

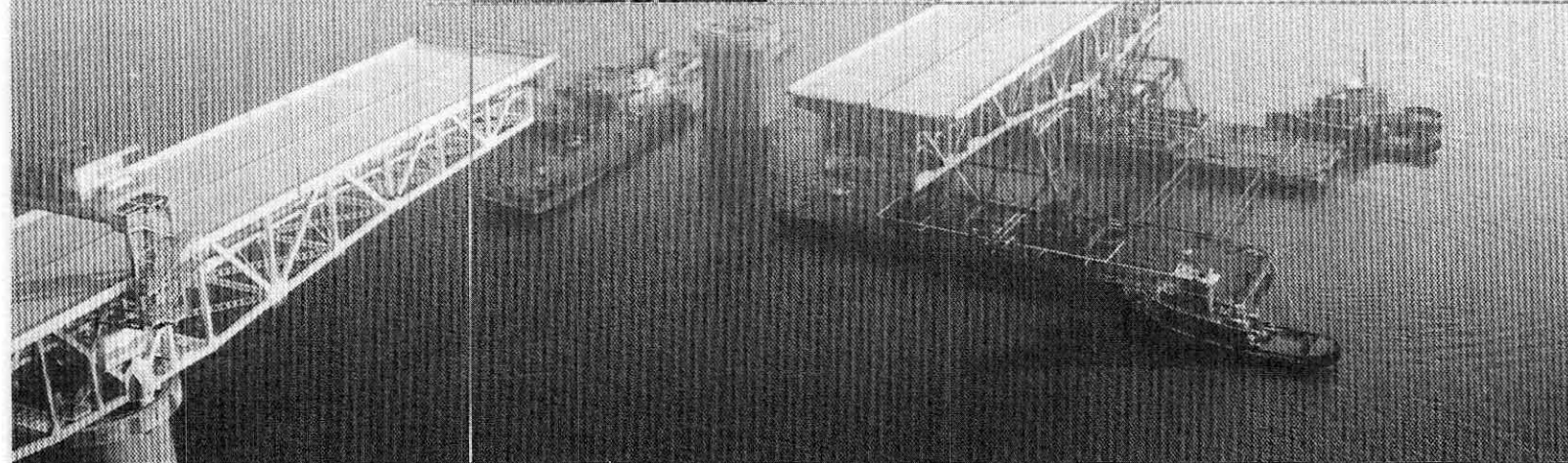
PB2004-104651



# A Procedural Manual for Implementing an Instructional Program

## In Highway Construction

## for Secondary Students



U.S. Department of Transportation  
Federal Highway Administration

Fort Worth Independent School District  
100 North University Drive  
Fort Worth, Texas 76107



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## SECTION 1: INTRODUCTION

Representatives from the highway construction industry approached the Fort Worth Independent School District and requested that a secondary education program in highway construction be developed and implemented. A proposal was developed and submitted to the Federal Highway Administration for funding to develop a pilot educational program for high school students to prepare them for career opportunities in this industry. The program was designed so it can be replicated nationwide by other educational institutions. This manual outlines the start-up procedures and provides information to assist other school districts with implementing a similar program.

## SECTION 2: RATIONALE FOR PROGRAM

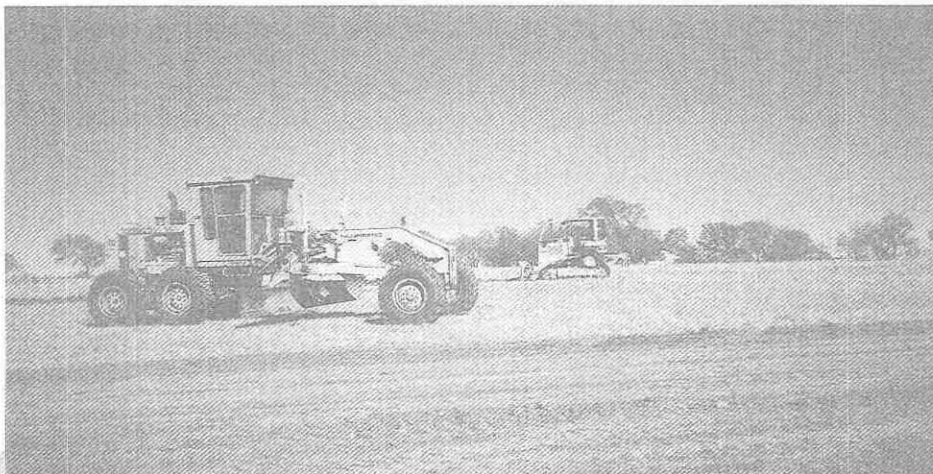
Fort Worth is in one of the fastest growing areas of the Nation. This area, known as the Dallas-Fort Worth Metroplex, has a critical shortage of individuals with the knowledge and skills necessary to succeed in today's workplace. This shortage is having an adverse impact on the highway construction industry, which has a current shortage of 3,000 employees in the metroplex area. The current level of extensive construction in the area is expected to continue

for a number of years and there will be recurring construction and improvements for many years. There are also state highway and city street construction projects, which need skilled employees. This situation is exacerbated by the age of the incumbent workers, many of whom are near retirement. Many younger workers have more options to move into other careers and professions. A highway construction program at the secondary level not only provides opportunities for youth but will help alleviate this shortage of skilled and knowledgeable workers.

