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Special Report 24

Highway Engineering Training Programs

For Professional and Preprofessional Employees

An Analysis

National Academy of Sciences—

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An Analysis

1957

Washington, D. C.

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Economics, Finance and Administration**

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Preface

At the January 10, 1955, meeting of the Committee on Education and Training of Highway Engineering Personnel a suggestion was made to study highway engineering training courses and to develop a suggested training program combining the better features of the programs in operation. The suggested training program could serve as a guide for any highway department desiring to know how other programs are being operated.

On September 15, 1955, a questionnaire was sent to each of the state highway departments requesting information on their training programs for college civil engineering graduates and high school graduates or other preprofessional employees.

The information obtained through the questionnaire was analyzed and summarized in preliminary form. The preliminary report was distributed to all state highway departments for review and correction. The final results are contained in this publication.

The cooperation and assistance of the state highway departments are gratefully acknowledged.

This report, prepared by Robley Winfrey with the assistance of Jack R. Hutchins, presents a summary of the replies to the questionnaires. A suggested training program for highway departments based on an analysis of the training programs now in operation for professional and preprofessional employees is also included.

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Highway Engineering Training Programs for Professional and Preprofessional Employees

An Analysis

I. A Suggested Training Program for Graduate Highway Engineers

EACH highway department offering training must develop a training program to fit its own organizational and geographical needs. However, many of the good programs have similarities and most training directors agree that a training program for graduate civil engineers in highway work must consider several important facts of psychology and education. The graduate engineer has studied for at least four years to obtain his bachelor's degree. He feels at the end of this time he would like to begin to contribute to his profession. However, he also realizes that he has had relatively little experience in any particular phase of engineering. Consequently, most college graduates are looking for employment where they not only contribute to the work of the organization but also have the opportunity of becoming familiar with all phases of the operations.

The present utilization of in-service training programs by the various highway departments is considered an excellent way of satisfying both demands. The graduate engineer has the opportunity to produce and, at the same time, the opportunity to learn.

In developing this type of program full consideration needs to be given to the direction of the training within the department. Several programs have been rescued from failure when the training was placed under the central control of a statewide personnel or training officer. This individual has full authority to determine the training needs and to judge whether these needs are being met. He works through the various operating officials, since the field engineers and heads of operating units are the ones who do the actual training. Through this central control, the training was kept from becoming as many different programs as there were individual units giving instruction.

Another important feature stressed by many training directors is the proper development of the training courses and agenda. The instruction must be presented by an individual who has enthusiasm for the training program, otherwise he will probably be wasting his time and the time of the trainees. If the program is worth presenting, it is worth presenting in a creditable manner.

The training programs which have developed into attractions for employees are those having the full support of top operating officials. Individuals who are taking training want to feel they are accomplishing a useful purpose. This feeling is expressed directly to them by many top operating officials in a letter from the head of the department to each trainee at the time he enters the program. This initial contact is followed within a month by additional correspondence. As soon as practicable all of the individuals in the program are assembled at the central office and personally greeted by the top officials. Most training programs either win or lose their trainees in the first four-month period. It is during this time that the closest attention is paid to the psychological aspects of employment.

The following suggested training program is based on the above ideas and the analysis of the information received from the state highway departments which are operating training programs.

RECRUITMENT

Many state highway departments utilize the excellent opportunity they have to recruit college men long before they are ready for graduation. The highway officials maintain close

cooperation with the various engineering colleges within the state. These colleges then recommend students for summer employment with the highway department. After two or three summers of employment the student is thoroughly indoctrinated in the opportunities available with the highway department. Consequently, at graduation it takes little effort to hire these men for the training program. Throughout the college year, highway department representatives contact the schools and talk to prospective graduates. The representative explains the training program and its opportunities to the faculty and students. These explanations are given to student professional groups, student seminars or through individual student contacts at the college.

Emphasis in recruiting is placed on the location of work assignment, advancement possibilities, type of work, and degree of independence available in the department.

A definite offer is made to the graduate for employment, probably during the winter months. The training programs are flexible to allow hiring of graduates at midyear.

REPORTING FOR WORK

One of the critical periods in the training program is the day when the new appointee reports to take his first assignment. Many departments make definite plans so the new employee is warmly greeted and immediately introduced to everyone in the office.

When the new employee is properly greeted he will probably have a favorable impression of the organization regardless of possible minor irritations. However, if a poor reception is followed by several minor irritations the man will probably become dissatisfied and begin to make plans to leave the department.

Once the trainee has been introduced to those in the office, he is assigned to a capable individual for a thorough orientation in the work of the department and its policies. This orientation does not consist of a vast quantity of reading material for the individual to read during the rest of the day. A well-qualified official generally explains the history of the department, its present broad policies and the opportunities available to the young engineer. The trainee then visits each of the staff engineers and receives an explanation of the work of that section. Thus, during the first day, he receives a brief but complete over-all picture of the work of each of the sections of the office.

ASSIGNMENTS

The trainee receives assignments in all of the sections of the highway department. These assignments vary from one month to six months each. While on an assignment the trainee is started on the minor duties in the section. However, his development is closely followed and he is elevated to other duties as soon as he is capable of performing them.

Many training programs have failed because the trainee was placed on unimportant work and never given an opportunity to try his hand at the more important duties — those that require some degree of engineering judgment.

