Driverless – but not humanless – vehicle systems

Research examines labor shift as autonomous vehicles become more viable

By Leah Kaplan, Zoe Szajnfarber and John Paul Helveston

Researchers and ride-hailing companies regularly claim that eliminating drivers via automated vehicles (AVs) will "zero out" labor costs for robotaxi services. These claims worry government officials who fear large-scale job losses and associated social upheaval from AVs.

For example, a 2021 report from the US-EU Trade and Technology Council calls for assessments of the future of transportation work in light of automation and its implications for skill requirements and workers' rights. But studies have shown that introducing automation often results in a *transformation* of human labor rather than a complete elimination of it.

This article highlights preliminary research insights on how vehicle automation is transforming the nature of labor in taxi services. Through field observations, archival research and semi-structured interviews with AV technical and operational experts, we investigate the transformational dynamics unfolding in cities across the U.S. Through this work, we can better inform the design of AV systems by considering the many other roles drivers fulfill beyond operating the vehicle, such as assisting passengers with disabilities, serving as a social monitor during shared rides, and performing basic cleaning. Moreover, by learning what new labor roles vehicle automation may create, companies and policymakers can better prepare for emerging workforce development needs.

Figure 1

Changing jobs

Three front-line labor roles in robotaxi services.

Role	Fleet management agent	Field response agent	Tele-assistant
Primary function(s)	Basic cleaning, refueling, prepping of vehicles	Incident response	Customer service, remote monitoring
Status	Typically contingent workers	Contingent or full-time employees	Contingent or full-time employees
Training requirements	Low	Medium/high	Medium/high
Specialized skills	Some familiarity with AV tech	Knowledge of AV tech & AV operation	Situational awareness

Uncovering new labor roles in emerging AV services

The California Public Utilities Commission recently approved 24/7 operations of robotaxi services in San Francisco. Robotaxi services are also available in Phoenix, Los Angeles and Austin, Texas, though in a more time- and geographically limited fashion. These services operate at what is commonly referred to as "Level 4" automation, meaning the vehicle operates with no safety driver.

To understand the differences between automated and nonautomated "taxi-type" systems, we directly observed and took multiple rides in a robotaxi service and drew on two in-depth ethnographic studies conducted by researchers Veena Dubal and Lindsey Cameron to provide context of status quo taxi and ride-hailing services. Dubal's research involved interviewing taxi workers and Uber drivers in San Francisco while Cameron conducted participant observations as both a ride-hailing driver and as a rider. From both ethnographies, we learned of the many ways in which drivers currently support passengers and taxi operations.

We then expanded on the robotaxi observations via interviews with AV technical and operational experts who are involved in AV regulation, operation of government-run pilot projects or commercial operations, and AV research.

Through analysis of the observations, interviews and ethnographies, we developed a list of detailed tasks involved in "taxi-type" services and the identification of who (or what) performs that function in each type of system. We intentionally focused our analysis on functions directly involved in interacting with a rider – what we might consider "front-line" labor roles. Through our analysis we found that these different functions have changed over the evolution of the taxi industry, and that new front-line roles have emerged with AV services. The table in Figure 1 highlights three of these AV front-line roles.

Keeping the vehicles moving

Two types of functions help ensure that vehicles in a taxi fleet can operate properly: vehicle general service and vehicle maintenance. Vehicle general service includes vehicle refueling, basic cleaning and, for AVs, additional tasks like software startup procedures and regular data downloads from the vehicles. While drivers typically perform these tasks in current taxi and ride-hailing systems, AV companies have had to shift these responsibilities to a distinct role, which we define as a fleet management agent. These agents have limited additional training requirements beyond gaining basic familiarity with AV technologies and are often contingent workers.

