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.