Preparing Today's Workforce for Tomorrow's Autonomous Transportation: Bridging Electrical and Civil Engineering Disciplines

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Introduction

Autonomous vehicles (AVs) are rapidly transforming the transportation industry and reshaping future workforce demands. Industry forecasts estimate that the AV market could exceed $2 trillion by 2030, creating thousands of new engineering and technology-related jobs. At the same time, automation may disrupt millions of existing transportation and automotive positions, creating significant workforce challenges. As AV technologies continue to advance, industries will increasingly require professionals with interdisciplinary expertise spanning transportation engineering, electrical engineering, computer science, and data analytics. Despite this growing demand, many existing educational programs remain discipline specific, limiting students' ability to understand the broader technological and operational challenges associated with autonomous transportation systems. Transportation engineers may lack exposure to AV hardware and sensing technologies, while electrical engineering students may have limited understanding of traffic operations and transportation infrastructure. Addressing these gaps is essential for preparing a workforce capable of supporting the safe and effective deployment of AV technologies.

Study Methods

This study developed and implemented the Workforce for Autonomous Vehicle Engineering (WAVE) program at California State University, Sacramento. The program was designed to address workforce gaps in autonomous transportation by combining transportation engineering and electrical engineering into a single interdisciplinary learning experience. WAVE focused on preparing students for AV-related careers through a blend of theoretical instruction and hands-on laboratory training. The curriculum was organized into two major components. First, educational modules introduced students to core AV concepts from both engineering disciplines. Transportation engineering topics included traffic control devices, traffic signal timing and phasing, traffic flow theory, roadway geometric design, human factors, and intelligent transportation systems. Electrical engineering modules covered signals and systems, sensor technologies, sensor fusion, artificial intelligence, control systems, and communication systems. The modules were delivered through a customized online Canvas platform that allowed students to complete the material at their own pace. Second, the program incorporated experiential learning through laboratory activities using the QCar autonomous vehicle platform in a Self-Driving Car Studio environment. Students worked with technologies commonly used in AV systems, including camera based perception, LiDAR mapping, depth sensing, lane-following systems, manual vehicle control, and multi-sensor integration. The seven-week certificate program was implemented during Spring 2026 and included 53 participants: 28 civil engineering students and 25 electrical engineering students. During the final two weeks, students completed interdisciplinary laboratory exercises in collaborative teams.

Findings

The WAVE program demonstrated strong outcomes across a three-layered evaluation framework designed to measure technical learning, student perceptions, and industry relevance. Together, the results showed that the interdisciplinary approach successfully improved students' readiness for careers in autonomous transportation systems. The first layer of evaluation focused on student learning outcomes through pre- and post-program surveys. Students completed technical assessments before and after participating in the program and also reported their confidence in their responses. Results showed substantial improvement in both technical knowledge and confidence levels by the end of the program. Importantly, students demonstrated not only stronger understanding of AV-related concepts, but also greater confidence in applying that knowledge. This shift suggests that combining theoretical instruction with hands-on laboratory experiences helped students develop both competence and self-efficacy.

The interdisciplinary WAVE program successfully improved students' technical knowledge, confidence, and readiness to work in the rapidly evolving autonomous vehicle workforce.

The second layer assessed student perceptions through an anonymous program evaluation survey. Feedback was overwhelmingly positive. More than 96% of participants agreed that the QCar laboratory activities were effective learning tools, while 94% reported increased interest in AV technologies after completing the program. In addition, nearly 89% of students stated that the program improved their confidence in working across engineering disciplines. These findings highlight the program's ability to increase engagement, interdisciplinary collaboration, and motivation to pursue AV related careers. The third layer involved feedback from an industry expert panel. Industry professionals strongly supported the interdisciplinary structure of the program and emphasized the importance of integrating classroom instruction with experiential learning. The panel identified the WAVE program as a promising workforce development model for preparing students to address the complex technical and operational challenges associated with autonomous vehicle systems.

Policy/Practice Recommendations

The findings from the WAVE program highlight the need for universities, transportation agencies, and industry partners to adopt more interdisciplinary approaches to AV workforce development. Traditional engineering programs often train students within isolated disciplines, while autonomous transportation systems require professionals who can work across transportation engineering, electrical engineering, artificial intelligence, sensing technologies, and data analytics. Academic institutions should therefore integrate interdisciplinary AV-related content into existing curricula and expand opportunities for collaborative, project-based learning.

The results also demonstrate the importance of experiential learning in preparing students for emerging transportation technologies. Policymakers and educational institutions should invest in laboratory infrastructure, simulation platforms, and industry supported training environments that allow students to engage directly with AV technologies. In addition, future workforce development initiatives should incorporate emerging topics such as connected vehicle systems, cloud computing, and AI-driven transportation applications. Strengthening partnerships between universities and industry can further ensure that educational programs remain aligned with evolving workforce needs and technological advancements.

About the Authors

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