The trainee has the opportunity, in most programs, to work with all the men in the section from the section chief down. Each trainee is assigned for a definite length of time to each phase of highway engineering. Naturally, the duration is flexible to meet emergency conditions and other unusual circumstances. Part IV of this report shows the time distribution between the different phases of highway engineering used by the various states. The following is a suggested time distribution between the various phases of highway engineering based on those in use:

	<u>Months</u>
1. Highway and bridge location	2
2. Highway design and plans	4
3. Construction	6
4. Materials testing	3
5. Bridge design and construction	4
6. Contracts and specifications	1
7. Highway planning	1

	<u>Months</u>
8. Right-of-way	1
9. Traffic engineering	1
10. Maintenance	1
Total	<u>24</u>

The order of these assignments is varied with each man in order to give him the best training possible and to meet the personnel needs of the department and seasonal conditions. Each one receives training in all of these phases. Most training directors agree that it is unwise to let a trainee remain permanently in one phase of engineering before he completes all the phases of training. Some individuals like each phase of work and, therefore, if allowed to stop would probably complete only half the required training.

ADVANCED TRAINING

After the trainee has completed the 24 months rotational program, he may be assigned to a phase of highway engineering on the bases of his interests and the needs of the department. Once it is agreed that the trainee will follow a particular phase of work some states assign him to an advanced training program. The trainee may spend three to six months working in his specialty of engineering in each of three or more different field districts of the highway department. The last district in which he receives his training is the one where he is most likely to be permanently assigned.

During this period the individual does productive work as a regular member of the organization. However, he is given the opportunity of performing these duties in three or more districts. The trainee thus receives diversified views and methods of accomplishing the same job; he is prepared to contribute to his particular organization rather than merely perpetuating an existing mode of operation.

REPORTING

During the two-year (or other length) rotational program most highway departments require the trainee to write a weekly or monthly report to the director of training, explaining the training he has received during the preceding period. The trainee is encouraged to make recommendations and comments about improving the training and the training program. This report is forwarded to his immediate supervisor for endorsement and comments on the trainee's ability, personality, performance, reliability, and other features important in his work. The report is then forwarded through the district engineer or division head to the training officer.

These reports are studied carefully as an evaluation of the training the man is receiving and his psychological adjustment to his job.

Requests made in the report receive prompt attention with a definite approval or disapproval of the request.

The report is filed in the man's personnel folder as a history of the training received and as a record of the evaluation by his supervisors.

TRAINEE CONFERENCE

An important feature of many training programs is a group meeting of all the trainees shortly after they have entered the program. The meeting is held as soon as all men report for duty and within the first four months of a training cycle. This meeting gives the trainees the opportunity to become acquainted with each other and with the operating officials of the department. The meeting is at least one week in duration and is generally held at the central office.

During this conference, the work of the various districts and sections is explained and an opportunity given the trainees to express their views on training and recommendations for improving the program.

Several state highway departments hold such a meeting once a year for each class or group of trainees.

GRADUATION

At the completion of the training program, including the advanced phase, a formal certificate or letter indicating satisfactory completion of the program is presented. In addition, many states hold a trainee conference in connection with the graduation. At this conference the top operating officials make an appearance and formally congratulate the individuals upon their accomplishments during the program. By so doing, prestige is added to the program and final inspiration is given to the new engineers entering on permanent duties.

SALARIES

The salary paid to the trainees is dependent upon the salary structure of each state highway department. Care is taken in establishing a salary plan, to provide for a promotion in grade and salary upon completing the training program.

INCENTIVE

A formal incentive award is offered by some states during the training period. This incentive award takes one of two forms, academic assistance or preferred work assignment. Academic awards are generally one year's advanced study towards a master's degree or attendance at a specialized traffic or highway institute. This additional training serves to increase the man's usefulness to the department and also gives an incentive during the course of the program.

Another method of rewarding the outstanding trainee is to assign him as a special engineering assistant to a district engineer for a one-year period following graduation. During this year the young engineer has the opportunity of working with the top officials in the district. He gains a good understanding of the district operational organization, and because he was an outstanding trainee he soon becomes a leader within the district. This training serves to improve his abilities to contribute to the work of the department.

When such an engineer assistant position is filled with a trainee, there is a definite understanding that the man will return to his phase of engineering at the completion of the year and, thus, leave the position open for the outstanding graduate of the next training group.

II. A Suggested Training Program for Preprofessional Employees

Many highway departments are planning to utilize preprofessional personnel to a greater degree in order to meet the engineering demands of the expanding highway program. Pre-professional engineering help has been of immense value to the departments that have taken time to train properly the new employees. Many jobs in highway engineering have been broken down and a segment of the job assigned to a capable preprofessional man. The highway departments give the preprofessional employees sufficient training so they can do good work in drafting, surveying, inspection, or estimating.

At the present time there are four general methods of training preprofessional employees:

1. Short courses of one to six weeks taught by the highway department engineers in a phase of engineering such as surveying, inspecting, drafting and office engineering.
2. Correspondence courses sponsored by the department and for which the department gives credit toward promotion.
3. Extensive training courses conducted by an engineering college for the highway department personnel.
4. Cooperative training programs with an engineering college for students to alternate semesters between practical experience with the highway department and academic training at college.

The following training program is based upon the practices found in the study. It is designed to give a state highway department a strong nucleus of preprofessional employees around which the department personnel may be expanded during the construction season.

RECRUITMENT

Many states maintain a strong nucleus of preprofessional employees by conducting an annual recruiting program for high school graduates who for one reason or another do not plan to attend college immediately.

These men are hired after being recommended by their high school principals as being capable students with the qualifications for learning engineering work.

REPORTING FOR WORK

When the high school graduates report to duty, the better training programs take particular care to give the men a favorable impression of the department. This is done by giving the trainee an appointment with a well-qualified individual who sees that he is instructed in the history of the department, its current work program, and the opportunities available for the employees. When properly handled, these preprofessional men stay with the department for many years and, therefore, a few minutes or a few hours invested in their orientation is well spent.

