## Transport Workers Union of America

# New Technologies in Transit Systems

*As companies continue to introduce new technologies onto our roads and into our cities, we must ensure that our communities are the ultimate beneficiaries of innovation*

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# Executive Summary

The Transport Workers Union of America (TWU) and our members have always been at the forefront of transportation innovation. We believe that new technologies must be measured against the following core set of principles:

1. Maintain high quality jobs
2. Achieve the highest levels of safety and security
3. Ensure that our transportation systems are reliable

Some 21st -century transportation technologies present major threats to the number and quality of jobs in our economy. At the same time, many of these same technologies hold the potential to create major gains for workers in safety, job security, and pay & benefits if they are properly overseen and implemented. These technologies include autonomous vehicles, fully electric buses, drones, and many discrete safety components like automatic braking.

Rather than ignore these changes or accept the worst possible outcome, leaders must prepare for new technologies before they create widespread economic pain. We have the power to control how technology will affect us and what role we want it to play in our future.

We must act now to influence how new technologies will be developed and deployed in the transportation sector. Policymakers should take the following steps to ensure the next generation of our economy is pro-worker, as well as pro- innovation.

- **Transparent Planning & Reporting**: Require employers to develop a timeline for reporting, budgeting, worker impact analysis, and investment in re-skilling of workers prior to implementing new technology that will significantly impact jobs and/or job functions.

- **Public Safety & Security:** Require fail-safe systems for new technologies which detect malfunctions and allow for human intervention when the technology fails. Advance rigid and fully enforceable safety standards. Reject exemption applications for new technologies which fail to meet existing safety, labor, and environment standards.

- **Workforce Involvement**: Require formal advance notices (similar to WARN notices) be sent to the workforce prior to introducing and implementing a new product or service that will significantly impact jobs and/or job functions. Require employers to create a comprehensive plan to transition or train employees to ensure new jobs created by technology benefit existing workers. Mandate collective bargaining over the terms of implementing new technology. Ensure that representatives from workers are included all technology-related working groups and committees established by our government; require these groups to address job issues as part of their work.

- **Privacy & Cybersecurity:** Establish clear, uniform, and enforceable safety, security and privacy standards. Require that new technology be subjected to cybersecurity requirements to prevent hacking and to ensure mitigation and remediation of cybersecurity events. Require robust privacy and data collection safeguards for new technology.

# Introduction


As transit agencies introduce new transportation automation technologies and services, it is crucial that we develop policies that mitigate their impacts on transit workers, passengers and other members of the public. ***Photo courtesy of Ineslacarne, CC BY-SA 3.0/WikiCommons***

The transportation sector is facing epic transformation as a result of emerging new technologies that automate transportation vehicles and functions. Many new automation technologies have been and continue to be implemented in the public transit arena – impacting bus and rail-based transit services, the workers who provide these services, the passengers who use them, and the public at large. These innovations also have public safety and security implications requiring intentional policies and vigorous oversight.

The timeframe for the widespread deployment of fully autonomous vehicles – whether personal or in transit service – is a hotly debated topic. However, there is no dispute thatdriverless vehicles are coming. It is not a question of if, but when. Companies and their investors, with access to public R&D resources, are pouring billions of dollars into the development of technology that they say will make transportation "safer" and "more efficient." According to Pitchbook, in 2018, venture capital financing in the autonomous vehicle industry was $10.3 billion globally.[i] And, the Brookings Institution reported that, between mid-2014 and mid-2017, more than $80 billion was invested in autonomous vehicle technology, partnerships and acquisitions.[ii]

States, cities, and transit agencies are jumping on the bandwagon, vying for opportunities to serve as public testing grounds for driverless shuttles and buses. Universities are also tapping into significant public dollars to develop and advance AV technology, with many serving as engineering and policy hubs.

As new technologies are introduced, they will change – and potentially eliminate – jobs in the transit industry. Some workers' jobs will be deskilled; some will need to develop new skills, or re- skill, to adapt to changes in their job responsibilities; others will be displaced from jobs that are fully automated and will require additional training to prepare for different jobs that may be created within their agencies, or in completely different industries. Options for some transit employees may be limited to early retirement if they are unable to find other opportunities in the labor market.

Up to 800 million jobs around the world are at risk according to a 2017 report by McKinsey.[iii] While the authoritative research on the precise job impacts specifically from automation varies, there is little disagreement that new technology in the transportation industry and transit systems will create major structural changes in the way we work, commute, and interact. Policy, business, and government leaders have not prepared for the scale of the coming transition.

