present classes teach the "how." It is felt that if everyone understands the reasoning behind specifications, compliance will be easier to obtain. In the 2½ years the program has been running, 4,700 men have received 40,000 man-hours of training. The result has been better construction, fewer citations, and an overall saving of money both for our contractors and the people of the State of Illinois.

MAINTENANCE TRAINING

During 1961, an administrative change in the state required the employment of an entirely new force to handle our maintenance and traffic field activities. It became quite obvious that methods formerly employed at this time for instructing new employees in their duties were far from ideal. Our maintenance organization began planning a formal training program that could be put into play at the outset of any subsequent wholesale personnel change. Although the new force had been working approximately three years by the time the training program was fully developed, it was felt a gain could be made by giving the program to those existing employees. This was done, first, for the sake of evaluating it; second, to give the maintenance field engineers experience in teaching; and, finally, to cover the possibility that some of the men might become acquainted with a point or two that had been overlooked in earlier training.

While we were preparing the maintenance training program, which consists of 2,000 thirty-five millimeter slides set in a sequential pattern and a syllabus explaining each of the slides, the maintenance field engineers were given basic management training and a course in teaching methods and principles. These two courses proved to be very helpful to the men when they began their periods of instruction. Presently, we are developing a series of classes for maintenance personnel like our specific task construction programs. These will, by sound moving picture or slides with recorded tape, show how specific maintenance tasks are accomplished.

Our maintenance field forces number approximately 4,300. All of them have been given the series of training courses that show the work in which they will be involved each season of the year and the duties that are required of them in many recurring situations. We feel that this program has greatly benefitted the existing force. Currently, we are involved with a change of administration, which hopefully may not again result in a complete change of our field forces.

MANAGEMENT TRAINING

Increased construction costs and manpower turnover dictated that we make sure our management processes were functioning in an optimum manner. Our organization, headed almost entirely by men with educations in engineering, had been exposed to little in the way of management training.

In 1958, the Division began a series of management seminars. Three-day seminars were held at locations remote from the University of Illinois campus. Instruction was given by University professors. Our district engineers and central bureau chiefs were in the initial class with other management levels following. Appendix A is a copy of the program for that first seminar. Due to promotions and retirements, it was not until 1965 that all of our administrative people completed the initial three-day course.

That same year, a second-level course was initiated. It was designed to give both depth and breadth to the material taught in the first course. To date, more than 400 people have received these two courses. A copy of the program from the second-level management series is included as Appendix B. Introduction to management as a profession has prompted many of our engineers to begin formal study in the area.

During 1967, a third-level course was begun to which only the district engineers, bureau chiefs and their assistants were invited. This course was designed to give these men a better perspective of their roll in the national and international frame. We are continuing this course at the same management level with the introduction of new subjects each year. Appendix C is a copy of the program presented in 1967.

SAFETY TRAINING

Though many formal programs are devoted entirely to personal and vehicular safety, training in safety is made an integral part of all instruction. Our central bureau and district safety representatives are given time during construction, design and materials seminars each year to emphasize the hazards incident to the many operations. The Defensive Driving Course developed by the National Safety Council has been revised to include our own accident records, statistics, and material unique to highway department operation such as snow removal and ice control, slow-moving maintenance operations and "backing accidents." Fifty-one men have been trained as instructors. To date, they have given "defensive driving" to 8,000 of our 9,000 employees.

EMERGENCY PLANNING

Recognizing that our statewide network of highways gave the Division a more complete coverage of the state than other organizations and that we had an obligation to keep the system as entirely open as possible in an emergency, it was natural that we prepare for the eventuality of natural disaster or nuclear attack.

Presently, in each of our districts and in our central bureaus, we have at least two radiological monitoring instructors and one radiological defense officer. These men have given 7½ hours of instruction to more than 2,300 men in radiological monitoring. A refresher course has been given to approximately 2,000.

The pilots of our aerial survey plane and our helicopter and two photographers have been trained in aerial radiological monitoring. Included in this training were five pilots of state-owned aircraft from other Departments.

STAFF DEVELOPMENT

Full-time employees wishing to take advantage of college-level courses, either related to their employment or leading to a degree, may do so and receive a limited

reimbursement of their tuition. Participation in advanced educational programs is encouraged as a part of career development. We look to those willing to spend their time in study as potential management staff. Beginning this past fall, a team of instructors was sent to the districts to begin the orientation of young graduates in management concepts. Advanced programs will be fielded each year so that by the time these men become well groomed in highway work, we will have discovered which are qualified for advancement.

CONCLUSION

Training is a basic need in both organization planning and staffing. These are ever-changing areas; therefore, continual training is necessary to ensure future staff and administration. Coupled with that need is the additional training required to keep current with changing practices and to properly orient new employees. It is our goal to provide the needed training to employees. We have come a long way toward reaching this goal, but there are many areas that have not as yet been touched. Future efforts in training will cover highway planning, design, and traffic safety. In crossing the threshold into these new areas, we will be feeling our way. Many computer applications yet untried will doubtlessly evolve.

The Illinois Division of Highways operates through 10 widely separated district offices. In past years, there was not much opportunity for an interchange of ideas between district personnel. An additional benefit derived from our training programs is that personnel, statewide, now are acquainted and have become vastly more aware of their rolls as members of the family. By getting together, they have found that many of their personal problems are, in reality, general problems.

Our further goal of inducing competency in administration and efficiency in operation is certain to be met.

Appendix A

ILLINOIS DIVISION OF HIGHWAYS

MANAGEMENT CONFERENCE

ROBERT ALLERTON PARK, NOVEMBER 16-19, 1958

PROGRAM:

Sunday, November 16, 1958

5:30 p.m.	Registration
6:00 p.m.	Buffet Supper
7:00 p.m.	Introductory Remarks: R. R. Bartelsmeyer, Chief Highway Engineer Keynote Address: "Movement to Management" Dr. Robert G. Seymour, Director, Executive Development Center, University of Illinois

Monday, November 17, 1958

7:45 a.m.	Breakfast
8:30-10:00 a.m.	The Job of Management: An overall look at the basic functions of the administrative process and how these functions apply to highway management. Irvin L. Heckmann, Jr., Associate Professor of Management, University of Illinois

Reading Assignments:
"An introduction to Management Theory," Manual, p. 5.
"The Basic Functions of the Administrator," Manual, p. 21.
"Skills of an Effective Administrator," Manual, pp. 21-27.
Newman: "Administration - A Basic Social Technique," pp. 1-9.
Drucker: "The Role of Management," pp. 3-17.

10:00-10:15 a.m. Coffee Break

10:15-11:15 a.m. Management by Objectives: Setting Goals and Objectives for Highway Management. Irvin L. Heckmann, Jr.

Reading Assignment:
"Essential Steps in the Organizing Process," Manual, p. 68.

11:15-12:00 n. Workshop Session: "Putting the Goals of Your Department Into Writing." Irvin L. Heckmann, Jr.

12:00-1:00 p.m. Lunch

1:00-2:00 p.m. The Role of the Administrator in the Administrative Process. Paul M. Dauten, Jr., Professor of Management, University of Illinois

Reading Assignment:
Manual, Chapter II, pp. 6-20 - Plus reading assignments at the end of this chapter

2:00-3:00 p.m. Delegating Responsibility and Authority: Emphasis Put on the Effective Utilization of your Personnel. Paul M. Dauten, Jr.

Reading Assignment:
"Good Management Men Delegate Authority," Manual, pp. 40-43 - Plus reading assignments on p. 45 of Manual

3:00-3:15 p.m. Coffee Break

3:15-4:30 p.m. Case Discussion and/or Role Playing
Anduluska State Highway Department, Manual, p. 49.
The Sherman and Haverliff Company, Manual, p. 44.

5:30 p.m. Dinner

Tuesday, November 18, 1958

7:45 a.m. Breakfast

8:30-9:30 a.m. Leadership and the Human Factors in Management: Main Emphasis Supervision and Motivation of Personnel. Wayne A. Lemburg, Instructor in Business Management, University of Illinois

Reading Assignment:
"On Leadership," Manual, p. 30.
"Three Ways to Lead - and When to Use Them," Manual, p. 31.
"Problem in Leadership," Manual, p. 32.
"What Makes People do the Things They do," Manual, p. 70.

9:30-10:30 a.m. Informal Organization:
W. A. Lemburg

Reading Assignment:
p. 88.

10:30-10:45 a.m.	Coffee Break
10:45-12:00 n.	Case Discussion and/or Role Playing: The Calhoun Company - The South Batavia Highway Department. Wayne A. Lemburg
12:00-1:00 p.m.	Lunch
1:00-2:00 p.m.	Communications (Both Upward and Downward). Joseph Litterer, Instructor in Management, University of Illinois
2:00-3:00 p.m.	Case Discussion and/or Role Playing. Bob Knowlton Case. Joseph Litterer
3:00-3:15 p.m.	Coffee Break
3:15-4:30 p.m.	Counseling and Case Discussion: Joseph Litterer
5:30 p.m.	Dinner
7:15-8:30 p.m.	Personnel Selection, Placement and Evaluation: Irvin L. Heckmann, Jr.

Wednesday, November 19, 1958

7:45 a.m.	Breakfast
8:30-9:30 a.m.	Controlling the Administrative Process: Paul M. Dauten, Jr., Professor of Management, University of Illinois
9:30-10:30 a.m.	Appraisal and Evaluation of Your Activities: Paul M. Dauten, Jr.
10:30-10:45 a.m.	Coffee Break
10:45-12:00 n.	The Art of Being a "Top-Notch" Administrator: Paul M. Dauten, Jr.
12:00-1:00 p.m.	Lunch
1:00-2:00 p.m.	Training and Developing Your Personnel: Irvin L. Heckmann, Jr., Associate Professor of Management, University of Illinois
2:00-3:00 p.m.	Problems Seminar: All Instructors Present for Discussion of Problems Closely Aligned With Bureau Chiefs' and District Engineers' Duties

Appendix B

ILLINOIS DIVISION OF HIGHWAYS

MANAGEMENT CONFERENCE - "B" COURSE

HOTT MEMORIAL CENTER - MAY 16-19, 1965

PROGRAM:

General Chairman: Richard C. Tussing

Sunday, May 16, 1965

5:00 p.m.	Registration
6:00 p.m.	Buffet
7:00 p.m.	Welcome and Introductions: Richard C. Tussing, Bureau of Business Management, University of Illinois
7:30 p.m.	Orientation: Roger Nusbaum, Assistant Chief Highway Engineer, Illinois Division of Highways
7:45 p.m.	THE JOB OF THE MANAGER - REVISITED A Brief Review of the Functions of the Manager Irwin Cochrun, Director, Bureau of Business Management, University of Illinois