ASSIGNMENTS

The assignments for the preprofessional employee during the training programs cover a period of one week to eighteen months. Each employee follows a planned rotation of assignments within a particular phase of highway engineering or attends a short course of instruction. In an eighteen-month program, his training includes all the fields related to his specialty. The main difference between a training program for preprofessional employees and professional employees is the broadness of the program and depth of technical operations. Professional employees receive training in all phases of highway engineering. Pre-professional employees receive training in all jobs associated with one phase of highway engineering.

The following is a suggested time distribution based on several training programs in the various jobs associated with a paving inspector's training program:

1. Classroom instruction in algebra, trigonometry, and plane geometry	1 month
2. Inspection at bituminous plant	1 month
3. Inspection of surfacing operations	3 months
4. Work in materials laboratory	3 months
5. Specifications and contracts	2 months
6. Survey party	3 months
7. Surfacing inspector	3 months
8. Maintenance	2 months
Total	<u>18 months</u>

The order or number of these assignments is varied to meet local conditions; however, the man has the opportunity to receive training in all the related jobs associated with his specialty. This gives him a good understanding of how his job affects others and the work of the department as a whole.

A similar program covering different types of work could be developed for draftsmen, surveyors, bridge inspectors, and grading inspectors.

REPORTING

During the training program many departments have the trainee write a weekly or monthly report to the training officer explaining the work he is doing and his recommendations for improving the training. These reports are endorsed by the man's immediate supervisor and forwarded through proper channels to the training officer. If, on the basis of these reports, the man is not thought to be developing into a capable preprofessional employee, he is taken off the training program and assigned regular duties with a survey, design, or construction crew.

TRAINEE CONFERENCE

Several departments offer classroom instruction in algebra, trigonometry, and plane geometry. Also, the trainees have the opportunity of becoming acquainted with each other and with the over-all policy of the department during the classroom sessions. At the end of the 18 months the man again attends a conference and is formally presented with a diploma or letter of completion. Such a formal graduation adds prestige to the program and serves as a final inspiration to the men when they go on their permanent assignments.

SALARIES

Where possible the salary is arranged to give an increase at the completion of every one or two phases of the program. These salary increases are generally small, but they serve as a recognition of the man's advancement.

INCENTIVE

Some training programs have an incentive feature to serve as a goal for the men through their training. Such a feature, it is felt, adds morale to the group and produces better trained men.

One incentive plan provides for selecting the outstanding graduate of the preprofessional training program each year and permitting him to enter the training for professional employees. This outstanding man thus gains more information and is of greater help to the department in its work. Most training programs are so organized as to give the maximum of productive time to the department. Consequently an individual in training is not a loss to the department but probably produces more work to justify the department's confidence in him.

CORRESPONDENCE COURSES

Employees in several highway departments are encouraged to take extension courses or

correspondence courses in subjects associated with the job. These courses are mathematics, English, surveying, drafting, and highway engineering. Some correspondence schools offer complete courses in highway engineering for high school graduates. Several highway departments pay the tuition for their employees.

COOPERATIVE TRAINING PROGRAM

Many highway departments have cooperative agreements with universities whereby a student may work part time for the department and attend school. These cooperative agreements have proven beneficial to many departments for they insure well-trained individuals returning to highway work upon completing college. At the same time, the department uses the man in its operations for approximately half the calendar year.

III. Report on Highway Engineering Training Courses for Professional and Preprofessional Employees

SUMMARY OF QUESTIONNAIRES

State	Summary of Training Programs for						State	Summary of Training Programs for					
	Engineers - College Graduates			High School Graduates				Engineers - College Graduates			High School Graduates		
	Year Started	Length of Training	Monthly Starting Salary	Year Started	Length of Training	Monthly Starting Salary		Year Started	Length of Training	Monthly Starting Salary	Year Started	Length of Training	Monthly Starting Salary
Alabama							Montana	A service-in-training program is under consideration.					
Alaska	Rotates new engineers.			Student-engineer-trainee program for high school graduates who intend to study engineering.			Nebraska	Rotates new engineers.			Apprenticeship with State Highway Department and International Correspondence School - four years.		
Arizona	1955	24 months	\$400	Encourage high school students to work for the department.			Nevada	A program is under consideration.					
Arkansas							New Hampshire	Encourage study with International Correspondence School. Cooperative program with Northeastern University. Encourage civil engineer students to work for the department during the summer.					
California	Program varies between districts due to seasonal construction conditions. Statewide program being formalized.			High school graduates assisted and encouraged to develop professionally through night classes and correspondence courses, plus on-job training through use of very complete manuals.			New Jersey	1955	6 months	\$335			
Colorado				Encourage correspondence training through International Correspondence School and rotate field and drafting personnel.			New Mexico	A program is under consideration. Cooperative program with New Mexico A & M College.					
Connecticut	A program is under consideration.			1955	70 hours		New York	A program is under consideration. Utilize engineering technicians who graduate from 2-year technical institutes.					
Delaware							North Carolina	A program is under consideration. Informal training classes. Encourage study with the International Correspondence School. Employ college students for the summer.					
District of Columbia	A program is under consideration.						North Dakota						
Florida	1953	30 months	\$350	1953	30 months	\$350	Ohio	1949	4 years	\$380	Training courses during the year for all technical employees. Summer work with the state highway department. Cooperate with many engineering schools.		
Georgia	1950	37 months		1953	3 summers	\$200	Oklahoma	Cooperative program with the University of Oklahoma and Oklahoma A & M College. Encourage employees to study with International Correspondence School.					
Hawaii							Oregon	Transfer engineers.					
Idaho	1952	48 months	\$390				Pennsylvania	Summer work with the state highway department.					
Illinois	1952	36 months	\$400	Cooperative program.			Puerto Rico						
Indiana		80 weeks	\$406	Cooperative program with Purdue University.			Rhode Island						
Iowa				1955	3 months	\$200	South Carolina						
Kansas	1956	24 months	\$436	Summer work agreement with the University of Kansas or Kansas State College.			South Dakota						
Kentucky	Master's degree at University of Kentucky for five engineers each year.			Cooperative program with University of Kentucky.			Tennessee						
Louisiana		18 months		Correspondence courses.			Texas	1952	4 years	\$350	Inspectors schools.		
Maine	Individual on-the-job instruction and orientation.						Utah	A program is under consideration.					
Maryland				Cooperative program with Drexel. Evening courses by the University of Maryland.			Vermont	Rotates new engineers			1952 only	6 months	\$123.93
Massachusetts				Cooperative program with Northeastern University.			Virginia	1945	4 years	\$360	Cooperative with Virginia Polytechnic Institute and an in-service-training program with a full-time director.		
Michigan	1949	13 months	\$426.30	Cooperative program with Detroit University. Summer survey camp in Wyoming. Instrumentman schools at university.			Washington	A program is under consideration.					
Minnesota	1953		\$385	Evening classes at vocational school sponsored by the department.			West Virginia	Cooperative program with West Virginia University.					
Mississippi	Cooperative program with Mississippi State College.						Wisconsin	1953	12 months	\$361	Trainee-surveyor - 18 months		
Missouri		18 months		Cooperative program with University of Missouri and Missouri School of Mines.			Wyoming						