New transit automation technology also has implications for public safety. The impetus for "driverless" technology is the anticipated improvement in traffic safety and decrease in injuries to and deaths of drivers, passengers and pedestrians. Ironically, autonomous vehicle technology is far from fail-safe and there are risks to both passengers and others who share the road with driverless vehicles. In California, 67 collisions involving autonomous vehicles were reported in 2018, compared to 29 in 2017.[iv] On average, the rate of AVs involved in crashes increased from 8.9% in 2017 to 10.2% in 2018, as the number of permitted AVs increased from 326 to 658.

The lure of transportation automation technology also poses risks related to the prudent use of public funds. At least some municipalities appear to be attracted to transportation automation technology simply due to the appeal of the "shiny new object." Purchasing decisions may be based on the desire to be "on the cutting edge," rather than on how they fit into a long-term strategic transportation plan focused on solving mobility challenges. In such cases, public funds may be wasted on technology that either does little to enhance transit services or drains resources that could have been deployed elsewhere to improve and expand service. Worse yet, technology that is implemented without preparation of the workforce may mean it cannot be operated or maintained properly and, therefore, not useable.

As transit agencies introduce new transportation automation technologies and services, it is crucial that we develop policies that mitigate their impacts on transit workers, passengers, and other members of the public, and that ensure the greatest value is obtained from these investments of public dollars.

# Autonomous Vehicles


*Waymo sees a future of personal cars without a safety driver. This, however, will be difficult to pull in buses.*

Autonomous shuttles are being piloted in dozens, if not hundreds, of locations around the globe, including many in the U.S. These vehicles, which typically carry 15 or fewer passengers and travel at slower speeds (about 15 mph), have proliferated on testing grounds, such as college and hospital campuses, business parks and industrial properties, airports, and sports/entertainment complexes. In addition, these shuttles have been piloted in rural and residential communities, as downtown circulators, and as first mile/last mile transit connection services.

While virtually all deployments of these vehicles have taken place with a "safety driver" on board, eventually AV technology is intended to replace the human operator altogether. The EZ10 shuttle manufactured by the French company EasyMile, for example, has no steering wheel and no driver's seat.[v,vi] Many other manufacturers are also deep into engineering vehicles without steering wheels.

In addition to shuttle vehicles, full-sized, autonomous buses currently are being tested. British bus company Stagecoach, bus manufacturer Alexander Dennis Limited, and Fusion Processing Ltd., are collaborating on the development and testing of an autonomous transit bus. The vehicle tested at the Sharston bus depot in Manchester, England reportedly operated autonomously within the depot, moving on its own to the bus washing and parking areas.[vii] This bus's technology incorporates radar, LiDAR (Light Detection and Ranging),[viii] optical cameras, ultrasound, and satellite navigation.

Reportedly, the technology used to pilot the vehicle will form the basis for an $8 million (£6.1 million) autonomous bus pilot called CAVForth that will entail the use of five full-sized buses transporting passengers across the Forth Road Bridge Corridor between Edinburgh and Fife, Scotland. These buses are expected to carry up to 10,000 passengers per week at speeds of up to 50 mph. The pilot is expected to begin in 2021. The vehicles reportedly will operate autonomously at Level 4,[ix] which requires a safety operator on board to take over if necessary.[x,xi] This is just one of several ongoing projects around the world for completely autonomous full-sized buses.

In the Netherlands, Mercedes-Benz has tested a full-sized transit bus, with a maximum speed of 45 mph, along 12 miles of Europe's longest bus rapid transit (BRT) route. Daimler reportedly considers BRT lines to be "predestined for autonomous driving" and is investing over $220 million in the development of the company's city-bus portfolio.[xii] An autonomous BRT pilot also was conducted by San Jose, CA-based LILEE Systems in Taiwan.[xiii] At a recent industry conference, the company reported that it expected to receive the first commercial license to operate a driverless bus in revenue service.[xiv]

In what may be the most ambitious full-sized autonomous bus trial, Volvo Buses is working with Singapore's Land Transport Authority and Nanyang Technological University to test full-sized electric autonomous transit buses. The Volvo 7900 electric bus is equipped with sensors and navigation systems all managed by artificial intelligence (AI).[xv] The project partners reportedly plan to pilot the buses in fixed-route service on public roads by 2022.[xvi]