Monday, May 17, 1965

7:45 a.m.	Breakfast
8:30 a.m.	THE NATURE OF CONTROL AND COORDINATION An Analysis of the Necessary Conditions for Effective Organizational Control Joseph A. Litterer, Associate Professor, Graduate School of Business Administration, University of Illinois
10:00 a.m.	Coffee Break
10:15 a.m.	THE APPLICATION - CONTROL A Case Study Joseph A. Litterer
12:00 n.	Luncheon
1:00 p.m.	METHODS AND PROCEDURES IN HIGHWAY NEEDS STUDY An Inquiry Into the Nature of Highway Needs Studies and Their Usefulness in Highway Planning Reed Winslow, Wilbur Smith and Associates
3:00 p.m.	Coffee Break
3:15 p.m.	CASE PREPARATION Small Group Study and Discussion of a Major Case Richard C. Tussing
6:00 p.m.	Dinner
7:00 p.m.	CREATIVITY IN PROBLEM SOLVING New and Improved Ideas Do Not Come From Old Thought Patterns W. H. Higginbotham, Consultant to Management, Clayton, Missouri

Tuesday, May 18, 1965

7:45 a.m.	Breakfast
8:30 a.m.	TOOLS OF PLANNING, I - DISCRIMINATE ANALYSIS A New Statistical Approach to Making Planning Decisions George W. Summers, Associate Professor, Graduate School of Business Administration, University of Illinois
10:00 a.m.	Coffee Break
10:15 a.m.	TOOLS OF PLANNING, II - SPECIFIC PLANNING AND CONTROL DEVICES An Evaluation of Load Charts, Progress Charts, Time and Motion Studies, and Other Tools Used to Increase Scheduling Efficiency L. J. Rago, Associate Professor, Department of Industrial Administration, University of Illinois
12:00 n.	Luncheon
1:00 p.m.	PRE-PLANNING New Dimensions in Management - Planning for Whom - Evaluating Alternative Courses of Action Paul Dauten, Professor, Department of Industrial Administration, University of Illinois
3:00 p.m.	Coffee Break
3:15 p.m.	PROBLEM STRUCTURING AND ANALYSIS The Nature of Planning - What it Means to Analyze - Policy Formulation - Relationship of Planning to Human Relations and Personal Growth Paul Dauten
6:00 p.m.	Dinner
7:00 p.m.	THE APPLICATION - COORDINATION A Discussion of the Case Studied in Small Groups on Monday Joseph A. Litterer

Wednesday, May 19, 1965

7:45 a.m.	Breakfast
8:30 a.m.	LINEAR PROGRAMMING A Brief Review of Relevant Mathematical Tools - Problem Illustrations - Practice Session for Participants Paul Dauten
10:00 a.m.	Coffee Break
10:15 a.m.	MANAGEMENT - A SYNTHESIS A Discussion of the Integrated Approach to Management and the Qualities of the Successful Executive Paul Dauten
11:45 a.m.	Conference Evaluation
12:00 n.	Luncheon

Appendix C

ILLINOIS DIVISION OF HIGHWAYS

ADVANCED MANAGEMENT DEVELOPMENT SEMINAR

HOTT MEMORIAL CENTER - DECEMBER 10-13, 1967

PROGRAM:

Seminar Chairman: Joe Weisenberg

Sunday, December 10, 1967

5:00 p.m.	Registration
6:00 p.m.	Buffet Supper
7:00-8:00 p.m.	Introductions and Orientation: For the University of Illinois: Irwin Cochrun, Director Bureau of Business Management For the Illinois Division of Highways: Virden E. Staff Chief Highway Engineer

Monday, December 11, 1967

7:45 a.m.	Breakfast
8:30-10:00 a.m.	NATIONAL ECONOMIC GOALS AND POLICIES A Picture of the Economic Environment Within Which Decisions Must be Made Today and in the Near Future. Carl T. Arlt, The Bailey Professor of Money, Banking, and Finance
10:00-10:30 a.m.	Coffee Break
10:30-12:00 n.	LEADERSHIP RESEARCH A Review of Current Thinking About Advanced Means and Methods of Leadership and Motivation Which are in Use or are Being Developed Today. Kendrith M. Rowland, Assistant Dean, College of Commerce and Business Administration
12:00 n.	Lunch
1:00-2:30 p.m.	HIGHWAY TRANSPORTATION AND REGIONAL DEVELOPMENT A Discussion of the Impact of Highway Transportation on Spatial Distribution of Industry and Population and of Ways in Which Highway Planning Interacts With Other State and Local Problems. Hugh O. Nourse, Professor of Economics
2:30-3:00 p.m.	Coffee Break
3:00-4:30 p.m.	TAXATION POLICIES A Discussion of the Major Problems of Public Finance With Special Reference to Current Problems of Financing the Construction and Maintenance of Highways. H. Kenneth Allen, Professor of Economics
6:00 p.m.	Dinner

Tuesday, December 12, 1967

7:45 a.m.	Breakfast
8:30-10:00 a.m.	LEGISLATIVE RELATIONS A Look at the Working Relationships Between the Highway Division and the State Legislature. Jack F. Isakoff, Professor of Law Southern Illinois University
10:00-10:30 a.m.	Coffee Break
10:30-12:00 n.	STATE-LOCAL GOVERNMENT RELATIONS A Look at the Working Relationships Between Personnel of the Highway Division and Local Governments. Jack F. Isakoff
12:00 n.	Lunch
1:00-2:30 p.m.	PROFESSIONALISM IN HIGHWAY ENGINEERING Consideration of Means by Which the Capabilities of Professional Engineers Can be Better Utilized to Attain Greater Efficiency and Increase Job Satisfaction. Ellis Danner, Professor of Highway Engineering
2:30-3:00 p.m.	Coffee Break
3:00-4:30 p.m.	COMPLETED STAFF WORK Guidelines for Preparation of Work to be Submitted to Higher Authority and for Work Requested of Subordinates. Irwin Cochrun, Director Bureau of Business Management
6:00 p.m.	Dinner

Wednesday, December 13, 1967

7:45 a.m.	Breakfast
8:30-10:00 a.m.	COMMUNICATIONS A Discussion of This Important Aspect of Effective Management. Robert D. Gieselman, Acting Chairman Business and Technical Writing
10:00-10:30 a.m.	Coffee Break
10:30-11:45 a.m.	OPERATIONS RESEARCH APPRECIATION A Survey of Some of the Largely Quantitative Methods Which are Being Developed to Provide New Solutions to Complex Old and New Problems. Louis R. Shaffer, Professor of Civil Engineering
11:45-12:00 n.	Evaluation and Adjournment
12:00 n.	Lunch

Note: Session times are flexible, particularly coffee break time and duration, and end of late afternoon sessions. Evenings are purposely left free for discussion or other activity.

Developing Programmed Learning Courses for Highway Construction Inspection Training

ALFRED L. MILLER, Highway Training Specialist,
Virginia Department of Highways

This paper describes the characteristics of programmed learning and how they lend themselves to the area of construction inspection training. The purposes of this paper are (a) to demonstrate the efficiency of programmed learning, (b) to describe the limits of potential of this teaching process, and (c) to show the need for management, understanding, and involvement in all stages of development. More programmed learning efforts fail during their administration than in any other stage of their development. Some efforts fail for natural reasons: a poor program. For the most part, however, the majority of the efforts fail because management could not or did not see what programming really involved.

The Virginia Department of Highways has developed several programmed courses, the use of which has proven highly successful. As a result of the implementation of this training device, 90+ percent of all new construction inspector trainees receive training in mathematics, plan reading, specifications and standards, and fundamentals of leveling within 6 months of employment.

•BECAUSE of the highly competitive labor market, public service agencies are finding it necessary to employ an increasing number of young men and women with substandard academic preparation. There was a time in recent history when a distinct dichotomy could be made between education and training. No longer is such the case, however. Business and industry must now think in terms of both. It has become necessary to upgrade new employee education to the trainability level. Programmed instruction is proving to be a valuable instrument in bridging the gap between the educational standard required and the entering and terminal behaviors of the new employee. The purpose of this paper is to describe the rationale behind, and the effectiveness of, programmed instruction courses as they are being developed and utilized in the training and educational efforts of the construction division of the Virginia Department of Highways. Emphasis will be placed on the training of the new employee. Further, certain weaknesses of programmed instruction experienced, and remedial actions taken, will be discussed.

What is programmed instruction? Programmed instruction is a method of presenting knowledge that allows the learner, working alone, to grasp new material in considerably less time, retain it longer, and enjoy himself in the process.

Like most modern advances made possible by science, it is simply a practical application of principles that have been known and accepted for some time. Programmed instruction applies the discovery made by psychologists and educators that learning is most rapid, pleasant, and permanent when the learner proceeds by small, easy steps,

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tests his understanding as he goes along, and avoids making errors along the way. Programmed instruction applies this discovery simply and literally. It subdivides the subject matter into small bits of information, arranges these in a rational, cumulative sequence, and introduces frequent checks of the learner's progress.

There are certain specific characteristics of programmed instruction which lend themselves to inspector training. P.I., as it is often referred to, is goal oriented. That is, objectives are established before a program is written (10, p. 55). The objective of any program is to change behavior. In other words, it trains one who is performing erroneously to perform correctly, or it causes one to perform who previously did not have the capacity to do so. Obviously these are two distinct problems with two distinct approaches. Thus, the first step in the development of a program is to define the problem. This step is critical, for what might be considered a training problem very often is a supervisory one.

Assume the following problem as having been defined: the new trainees cannot relate their position on the project to the construction plans. The deficiency, in this situation, is that young trainees do not know the concept of project stationing. The objective of the program, then, is: Trainees will be able to locate field features on the construction plans.

Having determined the objective of the program, the next step is to determine a means of evaluation whereby it can be established that the objective of the program has been attained. This means of evaluation becomes a criterion.

There is an immediate, or an internal, criterion that is usually found in the form of a test at the end of the program. The other criterion, called an external criterion, determines the effect the student's attainment of a program objective will have on an organization's operations and is specified before the program is written. In this case, the external criterion might read: Less time will be lost because materials were delivered to the wrong station, or the young trainee reported an incident at the wrong location to his supervisor.

Although the preceding example is a gross oversimplification, it should be apparent that this approach cuts through all of the unnecessary "nice to know" information and arrives at the specific behavior that is required in the field.

The educational sociologists are quick to demonstrate how social class stratification is a definite factor in the non-achievement of the lower classes attending middle-class institutions. The same could be said about training efforts. Admitting that less than adequately prepared persons are being hired today, because of the labor market competition, is it not possible that training of sub-technical personnel is attempted using the professional values and judgments gained in the "ivied halls of learning?"