IV. State Highway Department Training Programs for Graduate Engineers

March 22, 1956

Alaska

Engineers are rotated between field projects during the summer season and design work during the winter months.

Arizona

An engineer-in-training program was started in the fall of 1955 for engineering graduates. Engineers can enter the program within approximately one year following graduation from college.

The program extends over a period of two years and is divided approximately as follows:

	Months
1. Location	2
2. Plans, design and earthwork computation	3
3. Construction and maintenance	6
4. Materials	3
5. Bridges	5
6. Contracts and specifications	2
7. Economics and statistics	1
8. Right-of-way	1
9. Traffic engineering	1
Total	24

During the training each trainee is evaluated by the engineer-in-training officer and the division chiefs. Ratings are used as the basis for extending training in any phase or for transferring to another phase or to another division.

The initial salary is \$400 per month with an increase to \$425 at the end of six months and to \$450 at the end of 18 months.

Florida

An in-service training program was started in June 1953 for college graduates and state highway department employees who had a high school education. The college graduates are accepted without examination. The non-college graduates take a 4-hour general intelligence test and a 4-hour highway engineer examination.

The program lasts 30 months and is divided as follows:

	Months
1. Highway administration	3
2. Highway location	3
3. Roadway design	6
4. Highway bridge design	3
5. Highway and bridge construction	6
6. Highway materials testing	3
7. Highway maintenance	6
Total	30

At the completion of each phase of the training program the trainee must take an 8-hour examination on the work of the division. The trainee repeats the phase if he receives a grade lower than 70. Failure in two phases eliminates the trainee from the program.

The entrance salary is \$350 which is increased \$10 per month after each 3-month phase and \$20 a month after each 6-month phase. The maximum salary is \$450 per month.

Georgia

A training program for civil engineering graduates was started in April 1950. There is a bridge design and construction training program in addition to the general training program.

The general training program consists of the following phases of training during the 37-month program:

	<u>Months</u>
1. Orientation in general office	1
2. Survey party	6
3. Testing division	3
4. Inspection	3
5. Location and design	7
6. Right-of-way	1
7. Bridge design	7
8. Construction supervision	9
Total	<u>37</u>

Each supervisor rates each junior highway engineer on job performance and personality.

The bridge design and construction training program covers the following phases during the 37-month program:

	<u>Months</u>
1. General office, bridge department	6
2. Urban department or road design	4
3. General bridge office	6
4. Testing	3
5. Field bridge construction	12
6. General bridge office	6
Total	<u>37</u>

Salary increases are given at the end of each six months, with the exception of the first increase, which is given at the end of seven months.

Idaho

An engineer-in-training program was initiated February 1, 1952, for graduates from an approved engineering college. The program covers 4 years, with 2 years of generalized training in:

1. Construction
2. Maintenance
3. Highway design
4. Bridge design
5. Planning
6. Traffic
7. Materials
8. Location or right-of-way

During the second stage of the training program the engineer-in-training specializes for 2 years in one of the above phases.

The salary during the first stage ranges from \$390 to \$415 per month. Second-stage salaries range from \$440 to \$468 per month.

Each month the trainee writes a brief resumé of the month's activities for the review of the engineer and personnel officer. Once each 6 months the personnel officer visits each trainee to see how he is developing.

At the end of each training phase, the trainee is rated by his immediate supervisor on a

rating record form, and a report is written of his training and performance.

The personnel officer is responsible for outlining the Engineer-in-Training Program for each employee. The district engineers and department heads are responsible for transferring the trainee in conformance with the training program.

Illinois

The in-service highway training program for civil engineers was established in 1952. Graduate civil engineers are enrolled in the program when they enter the service of the division, usually in the district organizations. The program consists of an on-the-job rotation schedule operated entirely in the highway districts, along with group instruction and classroom lectures on all major highway activities.

