

## **Board 108: Enhancing Environmental Engineering Curriculum for the Transportation Industry**

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# Enhancing Environmental Engineering Curriculum for the Transportation Industry

## Introduction

The Water Resources Management Department at Central State University, one of the Historically Black Universities and Colleges (HBCUs), offers Environmental Engineering (ENE) and Water Resources Management (WRM) programs at the undergraduate level. Its environmental engineering program is one of the Accreditation Board for Engineering and Technology (ABET) accredited environmental engineering programs in HBCUs. While the environmental engineering program at Central State University is small, it significantly impacted the African American population in environmental engineering education by being the first ABET-accredited environmental engineering program in an HBCU and continuously producing minority environmental engineers to the workforce. According to recent ASEE’s Profiles of Engineering & Engineering Technology, Central State University’s Engineering programs (including the Manufacturing Engineering program) have served minorities heavily (ASEE, 2021; ASEE, 2022).

In the past, the ENE program educated, trained, and prepared students for the traditional environmental engineering fields, such as water supply and wastewater treatment, air quality management, and solid waste management, via coursework in these topics. Its graduates go to graduate schools for civil and environmental engineering majors or are hired by the public or private sectors with a focus on infrastructure.

## Transportation studies in HBCUs

It was found from the web search that among the 101 HBCUs, at least ten institutions offer transportation-related degree programs (Table 1). While some programs are at the undergraduate level, some institutions provide degrees at the doctoral level.

Table 1: HBCUs that offer transportation-related degree programs and the programs

Institution	Transportation-related program
Alabama A & T University	Civil Engineering
Florida A & M University	Civil Engineering
Hampton University	Aviation Management Administration   Air Traffic Control   Flight Education
Howard University	Civil Engineering
Jackson State University	Civil Engineering-General
Morgan State University	Civil Engineering   Transportation Systems Engineering
North Carolina A&T State University	Civil Engineering
Tennessee State University	Civil Engineering
Tuskegee University	Aerospace Science Engineering
Xavier University of Louisiana	Dual Civil program with another institution

Many of these programs provide transportation engineering as a track in the civil engineering programs with core transportation courses such as traffic engineering and transportation engineering.

### Transportation Industry and Environmental Issues

The transportation industry is impacted by environmental issues such as flooding and air pollution. At the same time, transportation also creates or contributes to many environmental engineering problems, including greenhouse gas emissions, noise pollution, increasing salinity of urban lakes (due to the use of salt on icy roads), urbanization, marine pollution, and solid and hazardous waste disposal (such as tires, batteries and decommissioned vehicles and vessels). This situation necessitates environmental engineers who understand transportation engineering and transportation engineers who are familiar with the solutions for environmental engineering issues. In this background, an undergraduate environmental engineering program can incorporate components in its curriculum and research to address transportation-related environmental problems. This inclusion can be done in two ways: 1. Developing a transportation engineering minor in an environmental engineering program; 2. Enhancing the existing environmental engineering curriculum with transportation components. In addition, an *Environmental Engineering for Transportation* certificate program can also be developed for practicing environmental and transportation professionals to enhance their knowledge and experience.

This paper aims to present the ongoing and planned efforts to address the environmental issues pertinent to the transportation industry in an ABET-accredited environmental engineering program in a minority teaching institution.

### Transportation studies at Central State University

In the past decade, the ENE program at Central State University identified the transportation industry as a niche industry for which the workforce program can produce environmental engineers. The ENE faculty enhanced the program with transportation industry-related coursework, research, and internships with the support of the Department of Transportation funding and collaborators. The faculty implemented these activities from the recruitment phase to the graduation phase.

**Curriculum:** The ENE curriculum includes environmental engineering courses, and the ENE majors can minor in WRM too. Except for the Water Transportation elective in WRM, neither program coursework covers the core transportation courses. However, these programs have enhanced their water, air, noise, and solid waste management course components to address pertinent transportation-related topics. These topics include greenhouse gas emissions, noise and energy related to transportation, highway culvert design, water quality, and garbage collection problems. Table 2 provides existing courses at Central State University in its ENE and WRM programs. In addition to these courses, the Department of Manufacturing Engineering also offers courses pertinent to the transportation and automobile industries through its Manufacturing Engineering and Industrial Technology programs.

