Training Programs for the Highway Industry

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INTRODUCTION

Probably one of the most serious problems facing the highway industry today is the shortage of engineers and technicians.

The shortage of engineers in state highway departments was brought rather clearly, and perhaps ironically, to my attention this winter. While a representative of the Ohio Department of Highways was visiting universities in eight or ten other states attempting to recruit their engineering graduates to be employed by the Ohio Department of Highways, we have had equally as many representatives from other state highway departments on our campus in Columbus attempting to employ our graduates.

While a basic cause of the present shortage of qualified engineers and engineering technicians is perhaps our very large construction program, I am sure that there are many other underlying causes. I would particularly like to consider some of the reasons for the present shortage and to examine the potential value of various efforts in education and training as a device for attracting more engineers and technicians to the highway industry and as a means of upgrading the capabilities of the men already employed.

The late Ben Petty once said in a talk before our Ohio Highway Engineering Conference, "True education raises as many or more questions than it answers." If I do not furnish the reader with any pat answers to questions, I may raise some other questions and perhaps a critical examination of these questions may lead to some answers.

To bring the picture of education and training needs for the highway industry, as it exists today, more sharply into focus it is important to realize how rapidly the tools for construction have changed and are continuing to change.

The first many centuries of civilization we used only muscle power, human or animal, windpower, or the power of moving water for con-

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struction activity. It was only roughly one hundred years ago that we first harnessed steam in a useful form for construction. Fifty years ago we harnessed electricity, forty years ago gasoline, thirty years ago the diesel motor, and the pneumatic tire.

Today we are harnessing the power of nature with many devices which were unknown only ten years ago. These include hydraulic controls for machines, electronic devices for control of line and grade, nuclear devices for control of quality of construction, computers for many tasks, laser beams and many others. On the horizon or already in the research and testing laboratory are many new adaptations of fundamental knowledge of science to construction equipment. It is estimated that our new engineering knowledge today is increasing at such a rate that it is approximately doubling every ten years.

It is also estimated that the amount of engineering construction that will be done in the world in the next fifty years will probably be greater than all engineering construction in the past history of civilization. Hence our engineering manpower shortage may become even more critical in the decade ahead.

We are fortunate in the United States to have a national agency, the Highway Research Board which very ably serves the function of assembling, examining, and disseminating new knowledge on road building. However, the lines of this dissemination of new knowledge often stop too short. Much of the knowledge in the form of research reports only gets as far as the offices or library shelves of the researchers.

Too often the state highway representatives who attend the Highway Research Board meetings and other similar technical meetings, are top echelon men and when these men return to their home desks, they find them piled high with routine work. While they may have had the best intentions, upon returning from the research board meeting, to put the new information to work, they find that after they return home they are so busy that they indefinitely postpone following through on the new ideas which they have learned. The reports thus often collect only dust on the shelves.

A contributing cause of this situation, and I suspect it occurs in all 50 states, is that the professional success of most state highway engineers does not depend on competition and thus they may somewhat lack the motivation for making the best use of new knowledge. In private industry, by contrast, to keep ahead an engineer must keep up-to-date and make best use of new knowledge.

One good means of getting the information on new road building
knowledge to the men who can absorb and use the findings is through continuing education in the form of in-service training courses, workshops, seminars, etc.

The vehicle of education is essentially communication; the passing on of an idea from one person to another. The communication may be verbal, in writing, or in pictures.

Communications can be for any of three purposes:

1. To inform—to pass on information to another person.
2. To instruct—to teach a person to acquire the ability to do certain things. These things may be physical, as operating a bulldozer, or may be problem solving, but in each case they should lead to the ability of the person being taught to make the proper decision as he comes to problems.
3. To convince—to cause the hearer to change his mind or his attitude about a certain situation.

Communication, however is only effective if the listener receives the same thought as the speaker is trying to express. For this reason communications in a classroom setting where the teacher-pupil relationship exists are most effective. The teacher can make sure through inquiry, questions or quizzes, that the listener is learning.

Needed education and training programs for the highway industry include all three kinds of communications, informing, instructing and convincing. They cover many areas, all the way from top management in the highway departments down to programs designed to interest junior high school students to look into the profession of engineering as a career. Let us then take a brief look at efforts which are underway at the various levels.

EDUCATION FOR HIGHWAY ADMINISTRATION

At the top level I would note your annual Purdue Road School. Through its 53 years of continued success it has demonstrated its value in providing an opportunity for communication between person in the various segments of the road building industry.