The program consists of 36 months of assignments which should be completed within a 4-year period, as follows:

	<u>Months</u>
1. Design	10
2. Construction	14
3. Materials	6
4. Research and planning	2
5. Maintenance	2
6. Local roads and streets	1
7. Traffic and safety	1
Total	<u>36</u>

Rotation in design, construction, and materials is required but group training and field trips may be substituted for individual assignments in the other activities.

Graduate civil engineers without prior engineering experience are appointed at a salary of \$400 per month and periodic salary adjustments are given in accordance with pay plan.

Indiana

Any qualified new employee who is a graduate civil engineer may elect to enter an in-service highway training program consisting of an on-the-job rotation schedule whereby the trainee becomes familiar with the various highway engineering activities of the department.

The program consists of approximately 80 weeks of on-the-job assignments to 11 branches of the department as follows:

	<u>Weeks</u>
1. Road location	8
2. Bridge location	8
3. Bridge construction	8
4. Road construction	8
5. Road design	8
6. Bridge design	8
7. Traffic	8
8. Highway planning	5
9. Right-of-way	3
10. Materials and tests	8
11. Maintenance	8
Total	<u>80</u>

A graduate civil engineer of an accredited college is appointed at a starting salary of \$406 per month. The salary is increased to \$431, \$456, and \$481 after completing 1, 2, and 3 years of service. The starting salary and each in-grade raise is increased \$10 a month if the graduate has passed his engineer-in-training examination given by the State Board of Registration for Professional Engineers. After 4 years of experience the graduate engineer is eligible to take an examination as a registered professional engineer. At that time he is eligible for promotion to a higher salary.

Kansas

A flexible 24-month training program is offered to graduate civil engineers. During the training period the trainee is rotated to the various engineering sections in the department. The last 22 weeks of the program is a probationary assignment in the department of the trainee's choice.

Kentucky

Kentucky began sponsoring a graduate program in highway engineering in cooperation with the University of Kentucky in June 1952.

A graduate engineer can apply for the program within 3 years after completing the requirements for the bachelor's degree. He works in the department for one year and in September of the second year he is assigned to the University of Kentucky for two semesters of graduate work. He completes his thesis within the third year of the program.

The department gives aid under this program to not more than 5 new employees each year. The employee pays all his school expenses including tuition, books, supplies, and personal expenses. The employee is on the same salary scale as other similar employees and is promoted accordingly.

Louisiana

On-the-job training is offered to graduate civil engineers in an 18-month training program. The training is optional for the engineers who may stop their training in any phase and continue to work permanently in the section of their choice.

The training assignments are in the following sections:

1. Bridge design	6 months
2. Road design	6 months
3. Construction	6 months
Total	18 months

Michigan

The engineer trainee program was started in 1949 for graduate engineers from accredited colleges after passing an examination for the position of Engineer Trainee I.

The trainee takes one year of extensive rotational, on-the-job, practical work and up to 6 months of specialized training in the field of final assignment. The different phases are:

	<u>Weeks</u>
1. Bridge construction	7
2. Bridge design	7
3. Road construction	7
4. Road design	7
5. Road surveys	7
6. Maintenance	7
7. Planning and traffic	7
8. Testing and research (soils)	7
Total	<u>56</u>

(or 13 months)

A performance rating is given in each assignment. There is no standard procedure for handling the trainee in the different operating sections. Each division has devised its own method in utilizing the services of the trainee.

The Trainee I salary starts at \$426.30 per month and is raised to \$435.00 in six months. After completing the rotational assignment of 13 to 18 months the engineer takes the examination for Trainee II (\$455.88 per month).

Minnesota

A training program established in July 1953 is being formalized. The central office will control rotational training in:

1. Construction and location surveys
2. Concrete, bituminous and bridge inspection
3. Soils
4. Road design
5. Bridge design
6. Traffic engineering
7. Hydraulics

Trainees must complete each phase of training satisfactorily before they are assigned to a new phase.

The starting salary is \$385 for graduates of 4-year colleges and \$400 for graduates of 5-year schools. Promotion to the next higher pay class is possible without registration.

Missouri

The highway engineers' training program is for graduate engineers who apply for the program within one year after graduation from college. The individual is termed an engineer-trainee for the first 12 months after which time his title is changed to correspond to the field of advanced training he enters.

The program consists of 12 months of rotational training and 6 months of advanced training in the field of permanent assignment.

	<u>Months</u>
1. Surveys and plans	2
2. Construction	3
3. Maintenance	2
4. Materials	2
5. Bridges	2
6. Highway planning	1
Total	<u>12</u>

The trainee is paid the basic starting salary in force for young graduate engineers without experience. After 6 months he is eligible for an automatic pay increase. After the initial 12 months in the program the trainee receives an additional pay increase.

Nebraska

Four to five years of informal training for civil engineer graduates starting as junior engineers is offered. They are trained in various activities, usually including design, construction and testing.

The informal training terminates when the engineer is permanently assigned to some division in the department, or until he obtains his professional engineer license and takes charge of a field project or a sub-section in bridge design or road design or testing.

New Jersey

A training program was started in 1955 for college graduates. Students are recruited without a written examination.

The program is 6 months in duration and includes assignments of from 1 to 6 weeks each of the following:

1. Bridge division
2. Geometric design
3. Planning and traffic

4. Road design
5. Road construction
6. Maintenance
7. Electrical operations
8. Engineering research
9. Soils
10. Testing laboratory

The trainees are assigned to departments in teams of two men. Weekly progress reports are required from the trainees. The starting salary is \$335 per month.