Autonomous transit buses are also planned for the U.S. In 2019, infrastructure and engineering giant AECOM announced the formation of the Automated Bus Consortium. The Consortium, which consists of more than a dozen transit and transportation agencies throughout the country, is seeking to accelerate the advancement and transfer of proven automated transit technologies to transit buses and to create a market for vendors to produce automated buses, by combining the partners' purchasing power to procure 75 to 100 automated vehicles. The Consortium plans to test the buses in a variety of line service environments, including fixed-route, BRT, and maintenance depots.[xvii]

***Impact on Employment***

As autonomous vehicles are introduced to transit agency fleets, there will be a significant impact on transit workers, most notably on operators and mechanics. Some jobs will change, requiring fewer skills or demanding new ones. Some jobs will disappear, while new jobs will be created.

How significant these impacts are – and whether they are positive or negative – will depend on choices made by transportation decision-makers and what policies are in place to protect and assist workers through the transition.

There are close to 700,000 bus operators in the U.S.xviii For generations, driving a bus has been a solid blue-collar occupation providing middle-class wages and benefits to workers, over 90% of whom typically lack a college degree.[xix]

Driving a bus requires significant skill. Operators must maneuver these large vehicles – frequently filled with passengers engaging in distracting behaviors – along busy, congested, narrow urban streets. They contend with unpredictable drivers, cyclists, and pedestrians, navigating their routes safely, while also keeping to a schedule. The challenges associated with the safe and efficient operation of a transit bus necessitate training, which is the reason operators are required to have a commercial driver's license (CDL). The introduction of AV technology could lead to significant de-skilling – or, worse, displacement – of the existing operator workforce depending upon the public policy response.

***Changing Nature of Work***

In addition to safely navigating buses along our streets, bus operators are responsible for the safety of the public -- both inside and outside their vehicles. While vehicles and equipment will continue to evolve as new technologies become available, the safety and security needs of transit passengers and others who share our roadways will not change.

Maintaining a certified operator on board to ensure that these needs continue to be met is essential to the well-being of our transit systems, their riders, and to the public at large. This may represent a shift in the nature of work, from primarily driving to primarily overseeing customer safety and security, but this change will not eliminate the existing needs of passengers on board.

Autonomous buses, like all buses, will face break downs and other problems. Failures in automation would effectively turn these vehicles into manual buses – the kind operators currently move safely across tens of thousands of miles each day. It has long been our position that as long as there are operational controls in the bus, a CDL holder should always be on board, responsible for the vehicle and passengers, ready to take control when needed.

Likewise, if a bus lacks operational controls (either on board or remote), the focus of the responsible bus operator will change from bus operations to passenger services. However, a trained worker on board is still necessary to ensure the wellbeing of passengers. It would be irresponsible for a transit agency to leave the care and safety of passengers to the passengers themselves, regardless of whether or not there are operational controls on board.

The re-skilling of the operator role will almost certainly result in agencies seeking to lower compensation for these workers, leading to the downgrading of what are currently solid middle- class jobs with wages as high as $35 per hour. The transition between manually operated and fully autonomous vehicles is likely to put downward pressure on these wages. This pressure must be resisted as it would disregard the fact that the main focus of bus operators' duties, serving as the frontline safety professional responsible for passenger and public safety, will not be altered by this kind of automation.


*Bus mechanics from TWU Local 260*

Transit vehicle mechanics will also be impacted by the implementation of new technologies. However, because autonomous buses will continue to require maintenance, repair, and upkeep, the number of mechanic jobs eliminated is likely be much lower than the number of operator jobs. And while some of their responsibilities will remain the same – for example, replacing worn tires and brake pads – mechanics will need to learn new skills so that they are equipped to maintain the array of sensors and other devices comprising the new autonomous vehicle systems. This will require a significant investment in workforce development, upskilling, well beyond the level of spending today.

Likewise, mechanics may also be assisted in their jobs by the technology itself. For example, there are products that run diagnostics and identify current or impending maintenance issues on a bus and transmit these telematics in real time to the maintenance department so that fixes are scheduled automatically. The automatic identification and transmission of telematics can catch maintenance issues before they become expensive repair issues.xx It also can save the maintenance department time spent diagnosing problems and scheduling repair work, which could decrease the number of workers required by the transit agency.