## SECTION 3: FORMATION OF INDUSTRY ADVISORY COMMITTEE

An effective industry advisory committee is essential to establish a program that meets industry needs and provides instruction that meets industry standards. Industry representatives advocate for program funding, provide employment opportunities for program participants and graduates, and monitor program quality.

To form an advisory committee, industry partners and school representatives worked together to identify potential members. A date and location for an initial meeting were established, and individuals and businesses were invited. Committee participants vary by



region, city and school district. For states with strong unions, their participation would be essential. For this pilot program, the committee consisted of:

- Associated General Contractors;
- Construction Education Foundation;
- Federal Highway Administration;
- Local Chamber of Commerce;
- Local School District Advisory Council for Career and Technology Education;
- Local School District Board of Education;
- High School Principal and Faculty;
- Highway Construction Contractors;
- State Association of Vocational Industrial Clubs of America (Skills USA - VICA);
- State Department of Transportation;
- Industry-training Providers (State Engineering Extension Service); and
- The Equipment Maintenance Council.

The role of the advisory committee was explained in its first meeting. Members were asked to:

- Identify industry needs and employment opportunities in the region and state;
- Provide recommendations on content of curriculum and program design;
- Assist with evaluating success and direction of program and developing plans for improvement;
- Serve as mentors for students;
- Provide internships and employment opportunities;
- Serve as advocates for the program and students;
- Support teachers and students.

## SECTION 4: DESIGN OF PROGRAM

The advisory committee assisted the school district with designing the program. They addressed various components as follows.

### DETERMINE AVAILABILITY OF INDUSTRY-TRAINING SITE

An industry-training site, which provides the laboratory component of the program, is a prerequisite. The site must provide an opportunity for students to practice operating the various types of heavy equipment and should be within a 30-minute drive of the participating school campus, as students will leave school several days a week to travel to the industry-training facility.

### GOALS AND OBJECTIVES

All partners should cooperate to identify goals and objectives for the program. The following is a guideline for developing goals and objectives.

The purpose is to develop a program for high school students to prepare them for career opportunities in the highway construction industry that can be replicated nationwide by other educational institutions.

The key objectives are to:

- Inspire students to achieve academic success in the core subjects of mathematics, science, communication and computer technology;
- Gain occupational knowledge and skills specific to highway construction careers;
- Acquire soft skills (work habits, attitudes, dependability, career management, and job-retention) necessary for success in the workplace;
- Introduce numerous opportunities for employment and contracting opportunities

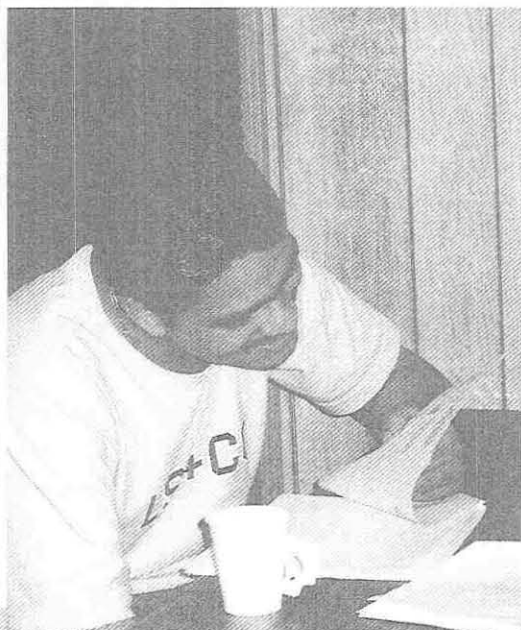
in the transportation and highway construction industries; and

- Encourage students to make plans to continue their education after high school to be able to advance in the industry.

## PROGRAM OVERVIEW

Once the goals and objectives are identified, a broad description of the program will assist with obtaining support and recruiting students. The following overview is provided as an example.

The program curriculum addresses highway construction and includes the application of mathematics and sciences, technology, and communications. Specific occupational-related instruction includes safety and first-aid, hazardous materials management, construction procedures and techniques, basic soil mechanics, estimating, surveying, theory of materials engineering, computer-aided design, operation of heavy equipment, and opportunities for advancement in the industry. Students qualify for certification in first-aid and in Occupational Safety and Health Administration (OSHA) requirements.



Students have study tours to construction sites, participate in internships in various components of highway construction, and have training at the industry-training site to obtain certification on the operation of specific heavy equipment. The program may be expanded to include options in materials testing and sampling and highway maintenance.

Instruction in employability skills (soft skills) addresses the importance of mutual respect among co-workers; appropriate dress; interviewing; job-seeking; promptness and regular attendance; work ethic; how employees contribute to the goals, efficiency and success of the company or tax-supported organization; and leadership. The curriculum of youth leadership, entrepreneurship and competition through Vocational Industrial Clubs of America (Skills USA – VICA) is an integral part of the instructional program and students are encouraged to participate in regional and state competitions.