Ohio

The highway training program was inaugurated March 1, 1949, for engineers who could meet the requirements of the Ohio State Board of Registration for Professional Engineers and Surveyors. The program is approximately 4 years in duration.

The original program had a definite schedule for rotation between the various phases of highway engineering. However, due to the critical need for engineers in design and construction, an engineer in training may now stay in any one phase as long as he may desire. If he requests a transfer, it is done as soon as practical.

The graduate engineer is appointed to the position of Engineer-in-Training I, at a salary of \$380 per month, until he passes the engineer-in-training examination given by the State Board of Registration for Professional Engineers and Surveyors. Upon passing this examination he is designated an Engineer-in-Training II or III at \$400 or \$440 per month. During the four years the engineer-in-training can progress to Engineer-in-Training II, and Engineer-in-Training III, with a top salary of \$525.

The training period is completed after the approximate 4-year period required for the engineer to attain full registration status.

Oregon

Oregon does not have a formal rotation plan for graduate engineers but allows engineers to request transfer to other divisions to round out their training.

Texas

Training of graduate engineers is accomplished on the job and is continuous over a period of approximately four years. The department has published a set of training manuals to supplement the experience gained on the job. Each district engineer is responsible for training the employees in his organization. The trainee fills a regular job and is rotated to different types of work. The amount of time spent on the different phases of engineering work is not fixed because it is dependent upon the work in progress. Classroom instruction is given in the district offices by the district organization. Every two years a school is conducted at the Austin office by the Road Design Division and the Construction Division. The Maintenance Operations Division and the Materials and Tests Division also participate in these biennial schools. An annual Short Course in Highway Engineering is held at College Station. The highway short course is conducted jointly by the Civil Engineering Department of the Agricultural and Mechanical College of Texas and the highway department. All phases of highway engineering are covered, and the course lasts approximately one week.

Vermont

The highway department has no formal engineering training program, but attempts to rotate the assignments of new engineering employees so that they will have experience in surveying, design, maintenance, and construction. Many of the recent graduates are assigned to the district offices as engineering assistants to the district highway engineers for periods of approximately two years. Following such assignments, the men are usually returned to construction work.

Virginia

The special training program for civil engineering graduates was established in 1945 and is 4 years in duration.

The program consists of the following phases:

	<u>Months</u>
1. Survey party	6
2. Location and design	6
3. Bridge division	6
4. Testing division	3
5. Inspection	15
6. Resident engineer aid	<u>12</u>
Total	48

The highway engineer trainee is appointed with a salary of \$360. He is given an increase every 12 months while in the training program. At the end of the program the trainee is given a salary of \$430.

The department also has a scholarship program where employees may be sent to college for graduate training and receive one-half of their current salary plus full tuition including fees as charged by the school. The employee must agree to stay with the department for a period of twice the duration of the training.

Wisconsin

The training program for highway engineers was started in 1953. It gives young engineers who join the staff an adequate understanding of the organization and its various activities during the first 18 months of employment.

A recruit (Engineer I) can enroll in the training program at any time. Each recruit is assigned to one of ten district offices where he receives most of his training. Trainees are generally handled individually and not as a group.

They are assembled as a group in the central office for orientation and central office training.

The normal program would be:

	<u>Months</u>
1. Surveys	2
2. Design	1
3. Construction	3
4. Right-of-way	1
5. Maintenance	1
6. Traffic control	1
7. Bridge design	1
8. Materials laboratory	1
9. Emergency	<u>1</u>
Total	12

After completing the program the trainee is eligible to take the qualifying civil service examination for Engineer II. Arrangements are then made for his permanent assignment to a district to further his career in highway engineering.

The starting salary for a Grade I Engineer is \$361 per month.

V. State Highway Department Training Programs for High School Graduates

March 22, 1956

Alaska

High school graduates who intend to study engineering in college and college freshmen are selected for a Student-Engineer-Trainee Program on the basis of scholarship and school and local references. They are assigned to survey parties during the summer when school is not in session. As they return in subsequent summers they are assigned to duties of greater responsibility. An evaluation is made of each trainee's summer experience by the supervisor.

After graduation from college the trainee enters on full-time duty with the Alaska Road Commission.

Colorado

Employees are encouraged to take correspondence courses in highway engineering where an employee does not have the opportunity to attend evening classes at a formal school. Records are kept in the headquarters personnel office about the employees' correspondence training. Colorado recognizes the successful completion of Divisions 1 and 2 of the International Correspondence Schools Highway Engineering Course as being equal to two years of related work experience as a credit for purposes of promotional examination qualification.

Connecticut

On June 15, 1955, the Connecticut Highway Department inaugurated a training program for new employees, subprofessional bracket, for Engineers-in-Training, Grade I and engineering helpers. The training consists of 70 hours of intensive and accelerated instruction at a designated highway maintenance garage site in each of the four highway districts. This training is under the supervision of the director of training assisted by an instructor and a four-man survey party. At the conclusion of the 70-hour training period the trainees are given certificates indicating course completion and then receive their probational assignments.

Florida

Noncollege graduates are eligible for the in-service training program on the same basis as college graduates.

Each year 30 trainees enter the program. The difference between the number of college graduates who accept employment each year and 30 is the number of regular employees who are chosen. They are chosen strictly on the rank they attain on the competitive entrance examination.

The program offers a noncollege graduate who has had several years of practical experience in the State Road Department the opportunity to compete with the college graduates. This has proved an incentive for the noncollege trained employee to study on his own.