Programmed instruction, properly developed and implemented, negates this schism. It goes without saying that objectives will be derived on the basis of entering behaviors—the background knowledges, skills, attitudes and aptitudes—of the trainee population. It is this study of the target population that not only determines the objectives of a training program, but also the level of difficulty and the size of the information bits that will be offered. Thus, a pre-training screening device is mandatory in training program development. This pre-screening is automatically done in developing programmed instruction courses.

In 1965, the construction division of the Department conducted a training needs study. The results of this study, based on questioning practicing inspectors and engineers in the field, indicated that 33 combinations of knowledges, skills, and attitudes are required for the inspection and documentation of highway and bridge construction. The training needs were validated by testing a cross section of each level of responsibility (3, p. 39).

Despite the fact that the study provided a complete and comprehensive curriculum, so designed as to provide the trainee with a logical sequence of actions to compensate for inadequate background and to promote upward mobility in the power structure, there are practical problems involved in its implementation. One of the major problems is that of time. This is one of the cardinal reasons that the Highway Department investigated the potential of programmed instruction. The bulk of the new trainees

are employed, generally, at the close of high school in late May or early June. Because this is the busiest time of the construction season, all too often the young trainee is relegated to unproductive work because very few experienced supervisors could take the time (or, perhaps more accurately, attempt to take the time) to do any meaningful on-the-job training. Thus the new employee's potential goes unexplored until the winter schools. This assumes that he has not left out of sheer boredom. Because programmed instruction is a self-teaching methodology, this need not happen in the future. The new employee can begin immediately to learn about the task he thought he was being hired to do.

Despite the auto-instructional characteristic of programmed instruction, the Department's experience has demonstrated a need for interaction between the trainee and the trainer. The trainer, in this case, might well be his immediate supervisor on the job.

The curriculum specialists in education have long championed the idea that the student learns as a result of planned activities and guidance as well as from his formal course of studies. According to the Stanford Social Education Investigation: "The more completely a purpose is accepted and understood and a goal recognized, the more efficient the learning will be . . . ." (7, p. 58). With this in mind, the Department has recognized the need for orientation courses for trainers in what programmed instruction is and how it works. Subsequent to this orientation, programmed instruction is receiving greater acceptance and success.

One of the major principles of programmed instruction is that an active response is required on the part of the student (11, p. 259). A well-written programmed instruction course will have the student do exactly during the training what is expected of him in the field upon completion. For example: One skill necessary in the vertical control (or leveling) aspect of construction inspection is the ability to read the level rod (Fig. 1). What better way, then, to ascertain that the student could indeed read the rod than to ask him to read the rod exactly as he would see it under field conditions?

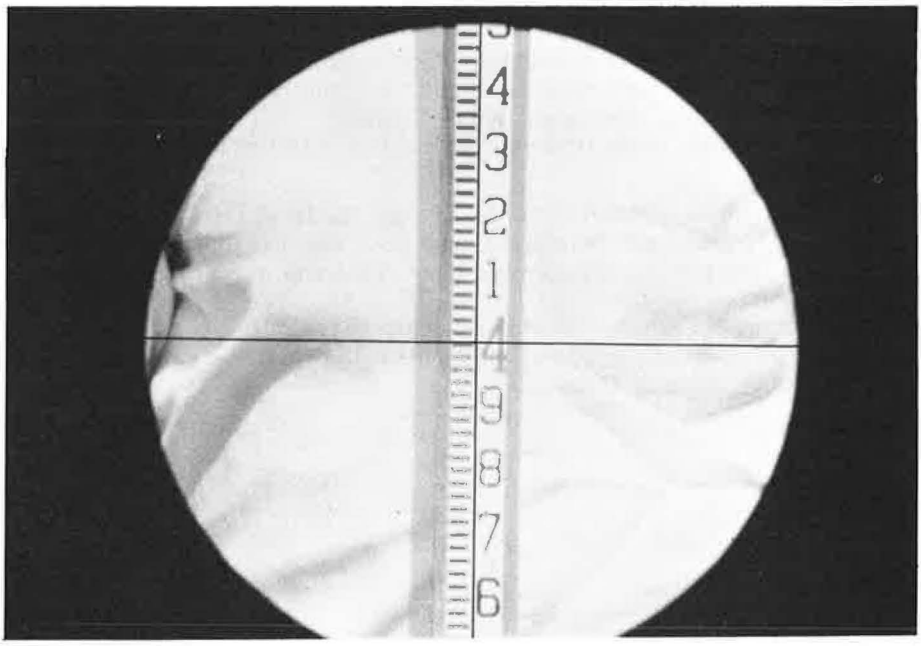


Figure 1.

Although the student can demonstrate an ability to read the rod by responding to a series of criterion photographs requiring correct readings, there still needs to be some planned activity of reading the rod under field conditions to develop proficiency. The criterion requirements are static, whereas the rod tends to waver under field conditions. In this respect, then, programmed instruction can act only in a complementary manner.

The self-pacing aspect of programmed instruction compensates for the variation of entering behaviors of the target population. This self-pacing is, perhaps, one of the greater assets of programmed instruction. The student does not have to concern himself with the progress of his peers, or for that matter, his own progress. It also encourages him to ask questions—for the question is already framed for him—he does not have to concern himself with trying to find the right words. Herein lies the opportunity for guidance by the trainer. Herein also lies one of the greater dangers of the use of programmed instruction. There is a tendency on the part of the trainer to "take over" the program. There must be a complete understanding of what programmed instruction is, and how it works, by those who are charged with the responsibility of implementing it. This can be accomplished by requiring the trainer to take the program that he is to monitor and also train him to write short programs of his own. The former action would give the monitor an understanding of the rationale behind the correct response required and the latter would train him to seek out areas of the student's difficulty and guide him through it without destroying the self-teaching characteristic of the program. As mentioned earlier, once the practice of orienting instructors in the nature and correct use of programmed instruction was initiated by the Department, success followed.

Analysis of the target population has already been noted as a prerequisite of good programmed instruction. Such an analysis will dictate the size of the knowledge bits—called steps—of the program. The principle of small steps in programmed instruction is misleading, for it brings to mind the question: How small is small? Suffice it to say that "small" indicates that amount of material necessary to progress with relative ease from one level of knowledge to the next level of complexity in the subject.

In summary, we submit a brief example of the process of programming to further an understanding of the mechanics of its development and also to show how this training tool lends itself to the area of construction inspector training.

To do this, certain basic assumptions will have to be made.

1. The target population has been studied and consists of high school graduates who have the capacity to do the fundamentals of addition, subtraction, division and multiplication of whole numbers, fractions, and decimals.
2. There is a need for these trainees to be able to use the instruments used in vertical control.

This small segment is restricted to how to read the level rod. The objective of this segment is that the trainee will be able to read the rod. The criterion will be satisfied when, in fact, the trainee will be able to read the rod with a high degree of accuracy and precision.

At this point, the programmer works backward to the initial point of no knowledge and designs a program of small bits of information to bridge the gap between no knowledge and proficiency (Figs. 2 through 7).

In the photograph below, there are two measuring devices. One is a level rod and the other a carpenter's rule.

Study the photograph carefully and answer the following questions.

1. The distance from the bottom of the carpenter's rule to the index finger of the right hand is _____ feet. There are _____ inches in this distance.

2. The distance between the "red" four and the "red" five on the level rod is _____ feet. There are _____ units between the 4 and the 5 which are/are not inches.

(underline correct answer)

Figure 2.

The answer to the preceding questions would be found elsewhere in the text as shown in Figure 2a.

PAGE X

1. one foot twelve
2. one foot ten are not.

(You will note that the numbers on the carpenter's rule that represent inches do not correspond to the numbers on the level rod. Therefore, since there are only ten units between the foot marks on the level rod, each of the black numbers must represent a tenth (0.1) of a foot.)

1. In the photograph below, the pencil is

one-third
one-fourth CHECK THE CORRECT ANSWER
one-half

of the distance from the four to the five. Therefore, the pencil indicates a measurement of

four feet five inches
or CHECK THE CORRECT ANSWER
4.5 feet

Figure 2a.

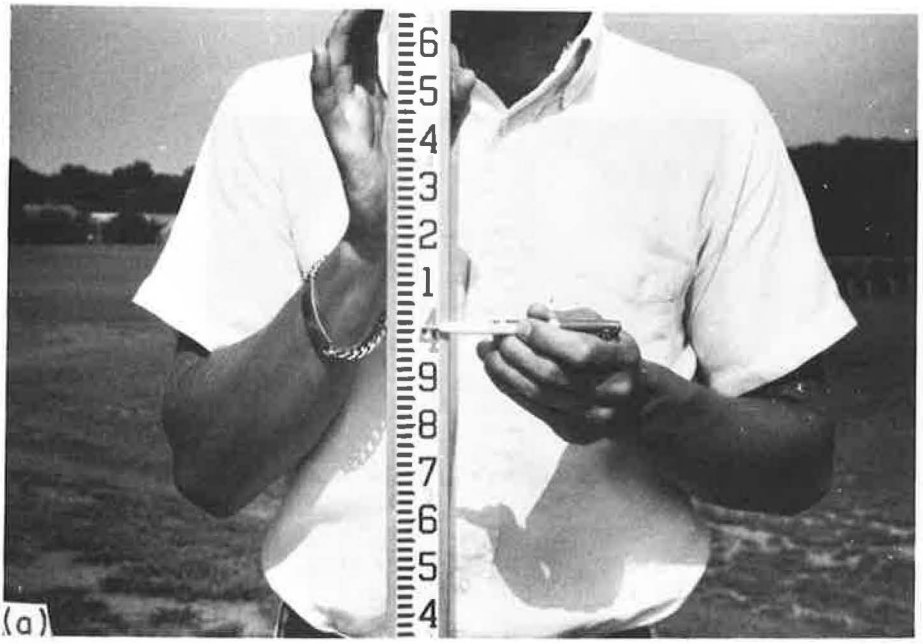
Figure 3.

