

## **BOARD #140: Funding Challenges for Curriculum Development for Automotive Service Technician Trainings in Electric Vehicle Repair and Maintenance**

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## **Abstract**

Over the last decade, several federal- and state-level initiatives have been passed in the United States encouraging the adoption of electric vehicles (EV). These initiatives generally focus on increasing compatible infrastructure (charging stations), manufacturing, and community and consumer education. However, these efforts do not attend to a longstanding and worsening deficiency in the EV ecosystem—an adequate workforce of trained and skilled automotive technicians to repair and maintain these new fleets of EVs. This paper aims to fill a gap in the existing literature by exploring how the rapid pace of EV and other emerging automotive technologies pose a significant obstacle to established automotive mechanic training programs. First, we lay out the history of repair labor and training as one of persistent shortages and under-resourcing. We then detail the present-day range of career and technical education institutions available to current and incoming mechanics, as well as the funding sources available to those institutions for updating training curricula. We conclude by discussing the obstacles that public education specifically faces in making use of those sources and keeping up with rapidly emerging EV technologies, as well as future challenges that those institutions can anticipate. This paper puts forward a much-needed deep dive into the historical roots of and contemporary difficulties that public career and technical training for automotive repair and maintenance face; we specifically aim to provide a foundation for future ethnographic or sociological work examining the on-the-ground challenges that these programs face in updating their curricula and securing the necessary funding to invest in those updates.

## **Keywords**

Education policy  
Two-year colleges  
Automotive repair  
Electric vehicles

## **Introduction**

In August 2022, the California Air Resource Board (CARB) adopted the provisions of the Advanced Clean Cars II (ACC II) rule, setting forth an ambitious goal for all passenger cars, trucks, and SUVs sold in the state to be zero-emission vehicles by 2035. Continuing its decades-long role as a leader in environmental regulation, California paved the way for the rest of the nation to embrace such standards, with an additional twelve states adopting ACC II to date. Legislative and regulatory enthusiasm for electric vehicles reaches far beyond CARB's rule as the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) allocated over \$7.5

billion to EV infrastructure and another \$43 billion to projects ranging from battery manufacturing to workforce transition for auto workers[1]. However, the goals set out by ACC II will require rapid and robust retraining of workers and restructuring of educational programs for automotive technicians and mechanics to meet the needs of the growing national electric vehicle (EV) fleet, a need not addressed in existing EV legislation.

The vocational training and technical education sector has long complained of being under-funded and under-resourced. A 1971 Texas Education Agency report revealed that 70% of executives of organizations in the automotive service and repair industry felt that programs in their state were not adequately equipped [2]. A 2007 dissertation [3] argued that insufficient funding was impeding vocational programs' and community colleges' abilities to update their curricula to best serve mechanics seeking to learn how to repair the most cutting edge automotive technologies. This underfunding might reasonably be connected to the ongoing, but increasingly acute, shortfalls in automotive repair labor. Today there are an estimated 794,600 automotive service technician and mechanics employed in the United States, with a projected average of 67,800 openings annually over the next decade [4].

Although initially proposed as an interview-based project engaged with educators working in the space of automotive repair training, we discovered that before we could undertake that fieldwork, we had to understand historical legacies and get a clear lay of the land of automotive repair education funding. Thus, this paper seeks to understand the challenges to training an adequate automotive repair workforce to support the ongoing transition from internal combustion engine (ICE) vehicles to EVs. To accomplish this, we first review the current needs for EV automotive technicians. We then explore the historical structures of automotive repair training, tracing its development from an informal network of knowledge sharing into a profession complete with standards and institutions. Following this, we present contemporary funding models for automotive repair training and curriculum development. Finally, we detail the ongoing challenges that EV-oriented automotive repair training programs face, as well as upcoming and anticipated challenges. The results of this project will provide an in-depth resource for educators, policymakers, and industry analysts looking to understand why current EV training programs are struggling and identify where productive interventions might be made. We hope that this work will contribute to the adequate funding of a robust and resilient repair training ecosystem that will support a smooth transition into the EV epoch.