The total program takes 30 months to complete and covers all phases of highway engineering. An 8-hour written examination is given at the completion of each of the seven phases. If a trainee fails the examination he must repeat the phase. If he fails two examinations he is transferred out of the training program.

Georgia

The Georgia student job training program in highway engineering was put into operation in 1953. Under this program students from the Georgia Institute of Technology agree to work one summer in engineering, one summer in contract construction, and one summer in an industry furnishing materials or equipment for construction work. A student does not work more than one summer with the same sponsor firm. The rates of pay are \$200 per month

for sophomores or freshmen, \$215 per month for juniors, and \$250 per month for seniors.

Illinois

Use is made of undergraduate civil engineering students during the summer months. A number of college students are employed on the basis of a cooperative work and study program.

Indiana

The Indiana Highway Department has a cooperative training program with Purdue University whereby college freshmen come to work for the highway department after their freshman year. The students then work a college semester with the highway department and alternate semesters between work and study at Purdue. It takes a student 5 years to complete college under this plan. The student stays on the campus for the full senior year of school.

While with the highway department the students take a definite program of work in 11 different phases of highway engineering.

The starting salary during the work periods is approximately \$300 which includes about \$125 expense allowance. The employee is advanced when he returns after completing each semester of college. The salaries are \$310, \$320, \$330, and \$350 for different classes of students.

Iowa

In December 1955, 64 rodmen, who had limited experience as instrumentmen, were selected to enter a three-month training course at Iowa State College. Their \$200-a-month pay was continued while they were in college and they were paid \$5 a day for expenses. Upon completion of the course the rodmen were qualified for jobs as second class instrument men at \$250 a month and, it may be assumed, were inspired to qualify themselves for even better positions.

Kansas

High school students are contacted and encouraged to enroll in civil engineering at either the University of Kansas or Kansas State College. The highway commission arranges with those students who can pass an engineering ability test administered by the school for summer employment while they are in school. If a student discontinues school, the highway commission will employ him on a level commensurate with his academic background.

Kentucky

The department of highways provides fourteen scholarships at the University of Kentucky, each valued at \$510 available to qualified students who intend to study in the field of civil engineering with emphasis on highway engineering.

The student engineering employee works for the highway department during the summer after finishing high school. He then enrolls in the University of Kentucky in the fall and receives \$60 per month from which he takes care of his own expenses at the university. The student works for the highway department during the summer and fall semesters of college until he is a senior. He spends the full senior year on the campus at his own expense. The graduate is expected to work for the department for one year after finishing the program.

Louisiana

The Louisiana State University has made correspondence courses as well as night courses available to the employees of the highway department. In addition, the department has cooperated with trade schools in organizing and conducting courses.

Maryland

A 3-year certificate course in highway engineering is offered in cooperation with the University of Maryland. The course is taught at Baltimore by the university during the evenings. Each employee pays a small charge to cover the minimum cost to the university. A cooperative program with Drexel Institute of Technology is also conducted by the department. Students alternate work assignments with attendance at school.

Massachusetts

There has been a cooperative plan in operation for more than 30 years with Northeastern University. Where possible, the undergraduate's work assignments are changed to give him training in the various fields of engineering.

Michigan

The engineering student summer program was established in 1946 to employ college students during the summer. In the fall they are granted a leave of absence to continue their college work. The students are paid in proportion to the level of their college work.

In 1947, the Michigan State Highway Department, in conjunction with the University of Detroit, inaugurated a cooperative work-study program, generally known as "The Cincinnati Plan" whereby engineering students, during their junior, pre-senior, and senior years in civil engineering, alternately are employed by the highway department and attend classes at the university for 3-month periods.

In 1953, the department started an 8-week summer highway surveying camp at Camp Davis, Wyoming, for the 50 high school graduates each year who place highest on a written examination. After completing the school the students are hired by the state highway department at a salary of \$268 per month.

The department also conducts instrumentman schools for rodmen in conjunction with the University of Michigan and the College of Mining and Technology.

Minnesota

High school graduates with training in mathematics and science are employed as trainees and assigned to construction field positions. They are assigned various duties to appraise their potential as inspectors, field office draftsmen, or instrumentmen.

All high school trainees and engineering aids are eligible to take subprofessional courses sponsored by the highway department and given by a vocational school. These courses are given in the evening at various locations in the state. The students pay a tuition fee to the vocational school and the school hires professional engineers as instructors.

Mississippi

There is a cooperative education program in force with Mississippi State College where the employee-students work one period of time and attend college the alternate semester.

Missouri

Missouri has a cooperative civil engineer training program with the University of Missouri and the Missouri School of Mines and Metallurgy. Under this program 10 high school graduates are selected to attend each of the two schools with alternate work periods and school attendance. The program is set up for 5½ years to 6½ years. The program is flexible and a student may spend more time in college and less on the job, if he is financially able to do so. The student must pay all his own tuition and other college expenses. Each applicant is given a written examination and the students are selected on the basis of engineering aptitude, character, and personality.

Nebraska

The state started a 4-year program available to high school graduates in 1946. During this training the employee takes a planned program of on-the-job training assignments and special classroom instruction in surveying and materials. In addition each trainee must register with the International Correspondence School and complete 84 lessons in civil engineering. The program was set up on the apprenticeship principle.

New Hampshire

For five years New Hampshire has had a cooperative agreement with Northeastern University whereby a student alternates semesters between college and the highway department. Under this schedule, started after the first college year, the student completes college in five years.

The highway department employs civil engineering students during the summer season. High school graduates who plan to enter an engineering college are also encouraged to work for the department during the summer.

Employees are encouraged to study the International Correspondence School's highway course in conjunction with their work.