Answers

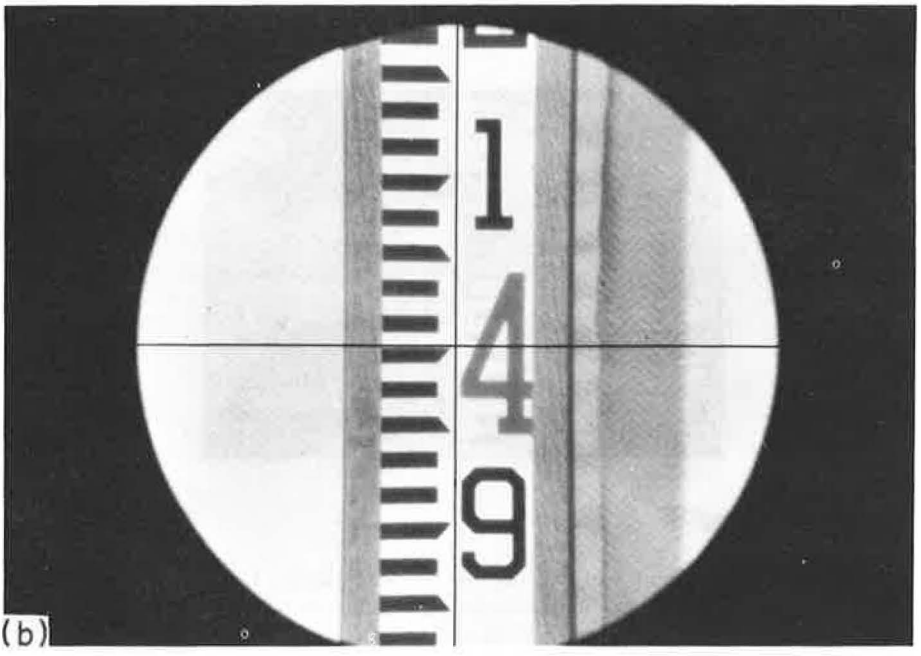
PAGE Y

1. one-half 4.5 feet (REMEMBER THAT THE LEVEL ROD IS DIVIDED INTO TEN UNITS BETWEEN EACH FOOT AND EACH OF THE UNITS THEN REPRESENTS A TENTH OF A FOOT.)

Figure 3a.



"Red" numbers denote even feet and black numbers denote tenths of feet, NOT INCHES, but tenths of feet.



View of above rod reading as seen through the level.

Figure 4.

Study the photograph below. The cross hairs indicate that the reading is between _____ feet and _____ feet.

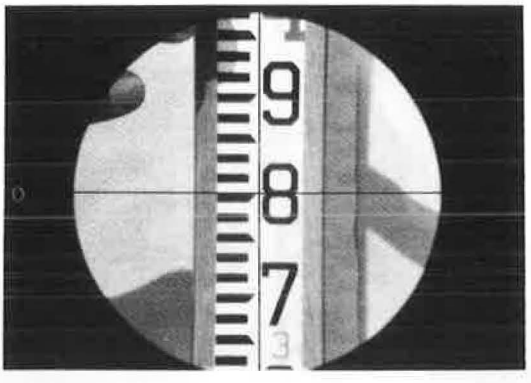


figure f

HINT: AT THE TOP OF THE PICTURE IS ENOUGH OF A CLUE AS TO WHAT THE NEXT FOOT WILL BE. ALSO, SOME LEVEL RODS HAVE LITTLE "RED" NUMBERS AT REGULAR INTERVALS FOR YOUR CONVENIENCE.

You are right, the cross hairs indicate a rod reading between 3 feet and 4 feet. The cross hairs further indicate that the reading will be _____ tenths of the way from 3 feet to 4 feet. The reading then should be written _____ feet.

Figure 5.

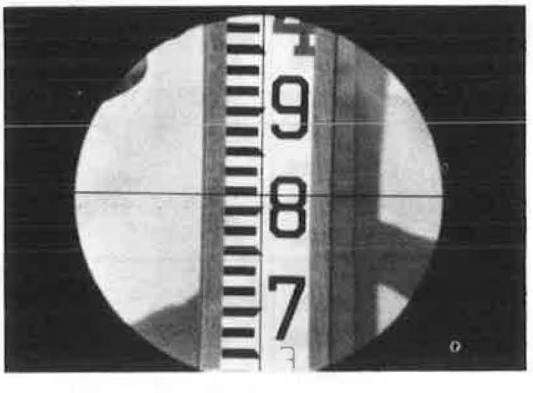


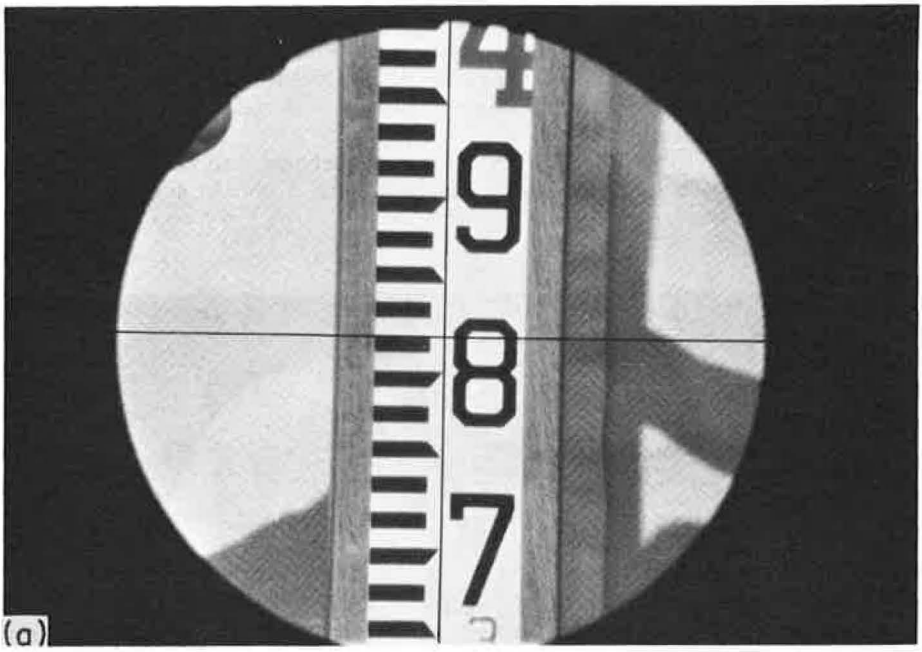
figure g

Remember that we said that the black marks were exactly 1/100 of a foot thick. Look very closely at the position of the horizontal line in figure f and the position of the horizontal line in figure g. If the black marks are 1/100 of a foot thick, then so are the white spaces. Thus this reading in figure g would be read 3 feet plus 8 tenths of a foot plus 1/100 of a foot or 3.81 feet.

Figure 6.

Give the rod readings for figures below:

(a) _____
(b) _____



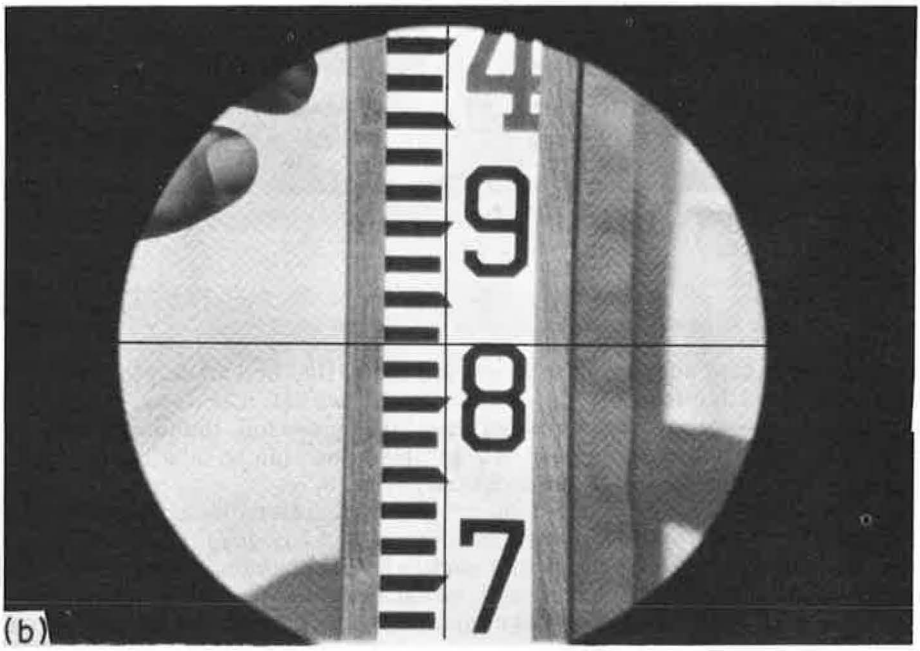


Figure 7.

The original program would take students stepwise (1/100 of a foot at the time to the next even tenth of a foot). Therefore, it is conceivable that the program would include many more photographs.

It should be noted that the programmer has constantly checked to assure that the steps are not too large for understanding by testing the material on one or two persons representative of the target population.

It was noted at the beginning of this summary that this example is but a very small segment of a much larger training effort called Leveling for Construction Inspectors. Before the final training program is published, it is field tested on a much larger segment of the target population. Where there is difficulty—noted by incorrect responses-revision takes place until greater than 90 percent of the target population makes the correct response.

The question might arise as to how programmed learning can be applied to the required actions such as plumbing the rod. Figures 8 and 9 should answer this.

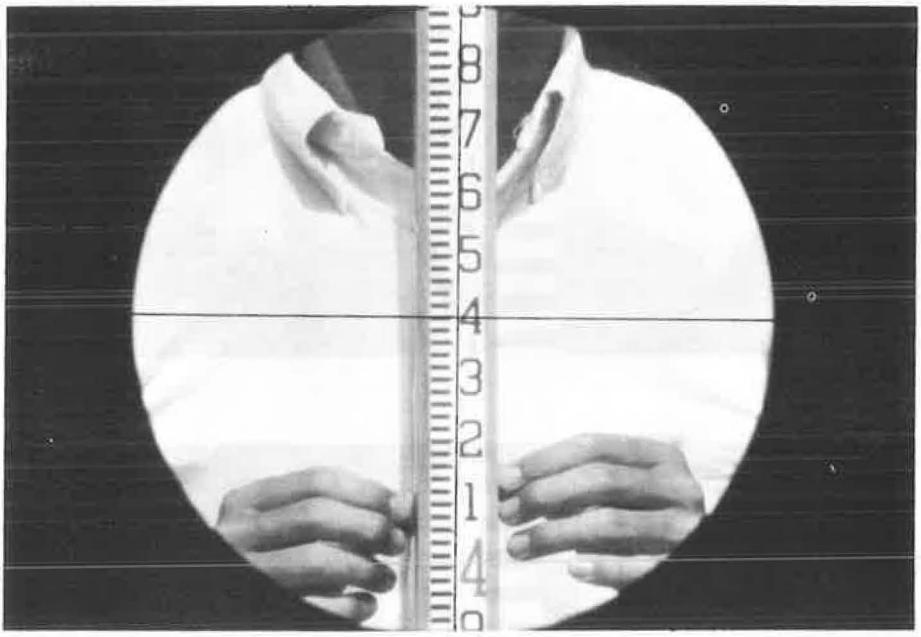


Figure 8.