### **Automotive repair technician training over time**

Training for automotive mechanics began as a largely informal practice before eventually becoming standardized and professionalized. Kevin Borg [5], in his seminal book *Auto Mechanics: Technology and Expertise in Twentieth-Century America*, traces this lineage. He describes how, in the early days of the automobile, repairs were often done by ad hoc mechanics

coming from a variety of trades—plumbers, blacksmiths, chauffeurs and others would learn through tinkering and reading; eventually, automakers standardized this training through in-house programs for training dealer mechanics. Formalized learning emerged later, initially through the establishment of for-profit commercial automobile schools, as well as through the US military's investments in motorizing during World War I. Public education did not enter the automotive training field until after the war, supported by industrial employers and organized labor, which sought more financially accessible ways to train the large numbers of mechanics needed by expanding automobility.

These broader educational initiatives, while successful at training many mechanics, did not necessarily result in professional recognition—in fact, automotive mechanics lacked formal professional recognition throughout licensure or other means for most of the twentieth century [5]. Indeed, while other forms of automotive knowledge and prowess gained social prestige in the decades post-World War II (e.g. owning a car, designing them, racing), automotive repair lost status. In an attempt to restore trust between consumers and mechanics, thus elevating the status of the mechanic and hopefully enticing more young men to pursue the profession, regulators pushed automakers to adopt electronic diagnostic systems in the 1970s and 1980s. The effort backfired in some ways, as these electronic systems (eventually standardized as On-Board Diagnostics, or OBD) now required mechanics to demonstrate mechanical, electrical, and electronic mastery across an ever-wider array of systems. By the early 1980's, research on automotive repair costs continued to reiterate the common complaints about the shortage of qualified mechanics and training programs as well as the increasing technological complexity of vehicles [6], [7]. The introduction of computerization to automotive technology maintained, if not exacerbated, the perennial lack of trained mechanics that the industry had been struggling with since the very inception of the automobile [5], [8].

The path to a career as an automotive mechanic today varies by location and employers' preferences. In some areas, local and state laws dictate a necessary set of certifications or credentials that qualify an applicant for mechanic and technician positions. The industry standard credential is an National Institute for Automotive Service Excellence (ASE) certification in any or all nine categories: automatic transmission/transaxle, brakes, light vehicle diesel engines, electrical/electronic systems, engine performance, engine repair, heating and air-conditioning, manual drivetrain and axles, and suspension and steering [4]. After passing at least the electrical/electronic systems and engine performance tests, technicians can sit for the Light Duty Hybrid/Electric Vehicle Specialist Certification Test. Research has demonstrated that ASE certified mechanics have higher average performance ratings on the job [9]. Other studies have moreover shown that, given the primacy that ASE certifications have in signaling expertise and, consequently, improving employment opportunities, that educational programs struggle to update their curricula to keep up with new technologies if ASE certifications don't require those updates first [3]. ASE certifications provide a basis for many states' policies on automotive

repair licensing as well as a desired industry standard in states that do not require minimum levels of education or experience. While ASE provides certification options to equip technicians for work on hybrid and electric vehicles, state certification pathways have not yet developed the educational infrastructure to support a growing EV repair and maintenance workforce. States like Michigan maintain a Repair Facility Manual containing testing requirements for motor vehicle mechanics, none yet calling for EV-specific knowledge or certification. In California, smog check inspectors, smog check repair technicians, and vehicle safety systems technicians must pass state licensing exams, but once again, the standard requirements for a mechanic are ASE certifications at employers' discretion. This variability can pose a challenge for advocates proposing federal funding programs for automotive repair training, as these differing educational standards imply that education priorities – and thus education funding – should be set at the state level.

### **Existing funding models and sources for training programs and curriculum updates for electric vehicle repair**

Writing over 30 years ago, Sutphin [11] describes the challenge that automotive mechanics faced at the time: “Twenty years ago, a car mechanic needed to understand 5,000 pages of service manuals to fix any automobile on the road. The radio was about the only electronic component in cars then. Today's technicians must decipher more than 500,000 pages of text, and that number keeps increasing.” One might imagine how exponentially that number may have increased since 1994, with the advent of autonomous and ADAS features and connected vehicle systems.

