

Developing an Environmental Engineering Technology Program

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I. Introduction

This paper describes how a Tech Prep Consortium, several high schools, a community college, and a host of local employers in Ohio's Miami Valley worked together to develop an Environmental Engineering Technology program that meets the needs of the community.

Background: In 1991 the Miami Valley Tech Prep Consortium was organized to bring together local employers and educators to jointly develop seamless technical degree programs that span the junior year in high school through community college with options to continue at a four-year institution. Tech Prep is a national education reform, designed to meet the needs of our changing workforce by providing skilled technicians for high demand fields. It is a cooperative effort between industry, secondary schools and post-secondary schools.

Tech Prep is designed to:

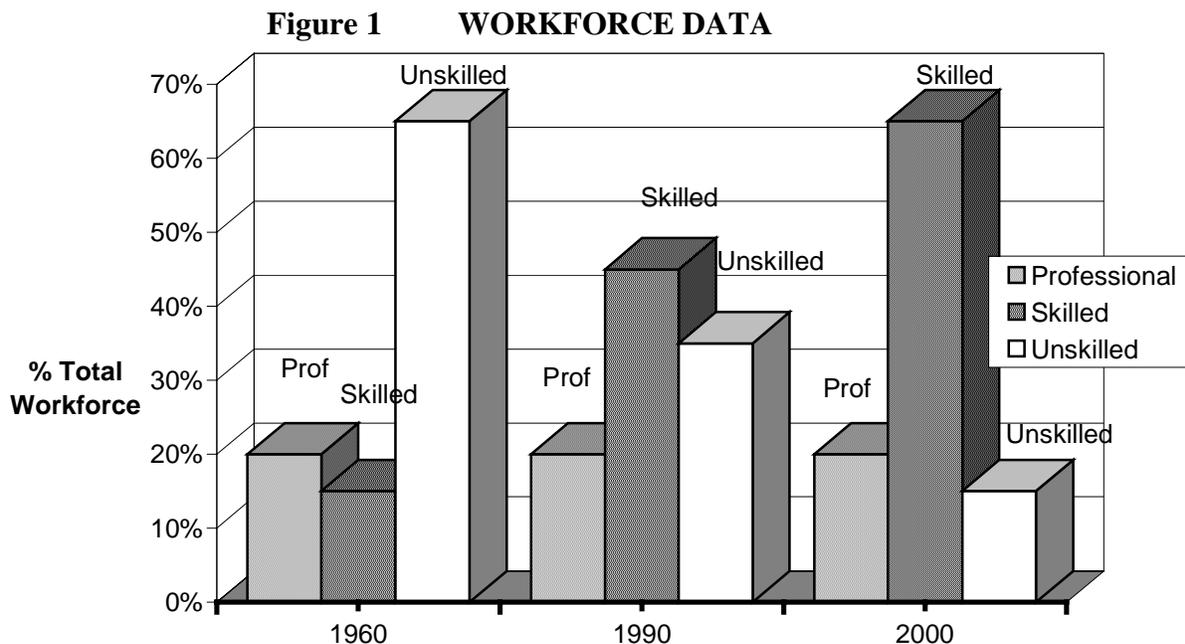
- increase the number of students enrolled in a demanding technical field,
- improve the preparation level of students entering college, and
- provide technical skills for high school graduates entering the workforce.

Tech Prep: The Ohio Tech Prep Program began in 1991 based on the concept of consortia. Grants were available to consortiums of secondary schools, community colleges and business partners. Twenty-eight Tech Prep consortiums were formulated and now serve most of Ohio. The Miami Valley Consortium comprised of Sinclair Community College, the University of Dayton, and seven Vocational Education Planning Districts, serves 64 high schools and over 100 business partners. In Ohio, the Miami Valley Consortium, which has the highest number of enrolled students, was named "Best In The Nation - 1996", by the U.S. Department of Education.

High School Enrollments: National statistics on high school enrollment indicate that 50 percent of high school students are generally unfocused, 25 percent are preparing for college and 25 percent are preparing for vocational training. Furthermore, according to a 1993 study by the U.S. Government Accounting Office⁽¹⁾, about 15 percent of high school freshmen go on to graduate and obtain a four year college degree within six years of high school graduation. Additionally, 97 percent of parents responding to a national survey expected their children to finish high school. Seventy percent expected that their children would complete a four-year college and receive a degree compared to 25 percent that actually fulfill this expectation.⁽²⁾

With the growing demand for technical training, the education system and industry are not in sync, thus creating losses for students, employers and the community. Tech Prep thus aims to provide a focused job-related technical education for the 50 percent unfocused students.