By giving the trainee something to associate mentally, he can relate the required action, and thus practice on his own. For instance, we tell a trainee, using photographs, that if he were to hold the rod between his fingers and thumbs in such a way that it barely touched any of them (Fig. 8), he should be able to take his hands away, and the rod should stand by itself, momentarily (Fig. 9).

The length limitations of this paper do not permit a fuller discussion of the potential of programmed instruction in the training of highway construction inspector trainees. Maximum effectiveness of this particular methodology is experienced when upper and middle management realize what programmed instruction is, and what it can and cannot do. All too often programmed instruction is viewed as a panacea when such is not the case. Programmed instruction will not make any lasting effect on the training efforts of business and industry because it has been accepted in view of what

Figure 9a.

Figure 9b.

it will do instead of what it can do (8, p. 1). Programmed instruction can provide for a logical sequence of actions that provide for study, activity, and guidance because of the nature of its construction and development. Programmed instruction can save vast amounts of time and costs because it does get to the specific behavior, or task, that it required.

In an address (9, p. 7) to the annual meeting of AASHO, Robert Schmidt asserted:

> . . . an inspector, when working on a particular item, needs knowledge of just that particular item. An engineer, of course, needs to understand the entire background of the problem, but the inspector needs only to deal with specific problems on a specific day. Because of his educational background, his knowledge also needs to be refreshed each time he progresses to a new type of work.

Realization that specialization has become necessary because of ever-increasing technological knowledge is being accepted with the slowness of geological time. When the time comes that it is fully appreciated, there is a valuable instrument, because of its very nature, available for training these specialists, namely, programmed instruction.

REFERENCES

1. Brethower, Dale M. Learning Theory. Univ. of Michigan Press, Ann Arbor, 1965.
2. Havighurst, Robert J., and Neugarten, Bernice L. Society and Education. Allyn and Bacon, Inc., Boston, Mass., 1967.
3. Roy Jorgensen and Associates. Construction Division Training Needs Study. Virginia Department of Highways, Richmond, 1965.
4. Lysaught, Jerome P., and Williams, Clarence M. A Guide to Programmed Instruction. John Wiley and Sons, Inc., New York, 1963.
5. Mager, Robert F. Deriving Objectives for the High School Curriculum. N.S.P.I. Jour., Vol. 7, p. 7-14, March, 1968.
6. Mager, Robert F. Preparing Instructional Objectives. Fearon Publishers, Inc., Palo Alto, California, 1962.
7. Oliver, Albert I. Curriculum Improvement. Dodd, Mead and Company, New York, 1965, p. 58, citing Bush, Robert N., The Teacher-Pupil Relationship. Prentice Hall, Inc., Englewood Cliffs, N. J., p. 129, 1954.
8. Rummler, Geary A. Programmed Learning: The Whole Picture. Reprint from Training Director's Jour., April 1963.
9. Schmidt, Robert D. Illinois Program for Specific Task Training. Talk given to 52nd annual meeting of AASHO Committee on Construction, Wichita, Kan., 1966.
10. Scharder, Albert W. The Process. In Managing the Instructional Programming Effort, ed. by Geary A. Rummler, Joseph P. Yaney, and Albert W. Schrader, Univ. of Michigan, Ann Arbor, 1967.
11. Wahl, Richard A. A Report . . . In Managing the Instructional Programming Effort, ed. by Geary A. Rummler, Joseph P. Yaney, and Albert W. Schrader, Univ. of Michigan, Ann Arbor, 1967.

Developing Subject Matter and a Decentralized Organization for Highway Construction Inspection Training

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Louisiana Department of Highways

Factors affecting the initiation of a formal training program for construction inspection personnel are identified. The organizational structure of a highway training system is described. Requisite characteristics of the training personnel are detailed, along with duties and responsibilities of the different job positions.

A systems approach to training was adopted. The approach was based on the findings of a training needs study. Some significant findings of the training needs study that contributed to the initiation of a systems approach were the identification of the construction inspection job elements and the knowledge-skill-ability combinations needed to perform specific jobs.

Problems related to the development of meaningful, accurate and complete subject matter are described. The approach to subject matter development, with awareness of the inherent problems of the Louisiana Department of Highways, is given. This approach includes the collection of basic data from field personnel, official documents, and manuals of reference, and the review and approval of these data by an authoritative committee of Department engineers.

•IN the planning and formulation of any organization it is necessary that fundamental decisions first be made. This especially holds true for a training organization. These decisions state objectives, define the scope, set parameters, identify the required resources and establish the administrative policies that will govern the efforts involved in achieving the objectives. Often, these fundamental decisions are arrived at without sufficient knowledge of the characteristics of the organization, or of the available resources. Another factor that affects these decisions is the difficulty of personnel within an organization making a truly objective evaluation of their vocational environment.

Recognizing this axiom, officials of the Louisiana Department of Highways solicited the help of an engineering and management consultant to conduct a training needs study in 1966. This study consisted of analyses of (a) the organizational structure of the department, (b) the age, education and experience levels of the affected personnel, (c) the potential for effective training, and (d) the attitude of the personnel toward training. From these analyses, conclusions were arrived at and broad objectives and the means for achieving these objectives were recommended.

DEVELOPMENT OF A DECENTRALIZED TRAINING ORGANIZATION

The development of an effective training organization is the key factor in the entire training effort. The success of the entire program depends on this organization. To be effective, a training organization must have well-defined policies to govern its

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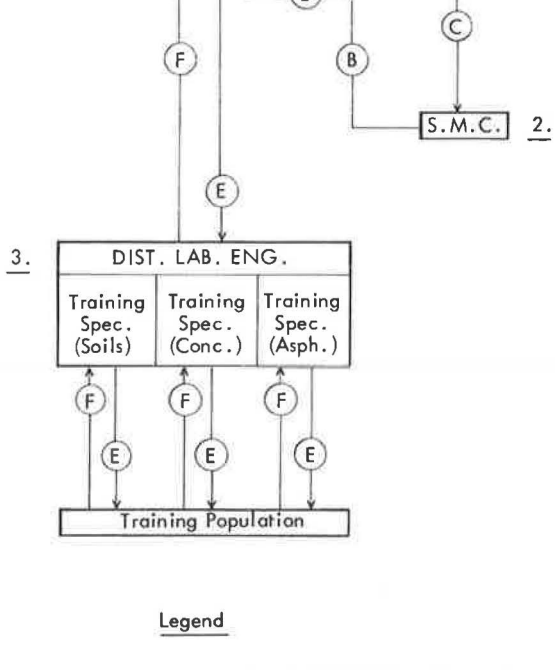
general activities, authority to carry out the policies, sufficient funds to operate, and an adequate staff of competent personnel.

The functions of such an organization should include (a) delineation of areas in whic training is needed, (b) defining the subject matter for specific training areas, (c) prescribing a training method that will result in the desired behavioral changes, (d) designing and developing training materials for the prescribed training methods, (e) supporting the implementation of training, and (f) analyzing the results of training.

Because the development of training materials involves considerable research, the highway training organization in Louisiana is part of the Research and Development Section.

Initial planning for the training organization was a joint effort of Highway Department officials and the consulting firm. Department officials placed one stipulation on any proposed organization: training must be accomplished on a decentralized basis. The findings by the consultant resulted in the recommendation and establishment of a training organization consisting of three functional elements: (a) a training unit, (b) subject matter committees, and (c) district training personnel. The relationships and the flow of subject matter data and finished training materials among the three element are shown in Figure 1.



Legend

1. Training Unit
2. Subject Matter Committee
3. District Training Personnel

A. Initial Subject Matter Data
B. Approved Subject Matter Data
C. Initial Training Material
D. Approved Training Material
E. Final Training Material
F. Training Feedback

Figure 1. Louisiana highway training organization.

Training Unit

A properly functioning train ing organization will have a nucleus from which guidance and resources emanate. This nucleus unit is called the "training unit" in the Louisiana Department of Highways. Such a unit must have the capability of identifying training needs, collecting subject matter data for training, converting these data into training materials and prescribing methods for implementing the training. The training unit should be staffed by personnel who possess the technology needed for organizing, writing, editing and illustrating the subject matter. It should also have the means for developing or collecting audio and visual training aids. A basic staffing pattern consists of a director, writer-editors, data collectors, illustrators and clerk-typists (Fig. 2).

Careful screening and selec tion of this staff is very critical to the entire training program. This is especially true of the writer-editor category. Persons in this category must know principles of learning, should have knowledge of behavioral psychology, must have a facility for learning technical nomenclature, must mix easily

with others, and above all, must have the ability to combine all these requisites into written, illustrated material that will bring about desired changes in behavior in the trainees. Experience has shown that persons, male or female, with strong English backgrounds work best. Training in journalism is a distinct advantage. Women seem to adjust easier to the monotony and confining aspects of the work.

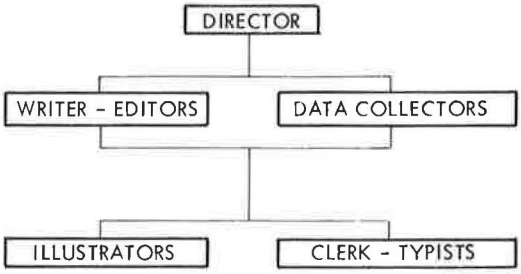


Figure 2. Highway training unit organization chart.

Data collectors may or may not be writers in the Louisiana setup. People collecting data must be able to organize random bits of information into logical content outlines. They must also be able to pursue the exploring of an area of investigation until all relevant data are described in writing and by illustration or photograph. The aptitude for probing until all questions are answered is a must. Since data collection requires going to the work site and dealing with men working in an outdoor, heavy-equipment environment, it is not ideally suited to women data collectors.

Illustrators need not necessarily be college graduates or proven artists. They must be able to produce realistic illustrations of highway elements and related equipment and materials. The ability to show perspective and plan and cross section views is vital. An illustrator must be able to improvise and create a graphic representation when all he receives from a writer is a written description of what is desired.

The Louisiana Highway Training Unit is staffed as follows: director—the highway training officer; writer-editors—5 or 6 training officers; data collectors—2 or 3; illustrators—2; and clerk-typists—3. As the scope of the work broadens, increases in staff positions will necessarily occur.

Subject Matter Committees

These committees are comprised of subject matter experts from the construction function. Most committee members are field engineers with intimate knowledge of the subject matter, the inspection personnel to be trained, and the conditions under which these inspectors must work. A separate committee is appointed for each training subject, and committee selection is predicated on the engineer's expertise in the subject and his availability based on his work load.

Committee responsibilities include reviewing the proposed content outline of the training course and making recommendations for revisions. Additionally, the collected subject matter data and the resulting training materials are reviewed and recommendations for revisions are proposed by committee members.

A properly functioning committee is one of the most vital elements in an effective training organization.