***Job-Loss Potential***

In addition to de-skilling, job loss is also a serious concern related to transportation automation. A 2016 White House report estimated that 60 to 100% (between 101,000 and 169,000) of transit and intercity bus operator jobs would be threatened by the development of autonomous vehicles.[xxi] According to another analysis, four million workers in driving occupations are at risk of unemployment if there is a relatively rapid transition to autonomous vehicle technology;[xxii] almost 15% are bus drivers.[xxiii]

People of color will be disproportionately impacted by technology-based displacement, as they are overrepresented in the driving occupations. For example, African Americans, who comprise 12.3% of the total employed population in the U.S., represent over 29% of bus operators.[xxiv] Because black workers in driving occupations earn annual median wages that are almost $2,500 higher than those in non-driving occupations, they will lose not only a greater-than-average share of jobs, but also relatively high-paying jobs. Hispanic workers in driving jobs, who earn almost $6,000 more than those in non- driving jobs, also will be more negatively affected if, and when, they are displaced by technology.[xxv]

Some transit agency mechanics could also face displacement if their employer opts to contract out maintenance to the AV technology provider. Some transit agencies may even see outsourcing as a short cut to savings. For example, in its automated driving system demonstration grant proposal to the Department of Transportation, Denver's Regional Transportation District (RTD) noted that some vehicle maintenance tasks might be performed by shuttle provider EasyMile's technicians rather than by the agency's in-house counterparts.[xxvi]

Similarly, the autonomous shuttle pilot operated by Harris County Metro in Houston called for the service provider to conduct both vehicle operations and maintenance. The transit agency employs mechanics and could have elected to train its personnel, rather than outsource the work to the shuttle contractor.[xxvii] This kind of short-term thinking likely will lead to the hemorrhaging of valuable, experienced workers who are essential to the long-term success of the transit agency. As has been the case throughout the history of public transit, a successful, rider-focused system requires investment in the people who operate and maintain it, not strictly for the company providing said technology.

***Risk to Passengers***

In addition to its impact on employment, transportation automation also has significant implications for public safety. Passengers on autonomous buses, occupants of other vehicles on shared roadways, cyclists, pedestrians, and others all face increased risks with the proliferation of automation technology.

As noted above, bus drivers do far more than safely operate their vehicles. As the identified authorities on their buses, operators serve in the role of "auxiliary police officers," watching out for, stopping, and/or reporting passengers who are unruly or engaging in harassing or criminal behavior.[xxviii] Operators act as emergency responders, helping sick or injured passengers and calling 911 to summon medical assistance.[xxix,xxx] They provide child protective services, overseeing the safe passage of young students to and from school, and spotting lost children along their routes.[xxxi,xxxii] They watch out for vulnerable seniors, finding individuals with dementia and ensuring they are returned to their homes and families.[xxxiii]

Bus operators are the "eyes and ears" of their communities, using their skills, street smarts, and common sense to serve the public in a manner that far exceeds their job description. For example, many bus operators in New York City went off route during the September 11, 2001 terrorist attacks, transporting those fleeing ground zero to safety.

Bus operators also perform more routine, but still essential, duties including providing directions, alerting passengers to their stops, and assisting elderly and disabled passengers with boarding. They provide a vital public service and are part of the social fabric of a community.

Autonomous technology may someday operate a bus safely and accurately, but it cannot replace the many jobs a human being does. As conceived today, technology being peddled for public transportation has no authority on a bus and cannot intervene in an emergency. This technology will not recognize a passenger suffering a heart attack or a seizure and call 911. And, this technology won't get off a bus to rescue a toddler wandering alone. With no operator on a bus, it will be up to other passengers to step up in these situations, and there is no guarantee they will do so. As we said earlier, it would be irresponsible for a transit agency to ask a passenger to pick up some of the work that a former bus operator used to do.

Some transit agencies may opt to keep an "attendant" on board their vehicles, who could serve an oversight or emergency response role, thereby mitigating some of these safety and security concerns. However, unless the attendants have a CDL and experience as a bus operator, they will be ill-equipped to take control of the bus should a technological problem, mechanical failure, or other incident or emergency occur.