Within their highway departments many states are conducting in-service training courses. Roy Jorgenson, of the Highway Users Conference, through his management conferences for highway administrators, has left an imprint on many states throughout the nation. In some states, schools in administrative management are now being carried on at the second echelon level. The highway departments are, generally
with the cooperation of departments of business administration of universities, carrying on management courses for their division engineers, bureau chiefs, etc.

A few states are helping to upgrade their professional engineers by allowing them, encouraging them, and even subsidizing them to carry graduate courses at universities. Perhaps if an engineer has worked ten years in the highway department a few months leave of absence, to attend a university full time and possibly even doing a little teaching there, could be of tremendous value to him.

**EDUCATION FOR PRACTICING HIGHWAY CONTRACTORS**

A second group of people who need and want education, especially for construction management, are the contractors. During the summer of 1957, the head of the Ohio Contractors Association asked me to work as a consultant for that organization, with my total assignment being to spend time on construction projects listening to the contractors' supervisory personnel to pick up ideas of what the association might be doing to better help the contractors.

While collecting many ideas on technological developments, on changes needed in specifications, administrative procedures, labor relation, etc., one thing that kept coming through clear and loud was the expression of project supervisors of the need for an opportunity to continue their education. Although our technical magazines are full of good information on new developments in equipment and procedures, the use of CPM, etc., most contractors' supervisors just do not have time to read these articles and they don't have the opportunity to ask questions if they do not understand something in the article.

To serve this indicated need, we set up at the University in the winter of 1958, a short course on Fundamentals of Construction Management. To provide textbooks, notebooks, honoraria for speakers, etc., and based on an estimated number of forty participants, we arrived at a registration fee of $35 per man. The Contractors Association agreed to bail us out if we failed to attract this number. The first week after the course was announced, we had 56 applicants. We closed the registration at 50, repeated the course again that winter and held two sessions during the following year. The only complaint which we received from contractors regarding the course was that for the bridge contractors we did not spend enough time on bridges; for the earth work contractors we did not spend enough time on earth work, etc. We then decided to use the rifle pattern and set up separate short
courses on specific subjects, rather than to try to broaden the course to cover everything.

On March 9, 1967, we completed our thirty-ninth separate course in this series, with a total participation of 1317 contractors. The registration fees have varied anywhere from $35 up to $150. For a course like Application of CPM to Construction Management, a full week is required with computer time, etc. The individual courses so far conducted and total participation in each are as follows:

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Participants</th>
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<tbody>
<tr>
<td>Fundamentals of Construction Management</td>
<td>7</td>
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<tr>
<td>Earthwork</td>
<td>3</td>
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<tr>
<td>Bridges</td>
<td>3</td>
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<tr>
<td>Bituminous Pavements</td>
<td>6</td>
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<tr>
<td>Portland Cement Concrete Pavements</td>
<td>2</td>
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<tr>
<td>Top Management</td>
<td>4</td>
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<tr>
<td>CPM in Construction Management</td>
<td>4</td>
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<tr>
<td>Cost Accounting</td>
<td>3</td>
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<tr>
<td>Middle Management</td>
<td>1</td>
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<tr>
<td>Water, Sewer and Drainage</td>
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<td>Data Processing</td>
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<td>Foreman’s School on Plans and Specifications</td>
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An examination of the roster of registrants of our short courses show a rather high percentage and seemingly an ever increasing percentage, of engineers who are serving as contractors’ supervisors. The sophistication of modern construction equipment and control technology is such that contractors today need the engineers’ kind-of-thinking for field supervisor work.

In the last few years we have publicised our short courses to county engineers and city engineers as well as contractors and have had a scattering of these engineers in attendance. Actually, I feel that having these county and city engineers in the courses has been beneficial not only to these participants, but also to the contractor’s representatives present. The informal exchange of ideas on construction procedures and controls has been beneficial to both groups.

In our short courses, I have used as speakers many bright young supervisors from contractors organizations as well as younger staff engineers from the department of highways. The experience of preparing to talk for an hour, before a group of practicing supervisors, is
rather challenging to another supervisor or a young engineer and forces him to really crystalize in his thinking what is important. I have found that our better contractors are willing to let their supervisory personnel handle such assignments, recognizing that they become better supervisors because of having been forced to handle such an assignment.

HIGHWAY ENGINEERING COURSES IN COLLEGE CURRICULA

Within the past few years, there has been quite a hassel within the engineering colleges as to just what should be the goal of engineering education. The development of new knowledge and of more sophisticated hardware is causing most universities to tend to make up their engineering curricula ever more of fundamental science and to leave out the courses in application of scientific knowledge. Many college administrators support this attitude through a generally practiced policy which is known among young instructors as "publish or perish", that is, keep on doing fundamental scientific research work, publish the reports or fail to get promoted.