District Training Personnel

In the Louisiana setup, the district laboratory engineer is responsible to the district engineer for training activities. Under the supervision of the district laboratory engineer are district training specialists assigned under the three broad work categories of soils, concrete, and asphalt. District training specialists are selected on the basis of knowledge of a particular area of inspection and demonstrated ability to perform inspection functions in this area. An additional requisite for these positions is the ability to develop rapport and mix easily with field personnel. Experience has shown that constant contact and follow-through with field personnel by the training specialists is required to provide impetus to training.

These training personnel are jointly responsible for determining, by testing, the personnel who need training in specific subject areas, distributing the training materials, providing assistance to trainees and determining training effectiveness based on evaluation of job performance. These responsibilities further validate the necessity for experienced, knowledgeable training specialists. An effective liaison between the training

unit and the district training personnel is imperative to reaching training objectives. The lack of administrative control by the training unit over the district personnel is probably the greatest weakness in this arrangement.

This method of operation has been in effect for approximately two years in the Louisiana Department of Highways, and from all indications is effective. Revisions will be initiated when experience reveals a better approach.

DEVELOPMENT OF A TRAINING SYSTEM

Department experience in training efforts prior to the establishment of the training unit was that training needs definitely were not being satisfied. Lack of retention by trainees was a major problem. The absence of a logical, systematic approach to organizing and implementing training was obvious. The total organized effort toward training consisted of several weeks of classroom-type instruction in each district on soils and base courses, asphaltic concrete and portland cement concrete inspection. These winter training sessions were organized and conducted by personnel with no formal training for this task. With this background in mind, a training needs study was undertaken.

Training Needs Study

Recommendations in this study by the consultant included the development of self-instructional materials and self-operating workshops. A systems approach for achieving these objectives was adopted. The training needs study identified the 17 basic job elements involved in construction inspection in Louisiana and the characteristic tasks associated with each specific job element. Additionally, the study established that there are at least 40 knowledge-skill-ability combinations required to perform effectively the 17 job elements. The forty knowledge-skill-ability (KSA) statements provide the bases for the development of the individual training courses. The job elements and KSA statements are detailed later under "Subject Matter Development."

The study revealed much useful information about the inspectors as well as the work Some of the relevant and more interesting data pertaining to characteristics of construction inspection personnel of the Louisiana Department of Highways are given in Table 1

A Systems Approach

The development of a KSA statement into training data is accomplished by (a) makin a detailed study of each inspection task and collecting the relevant data, (b) researchin documents that govern the tasks, (c) resolving conflicts in governing documents, (d) eliminating outdated requirements, and (e) standardizing nomenclature and methods. This requires a systematic analysis of all governing documents, manuals of reference, prevailing work practices, organizational structures, intradepartmental relationships and relationships between department personnel and contractor personnel.

Method of Implementation

The need for individual training in a specific subject area is determined by administration of a test based on criterion questions. Self-instructional training materials are furnished the trainees free of charge. Training on Department time during slack time in construction is encouraged. Workshop areas are proposed for each district headquarters. The workshops will supplement the written materials by providing samples, visual aids and the materials and space needed to perform sampling, testing, or inspection procedures.

Evaluating the effects of training, based on changes in the trainee's behavior while accomplishing his tasks, and providing on-the-job assistance are roles of the district training specialists. District training personnel provide feedback of training effectiveness and associated problems to the training unit. This results in statewide evaluation of all training activities.

TABLE 1

DISTRIBUTION OF PERSONNEL

Characteristics	Personnel Classification—Number of Persons in Sample						Total	Percent of Sample	Number in Total Force	
	Engineering Aide				Engineering Specialist				Estimated[a]	Cumulative
	I	II	III	IV	I	II				
Age:										
Less than 25 years	7	12	4	1	—	—	24	24	373	373
25-34 years	1	6	18	15	2	1	43	44	685	1, 058
35-44 years	1	2	3	3	8	—	17	17	265	1, 323
45-54 years	—	5	—	2	2	—	9	9	140	1, 463
55-64 years	—	1	1	1	2	1	6	6	93	1, 556
Total	9	26	26	22	14	2	99	100	1, 556	
Education:										
Less than 8 years	1	—	—	—	—	—	1	1	16	16
8 years	—	2	1	—	3	—	6	6	93	109
9 to 11 years	—	2	3	—	—	—	5	5	78	187
High school grad.	8	17	17	19	8	2	71	72	1, 120	1, 307
1 to 3 college years	—	5	5	1	3	—	14	14	218	1, 525
Bachelor's degree	—	—	—	2	—	—	2	2	31	1, 556
Total	9	26	26	22	14	2	99	100	1, 556	
Experience:										
Less than 2 years	8	8	—	—	—	—	16	16	249	249
2 to 4 years	1	12	9	2	—	—	24	24	373	622
5 to 9 years	—	5	14	9	1	—	29	30	467	1, 089
10 to 19 years	—	1	3	11	11	1	27	28	436	1, 525
20 years or more	—	—	—	—	1	1	2	2	31	1, 556
Total	9	26	26	22	13[b]	2	98	100	1, 556	

[a]If the percentages in the sample hold true for the total force.

[b]One person omitted his experience record.

SUBJECT MATTER DEVELOPMENT

The accumulation of meaningful, accurate and complete data is the key to subject matter development. The principal source for these data should be the subject matter experts who perform the tasks involved. Data based on actual working situations are immeasurably more meaningful for use as training subject matter than are data from conventional agency publications such as construction manuals or sampling and testing manuals. Most manuals of reference and department directives specify what to do but very seldom do they prescribe the acceptable methods of how to do it. More often than not, these publications are in need of updating and revision. Constant changes in the state of the art result in the issuance of policy and procedure memoranda that make hopeless the keeping of current manuals. Also, it is found that many of the practices stipulated in these manuals of reference are based on ideal situations rather than actual conditions.

Recognizing these facts, it was agreed that the data for Louisiana would originate from personnel with knowledge based on experience in the subject matter area. These data are reviewed by the subject matter committees in light of existing official documents on policy, practice, procedure and authority. Being mindful of changes in technology and the continual obsolescence of official documents, these committees provide a means for initiating needed revisions in inspection practices. In many instances in the past the need for revisions has been recognized, but there was no individual or section charged with the responsibility or given the authority to accomplish these changes. There still exists a need for a more systematic approach to keeping construction inspection practices up to date with advances in construction technology. Many construction operations are computerized, while the related inspection standards are holdovers from another era. Perhaps this gap can never be entirely eliminated, but it is obvious that it can be closed considerably.

TABLE 2

JOB ELEMENT STATEMENTS THAT DESCRIBE CONSTRUCTION INSPECTION FUNCTION

1. Clearing and grubbing inspection
2. Excavating and embankment placement inspection
3. Pipe placement inspection
4. Bridge construction inspection
5. Box culvert, headwall, catch basin and other reinforced minor structures, construction inspection
6. Subbase and base construction inspection
7. Asphaltic concrete paving inspection
8. Asphalt surface treatment inspection
9. Asphaltic concrete batch plant inspection
10. Portland cement concrete paving inspection
11. Portland cement concrete batch plant inspection
12. Seeding, sodding, erosion control and beautification inspection
13. Guardrail, guide post, sign, delineator and light placement inspection
14. Fence placement inspection
15. Utilities relocation inspection
16. Location surveying
17. Project management

Subject Matter Criteria

Data to be used as subject matter for training should be confined to that related to equipment and methods used to accomplish the necessary tasks, the knowledge needed to accomplish the tasks, sequence of activities, standards for acceptance, reasons for rejection, tricks of the trade and documentation. The subject matter must define the work only to the extent that it affects the person to be trained. Work methods, principles and techniques should be emphasized, but frequencies or intervals should be omitted because they are subject to constant change.

Defining Subject Matter Areas

Before data can be collected, the subject areas in which training is needed must be defined. This was accomplished in Louisiana by assembling a committee of professional subject matter experts that was capable of identifying the work functions involved in the construction of roads and bridges, and the knowledge-skill combinations required to inspect these work functions. These work functions, which we call job elements, are given in Table 2, and the knowledge-skill-ability (KSA) combinations are given in Table 3.

Training Course Prescription

Determining the course content requires the establishment of terminal behavioral objectives. It must be decided just what the trainee must be capable of performing in order to adequately accomplish his duties. These behavioral objectives should be defined to the extent that precisely what performance is expected, under what conditions, and what equipment or supplies are to be used in the performance are clearly stated.

TABLE 3

KSA STATEMENTS DEVELOPED TO REPRESENT COMBINATIONS OF KNOWLEDGE, SKILLS AND ABILITIES REQUIRED FOR INSPECTION OF HIGHWAY AND BRIDGE CONSTRUCTION

Basic KSA's

1. Department orientation
2. Construction orientation
3. Contractor operations
4. Contracts, agreements and specifications
5. Terminology and nomenclature
6. Drawing and lettering
7. Documentation and records
8. Manuals of reference
9. Equipment and tool usage
10. Mathematics one
11. Mathematics two
12. Dimensions and conversions
13. Basic sampling and testing
14. Surveying one
15. Plan reading
16. Project safety
17. Public relations
18. Soils and aggregates

Intermediate KSA's

19. Mathematics three
20. Surveying two
21. Surveying three

Intermediate KSA's (continued)

22. Surveying four
23. Clearing and grubbing inspection
24. Utilities inspection
25. Earthwork inspection
26. Portland cement concrete placing and testing—structural
27. Portland cement concrete batch plant inspection
28. Asphaltic concrete batch plant inspection
29. Bridge construction inspection
30. Box culverts and concrete structures inspection
31. Soil-cement and lime stabilization inspection
32. Asphalt surface treatment inspection
33. Asphaltic concrete pavement inspection
34. Portland cement concrete pavement inspection
35. Seeding and sodding inspection
36. Guardrail, guide post, sign and light placement inspection
37. Fencing inspection
38. Pipe placement inspection

Advanced KSA's

39. Supervision
40. Inspection management

An example of a behavioral objective is: "Given a sample of freshly mixed portland cement concrete, the slump cone, tamping rod, engineer's scale, and an impermeable surface, perform the slump test in accordance with the approved testing procedure, and document the test results." Again, these broad behavioral objectives can best be established by subject matter experts. Extensive subject matter knowledge is needed to prescribe behavioral objectives.

Obviously, a behavioral objective is something measurable. Concepts, principles and helpful knowledge are not measurable, but are often essential to training. These additional data may be compiled by those preparing the course prescription for inclusion in the course. By combining behavioral objectives and supplemental information, a general content outline, or prescription, is formulated. In the Louisiana setup, course prescription is determined by the subject matter experts, not the training personnel.

Training Course Data Sources

Sources of information consist of subject matter experts; construction, sampling, and test procedures manuals; standard specifications; special provisions to the specifications; policy and procedure memoranda; construction plans; and documented historical data.