## SELECTING CURRICULUM MATERIALS

Curriculum materials that meet industry standards have been developed by the organizations that provide industry-training for adults. The Fort Worth Independent School District, in cooperation with the Texas Engineering Extension Service, adapted the curriculum for a secondary education program. The curriculum outline is included as Attachment A.

## ESTABLISHING STUDENT QUALIFICATIONS

The following information is included to serve as a guideline for developing criteria for student eligibility for the program and to ensure equity and diversity among participants.

To ensure equity, a diverse population of students will have equal access to the program. When marketing the program, emphasis is

given to opportunities in the industry regardless of race, ethnicity or gender. The program includes diversity training to emphasize mutual respect among co-workers.

For the pilot program, prerequisites were established to ensure students acquired the knowledge and skills to meet the needs of the industry. To enroll, students are required to:

- Pass the Texas Assessment of Academic Skills (state test on language, communication and mathematics required for graduation from high school);
- Have a grade average of 75 or above in core academic subjects for the previous school year;
- Be in grade eleven or twelve and have sufficient credits to enroll in the highway construction curriculum and complete graduation requirements with their graduating class;
- Demonstrate good work ethic (good attendance, citizenship, ability to work in teams, and follow school rules);
- Complete interview successfully with industry representatives and be recommended for the program; and
- Have shown evidence of aptitude for and interest in careers in highway construction.





## DETERMINING LOCATION OF PROGRAM

Each school district must determine the campus location that is most appropriate for the program. Factors to consider may include:

- Access to industry-training site;
- Schedule that permits students to leave campus on alternate days for extended periods of time (A-B Block);
- Support of high school principal, school board member, and school district Superintendent; and
- Opportunity for students from across the district to transfer to the selected campus to participate in the program.

## DETERMINING SCHEDULE AND CALENDAR OF CLASSES

In the pilot program, students met for three 90-minute periods on alternate days and earned up to three Carnegie units per year. The students were transported to the industry-training site where they received related instruction and the opportunity for hands-on practice using the equipment. Upon arrival at the training site, students reviewed accomplishments from the previous day and discussed plans for the current day. When appropriate for instructional objectives, students view and discuss videotapes, written materials, and complete written assignments. Students are assigned a specific task on a given piece of equipment. They then report to the equipment and practice under the direct supervision of the teacher.

A sample schedule of classes for a student in Group #1 is as follows:

	<u>A-Day</u>	<u>B-Day</u>
Period 1	English	Mathematics
Period 2	Highway Construction	Government
Lunch		
Period 3	Highway Construction	Speech
Period 4	Highway Construction	Science

A sample schedule of classes for a student in Group #2 is as follows

	<u>A-Day</u>	<u>B-Day</u>
Period 1	Mathematics	English
Period 2	Government	Highway Construction
Lunch		
Period 3	Speech	Highway Construction
Period 4	Science	Highway Construction

As close supervision of students is required for safety and effectiveness of instruction, a maximum of two groups of ten students is recommended.

## DETERMINING TEACHER QUALIFICATIONS

Contact the accrediting agency for teacher certification in the state. The teachers should have a minimum of two years operating heavy equipment in the industry.

The teacher should also be willing to obtain certification to teach such components as OSHA safety training so students can earn their certifications. The teacher should obtain a Commercial Driver's License to transport students by bus to and from the industry-training site.

The responsibilities of the teacher include student recruitment, instructional planning and

delivery, evaluating and grading student success, driving the bus to transport students to the training site, and locating and ordering materials necessary for operation of the program.

### DETERMINING MEANS OF TRANSPORTATION TO INDUSTRY-TRAINING SITE

A bus or van will be necessary to transport students on the alternate days they go to the industry-training site. Require signed permission statements from parents or guardians for students to ride to and from training site.

The school district will be expected to provide instructional supplies, safety gear for students, curriculum materials, reference books, and rental equipment.

Heavy equipment and hand tools are provided by the industry-training site.

### SELECTION OF EQUIPMENT

The pieces of heavy equipment available for student practice include:

- Bulldozers
- Track loaders
- Front end loaders
- Motor graders
- Backhoe and loaders
- Hydraulic excavators

### SECTION 5: DEVELOPMENT OF AGREEMENT WITH INDUSTRY- TRAINING SITE

Work with training site representative to determine willingness to enter into a contract to provide training for secondary students and agree upon cost for the service.

### SECTION 6: DEVELOPMENT OF BUDGET

Prior to requesting approval for the program, the school district developed a budget. Components of the budget are explained below.

#### TEACHER SALARY

Refer to salary handbook of school district.

#### COST FOR LABORATORY TRAINING PROVIDED BY INDUSTRY -TRAINING SITE

Collaborate with industry-training site to outline services, and execute a contract with an agreed upon cost and timeline. As a point of reference, the training cost for the pilot program at the industry-training site on alternate days was \$176,500.