A by-product of this type of scientifically oriented college curriculum is that we will have an ever increasing shortage of young engineers capable of the kind-of-thinking which will enable them to go out, look at a situation in the field, plan, design and construct a proper and economic road or bridge or building or whatever structure may be needed. This is where the big money is spent. And whether it is spent economically or wasted depends upon the judgment of the engineer. The man responsible for such decisions must be an engineer familiar with all of the characteristics of the materials which will be used, the theory of design, and he should have sufficient good judgment to make proper decisions.

To fill this gap it will not be surprising to see the establishment of many new technical institutes, and to see technical institutes which now have a two-year program go to a four-year program. This poses an interesting question for such schools as the Massachusetts Institute of Technology and the California Institute of Technology. Will they change their ways or change their names?

TRAINING OF ENGINEERING TECHNICIANS FOR HIGHWAY DESIGN AND CONSTRUCTION

Many states are making efforts to increase the number and upgrade the quality of inspectors, surveyors, etc. in the highway industry.
At the University of Illinois, there has been a program continuing for a number of years where each year from 100 to 200 boys, newly graduated from high school are brought into the university for an extensive orientation course for two months after which they become full time employees with the Illinois Department of Highways.

Kentucky has for many years had a scholarship program in which they select on a competitive basis a few new high school graduates from each of the highway divisions of the state, subsidize their university costs and give them full employment for the summer. During their summer vacation period these boys work as engineering technicians but, of course, ultimately become engineers with, at least a moral obligation to continue working for the state highway department.

In Ohio last spring the director of highways offered summer employment for any student who was finishing his freshman year in engineering at the university. Prerequisite to the summer job was a ten-weeks, one-hour-per-week, orientation course which was conducted at the University. Of 156 boys who took the orientation course last spring and worked with the highway department during the summer, a majority have indicated that they plan to work with the department again this summer.

Feedback from the participants of our last summers course indicates that a majority of the boys were delighted with their summer experience opportunity and really felt that they were doing challenging sub-professional engineering work. Some of the boys, and perhaps far too many, reported that they were left standing around with not enough to do most of the time. Making sieve analyses of aggregates all day every day, or making soil density tests by the sand cone method or collecting weight tickets from truck drivers are necessary tasks on a construction job, but if the highway department wants to encourage a freshman engineer to seek a career in the highway industry, they need to give him an opportunity during his first summer employment to learn a few other things. I am hoping that this summer when our course will be repeated that we can get the highway division engineers to take a real personal interest in these potential permanent employees and see to it that they are challenged in studying plans, analyzing specifications, etc.

The new training center at Lafayette certainly looks like a long step in the right direction in providing facilities for orientation programs and in-service programs for highway engineers and engineering technicians.
CONSTRUCTION EDUCATION AT THE HIGH SCHOOL AND JUNIOR HIGH SCHOOL LEVEL

A project now underway in the College of Education at the Ohio State University may be of much interest to all highway departments. The group of people working on this project have felt that in the teaching of industrial arts, as it is usually called, in high school and junior high, boys and girls usually only learn how to build bird houses, etc., and get little conception of what the construction industry really is. Under a substantial financial grant from the U.S. Department of Health, Education and Welfare they have prepared, with the aid and advice of people in the construction industry, a curricula or set of courses which is to be taught this year in several states at a number of selected junior high schools in construction as a profession. The aim of the courses will be to create an awareness of the magnitude of the construction industry and the employment opportunities there-in.

Through the cooperation of the Ohio Contractors Association we have prepared in Ohio a brochure attempting to describe civil engineering as a profession. This brochure has been put out in two editions. The college edition is intended to encourage freshmen or sophomores in college to choose civil engineering, and hopefully highway engineering as a career. The high school edition is intended to attract boys into engineering and hopefully into civil engineering. Copies of this edition were sent to every high school in the state for use by vocational guidance counselors.

SUMMARY

There is greater need today than ever before for education and training programs for the highway industry. There is need for much in-service continuing education for practicing engineers and administrators to keep them up-to-date with the new knowledge that develops each year. There is need for more education in construction supervision. There is also need for encouraging more young men to get into the highway industry and need for more adequate education and training programs for these young men to make them competent to undertake the responsibility which will be theirs. Certainly state supported universities in cooperation with state departments of highways and the construction industry are in a position to best provide for these needs.