Data Collection

Collection of training data for highway construction inspection requires that the data collector find a subject matter expert who can perform his duties and answer questions related to this performance while being observed at work by the data collector. In almost every case, this limits data collection to construction work in progress. It has proved extremely difficult to collect data that satisfy questions raised by trainees if the activity to be described is not in progress at the time of data collection.

Findings to date have been that even an experienced data collector never collects all the needed data for a training course on the first attempt. Unanswered questions always crop up and another round or rounds of data collection is needed. Further, more than one subject matter expert and one job should be used as the basis for training data. Normally, five to ten experts are sufficient. The first two or three experts usually supply around 80 to 90 percent of the needed data. The last 10 to 20 percent proves hard to get and requires more time for collection than the initial 80 to 90 percent.

Determining Data Validity

A subject matter review committee, which may be a different committee than one that determines course content, is charged with reviewing the collected data for accuracy, completeness and meaning. The qualification requirements for this committee are the same as those described earlier for the subject matter committee. No training materials should be developed until committee approved data are available to the writer. Conflicts in the data package should be resolved by the committee, or proper authority, before the data package is released to the writer.

Mistakes will occur in development of training materials as they occur in any other productive activity. The use of committees is an attempt to minimize the chance for error. A more objective training course prescription and review is possible by using persons outside the training organization on these committees.

SUMMARY AND CONCLUSIONS

1. To be effective in attaining objectives, a highway training organization must have top management support in the form of specific policy statements and adequate financial provisions, and must be provided with the personnel necessary to staff the required positions.
2. State highway departments are adaptable to decentralized training due to their basic organization pattern.

3. Data for construction inspection training are most meaningful when obtained from subject matter experts who have performed the tasks to be described.

4. Experienced construction engineers are best qualified to formulate construction training course prescriptions, and to review the data and training materials resulting from the data.

Maintenance Training Research

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•THE Louisiana Department of Highways is conducting research to develop effective methods for training maintenance personnel. The training research is based on findings of a more extensive research undertaking directed toward the development and implementation of a modern maintenance management system. The principal elements of the management system—and bases for maintenance personnel training—are performance standards defining optimum service levels, quantities of work, and work methods and procedures.

This paper reports on that phase of the research directed to the testing and evaluation of different training methods. The following subject areas are covered:

Work Force Characteristics—A description of the characteristics of the maintenance supervisory personnel who are to be trained. These characteristics influence decisions on the selection and development of training methods.

Subject Matter Content—A general outline of the subject matter—developed from performance standards—used to conduct the research and a discussion of some management actions required before end-behavior can be altered.

Training Methodology—A description of the different training methods selected for testing.

Evaluation of Effectiveness—The plan for evaluating the effectiveness of training and some preliminary conclusions reached at this stage of testing the methods.

WORK FORCE CHARACTERISTICS

Maintenance supervisors in Louisiana are very similar in terms of age, education and experience to those found in other states and Canadian provinces with whom the consultant has been associated.

Typically, they are extremely dedicated men who have spent the greater part of their lives as public servants of the highest order. Still, they present some difficult problems from the standpoint of their capacity to absorb training material.

Their age places them many years away from the formal learning processes of school and they are generally lacking in education. Their experience often represents many years of doing things the same way, which means some nonefficient work habits and methods are quite ingrained.

Age

The range in age of maintenance supervisors to be trained was from less than 25 to more than 65 years. Equipment operators, from whom future supervisors will be drawn, had roughly the same distribution in age. The distribution of both groups is shown in Figure 1. As can be noted, the mode of the distribution of both groups is in the 55 to 64-year range. The average age of the present supervisors is 51 years; the average age of potential supervisors is 49 years. These data indicate a potentially high turnover from retirement and the promotion of new men will not shift the age distribution to any appreciable extent. Therefore, training materials and methods must be designed to accommodate both the young and old supervisor.

Paper sponsored by Committee on Maintenance Personnel (Joint with AASHO) and presented at the 48th Annual Meeting.

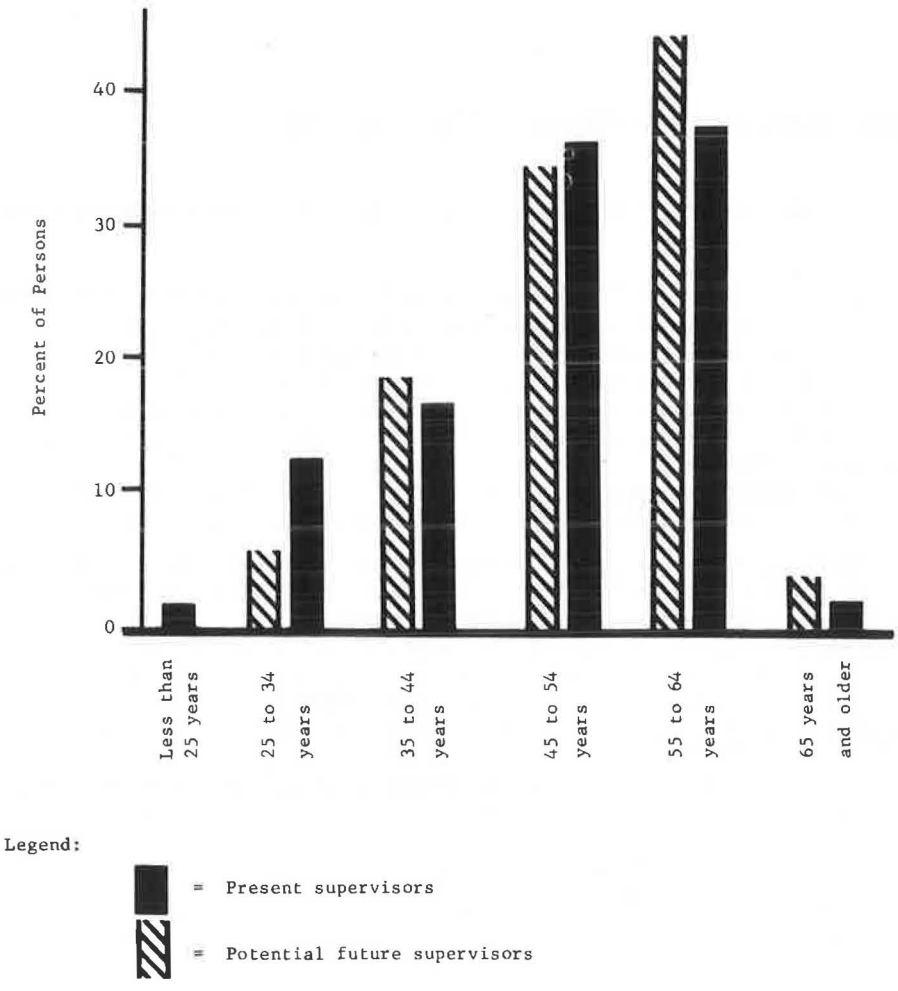

Figure 1. Age distribution of maintenance supervisors.

Education

The education distribution of maintenance supervisors is shown in Figure 2. The average number of school years completed was 8.9 for current supervisory personnel and 6.7 years for potential supervisors. The number of years of education ranged from less than 4 to 16 years. The educational level is a significant factor in any training program because verbal or reading skills have a large effect on trainability. Training must be designed to cope with the person who can barely read and write as well as the high school or college graduate.

To complement the inventory of education data, a Wonderlic Personnel Test was given to a sample of supervisors. This widely accepted test indicates the relative capacities of individuals to learn from training. A summary of the results of this test is given in Table 1.

In a similar test of the potential supervisors, only 9 percent showed a general ability to be trained. These test results mean that new techniques must be developed if personnel with low capacities for learning are to be trained successfully.

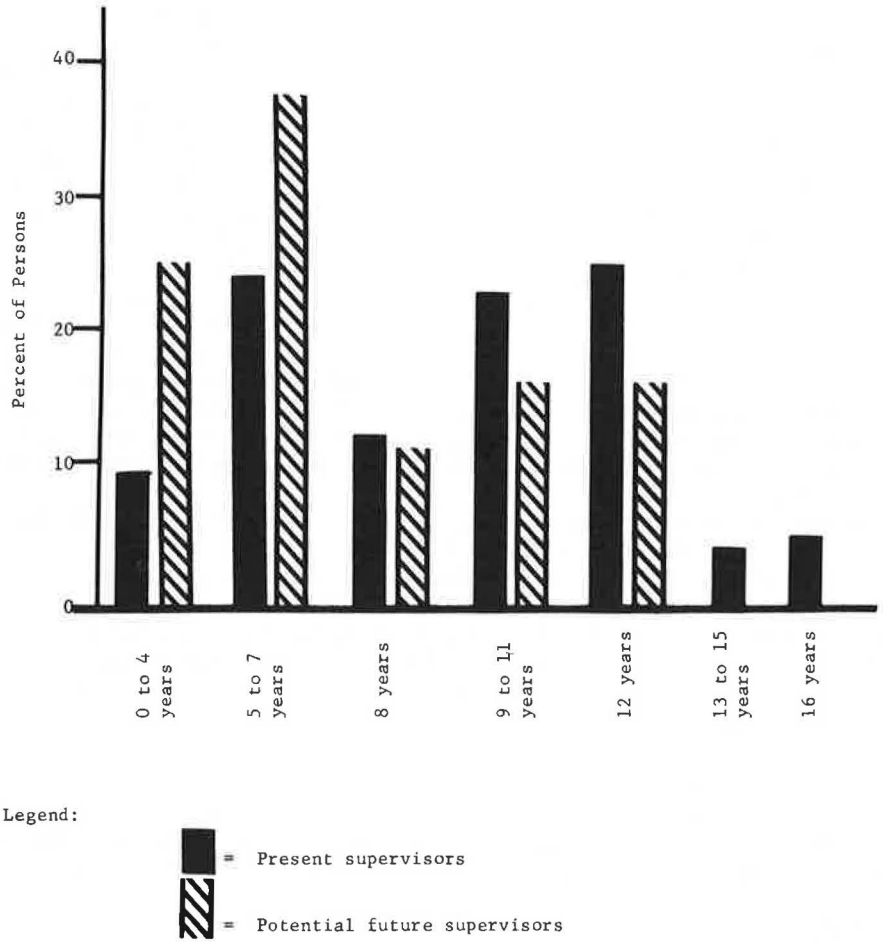

Figure 2. Education distribution of maintenance supervisors.

Experience

Both current and potential supervisors are generally well experienced. More than 79 percent of the current supervisors have more than 10 years experience—and 20 percent of them have more than 20 years. The potential supervisors generally have less experience with only 41 percent having more than 10 years.