***Threats to Other Vehicles and Pedestrians***

The expectation that autonomous vehicles will be safer than those operated by human beings has been a key driver of the development of this type of technology. While driverless vehicle technologies are advancing, they have a long way to go before they are proven safe. Unless and until autonomous transportation technology is proven flawless, driverless buses pose a risk to the safety of other motorists, cyclists, and pedestrians as well as property. For example, a report by the Governors Highway Safety Association notes that autonomous vehicles "may cause or contribute to some crashes because they may not be able to analyze and react appropriately to every potentially risky situation in the same way that a human driver would."[xxxiv]

Autonomous vehicles also reportedly have difficulty detecting and responding to the wide variety of bicycle shapes and sizes, the direction in which they are pointing, and changes of speed. The unpredictability of cyclist behavior makes the interaction between driverless vehicles and bicycles even more challenging.[xxxv] With the rise of new transit choices such as scooters, the challenge of safely traversing our streets with autonomous vehicles will only grow. And, at least one study has reported on the lower accuracy of driverless vehicles in detecting pedestrians with darker skin tones, versus lighter skin tones. "We hope [the study] provides compelling evidence of the real problem that may arise if this source of capture bias is not considered."[xxxvi] This finding raises significant concerns pertaining to pedestrian safety.

The hazards associated with autonomous vehicles are exemplified by recent accidents resulting in property damage, injuries, and even death. In perhaps the most notorious example, a pedestrian in Arizona was killed by an Uber automated test vehicle as they walked their bicycle across the street. The vehicle had been equipped with a proprietary automated driving system which, according to the National Transportation Safety Board (NTSB), was activated during the accident.

In its report, the NTSB found that the incident was attributable in part to the company's failure to "adequately manage the anticipated safety risk of its automated driving system's functional limitations, including the system's inability in this crash to correctly classify and predict the path of the pedestrian crossing the road midblock."[xxxvii]

The report went on to say, "Because the Uber Advanced Technologies Group's automated driving system was developmental, with associated limitations and expectations of failure, the extent to which those limitations pose a safety risk depends on safety redundancies and mitigation strategies designed to reduce the safety risk associated with testing automated driving systems on public roads."[xxxviii]

In another well-known incident, a Tesla operating in driverless mode failed to brake for a truck making a left-hand turn and crashed, killing the vehicle's passenger.[xxxix] According to Tesla's press release after the accident, neither the "auto- pilot nor the driver noticed the white side of the tractor-trailer against a brightly lit sky, so the brake was not applied."[xl]

Though less catastrophic, autonomous shuttle buses also have been involved in a number of accidents. In February 2020, a passenger was injured when a driverless shuttle being tested in Columbus, OH came to an abrupt stop, throwing her from her seat to the floor of the vehicle. In response, the National Highway Transportation Safety Administration (NHTSA) ordered EasyMile, the shuttle company, to shut down passenger operations provided by 16 of its vehicles in 10 cities around the U.S. until the cause of the incident could be determined. [xli,xlii] Following an investigation, NHTSA outlined conditions to lift the temporary suspension if updates were made in accordance with a new Safety Passenger Enhancement Plan developed by EasyMile and NHTSA. Among the new guidelines include installing seatbelts in the shuttles; an awareness campaign for sudden stops; and training for safety operators to remind passengers to hold on.[xliii]

In Las Vegas, an autonomous shuttle collided with a delivery truck on its first day of operation. While the truck driver was cited as the cause of the accident, passengers on the shuttle reported that the vehicle did nothing to avoid the collision. "The shuttle just stayed still. And we were like, it's going to hit us, it's going to hit us. And then it hit us. The shuttle didn't have the ability to move back. The shuttle just stayed still," said one of the passengers.[xliv] Unlike human drivers, who often are able to anticipate and avert this type of accident, this driverless shuttle was equipped only to avoid causing an accident, not evading one. In other examples, an autonomous shuttle hit a student on a university campus in Florida, causing her minor injuries,[xlv] and a shuttle trial in Vienna, Austria, was suspended after the driverless vehicle hit a pedestrian as she crossed the street.[xlvi]

On a less deadly, yet just as serious an example, security researchers using a 2" piece of black tape were able to alter a road sign and trick a Tesla using its MobilEye EyeQ3 camera system to go over twice the speed limit by convincing its sensors that a 35 MPH zone was an 85 MPH zone.[xlvii] All that the researchers did was to merely stretch the middle "finger" of the number 3 to fool the software into thinking it was the number 8. While newer versions of the MobilEye Q3 software appear to have patched this bug, it is yet another example of the rigorous testing software such as this still needs to be subjected to before it can be ready for our roadways.