New Mexico

A cooperative student trainee program was begun with New Mexico A & M College, in 1953. It offers a five-year rotating plan prior to graduation; trainees get six months theory at school and six months application in actual procedures in the field. In the employment phase, trainees receive salaries beginning at \$230 a month. Step raises are offered reaching \$345 with full-time employment. All types of highway work are covered during the course. Trainees sign an agreement to remain with the highway department at least 18 months after graduation. Some 23 students are currently participating in the program. Plans are for increasing this number.

For the winter of 1955-56 classes for highway personnel were conducted at the state university: two in elementary surveying (72 hours), and one in soil's testing (96 hours). The classes were composed of 60 field trainees from throughout the state recruited through aptitude tests. Salaries, per diem, tuition and text books were underwritten by the highway commission. This is a continuing program.

Five classes in elementary drafting have been set up for the general office. These are of two weeks duration, consisting of 80 hours in theory and practice of drafting. Some 25 employees will be drawn from the field for this training, under direction of a skilled squad boss.

New York

A series of engineering technician titles designed to use graduates of two-year technical institutes has been established. At present two schools offer a course in highway technology.

North Carolina

Employees are encouraged to study with the International Correspondence School. On-the-job training classes for Engineering Aid I and Highway Inspector I are conducted by the department. The highway inspectors are advanced to Highway Inspector II after completing 2 years of experience and on-the-job training.

College students are hired during the summer to acquaint them with the opportunities in the highway department.

Ohio

Several days of training before the construction season starts are scheduled for inspectors. Enough materials are covered to provide a general knowledge of highway construction. This is followed by several days of intensive instruction in small groups in specialized subjects such as embankment control and concrete control.

Oklahoma

On January 1, 1956, the department adopted a cooperative engineering trainee program with the University of Oklahoma and Oklahoma Agricultural and Mechanical College. A student will work for the department for 6 months and then enter either of the two colleges for 6 months. He will continue this procedure until a degree in civil engineering is earned. After graduation the engineer is obligated to the department for 18 months.

The department also encourages its employees to study with the International Correspondence School.

Pennsylvania

This year, a campaign for the recruitment of engineering students interested in state highway work was begun. The students would receive "on job" training during the summer vacation period.

Vermont

During 1952, the department conducted an intensive course for 14 selected students who had graduated from high school. During the first 4 weeks they were given an intensive course in trigonometry and plane surveying. For the next 6 months the trainees were given instruction and on-the-job training in surveying, construction, design, or laboratory work under close supervision of higher grade engineers. The men were hired at \$28.60 per week, promoted to \$32.10 after four weeks, \$45.90 after 6 months, and later the men were advanced to Engineering Aid-B at \$51.00 per week.

Virginia

The cooperative engineering program conducted by the Virginia Department of Highways combines actual working experience with college study at Virginia Polytechnic Institute. During the first quarter (3 months) the student is in the classroom; during the second quarter he is employed full time in the highway department. This alternation continues for 4 years. The senior year is spent uninterrupted in the classroom. Thus in 5 years a student may complete his degree and earn his expenses in so doing.

West Virginia

There has been a cooperative program with West Virginia University since 1953. Under this program a student takes one semester a year at the university and is then employed by the State Road Commission the balance of the year.

Wisconsin

The trainee-surveyor training program was started in 1953 to give 18 months of training to high school graduates. Under this program an individual was assigned to a district for varied experience. During the 18 months, they spent six weeks at the University of Wisconsin for classroom instruction set up by the university in cooperation with the department. Instructors are selected from the Commission's Engineering Staff to teach surveying, drafting, and mathematics. The trainees are in class 8 hours per day for 6 weeks. There is a 1-hour quiz each week in each subject and a final 2-hour examination in each subject on the last day.

At the conclusion of the school, the trainees returned to their respective districts and resumed regular duties. After 18 months of training the men are promoted and assigned to permanent jobs.

THE NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare. The ACADEMY itself was established in 1863 under a congressional charter signed by President Lincoln. Empowered to provide for all activities appropriate to academies of science, it was also required by its charter to act as an adviser to the federal government in scientific matters. This provision accounts for the close ties that have always existed between the ACADEMY and the government, although the ACADEMY is not a governmental agency.

The NATIONAL RESEARCH COUNCIL was established by the ACADEMY in 1916, at the request of President Wilson, to enable scientists generally to associate their efforts with those of the limited membership of the ACADEMY in service to the nation, to society, and to science at home and abroad. Members of the NATIONAL RESEARCH COUNCIL receive their appointments from the president of the ACADEMY. They include representatives nominated by the major scientific and technical societies, representatives of the federal government, and a number of members at large. In addition, several thousand scientists and engineers take part in the activities of the research council through membership on its various boards and committees.

Receiving funds from both public and private sources, by contribution, grant, or contract, the ACADEMY and its RESEARCH COUNCIL thus work to stimulate research and its applications, to survey the broad possibilities of science, to promote effective utilization of the scientific and technical resources of the country, to serve the government, and to further the general interests of science.

The HIGHWAY RESEARCH BOARD was organized November 11, 1920, as an agency of the Division of Engineering and Industrial Research, one of the eight functional divisions of the NATIONAL RESEARCH COUNCIL. The BOARD is a cooperative organization of the highway technologists of America operating under the auspices of the ACADEMY-COUNCIL and with the support of the several highway departments, the Bureau of Public Roads, and many other organizations interested in the development of highway transportation. The purposes of the BOARD are to encourage research and to provide a national clearinghouse and correlation service for research activities and information on highway administration and technology.