Changing Workforce: Since the 1960s, the workforce has significantly changed. The percent of the skilled workforce increased from approximately 15 percent to over 60 percent, while the unskilled workforce decreased from 60 to 15 percent⁽³⁾ (Figure 1). The environmental technician labor market is considered part of the professional and skilled workforce.



Growth Rate/Projections: A 1995 study forecasted that the environmental labor market will:

- remain unchanged by economic fluctuations in the next century,
- increase by 39.5% by 1998 in Ohio,
- increase by 7.3% --- 46 % faster than the anticipated growth in all U.S. markets,
- continue to suffer educationally, because universities are only producing 5% of the necessary graduates, and
- become the largest business in the world by the year 2000.

Furthermore, by the year 2000, pollution control and waste management costs will increase by 50% and jump from 2% to 3% of the GNP.⁽⁴⁾⁽⁵⁾⁽⁶⁾⁽⁷⁾ Statistics from the Ohio Bureau of Employment Services for specialized environmental occupations, predict a moderate growth rate as shown below:

Occupation	Annual Rate of Change 1996 – 2006
Environmental Science Technicians	0.3 %
Environmental Compliance Inspectors	0.2 %
Environmental Scientists	1.4 %

It is evident from these forecasts that the demand for skilled employees (technicians) will continue to exceed the supply. To meet this growing demand for technicians, industry must look to high schools and community colleges to provide more opportunities for technical training and to produce more technically trained individuals who are ready to enter the workforce.

Region: In the Miami Valley, there are 22 large environmental firms that would participate in this growth rate and would thus require additional trained environmental technicians. These firms are within the area serviced by Sinclair and would benefit from the training provided by an environmental engineering technology program. Furthermore, locally trained employees would provide a more in-depth appreciation of the community and strive through their environmental technical know-how to make it a better place to live and work.

II. Program Development

Demand: Due to strong interest from students and local industry leaders, it became apparent that an environmental engineering technology program at Sinclair Community College could effectively serve the community. Based on Ohio's low ranking in overall environmental quality (see Table 1) and a top ten state in toxic releases (see Table 2), there is a viable need for employees trained and skilled in environmental engineering technology. In Table 1, for example, Ohio's forty sixth ranking indicates that the overall environmental quality is poor when compared to other states. In Table 2, Ohio's number four ranking in "Air" indicates that only four states release more air pollutants than Ohio. Based on these rankings there should be a high demand for environmental technicians throughout the State of Ohio.

TABLE 1. Ohio Ranking⁽⁸⁾

Environmental Condition	Ranking (out of 50 states)
Overall Environmental Quality	#46
Air Pollution	#49
Toxic Chemical Waste	#49
Water Pollution	#45
Solid Waste Generation	#45
Per Capita Spending on Public Health	#48

TABLE 2. Ohio's National Rank⁽⁹⁾

Disposal Medium	Ranking (out of 50 states)		
	1995	1996	1997
Air	5	5	4
Water	10	7	9
Land On-Site	4	4	3
Deepwell Injection	4	4	4
Number of TRI* Reporting Facilities	1	1	1

* Toxic Release Inventory

Training Requirements: Based on the anticipated growth rate and Ohio's ranking in environmental conditions, individuals entering the environmental technology and science fields will be in growing demand. Sinclair Community College in cooperation with the Tech Prep Consortium has taken the lead role in developing fully trained graduates that can meet the

growing demands of the community. The three major steps in this endeavor included:

- determining the competencies required by industry,
- developing a curriculum that includes all the competencies, and
- establishing an associate degree program that allows graduates to function in various environmental positions or continue to a four-year institution.

Competencies Required by Industry: Once the need was determined and employers committed, development of the Technical Competency Profiles (TCPs) began. Employers and industry leaders (Industry Team) were sent a draft list of competencies based on national skills standards and related programs. The Team then attended full-day sessions to critique the competency list, adding, deleting, rewording, grouping into units and at times making dramatic changes. The 37 training units, which constituted the TCPs, are shown in Appendix A.

The Technical Competency Profiles (TCPs), developed by the Industry Team, outlined the training required to work in the environmental field. The Team focused on core competencies such as communications, mathematics and science and environmental skills such as environmental science, laws, regulations, assessments, air pollution control, solid waste, water/wastewater and hazardous wastes. Competency builders further defined each general competency. The competency builders included classroom and hands-on training requirements. The training units, competencies and competency builders, developed by the “Industry Team”, were then submitted for review by the “Educators Team”.

High school, community college, and university educators (Educators Team) from all disciplines met to critique the work of the Industry Team. They did not have the license to make changes to the competency list, but they could flag areas with which they had questions and/or disagreements. The real aim was to level the competencies and determine what can be taught at the high school, the community college, and the four-year institution.