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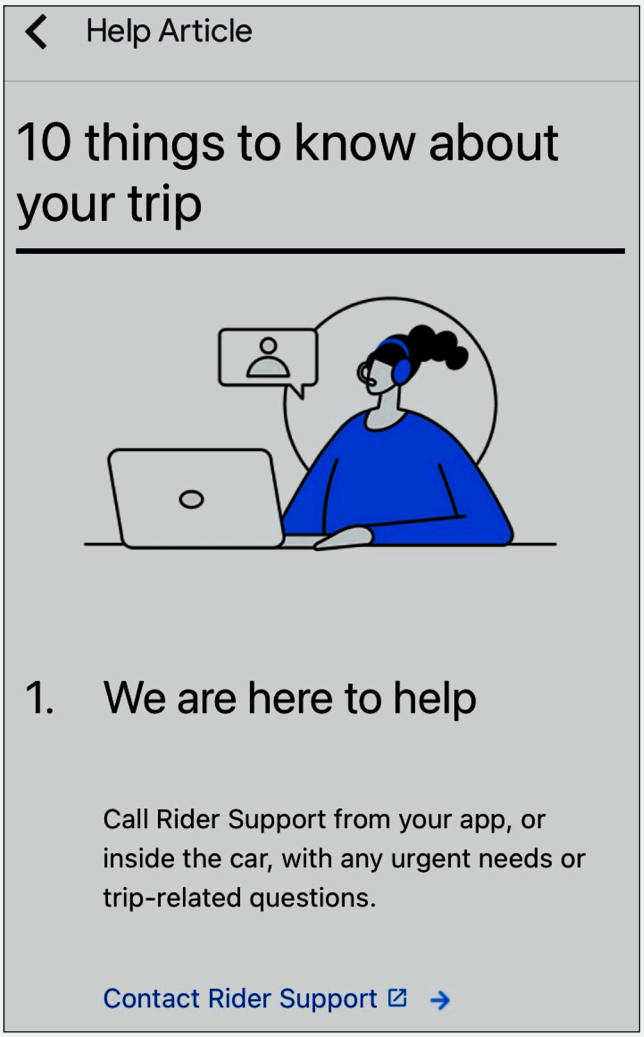
A 2018 *TechCrunch* article highlighted how AV company Waymo partnered with fleet management companies AutoNation and Avis Budget Group to contract out this work. Some companies are even looking to automate these general service functions in the future. Though automating these routine service functions may be possible, companies will need to weigh the added costs of layering in additional automation technologies against paying a human worker to perform these tasks.

Less easily automated are more technical vehicle maintenance tasks that are traditionally performed by a mechanic. Vehicle mechanics will remain an integral labor role in an AV future. Thus, some AV companies are proactively partnering with local community colleges to create AV-oriented mechanic training programs. As

Figure 2

Help on the app

A help article embedded within one AV robotaxi app describes how passengers can connect with a tele-assistant.



their fleets grow in size, AV companies may also need to upskill existing traditional mechanics in order to foster an AV-ready mechanic workforce.

When things go wrong

AV companies recognize that the safety requirements of their systems extend beyond their hardware and software and into the operational domain. This additional operational safety layer has required the development of two new roles, which we define as a field response agent (FRA) and a tele-assistant (names and exact job functions vary by company). Field response agents, some of them former safety drivers who helped train and test the AV systems, are responsible for providing in-person incident response. These incidents range from small problems like a flat tire to more significant issues like half a dozen vehicles clustering together, stalling out and blocking San Francisco traffic for hours.

To be able to interact with and respond to problems with the AVs, FRAs receive fairly extensive training that can range in length from two to four weeks. This training typically involves a mix of learning about the AV technologies, hands-on practice operating an AV in both closed-course and on-road settings and shadowing more senior FRAs. Given these specialized skills, FSAs can be more highly compensated, with pay ranges from $17 to over $30 per hour.

Our research suggests that although vehicle automation may eliminate drivers, AV firms will still require human labor for numerous other roles, many of which are likely to persist in some capacity even as AV technology improves.

While signaling the development of a new type of midskill job, the role of FRAs will likely continue to evolve alongside AV technology. Technology improvements may decrease the frequency of incidents and may also impact how the agents are able to respond to incidents. If future AV designs remove steering wheels altogether, companies will need to develop alternative strategies and response plans for how FRAs can move AVs after an incident and assist riders. Given the safety-critical nature of the FRA role, companies will also need to determine efficient vehicle to FRA ratios that balance labor costs and fast response times.

Providing help from afar

Some forms of assistance can be accessed from afar. In some of the current AV designs, passengers can connect with a human tele-assistant by pressing a help button located inside the vehicle (Figure 2). This button connects the rider to a human in a remote location who then is able to monitor and interact with the vehicle in a limited capacity. Currently, tele-assistants often provide a customer service function, including answering rider questions about the AV technology. As riders become more familiar with AV systems, some of those customer service functions could be transferred to a question section in the app interface, as is generally available in existing ride-hailing apps.

A second, more critical function of the tele-assistant role is the remote monitoring function which involves real-time monitoring of the vehicle, issuing safety

Photo by Leah Kaplan

Members of the public can hail an automated vehicle with no human operator onboard in limited service areas, as with this Waymo vehicle operating in Phoenix, Arizona.

reminders, and providing remote assistance as needed. One interviewee described an experience during which a tele-assistant virtually "came onboard" to issue a safety reminder:

"I was riding in an (AV company's vehicle) a couple of months back ... and one of the ladies ... failed to put on her seat belt. One of the (tele-assistants) kind of came onboard, and gently reminded her that she needed to be belted in before the ride would resume."

Drivers are technically responsible for issuing these types of safety reminders to riders in taxi and ride-hailing systems. Some ride-hailing companies have recently started to introduce elements of tele-assistance into their systems to increase rider safety. Lyft's website, for instance, describes how the company uses riders' phone GPS locations to monitor for route deviations (in certain countries). Lyft has also partnered with established security firms to provide human support via phone or chat if riders encounter any safety problems. Such partnerships demonstrate how AV companies may be able to outsource some elements of the tele-assistant role to professional security firms in the future.