# HIGHWAY CONSTRUCTION PROGRAM FOR SECONDARY STUDENTS

## TRANSPORTATION COSTS

Work with school district transportation department to determine cost to the district for providing transportation over the course of the school year. In some states, the state will reimburse the district for transportation of students in career and technology education programs to their laboratory sites.

## SAFETY GEAR

- Hard hats
- Dust masks
- Leather gloves
- Steel-toed boots
- Ear protection
- Overalls

## FURNITURE AND EQUIPMENT:

- Computer
- Printer
- Scanner
- Teacher's desk and chair
- Storage cabinet
- Surveying equipment and supplies
- 2 Coolers (50-quarts each)
- Cell phone

## CURRICULUM AND REFERENCE MATERIALS

- Curriculum guides
- Reference materials
- Instructional videos

A sample start-up budget is included as Attachment B.

## SECTION 7:

### DEVELOPMENT OF PROGRAM PROPOSAL FOR SCHOOL DISTRICT APPROVAL

The information in the proposal for school district approval included:

- A. Program Overview
- B. Goals and Objectives
- C. Industry Commitment
- D. Benefits for Students and Industry
- E. Industry Demand and Employment Potential
- F. Guidelines for Program Equity and other Prerequisites
- G. Projected Costs

When the program design was approved, a proposal was developed to request funding from the Federal Highway Administration.

## SECTION 8:

### RECRUITMENT OF STUDENTS

The marketing plan addressed the career ladder of employment opportunities including entry-level jobs upon graduation from high school, supervisory and professional level employment, and entrepreneurship. The school district advertised meetings with parents and students to facilitate understanding of opportunities in the industry and to encourage youth to enroll in the program. Efforts of the district and industry to support higher achievement by students were emphasized.

Recruitment activities included meetings with parents, school counselors and students. Advisory committee members arranged for industry representatives to deliver several pieces of heavy equipment to the school to be demonstrated to students.



In the spring, interested students were transported to the highway Construction Career Days fair that was sponsored by industry representatives. At the fair, students were able to observe demonstrations of equipment and, under the guidance of an experienced equipment operator, operate various pieces of equipment.

The school district staff developed a four-color brochure and a Power Point presentation to explain the program. These materials were shown and distributed at all activities promoting the program. The four-color brochure was sent to other high schools in the district for the benefit of any students who might be interested in transferring to the school where the program is offered.

### BENEFITS FOR STUDENTS

The school district developed recruitment materials that stressed to students the benefits of the program. The benefits are:

- Provide students with a focus and goal that extends beyond high school;

- Prepare students for high-paying and high-demand employment upon graduation from high school as well as for continuing their education;
- Help students develop an understanding of the expectations of the workplace and the importance of a good work ethic, and having technical and people skills;
- Help students improve academic performance as they see the relationship of academic skills to the workplace; and
- Prepare for entry into a career that provides opportunities for advancement and entrepreneurship.

### SECTION 9: EVALUATION OF STUDENT PROGRESS

A variety of methods were used to evaluate student progress.

As soon as students mastered the desired level of competence on a piece of equipment, they were assigned to another piece of equipment. Grades were partially based on the number of pieces of equipment students mastered over the course of the year.

To determine equipment mastery the teacher first administered written tests on general safety, safety relative to the specific equipment, the principles of maintenance on each of the pieces of equipment, and the consequences of inadequate maintenance. Before the students could begin hands-on practice on a specific piece of equipment, they had to demonstrate the preventive maintenance procedures to be followed prior to starting the equipment. Checklists document that the students completed all required procedures.



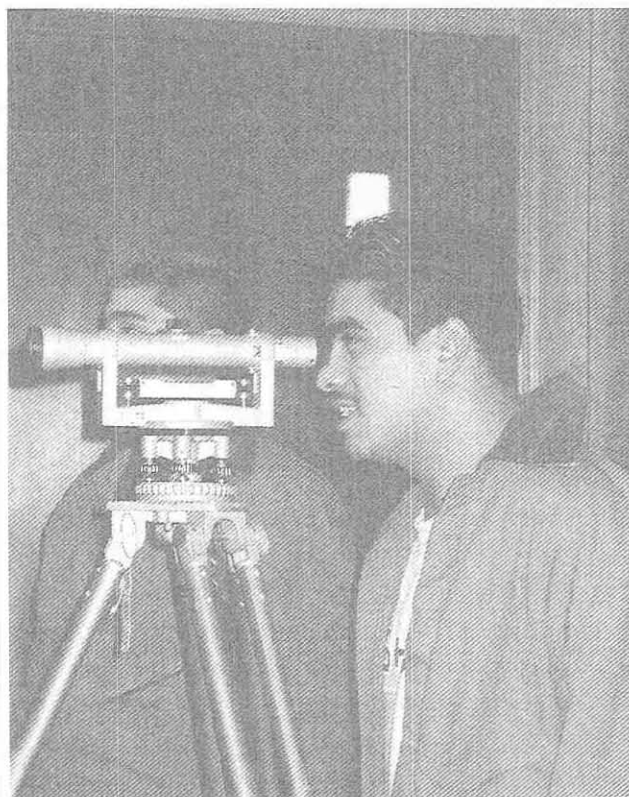
During the hands-on practice period of instruction, the teacher assigned various procedures beginning with the simplest and advancing to more complex assignments.