The “leveling of the competencies” determined the grade level where the competencies could be effectively taught. The following determinations were made for each competency:

- the level where it can be introduced,
- the level where full competency can be expected,
- the level where reinforcement would be required, and
- training/education that would be required at the student’s place of employment.

The educational levels considered included tenth through twelfth grades, associate degree and bachelors degree. For example, it was determined that the competency “Demonstrate Environmental Sampling Procedures” could be introduced at the twelfth grade level, attained at the associate degree level and reinforced at the bachelors degree level. This leveling process was completed for each competency. A typical training unit, with competencies, competency builders and grade levels, is shown in Appendix B. Upon completion of the leveling process, both the educators and industry teams finalized the competencies, developed course objectives and prepared curriculum pathways.

Curriculum Development: The curriculum was designed to provide a full range of courses that would prepare students for entry-level positions in the environmental engineering technology field. The technical curriculum provides a background in environmental laws and regulations,

site assessments, emergency response to situations involving hazardous chemicals and wastes, storage, treatment, transportation and disposal of hazardous wastes, sampling, analysis, air pollution, water and wastewater management and remediation. The curriculum core includes three English/communications courses, four math courses, three chemistry courses, biology, physics and a computer course. For the first three of six terms the curriculum focuses on core courses and introductory environmental courses. During the fourth, fifth and sixth terms the student, in addition to advanced courses, has the option to take one of three tracks, chemical, industrial hygiene or hazardous materials. The chemical track includes three organic chemistry courses and prepares the student for continuation to a four-year college. It should be noted that most four-year institutions will accept the core courses such as math, English and chemistry to fulfill their curriculum requirements. However, some courses included in the industrial hygiene and hazardous material tracks may not be accepted at four-year institutions. These tracks are thus geared toward those students that expect to join the workforce upon graduation from Sinclair. The industrial hygiene track includes industrial hygiene, toxicology and industrial hygiene instrumentation courses and prepares the student for employment in the environmental and/or industrial hygiene areas. The hazardous materials track includes asbestos management, lead management, confined space management and the 8-hour OSHA hazardous waste operations refresher and prepares the student for immediate employment in a hazardous material/waste environment. Students, upon completion of the curriculum, will have the skills and knowledge for environmental engineering technician positions in consulting, industrial and governmental organizations. The curriculum, shown in Appendix C, includes all the competencies and specialized tracks developed by the industry and education teams. After the curriculum was developed the next step was to establish the Environmental Engineering Technology Associate Degree program.

Establishing an Associate Degree Program: The Ohio Board of Regents approved the Environmental Engineering Technology Associate Degree program in March, 2000. The proposal submitted to the Board of regents, included program objectives, community needs, job opportunities, financial resources and a detailed analysis of the projected student enrollment. Following is a summary of the projected enrollment analysis. Student entering the Environmental Engineering Technology program would come from three areas: Tech Prep, high school graduates, and industry.

Tech Prep

This program selects high school students during their sophomore year to enter the Tech Prep Environmental program. Students then take an environmentally based curriculum during their junior and senior year and upon graduation, can enter Sinclair's Environmental Engineering Technology program with a \$1,000/year scholarship. Two high schools (Bellbrook and Miami Valley Career Technical Center) started the Environmental Tech Prep program in 1998. Approximately 30 students at each school, who entered the program, graduated in 1999. Some of these students enrolled in environmental courses at Sinclair. Two other high schools (Miamisburg and Centerville) started the program in 1999 with two additional schools contemplating a Tech Prep program in 2000. Ten Tech Prep students enrolled in Sinclair's Environmental Engineering Technology program in the fall 1999 term.

High School Graduates

High school students have expressed an interest in the Environmental Engineering Technology program through Sinclair’s visits to the high schools and through high school visits to Sinclair during Engineer Day and other special functions. Sinclair, with its diverse programs and low tuition (lowest in the state), attracts over 27 percent of the region’s college bound high school graduates. Each year over 5,000 student enter Sinclair. Of these, approximately 1,600 have graduated high school within the past year. Furthermore, every year over 300 students declare Engineering and Industrial Technologies as their major. It is expected that 5 percent (or 15 students) of the students entering Engineering and Industrial Technology will enter the Environmental Engineering Technology program.