Existing research on the scale and extent of workforce training and retraining needs is scant, as most assessments of the EV transition focus on changes to manufacturing or sales. There is a broad consensus in the literature that, because EVs have fewer parts, do not use gasoline or oil, and need brake services less frequently, they are likely to require fewer maintenance and repair services, and thus repair and maintenance revenue for EVs is expected to decrease relative to ICEVs, though studies differ on the magnitude of the loss [12]. However, studies also anticipate that EV collisions, although expected to be rarer due to the increasing prevalence of advanced driver assistance systems (ADAS), may require more extensive or sophisticated repairs; in fact, in 2019, over half of EVs involved in collisions resulted in complete write-off, largely due to structural issues with the batteries [13]. Reolfi et al. [12], in their review of existing literature on the EV transition's impact on vehicle service workers, conclude that supporting and including this sector is crucial to ensuring a successful and just transition, and to this end, more research is needed.

This section provides an overview of existing models for funding automotive repair technician programs. In it, we demonstrate how this industry is maintained through a diverse but

at times unreliable patchwork of funding sources, including tuition-based models, publicly funded programs, and private programs and partnerships.

### *Private partnerships*

Industry has had a notable but unstable hands-on approach to guiding education through partnerships with governments and educational institutions, almost since the very beginning of the automotive industry [5], [7]. While these partnerships can enhance access to the materials and curricula needed to train the workforce, handing over the production of educational resources to automotive companies leaves these programs limited in scope and availability and opens them to vulnerabilities from market fluctuations.

Automotive and aftermarket brands have partnered directly with community and technical colleges with the goal of producing technicians for their dealerships. Such partnerships include the General Motors Automotive Service Educational Program (GM ASEP), Mopar's Career Automotive Program (Mopar CAP), Mercedes-Benz Drive (MB Drive), and Tesla START. These partnership programs provide the benefit of specialized training on a specific set of vehicles with a clear path to employment at a dealership. However, some programs, like MB Drive, are targeted at existing technicians, offering the opportunity to specialize in their careers, while programs like GM ASEP involve dealership shadowing and experience while earning an associate degree. Tesla's START and Pathway to START programs offer both of these options, with the Pathway program guiding students through 8 weeks of shadowing and lectures at partnered community colleges to prepare them for the full START curriculum. A major limitation of these programs is restricted availability by location. These are not broad, open-source curricula, but rather direct partnerships with approved institutions, so each company has a select number of schools where their program is available, sometimes complementing a selection of in-house training programs at dealerships and service centers.

Manufacturers are not the only private actors interested in EV education; car rental agencies need to keep their fleets up to date and serviceable as technologies change. Throughout 2023, Hertz launched a series of "Hertz Electrifies" public-private partnerships with cities across the U.S. to increase charging infrastructure and EV availability and provide training and education materials to high schools, and community and technical colleges. Hertz had previously partnered with Tesla to boost their fleet electrification goals, but by early 2024, the rental company was offloading approximately 20,000 electric vehicles citing high repair costs [14]. Having set lofty fleet-electrification goals to achieve by the year's end, this marked a significant shift in Hertz's commitments. A private company's resources and expertise can certainly aid in education for a workforce transition for EVs, but it is a tall order for these companies to be responsible for building out the entire infrastructure of charging, maintenance and repair, and consumer adoption.

### *Public funding through federal- and state-level grant programs*

One form of possible support that existing research has not yet considered is direct funding for automotive technician training and continuing education programs. That is not to suggest that such funding does not exist. One source of funds for curriculum development and training is National Science Foundation's (NSF) Advanced Technological Education (ATE) program. NSF ATE supports a handful of projects building curricula or providing opportunities for EV maintenance and repair technician education in community colleges and technical schools. Notable projects include:

1. **Collaborative Research: Revolutionizing Electric Vehicle Education [15], [16], [17], [18]**
  - a. Four South Carolina institutions—Trident Technical College, Greenville Technical College, Clemson University, and Spartanburg Community College—have received ATE grants to create a consortium focused on preparing the workforce for the Electric Vehicle (EV) industry using innovative VR and AR educational methods. Collaborating with major industry partners like Volvo, BMW, and Bosch, the project aims to identify educational needs, develop cross-disciplinary curricula, and share best practices for maximum impact. The initiative also emphasizes promoting the new curriculum through professional development to ensure sustainability and effectiveness across institutions.
2. **National Electric Vehicle Consortium [19]**
  - a. This grant, awarded to Indian River State College, establishes a National Electric Vehicle Consortium (NEVC) of 15 community colleges, 19 industry partners, two research universities, and ATE Centers and projects. The project goals include facilitating a national network of training needs and providers, building connections among industry, regulators, and educational institutions, and aligning academic programs with industry sector needs.

The Bipartisan Infrastructure Law (BIL, formally the Infrastructure Investment and Jobs Act) and Inflation Reduction Act (IRA) created an abundance of programs, credits, and other systems to encourage EV access and use, but still greatly lacked emphasis on developing a workforce for maintenance and repair. The Environmental and Energy Study Institute reports that the BIL provides more than \$7.5 billion in funds to support the buildout of EV infrastructure, in addition to more than \$43 billion of flexible spending that could be dedicated to battery manufacturing, grid updates, updating existing automotive facilities, and retraining and rehiring existing workers in the automotive sector [1]. While it may sound like these funds could

be used to develop and transition the maintenance and repair workforce from ICEs to EVs, these funds have been primarily allocated to manufacturing facilities.

In August of 2023, the Department of Energy announced a \$15.5 billion package “primarily focused on retooling existing factories for the transition to electric vehicles (EVs)—supporting good jobs and a just transition to EVs” [20]. While it is necessary to protect jobs in communities that rely heavily on the automotive manufacturing industry, it is just as critical that there is a plan for a maintenance and repair labor force that will sustain the products of those factories. This package may be a good starting point for mapping out investment in maintenance and repair workforce protection and education, as many educational programs could benefit from retooling assistance, and the stipulations tied to the Domestic Manufacturing Conversion Grants, which prioritizes “projects that are likely to retain collective bargaining agreements and/or those that have an existing high-quality, high-wage hourly production workforce,” would be beneficial in protecting maintenance and repair jobs as well.

### *Tuition-based funding*

Public funding sources are generally oriented toward providing one-off funds for research projects or seed funds for developing new, eventually self-sustaining, programs. Once the seed funding has been spent, these new repair and maintenance curricula must sustain themselves through tuition payments.

Tuition rates can be a tool for maintaining and updating public community college programs, though institutions must strike a balance between generating revenue for the advancement and development of their programs and remaining an affordable option for students. Federal grants can play an important role in achieving this balance by supporting the development of new curricula and acquisition of materials while allowing tuition to remain affordable. In 2009, Macomb Community College, a long-time major actor in automotive technician education, was able to maintain credit-hours rates through a combination of National Science Foundation grants and worker retraining programs. At the time, the Obama administration was looking to community colleges to contribute to economic recovery efforts following the 2008 recession [21]. Macomb’s efforts to stay ahead of industry trends exemplified how robust support from tuition and public funding allows community colleges to drive workforce development and adapt to industry advancements for new students.

### **Ongoing challenges**

Many of the perennial challenges that automotive repair programs have faced over time have not changed, and many have in fact worsened. While researchers have for decades identified the high cost of equipment and training facilities as a hindrance for mechanic training



programs (e.g.[6]), the rapid and ongoing introduction of new computerized, connected, and autonomous forms of automotive technology are exacerbating this. In a report produced by the Texas Connected and Autonomous Vehicles Task Force, the ASA-Texas urged policymakers to mandate manufacturer-led training. Their concerns are that if repair technicians themselves are left responsible for funding their own training and equipment purchases, which are expensive, then it will be harder to recruit and retain qualified technicians [22]. Moreover, the proprietary nature of many of those intelligent and connected systems makes it costly, if not altogether impossible, for public education programs to access them. Consequently, public career and technical education institutions are struggling to compete with training programs offered by manufacturers and dealers.