The general sequence was as follows:

1. Complete routine preventive maintenance procedures, cleaning, adjustment, and minor repairs;
2. Demonstrate pre-start and safety inspection procedures;
3. Follow safety practices specific to the equipment;
4. Steer and control the equipment while driving it at a slow speed;
5. Check and maintain lubrication levels;
6. Park at a designated location; and
7. Complete specific applications for each piece of equipment (see Attachment D for sequences for each piece of equipment).

The following scale is useful for grading students according to the level of independence and quality of work with which they demonstrated each competency. The rankings are as follows:

- 4 - Requires no assistance to complete task with desired results
- 3 - Requires minimal assistance to complete task with desired results
- 2 - Requires moderate assistance to complete task with desired results
- 1 - Requires direct supervision and assistance at all times to complete task with desired results
- 0 - No exposure to skill/competency



## SECTION 10: RESOURCES

When the pilot program proposal was approved and funded, the school district ordered the necessary materials, supplies, furniture, and small equipment. Refer to Attachment C for vendors and materials.

Local school district staff involved in developing and implementing the program included:

- Director of Career and Technology Education
- Program Director for Career and Technology Education
- Campus Career and Technology Coordinator,
- District School-to-Careers Specialist,
- High School Principal, Counselors, and Teacher

## SECTION 11: SUCCESSSES AND CHALLENGES

The program received recognition as a successful pilot program that met the needs of the industry as it was featured in the *Texas Contractor*, a publication of the Associated General Contractors, and in the newsletter of the Texas Engineering Extension Service of Texas A&M University.

### STUDENTS SUCCESSSES AND CHALLENGES

Successes are reflected in the impact of the program on students who participated. As a result of the program starting after the beginning of the school year, enrollment was a challenge as almost all students in Technical High School were already focused on a career concentration. The teacher and Career and Technology Coordinator identified a new pool of potential students by working with the Newcomer Career Academy (NCA). NCA is an alternative high school within the Fort Worth Independent School District for youth who are new to the country. Many have a very limited mastery of the English language and much to learn regarding life in the United States.

However, most came with parents who are in the United States to improve their lives and place high value on having a job that pays well.

It is common for the students not to understand the overall picture of succeeding in such a way that will contribute to their employability and then succeeding in the workplace. Many require ongoing and repeated explanation of the importance of succeeding in academic classes as well as career and technology classes.

Many also have to learn the importance of following school rules, and developing personal management skills that contribute to their punctuality and regular attendance in all classes, and even remembering to bring lunch.

The teacher worked diligently to teach students how to manage their time and plan their day, and to relate academic work, attendance habits, and school rules to success in the workplace. As a result, several students improved their behaviors, academic performance, communication skills, and personal management skills. Personal management skills were of critical importance as a number of students had to work full-time to support their families. This heavy load often resulted in excessive absences and required continued intervention by the teacher.

In the NCA, one student caused significant problems with frequent tardiness, absences, and poor academic performance because of indifference toward school. The NCA staff almost gave up on this student. At the beginning of the program, the student was non-communicative even in the highway construction class. As the year progressed, the student actively contributed to classroom





discussions, provided leadership to other students in the construction and academic classes, improved academic performance and attendance, and passed all three sections of the Texas Assessment of Academic Skills (TAAS), all requirements for graduation from high school.

Another student had parents who did not encourage enrollment in the construction course because they wanted him to have something "better." The 20-year-old student insisted on enrolling and began the year as a student who did not communicate with his peers or the teacher. Through the year, he became a leader, developed communication skills and leadership abilities, and graduated in the top 3 percent of the class.

Another example, a third student came from a non-supportive environment. He was self-supporting, yet dependent upon others for assistance with making life decisions. The teacher helped with decisions on housing, vehicles, and other decisions that would contribute to his ability to be successful in the workplace. The teacher also helped him obtain tutoring for certain academic courses. By the end of year, he was making decisions independently and was successful in the program. The student passed all sections of the TAAS, graduated with grades high enough to be accepted by a local university and has saved approximately \$6,000 to buy a house. While he entered the program without a career direction or goal, he plans to continue onto higher education and enter the highway construction industry. However, upon graduation from the program and application for employment, he learned that his father had sold his social security number and birth certificate.

### ADMINISTRATIVE SUCCESSES AND CHALLENGES

For the pilot program, the bureaucracy within the school district resulted in the failure to order a school bus to provide transportation to the industry-training site. The challenge was overcome by leasing a van. This alternative was extremely expensive.

Obtaining protective clothing proved to be a challenge. Insulated coveralls were purchased and are appropriate for colder climates or seasons. However, budget limitations prevented the purchase of protective wear for warmer weather and most of the students do not have the financial resources to purchase their own. Uniform rental is an alternative.

Difficulty of students to obtain social security numbers was an ongoing challenge. The teacher has worked continually to emphasize the many reasons one must have a social security number to be a fully functioning member of this society, including having a driver's license to be able to drive to job sites. The teacher continued to work with the NCA principal. In Texas, the issue of legal residency and eligibility to work is an ongoing concern for many students that is not easily resolved.