Industry

The increased concern for hazardous chemicals has prompted EPA to take aggressive action in inspecting and reporting releases. Additionally, the Emergency Planning and Community Right-to Know Act (EPCRA) requires annual reports on hazardous chemicals that are purchased, used, stored, and released. This Toxic Release Inventory (TRI) report requires extensive research on how chemicals are used and how they can be eliminated, reduced, or recycled. Industry is thus faced with hiring environmental engineering technologists and/or training its workforce. The Sinclair Environmental Engineering Technology program is designed to provide the necessary training. Courses such as SRM 151-OSHA 40 hour Hazardous Waste Operations, EVT 260 Treatment, Storage, and Disposal of Hazardous Wastes, and EVT 200 Environmental Waste Management (Pollution Prevention) are just a few of the subjects sought by industrial firms. Students, who enroll to take one or two work-related courses, often return to complete a degree program. Thus the Environmental Engineering Technology program will not only draw industrial employees to take selected courses but will also draw more full-time students.

Enrollment Projections: The enrollment projections for the Environmental Engineering Technology program are shown below. These projections take into account an official program start date of fall 2000. It should be noted that an environmental track currently exists under the Safety Risk Management program and that some of the students currently enrolled in this program will transfer to the Environmental Engineering Technology program. Anticipated enrollments are shown below:

		2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
First-Year Students	Full-time	15	30	43	60	70
	Part-time	4	10	15	20	25
Second-Year Students	Full-time	14	24	38	50	
	Part-time	4	10	12	15	

III. Conclusion

The Environmental Engineering Technology program will produce students that possess competencies developed and verified by corporate managers, federal, state and local government employees, and high school and college instructors. The student's skills in these competencies will provide the needed technical education and hands-on experiences sought by prospective employers. Additionally, the students will receive the education and training needed for employment in the environmental field and/or continuance to a four-year college or university.

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APPENDIX A COMPETENCY UNITS

- Unit 1: Employability Skills
- Unit 2: Professionalism
- Unit 3: Teamwork
- Unit 4: Professional & Ethical Standards
- Unit 5: Project Management
- Unit 6: Problem Analysis
- Unit 7: Computer Applications
- Unit 8: Technical Documentation
- Unit 9: Statistical Analysis
- Unit 10: Basic Economics
- Unit 11: General Administrative Functions
- Unit 12: Management & Supervision
- Unit 13: Psychology of Stress
- Unit 14: Equipment & Maintenance Procedures
- Unit 15: Physics Concepts
- Unit 16: Environmental Science
- Unit 17: Energy Sources
- Unit 18: Environmental Laws and Regulations
- Unit 19: Environmental Safety
- Unit 20: Emergency Response
- Unit 21: Soil Science
- Unit 22: Sampling Methods
- Unit 23: Bio-Chemical Technology
- Unit 24: Environmental Assessments
- Unit 25: Hydrogeology
- Unit 26: Drinking Water & Wastewater Treatment Operations
- Unit 27: Pollution Control
- Unit 28: Hazardous Waste Management
- Unit 29: Solid Waste Management I
- Unit 30: Solid Waste Management II
- Unit 31: Hazardous Materials Incident Management I
- Unit 32: Hazardous Materials Incident Management II
- Unit 33: Self-Contained Underwater Breathing (SCUBA) Diving
- Unit 34: Communications
- Unit 35: Math
- Unit 36: Science
- Unit 37: Career Competencies

APPENDIX B TYPICAL COMPETENCY UNIT

Each competency has been leveled as to when it will be taught and at which level. The following designation has been used:

10 = @ 10th Grade

12 = @ 12th Grade

AD = @ Associate Degree

BD = @ Bachelor Degree

WS = @ Work Study

LL = Life Long Learning

In addition to leveling of each competency, an **I** (for initial introduction), **C** (for competency attainment) and **R** (for reinforce competency) has been inserted in each competency area as appropriate.

Unit 24: Environmental Assessments

Competencies:

Perform Assessment (Phase I)

Identify Past Practices (Phase I)

Conduct Field/Lab Analysis (Phase II)

Collect Physical Data (Phase II)

Remediate Site (Phase III)

Competency: Perform Assessment (Phase I)

I@12, C@AD, R@BD

Competency Builders:

Identify key elements in Phase I, II and III assessments

Describe the importance of each

Gather drainage area data

Complete field data sheet

Record physical and topographical data

Interpret basic soil differences

Measure groundwater level

Identify flood plain areas

Measure stream flow

Complete title search

Calculate water runoff

Competency: Identify Past Practices (Phase I)

I@12, C@AD, R@BD

Competency Builders:

Locate regulatory reference materials

Collect background information

Verify accuracy of information

Investigate background of complaint

Interact with various regulatory agencies

Use regulatory reference materials

Competency: Conduct Field/Lab Analysis (Phase II)