Perhaps the greatest challenges the electric vehicle manufacturing (and, frankly, all automotive manufacturing) and automotive technician training (and, frankly, all training and education) sectors face are the ongoing destabilizing actions of the second Trump administration. The EV market itself is facing an unpredictable future. Within his first ten days in office, Trump issued an executive order rescinding an existing Biden executive order setting a target of seeing 50% of new vehicles sold in the US be battery-powered; by early March, the Environmental Protection Agency had announced that it was indeed beginning efforts to reverse Biden-era emissions rules that pushed for greater EV production and adoption [23], [24]. Two weeks later, he paused the National Electric Vehicle Infrastructure program, which had been established by the Biden-era bipartisan Infrastructure Investment and Jobs Act in 2021 to build a nationwide network of EV charging stations; about \$3 billion remain in limbo at the time this paper was submitted [25].

Vocational training, community colleges, and technical education programs are having a more ambivalent experience. On the one hand, the Trump administration has proposed enormous investments in career and technical education, nearly doubling the amount the federal government would provide to states to fund these programs [26]. On the other hand, the Trump administration has also moved to dismantle the Department of Education, a move which career and technical education (CTE) experts say will “hinder the distribution of Perkins grants, disrupt data collection on CTE participation and outcomes, reduce essential guidance, and jeopardize access for vulnerable learners” [27].

## **Concluding thoughts**

The challenge of developing and maintaining up-to-date, rigorous, and reliable automotive technician training programs has been an enduring one, having emerged almost at the same moment that the automobile itself did. With variable paths to this career and an ever-changing industry landscape for already trained technicians, institutions concerned with education and certification bear a responsibility to bring licensing and certification requirements

up to date with the industry's newest technologies. For nearly a century, the state has seen itself as a crucial actor in this system, rather than leaving all education and training to private institutions. The federal government has stepped in as a major source of support, both systematically and financially, of repair education, understanding it to be a crucial component of America's transportation backbone. In spite of this, somehow these efforts have perennially fallen short.

Given that the federal government has played such a substantial role in incentivizing EV adoption and supporting infrastructure development, it only stands to reason that the development of a workforce capable of maintaining these vehicles is an equally important obligation. Private actors have a role to play here too, of course; scholars have agreed that automotive manufacturers and dealers have a responsibility for providing continuing education opportunities considering their direct access to the specifications and protocols of new technologies [9]. However, leaving it to private industry to fund and promote these education initiatives on their own risks not only leaving the field under-resourced, but also privatizing and centralizing vocational education and workforce development, programs are crucial for furthering the public interest in reliable, sustainable, and safe transportation systems.

This paper is a step towards a more historically informed and comprehensive understanding of the obstacles automotive technician training programs in public education have and continue to face. The authors of this paper are preparing to expand these findings by conducting interviews of current automotive repair education programs to understand how they continuously update their curricula to integrate emerging EV technologies, what funding they use to do so, and how the federal and state governments can improve their provisioning of funds to help public education keep pace with the EV requirements those governments set. Future research could also consider how efforts to fund public EV repair training initiatives struggle to find footing in the legislature, particularly with regards to pushback from private actors like manufacturers and for-profit programs. Other work might also consider whether the status or prestige of automotive repair is changing as cars become more technologically sophisticated – are repair technicians held in higher regard now that they have aptitude in both software and mechanical engineering, and if so, how is this affecting the recruitment of young people into this career path?

In this moment where the US government – and, indeed, national governments worldwide – are investing heavily in a wholesale paradigm shift away from internal combustion engines and towards electric vehicles, this support is more important than ever. Without robust federal support, public automotive training programs will languish, unable to compete with private, usually manufacturer-related, institutions that have privileged access to electrified automotive technologies and their repair requirements. Other scholars have already demonstrated how this centralization of power over electric vehicles is already resulting in the decline of the

independent automotive repair industry [28] and DIY automotive practices [29]. This paper extends that literature by establishing the needs of the automotive repair training sector and urging for greater investment in updating and maintaining curricula for the EV future of the US.

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