Another challenge was getting school counselors to recognize the value of the program to students. The teacher constantly spoke with counselors. For the following school year, the Career and Technology Coordinator and teacher plan to take the counselors to the industry-training site to observe students at work. The purpose of this effort is to provide greater understanding of the program so counselors will encourage more students to participate in the Construction Career Days fair sponsored by the highway construction industry during the spring.



## HIGHWAY CONSTRUCTION PROGRAM CURRICULUM

### I. Safety Principles (18 hours)

- A. General Safety (8 hours) - The course begins with a unit focused on general safety. Students learn how to protect themselves, their co-workers and the equipment they are using by following safe practices including paying attention to surroundings, weather, and co-workers and by watching for safety hazards such as chemicals, machinery and job site occurrences. At the conclusion of this unit, the student will be able to:
- Explain the importance of wearing appropriate safety gear for personal protection when operating heavy equipment;
  - Outline principles of job site safety;
  - Explain first-aid practices that may be used at a job site; and
  - Explain the relationship of weather to safe operation.

Throughout the course, principles of general safety are repeatedly reinforced.

- B. OSHA Safety (10 hours) - This unit aligns with OSHA guidelines and emphasizes the procedures required to implement the laws that govern the highway construction worksite. The teacher must have the OSHA certification required to teach the unit. As a result of this unit, students will be given a certificate indicating they have successfully completed the OSHA course in Construction Safety and

Health. Students who complete the unit will be able to:

- Explain background, purpose and importance of OSHA;
- Explain OSHA safety rules that regulate equipment operation and safe job procedures in highway construction;
- Apply the laws that govern the job site that allow employees to safely complete jobs without harming equipment, employees or the environment;
- Explain proper use and disposal of chemicals; and
- Recognize violations of OSHA laws that pertain to job site safety.

### II. Maintenance (18 hours)

Students learn that safe maintenance and operation of equipment is one of the most important responsibilities of an equipment operator. Students learn to keep equipment in working order by identifying potential problems and applying corrective measures; view videos from manufacturers for each piece of equipment; and observe demonstrations of appropriate maintenance procedures.

- A. Diesel Engines (2 hours) – Upon completing this lesson, the student will be able to:
- Explain the importance of maintenance;
  - Identify the required preventive maintenance;
  - Demonstrate required preventive maintenance procedures;
  - Explain the consequences of inadequate maintenance; and
  - Apply safety principles.



B. Air Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

C. Fuel Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

D. Lubrication Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify required the preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

E. Cooling Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

F. Electrical Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

G. Hydraulic Systems (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

H. Power Trains (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance;
- ii. Identify the required preventive maintenance;
- iii. Demonstrate required preventive maintenance procedures;
- iv. Explain the consequences of inadequate maintenance; and
- v. Apply safety principles.

I. Lubrication Charts and Maintenance Records (2 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of maintenance records and lubrication charts;
- ii. Read and interpret lubrication charts;
- iii. Identify the lubrication required; and
- iv. Keep accurate lubrication records for each piece of equipment.

### III. Excavation Safety (12 hours)

Students successfully completing this unit on excavation safety will receive an OSHA excavation safety certificate from the industry-training facility. Students learn when excavation safety procedures are needed, why safe procedures are essential, and how to apply the various procedures.

A. Excavation Operation (8 hours) – Upon completing this lesson, the student will be able to:

- i. Explain the importance of following safe practices in excavation;
- ii. Explain the OSHA safety standards that are specific to excavation operations;

iii. Explain the importance of soil mechanics and mechanics;

iv. Recognize soil composition types; and

v. Explain how soil composition types and surroundings impact safe excavation practices.

B. Shoring and Shielding (4 hours) – Upon completing this lesson, the student will be able to:

i. Explain the importance of shoring and shielding in safe excavation practices;

ii. Determine type of shoring and shielding devices required for various excavation jobs;

iii. Explain proper installation of shoring and shielding; and

iv. Outline the laws that govern proper installation of shoring and shielding.

### IV. Basic Survey (8 hours)

This unit emphasizes the importance of accuracy when surveying construction sites and protecting grade stake measurements. Repeated practice with survey equipment prepares students to understand the job and how operators contribute to the accurate construction of the overall project. Upon completion of this unit, the student will be able to:

A. Explain the importance of surveying to construction;

B. Use a transit to set up and read elevation points;

C. Use a laser level to set up and read elevation points;

D. Read and interpret information gained from readings; and

E. Correctly position, label and read grade stakes.

V. Project Plans, Specifications, and Blueprints (5 hours)

This unit introduces the importance of project plans and specifications to complete a job. By discussing and reviewing blueprints, students learn the connection between the overall project plan, surveying and grade stakes, and the construction process. The importance of accurately interpreting and applying grade stake markings is emphasized. Upon completion of this unit, the student will be able to:

- A. Explain the importance of project plans and specifications; and
- B. Explain the relationship of grade stakes to project plans and specifications.