I@12, C@AD, R@BD

Competency Builders:

Perform Biological Demand (BOD) analysis
Perform Chemical Oxygen Demand (COD) analysis
Perform pH analysis
Perform specific conductivity analysis
Perform dissolved oxygen analysis
Perform suspended analysis
Measure water temperature
Measure water hardness
Measure water level and flow
Perform nitrates and nitrites analysis
Measure turbidity
Measure oxygen level
Analyze water using portable test kit
Measure Lower Explosive Levels (LEL)
Measure airflow rate and temperature
Perform air particulate analysis
Describe procedures for measuring toxic gasses, organic vapors and radiation
Measure toxic gasses
Measure organic vapors
Measure basic field level of contamination
Measure radiation
Measure radon
Measure flashpoint
Measure free liquids
Perform percolation tests
Determine moisture content/dry content (DC)
Measure density
Measure chlorinated compounds
Identify background analytical data to establish norm for site

Competency: Collect physical data (Phase II)

I@12, C@AD, R@BD

Competency Builders:

Identify safety hazards of materials
Develop “Chain of Custody” procedures
Identify physical condition of materials
Identify marking procedures
Select sampling tools
Identify preparation and preservation procedures of samples
Collect and label samples
Document samples using “Chain of Custody” forms
Sign over “Chain of Custody” form

Competency: Remediate site (Phase III)

I@12, R@AD, C@BD

Competency Builders:

Identify options

Resolve issue with concerned party (s)

Assess options for corrective action

Implement selected option for correction

Document investigation with summary reports

**APPENDIX C
CURRICULUM**

**SINCLAIR COMMUNITY COLLEGE
ENVIRONMENTAL ENGINEERING TECHNOLOGY
105-111 CREDIT HOURS**

CREDIT HOURS	COURSE NUMBER	COURSE TITLE
<u>FIRST QUARTER (18)</u>		
3	EVT 120	Environmental Sampling & Analysis
5	MAT 131	Technical Math I
4	CHE 131	Technical Chemistry
3	ENG 121	Technical Communications I
3	EVT 110	Environmental Compliance
<u>SECOND QUARTER (19)</u>		
2	MET 198	PC Applications in Engineering Technology
4	CHE 121	Intro to Organic Chemistry
5	MAT 132	Technical Math II
5	BIO 107	Human Biology
3	ENG 122	Tech. Communications II
<u>THIRD QUARTER (19)</u>		
5	MAT 133	Tech Math III
4	EVT 200	Waste MGT/Pollution Prevention
3	HUM 135	Environmental Ethics
4	CHE 134	Environmental Chemistry
3	COM 211	Effective Speaking
<u>FOURTH QUARTER (16-18)</u>		
4	MAT 122	Statistics
4	PHY 131	Technical Physics I
5	SRM 151	OSHA 1910.120 Hazardous Waste Operations
3-5	_____	Track Electives
<u>FIFTH QUARTER (16-18)</u>		
3	EVT 106	Air Pollution
3	EVT 107	Water Management Technology
4	EVT 210	Environmental Site Assessment
3	EVT 260	Hazardous Waste Stor,Tmt & Disp
3-5	_____	Track Electives
<u>SIXTH QUARTER (17-19)</u>		
3	EVT 278	Capstone
4	EVT 265	Remediation
4	EVT 240	Groundwater/Fluid Mechanics
3	EVT 180	Solid Waste Management or Internship
3-5	_____	Track Electives

TRACK ELECTIVES

CREDIT HOURS	COURSE NUMBER	COURSE TITLE
CHEMICAL TRACK		
<u>FOURTH QUARTER (5)</u>		
5	CHE 201	Organic Chemistry I
<u>FIFTH QUARTER (5)</u>		
5	CHE 202	Organic Chemistry II
<u>SIXTH QUARTER (5)</u>		
5	CHE 203	Organic Chemistry III
INDUSTRIAL HYGENE TRACK		
<u>FOURTH QUARTER (3)</u>		
3	SRM 215	Industrial Hygiene
<u>FIFTH QUARTER (3)</u>		
3	SRM 217	Industrial Toxicology
<u>SIXTH QUARTER (3)</u>		
3	SRM 219	Industrial Hygiene Instrumentation
HAZARDOUS MATERIAL ABATEMENT TRACK		
<u>FOURTH QUARTER (4)</u>		
4	EVT 215	Asbestos Management
<u>FIFTH QUARTER (3)</u>		
3	EVT 216	Lead Management
<u>SIXTH QUARTER (4)</u>		
2	EVT 217	Confined Space
1	SRM 152	OSHA 1910.120 Hazardous Waste Operations Refresher