What may prove more difficult to outsource, for both technical and regulatory reasons, is the remote assistance element of the tele-assistant role. One interviewee explained the remote assistance function performed by tele-assistants:

"Remote assistance is when the car gets into a situation where it's, say, maybe less familiar, or wants to double-check something, a human behind a terminal can take a look at what the car is seeing and sort of answer some questions for it to let it continue to operate. ... (The) expectation is to have these calls answered within a couple seconds. So basically, instantly, the scene comes up on the terminal in front of the (tele-assistant). ... They have access to all the cameras that are functioning in the car plus an overlay of LIDAR [Light Detection and Ranging] data. They have really strong situational awareness, and they'll help confirm the scene for the car, basically. And then the car is still driving itself, it continues on through the situation."

This remote assistance function requires an additional specialized skill of maintaining situational awareness. Tele-assistants receive specialized training on interfaces used to interact with AVs in order to effectively monitor the AV fleets and assist vehicles, as needed. Given the complexities of roadway driving and the inevitability of edge-case scenarios, the remote assistance element of the tele-assistant role is unlikely to ever be fully eliminated, though the vehicle to tele-assistant ratio may increase as AV technology improves, decreasing the labor requirements and associated labor costs.

The road ahead for AVs and labor

Our research suggests that although vehicle automation may eliminate drivers, AV firms will still require human labor for numerous other roles, many of which are likely to persist in some capacity even as the technology improves. While we do not attempt to make predictions about the number of jobs eliminated or created due to AVs, we recognize that the scale of job losses or gains has critical implications for local and national economies as well as the individual experiences of workers.

Dubai to deploy robotaxi fleet; more US cities set plans

One growing international city is ready to take the next step toward autonomous vehicle use.

Dubai planned to roll out a fleet of robotaxis this fall on a 5-mile stretch of road in its upscale Jumeirah district, *CNN.com* reported Sept. 27. The United Arab Emirates city hopes to become the first in the Middle East to deploy the technology, according to Ahmed Bahrozyan, the CEO of Dubai's Roads and Transport Authority.

The city authority and General Motors' subsidiary Cruise have entered a 15-year contract to provide the autonomous electric vehicles. Cruise already operates commercial robotaxis in San Francisco and other U.S. cities.

"We are doing our own set of tests and trials in Dubai ... every city has its own characteristics," Bahrozyan told CNN. "We have weather conditions that are certainly different than the U.S."

The Dubai authority plans to use 4,000 self-driving taxis by 2030 joining its current fleet of 12,000 traditional driver-piloted taxis.

Meanwhile in the United States, the number of cities looking to test robotaxis also is growing. As of October, only three major cities used the technology (San Francisco, Phoenix and Austin, Texas) but more plan to climb on board.

Axios reported General Motors' Cruise has announced test services in 14 cities, including Atlanta, Seattle, San Diego, Miami, Nashville, Tennessee, Raleigh and Charlotte, North Carolina, and Washington, D.C. Two Texas cities, Dallas and Houston, are close to launching the service.

"Since each new city requires less work than the last, we've been able to ramp up the rate at which we launch in new cities," Cruise CEO Kyle Vogt stated on social media. "Each time we add a new city, the performance in our current cities keeps getting better."

While the U.S. Congress has not passed legislation governing the use of autonomous vehicles, the Autonomous Vehicle Industry Association says 23 states have done so to allow AV testing and/or deployment.

In future expansions on this work, we aim to hone in on this individual experience, delineating what types of individuals currently fill AV industry jobs, including their backgrounds and qualifications. Taxi and ride-hailing driver roles are often filled by people for whom full-time wage work is unavailable, raising questions as to whether those individuals could realistically pivot into roles in the AV industry.

We also find some evidence of new middle-skill workforce opportunities. Moreover, some of these roles

have specialized training requirements that should be considered as part of future workforce development plans.

Finally, a critical element for understanding labor impacts is considering the potential firm structures for AV companies, which could significantly impact employee classifications and worker experiences. In her paper, "The drive to precarity: a political history of work, regulation, & labor advocacy in San Francisco's taxi & Uber economies," Dubal describes how taxi firms evolved from organizations that owned their vehicle fleets and formally employed drivers to those that leased vehicles to drivers who functioned as independent contractors.

AV companies are currently exploring a variety of business models and firm structures, with some planning to maintain their own vehicle fleets and others aiming to lease their vehicles to fleet operators or ride-hailing companies. We may also see business models in which AV suppliers, ride-hailing platforms and human independent contractor drivers all interact in a transportation market. These evolving business models could impact how workers are classified (i.e., as employees or independent contractors) and what company ultimately employs them. We continue to explore these potential dynamics in our ongoing work. ❖

Note: For a full list of references used by the authors for this article, see the *ISE* reference page, *iise.org/isemagazine/references*.

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