VI. Soil Mechanics and Compaction (2 Hours)

This unit provides an overview and explanation of soil types including sand, clay, black dirt, caliche and gravel. Upon completion of this unit, the student will be able to:

- A. Read soil types to determine safe practices for trenching; and
- B. Explain standards of compaction.

VII. Obtaining Employment (20 hours)

Representatives from industry come to the class throughout the year to relate expectations and opportunities of industry. Industry representatives explain the various types of jobs available and the qualifications for each. Visits from industry representatives reinforce daily lessons, as students understand that these individuals are their future employers. Upon completion of this unit, the student will be able to:

- A. Explain the importance of following appropriate procedures when applying and interviewing for employment;
- B. Relate to characteristics that employers are seeking in potential employees;
- C. Identify opportunities for advancement in highway construction;
- D. Explain how to locate and evaluate job opportunities;
- E. Demonstrate how to correctly complete job applications; and
- F. Demonstrate appropriate job interview techniques.

VIII. Operation of Heavy Equipment (180 hours)

Hands-on operation of heavy equipment provides students the opportunity to apply concepts from previous units. The teacher repeatedly reinforces important points from earlier lessons throughout the time the student is working with equipment. While working with students on each piece of equipment, the teacher discusses how much dirt can be moved in a day with a given machine, how much time is required to build a structure such as a road, stock pond or dam to complete an excavation or lay a pipeline. Additional discussions include how various factors such as weather; mud and other soil conditions; equipment breakdown; and mistakes can impact the timeline of job completion. These concepts are essential to the ability to estimate costs for any highway construction project.

To introduce new skills on each piece of equipment, the teacher explains and demonstrates safe practices, maintenance procedures and the various operations the student is to learn.



## HIGHWAY CONSTRUCTION PROGRAM FOR SECONDARY STUDENTS

### A. Dozer Operation (30 hours)

The operations include ditching, trenching, flat blading, ripping, slopes, and stock piling. Students then practice until they can successfully demonstrate various operations. Upon completion of this unit, the student will be able to:

- i. Explain the purposes of a dozer;
- ii. Explain safety practices particular to the dozer;
- iii. Identify safety gear required for dozer operation;
- iv. Demonstrate practices for personal protection when operating a dozer;
- v. Demonstrate pre-start and safety inspection procedures;
- vi. Demonstrate principles of safe operation of a dozer;
- vii. Operate safely a dozer for various practical applications; and
- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

### B. Track Loader Operation (30 hours)

The operations include loading trucks, stockpiling, rough grading, excavating, backfilling, digging banks, and hauling materials. Upon completion of this unit, the student will be able to:

- i. Explain the purposes of a track loader;
- ii. Explain safety practices particular to the track loader;
- iii. Identify safety gear required for operation of a track loader;
- iv. Demonstrate practices for personal protection when operating a track loader;

- v. Demonstrate pre-start and safety inspection procedures;

- vi. Demonstrate principles of safe operation of a track loader;

- vii. Operate safely a track loader for various practical applications; and

- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

### C. Front End Loader Operation (30 hours)

The operations include loading trucks, stockpiling, rough grading, excavating, backfilling, digging banks, and hauling materials. Upon completion of this unit, the student will be able to:

- i. Explain the purposes of a front-end loader;
- ii. Explain safety practices particular to the front-end loader;
- iii. Identify safety gear required for operation of a front-end loader;
- iv. Demonstrate practices for personal protection when operating a front-end loader;
- v. Demonstrate pre-start and safety inspection procedures;
- vi. Demonstrate principles of safe operation of a front-end loader;
- vii. Operate safely a front end loader for various practical applications; and
- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

### D. Motor Grader Operation (30 hours)

The operations include cutting, shaping, earth moving, fine grading, leveling, ripping, V-ditch construction, flat bottom ditch cutting, mixing and

spreading materials, and road maintenance. Upon completion of this unit, the student will be able to

- i. Explain the purposes of a motor grader;
- ii. Explain safety practices particular to the motor grader;
- iii. Identify safety gear required for operation of a motor grader;
- iv. Demonstrate practices for personal protection when operating a motor grader;
- v. Demonstrate pre-start and safety inspection procedures;
- vi. Demonstrate principles of safe operation of a motor grader;
- vii. Operate safely a motor grader for various practical applications; and
- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

E. Backhoe and Loader Operations (30 hours)

The operations include truck loading, straight-line ditches, square and offset excavations, benching, sloping, backfilling, leveling, and carrying a load. Upon completion of this unit, the student will be able to:

- i. Explain the purposes of a backhoe and loader;
- ii. Explain safety practices particular to the backhoe and loader;
- iii. Identify safety gear required for operation of a backhoe and loader;
- iv. Demonstrate practices for personal protection when operating a backhoe and loader;
- v. Demonstrate pre-start and safety inspection procedures;

- vi. Demonstrate principles of safe operation of a backhoe and loader;
- vii. Operate safely a backhoe and loader for various practical applications; and
- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

F. Hydraulic Excavator (30 hours)

The operations include straight-line ditches, square and offset excavations, benching, sloping, backfilling, and leveling. Upon completion of this unit, the student will be able to:

- i. Explain the purposes of a hydraulic excavator;
- ii. Explain safety practices particular to the hydraulic excavator;
- iii. Identify safety gear required for operation of a hydraulic excavator;
- iv. Demonstrate practices for personal protection when operating a hydraulic excavator;
- v. Demonstrate pre-start and safety inspection procedures;
- vi. Demonstrate principles of safe operation of a hydraulic excavator;
- vii. Operate safely a hydraulic excavator for various practical applications; and
- viii. Demonstrate appropriate maintenance, cleaning, adjustment and minor repairs.