The experienced supervisor has a good general familiarity with maintenance equipment, materials and needs. However, supervisors with long experience will be reluctant to take training with less-experienced personnel. They also will have more difficulty in accepting new concepts.

SUBJECT MATTER CONTENT

The content of maintenance training is recognized as one of the chief problems in training. As compared to the fields of construction or materials testing, the procedures of maintenance are very poorly defined. Furthermore, the knowledge of maintenance operations possessed by maintenance engineers is often lacking in sufficient detail for use as subject matter data for training.

TABLE 1

WONDERLIC TEST RESULTS

Wonderlic Test Scores	Ease of Training	Percent of Present Supervisors
0 to 11	Difficult—inability to read or grasp numerical relationships and abstract concepts.	66
12 to 15	Marginal—can be trained in repetitive tasks.	13
16 to 50	Readily trainable—by using carefully developed materials.	21

As a result of other research efforts to improve management practices in Louisiana, virtually all maintenance work methods and procedures are being modified. This meant that the collection of training data by observing crews in action was not possible because no crew was doing the job according to the revised methods.

Therefore, the approved performance standards were used as the basis for developing training material. Basically, these standards indicate when work should be undertaken, how much work should be done, and what methods and procedures are the most productive. The performance standards were expanded into training material through discussions with persons thoroughly familiar with the rationale behind the new practices.

To evaluate the training methods, the maintenance category of "bituminous surface care" was selected as the subject matter for development. The most salient feature of the new bituminous surface care program is the planned seal coat of a road every 5 years. A number of bituminous surface work functions must be performed. Each has a distinct purpose and is directed toward obtaining a specific quality or service level. For each, the amount of work to do, labor/equipment staffing pattern, work procedures and standard unit cost have been spelled out. The aspects of the surface care job in Louisiana are set forth in the following sections.

Surface Treatment Patching

Surface treatment patching is a spot seal coat operation consisting of an application of liquid asphalt and cover aggregate. Its purpose is to prevent deterioration of a pavement beyond the stage of light pattern cracking or oxidation in-between seal coats.

Premix Patching

Premix patching is repair of traffic hazards—potholes and severe depressions—by bringing the area of failure back to the original surface height. The Department's desire is to keep emergency work separate from planned, major programs and to hold the amount done by these methods to a minimum.

Patching Base

Base repair consists of the removal of unsuitable base and its replacement with good material. All base repairs are subject to specific approval by an engineer from the district.

Seal Coat

A seal coat is a full-width treatment consisting of a single application of liquid asphalt and cover material. The seal program is intended to have an average frequency of 5 years.

Premix Leveling

Premix leveling is a general leveling course applied in the same season as a road is sealed. It is intended to restore all cross section deviations greater than top-size premix aggregate. This work is authorized along with the seals on a road-by-road basis by the district.

Spot Surface Replacement

Spot surface replacement consists of removing necrotic surface material that has cracked all the way through and re-paving the area with hot mix.

Training must communicate to maintenance field supervisors the way a job should be done. In this sense, training is one part of the implementation process required for new practices. In addition to the training of supervisors, there are significant changes in the action patterns of other managers required to accomplish the desired end behavior. The actions required of persons other than the supervisors being trained include:

1. The development of an objective maintenance program for the districts involved in the research. (The program is built up from performance standards and represents an objective in terms of good performance. This is contrasted with a program based on past performance, which would be essentially predictive.)
2. A formal inspection jointly conducted by the supervisor and an engineer from the district office to designate roads for major maintenance effort and to agree mutually on approaches to specific problems.
3. The installation of a scheduling process in each parish to facilitate scheduling of work as called for by performance standards.
4. Minor reorganization within the operating forces to allow greater flexibility of operations on the part of the field supervisor.

TRAINING METHODOLOGY

Through a review of training methods now in use, those tested in other maintenance research, and those utilizing the new techniques of programmed instruction, the decision was made to investigate 5 basic methods. These are as follows:

1. Written programmed instruction—self-instructional materials in a printed book format, prepared according to the generally accepted programmed learning technique.
2. Audio-visual programmed instruction—self-instructional materials that minimize the need for reading by use of a "teaching machine." For this research, a slide projector and tape recorder were used.
3. Programmed workshop—a carefully led small group that uses written materials highlighted by both classroom models and field observations of road conditions and proper corrective procedures.
4. Group discussion—a leaderless small group that uses written materials. The job of temporary discussion leader is rotated among the trainees.
5. Conventional lecture—presentation of training material through the standard lecture technique using a knowledgeable instructor.

Each training method was selected because of certain characteristics that are spelled out in the following sections.

Written Programmed Instruction

The usual written programmed instruction materials have a number of advantages not found in other training methods. Their effectiveness in industry has been conclusively demonstrated and, as a result, they formed the basis for this training research. Their characteristics are as follows:

1. They are self-pacing. The student is paced entirely according to his own abilities. It has been found that differences in test results of other training methods are merely the result of differences in speed of learning; so, the results do not accurately reflect the total amount of information a person can learn.
2. The student is unlikely to be embarassed—an important factor in training adults.
3. The materials are always conveniently available and can be effectively used in slack time.
4. Retention generally is superior to other forms of training.

5. The disadvantage of these materials is that they depend on reading ability. For this research, the subject matter material was prepared for fourth grade reading level. However, only time will tell whether or not this will be satisfactory.

Audio-Visual Programmed Instruction

The same characteristics of learning—discovery of the facts by the student and immediate confirmation of correct answers—that make programmed instruction so effective are also inherent in an audio-visual format.

A series of slides, designed to illustrate concepts and to create mental interruptions at the appropriate time, will be used for this method. As the slides are being viewed, spoken supporting information will be furnished to the student by means of a prerecorded tape program. The student is asked questions on the material and his answers are verified by the tape.

It is anticipated that most learning problems associated purely with reading can be eliminated. Comparison of test results with conventionally programmed material should provide needed insights into the significance of reading ability. There are available a number of self-instructional reading improvement programs that may well be an alternative for the Department should this be noted as a significant factor.

Programmed Workshop

For training to be effective, the student not only must gain knowledge but also must act on that knowledge in the field. The principal characteristic of this method is the immediate reinforcement in the field of the information learned during a group discussion.

The method planned is to use a series of classroom models augmented with demonstrations in the field to support the written material. The student will be asked to evaluate some existing road conditions and to indicate the proper corrective actions. The student also will be shown approved procedures for performing each function of surface care job.

Group Discussion

It is recognized that many motivational factors affect the behavior of men trained, and that these factors cannot adequately be separated from other training considerations.

One of the primary motivators, theoretically, is group acceptance of a concept. Conceivably, an individual could agree completely with what he was taught, but not be moved to act for fear of being the only person around who would be doing the job in a new way. This training method will be tested so that the combination of programmed preparation and group dynamics can be evaluated.

Conventional Lecture

The material on bituminous surface care will also be presented in a conventional lecture format. A blackboard will be used as the major visual aid to stress major points and to avoid extraneous material. In effect, the lecture is being used as a "control" method to determine the extent of improved training through the programmed methods.

EVALUATION OF EFFECTIVENESS

The basic procedure for testing each of the training methods is as follows:

1. A comprehension test—The purpose of this test, which consists of 97 basic questions on language and mathematics, is to determine the learning ability of the trainees so they can be divided into comparable sub-samples.
2. A pre-test—This is used to determine the amount of subject knowledge prior to training.
3. One of the 5 "bituminous surface care" training methods.

4. A post-test—The purpose of this test is to determine the amount of subject knowledge immediately after training.
5. Retention tests—These tests will be administered at one-month and three-month intervals after the training to measure trainees' retention levels.

The training methods will be evaluated in two stages. These are as follows:

1. Immediate or short-term—An evaluation directed to the comparative communication ability of the various methods as determined from pre- and post-testing.
2. Long-range—An evaulation in terms of specific retention levels and also one coming automatically from the Louisiana Maintenance Reporting System, which will show performance change and dollar savings.

The training will be administered by the line organization. Representatives of each district have been instrumental in developing the standards, which have the approval of the maintenance engineer. Obtaining standard results or better is the objective of the Department. If this objective is to be fulfilled, managers in both the central office and the districts must give full notice to their people that that is what they want done. In essence, this is a regular part of the management and supervision of the maintenance function. Such an outlook is essential to the success of a training effort. No one is likely to change his methods of doing work unless he is convinced this is the way his organization wants him to do it.

Short-Term Plan

The primary evaluation will consider the following factors:

1. The test results obtained compared with an evaluation of the man's learning potential.
2. The reaction of people as evidenced by their attitude toward training and their desire to take more training.
3. The changes in work behavior.
4. The organizational convenience of each training method.
5. The amount of follow-up required by district-level supervisors.

The research team will assist Department and district managers in evaluating research results, but the decision as to what methods should be adopted for use will lie with them.

Preliminary Results

Based on the limited sample tested to date, the following preliminary conclusions were drawn:

1. Above-average trainees (in terms of age; education, experience, and learning ability) gained more from the audio-visual and workshop methods than from any other method.
2. Average and below-average trainees gained more from the audio-visual and group discussion methods than from any other.
3. The amount of information gained does not seem to be dependent on the age, experience, or educational level of most trainees. Insignificant correlations were found among these variables.
4. The comprehension test seems to be a good predictor of the capacity to learn. Trainees who scored high on the test gained more knowledge than those with low test scores. Therefore, the test can serve as an aid in the selection and the screening of good potential supervisors.
5. The first retention tests indicate that the average trainees retained about 90 percent of the information learned.
6. The attitudes during the pre-test ranged from the noncommittal to an "I don't need training" remark. Trainees definitely became more interested as they progressed through the course and all but 5 of the 90 sampled to date felt that further training in other areas was essential.

TABLE 2

TRAINING METHOD RESULTS

Method	Approximate Time to Administer (hr)	Average Comprehension Test Score[a] (¢)	Average Gain Rate[b]
Written programmed instruction	7	45	0.60
Audio-visual programmed instruction	6	45	0.73
Programmed workshop	20	46	0.68
Group discussion	13	46	0.68
Conventional lecture	3	46	0.46

[a] Perfect score = 97.0

[b] $\text{Gain rate} = \frac{\text{Post-test score less pre-test score}}{\text{Perfect score less pre-test score}}$

7. About one-half of the trainees indicated that they planned to conform to maintenance procedures learned during the course. The remaining trainees accepted only parts of the training, indicating the need for follow-up by supervisors.

The relationship among the various methods is given in Table 2.

Long-Range Plan

Tests for retention of information will be conducted at regular intervals after conclusion of the training; but the final evaluation will occur several months later when the data feedback from the Louisiana Maintenance Reporting System shows the change in the quality of the work, in the amount of work required when done properly, and the unit costs. This will be looked at as the final test of the different methods.