Table 2: Transportation components in ENE & WRM curricula at Central State University

Course	Transportation-related component(s) – not a complete list
Water Transportation Systems	Elective
Engineering Hydrology	Flooding, Culvert Design Introduction
Applied Hydraulics	Culvert Design Principles
Water Model Applications	Culvert Design software (Culvert Master)
Urban Water Problems	Water Quality issues related to land and water transportation
Air Quality Engineering	Transportation-related Air & Noise issues; MOVES & TNM
Introduction to Geographic Information System	Applications in Transportation
Solid & Hazardous Waste Management	Transportation waste; waste collection & transportation
Surveying	Leveling, Cut & Fill, Curvature
Internship	Transportation industry internship
Senior Capstone Design	Sustainability   ENVISION – Transportation

Research: Since 2009, the department has collaborated with other institutions to receive funding from the Department of Transportation for transportation research. While the other consortium institutions focused on research in the core transportation engineering areas (such as pavement design, traffic congestion, and connected and autonomous vehicles), Central State University focused on transportation-related environmental issues (such as greenhouse gas emissions, traffic noise modeling, and the impact of COVID-19 on air pollution). These opportunities helped build facility capabilities and paid student undergraduate research and internships in these areas and internships. Table 3 provides the Transportation consortiums that Central State University was a member. The students could submit their research at the conferences such as the annual Transportation Research Board (TRB) Conference, Ohio Transportation Engineering Conference, and University Transportation Consortium conferences. The students also participated as Minority Transportation Scholars in the programs. The authors also participated in panel discussions relevant to minorities in the transportation workforce. In addition to the air quality and energy research, One author is involved in relevant professional development activities such as MOVES training and as a part of the TRB Friends of the Air Quality and Hydrology and Hydraulics committees. The first author is also a reviewer of air quality-related TRB conference papers.

Table 3: Central State University affiliated Transportation Consortiums & Research

Consortium	Research
Ohio Transportation Consortium (OTC)	On-Road Mobile Source Pollutant Emissions: Identifying Hotspots and Ranking Roads
USDOT Region V Regional University Transportation Center (Nextrans)	Inventory of Greenhouse Gas Emissions from On-Road Vehicles in Midwestern States and Integrated Approach to Achieving Environmental Sustainability in Transportation
Center for Connected and Automated Transportation (CCAT)	CAV Developed Vehicles as Real-Time Sensors for Assessing Greenhouse Gases; CAV Systems Incorporating Air Pollution Information from Traffic Congestion
Center for Connected and Automated Transportation (CCAT)	Starts in 2023 Summer; Energy, Diversity, and Air Quality issues in transportation

Recruitment: From 2008 to 2018, the department and the first author were involved in the four-week Summer Transportation programs for high school students to recruit students for the environmental engineering programs. These activities are elaborated in Kandiah *et al.*, 2017.

In the future, the ENE program intends to further strengthen the transportation components by including environmental equity and justice, and energy issues. The department has proposed a minor program that would exclusively strengthen the transportation-related curriculum. This curriculum will be interdisciplinary and include social sciences and computer science courses.

## Conclusion

This paper presented the potential to take advantage of the environmental engineering-transportation industry nexus needs for a growing small undergraduate environmental engineering program in a teaching institution mainly serving the underrepresented community in the workforce. While serving the targeted population, this example can also help similar programs use this as a model to develop their programs.

This can also increase the learning curve for educators and administrators to develop unique programs for the industry's demands while enhancing workforce diversity, equity, and inclusion.

The reproducibility of this model in other institutions depends on how the other institutions adopt and adapt this model for their institutions. It is hard to generalize the reproducibility as each university program is unique and bound by its conditions.

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