## REFERENCES AND INSTRUCTIONAL MATERIALS

*Heavy Equipment Operator: Basic Core – Instructional Manual*

*Heavy Equipment Operator: General Equipment Instructional Manual*

*Construction Equipment Preventive Maintenance and Safety Handbook*

*Excavation Safety Handbook*

*Field Day Safety Seminar Heavy Equipment Operation Handbook*

*"Trenching and Excavation Safety" (Shoring Safely, Competent Person, Soil Testing & Cave In Response) – 120-minute Videotape*

*"Preventive Maintenance" (Air, Cooling, Lube & Fuel Systems) – 60-minute Videotape*

*"Down is Up" (Preventive Maintenance and Safety) – 30-minute Videotape*

*"It Always Happens to the Other Guy" (Safety) – 30-minute Videotape*

*"Shake Hands with Danger" (Safety) – 30-minute Videotape*

*"Multiple Choice" (Safety) – 30-minute Videotape*

*"Multiple Choice Safety Handbook" 30-minute Videotape*

## VENDOR

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Caterpillar, Inc., Peoria, Illinois 61266



## SAMPLE BUDGET HIGHWAY CONSTRUCTION PROGRAM – STARTUP YEAR

Budget Category	Amount	Description
<b>PERSONNEL</b>		
Teacher	\$55,000	Teacher salary for 210 days
Fringe benefits	6600	12% of salary
<b>TRAVEL</b>		
Youth leadership	\$1,630	Hotel and per diem for participation in region VICA
	\$1,500	Hotel and per diem for participation in state VICA
Transportation to training site	\$17,000	Fuel, maintenance, storage and operation of bus for one year
<b>SUPPLIES</b>		
Instructional materials	\$113	Heavy Equipment Operator: Basic Core
	\$126	Heavy Equipment Operator: General Equipment Teacher Book
	\$300	Instructional videos 6 @ \$50
Technology	\$1,500	Computer
	\$900	Printer
	\$200	Scanner
Safety gear	\$500	20 Hard hats @ \$25
	\$20	First Aid Kit
	\$100	Dust masks 10 boxes of 50 @ \$10.00
	\$330	Ear protection 10 boxes of 100 pair @ \$33
	\$100	20 Leather gloves @ \$5
	\$700	20 Steel-toed shoes @ \$35
	\$80	Water coolers (2 @ \$40)
	\$500	20 Coveralls @ \$25
	\$3,000	2 computers @ \$1500
	\$1,000	1 Printer
	\$200	1 Teacher desk
	\$50	1 Teacher chair
	\$600	4 Storage cabinets (\$150 x 4)
	\$875	Laser Alignment LB 100 (surveying equipment)
Surveying Equipment	\$70	Fiberglass Grade Rod (10ths) – 16 feet
	\$65	Heavy Duty Aluminum Tripod
	\$350	Cst Berger 20x AutoLevel Kit (surveying equipment)
<b>CONTRACTUAL SERVICES</b>		
	\$15,000	Bus lease fee (1 year)
	\$840	Cell phone service (12 months x \$70/month)
	\$176,500	Agreement with Industry-training facility to provide laboratory instruction
<b>TOTAL</b>	<b>\$285,749.00</b>	

## REFERENCES AND INSTRUCTIONAL MATERIALS

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## SEQUENCE OF TASKS FOR EACH ITEM OF HEAVY EQUIPMENT RANKED FROM SIMPLE TO COMPLEX

### Dozer

1. Flat-blading
2. Ripping
3. Ditching and trenching
4. Stock-piling
5. Working on slopes
4. Leveling
5. Mixing and Spreading materials
6. Maintaining roads
7. Ripping
8. Constructing V-ditch
9. Constructing flat bottom ditch
10. Fine grading

### Track Loader

1. Rough grading
2. Back filling
3. Hauling materials
4. Excavating
5. Digging banks
6. Stock- piling
7. Loading trucks

### Front End Loader

1. Rough grading
2. Back filling
3. Hauling materials
4. Excavating
5. Digging banks
6. Stock- piling
7. Loading trucks

### Motor Grader

1. Cutting
2. Shaping
3. Earth-moving

### Backhoe-Loader

1. Straight-line ditches
2. Backfilling
3. Carrying a load
4. Leveling
5. Benching
6. Sloping
7. Square and offset excavations
8. Truck loading

### Hydraulic Excavator

1. Straight-line ditches
2. Backfilling
3. Leveling
4. Benching
5. Sloping
6. Square and offset excavations



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