***Privacy and Cybersecurity Threats***

Privacy and cybersecurity are also issues of concern in autonomous vehicle technology. In a simple test of this vulnerability, "white hat" hackers took control of a Jeep Cherokee through its entertainment center on the dashboard despite being hundreds of miles away. They had full control of the car's steering, brakes, and transmission.

Cybersecurity experts have also successfully hacked other standard automobiles and warn that autonomous vehicle systems also are vulnerable to infiltration. "These are no longer cars," said Marc Rogers, of cybersecurity firm CloudFlare. "These are data centers on wheels. Any part of the car that talks to the outside world is a potential inroad for attackers."[xlviii]

But, it's not just through the Internet where hackers can potentially exploit a vehicle's vulnerabilities. Recently, researchers from Mitre Corporation, a federally funded research and development center (FFRDC), won a patent for a keyless entry system (KES) security enhancement.xlix This technology mitigates a hacker's ability to control a vehicle's onboard computer through its key fob. One of our staffers was able to see a white hat hacker taking command of a vehicle firsthand, and it put a chill down their spine thinking what would happen if a bus full of people could be controlled in that manner. Connected autonomous vehicles (CAVs) can be more easily compromised and weaponized because the technology that supports the communication between the vehicles and infrastructure also enables cyberattacks to be carried out over wireless, Bluetooth, or cellular networks.[l]

With no bus operator on board, there would be no one trained to provide an immediate response and take control of the vehicle if such an incident were to occur. And, even if there were a bus attendant on board – if the wrong choices are made – it is possible there would be no steering wheel, brake pedal, or other mechanism that could be used to control the vehicle. So, while having a CDL holder to always be on board is essential, having the operator quickly gain control of the vehicle when the technology fails is a must in order to avoid a potentially catastrophic accident.

# Advanced Driver Assistance Systems (ADAS)


*A Tesla Model X engaged in autopilot mode, controlling distance from lead car and centering vehicle in lane*

While AV technology is attracting the attention of municipal leaders, transit agencies, and the media, truly autonomous transportation is decades away. Driver-assist technology, or ADAS, on the other hand, is available and is currently being utilized in many localities. These more tried and true solutions have been incorporated into private vehicles and are being implemented by some transit agencies to help advance transportation safety and efficiency. And, as the name suggests, this technology is intended to work with – rather than displace – vehicle operators.

ADAS consist of features that help with automatic emergency braking; collision, object and curb avoidance; precision docking/parking assist; lane-keeping and narrow lane/shoulder operations; smooth acceleration and deceleration; driver fatigue/inattention alerts; and platooning.[li,lii]

Although mainly utilized in personal, light-duty vehicles, some of these technologies are transferable to transit buses and other heavy-duty vehicles with modifications.liii With proper implementation, these driver-assist technologies could prove to be a boon to transit agencies, as they can help make public transportation – already an extremely safe way to travel – even safer.

This technology can also help make bus rides smoother and more efficient and, therefore, more attractive to transit riders.

***Worker Impacts***

Unlike autonomous vehicles, driver-assist technologies are not intended to replace human bus operators. Rather, their purpose is to enhance the safety of human-operated bus transportation. Provided their vehicles are outfitted with proven technology, operators may benefit from features that help them “see” people or vehicles in their blind spots, avoid traffic jams, pull right up to the bus stop without hitting the curb, and improve fuel efficiency by avoiding sudden acceleration or deceleration.

Bus drivers also may experience lower levels of occupational stress, including post-traumatic stress (PTS) caused by their involvement in road traffic accidents, which could increase longevity on the job. For example, when driver-assist technology was used in a "bus on shoulder" (BOS)[liv] trial by the Minnesota Valley Transit Authority, it resulted in operators keeping buses in the shoulder lane 10 percent longer and driving three miles per hour faster. Additionally, one- third of drivers using the driver-assist systems also reported feeling more confident.[lv] However, caution is required, as analysis also has shown that even technology that is intended to assist rather than replace a bus operator may pose significant safety risks.

According to an assessment by the Federal Transit Administration (FTA), of the 13 automation systems studied, only one – Object Detection and Collision Avoidance (ODCA) – would be transferable to a bus with only minor modifications to the foundational bus system. All the others would require major modifications of the bus system or significant new technology. And, features such as Automatic Emergency Braking, Full Park Assist, Valet Parking (Bus Yard), and Adaptive Cruise Control, would necessitate significant modification and may present moderately high safety issues, according to the FTA's assessment.[lvi]

For example, in the Minnesota Valley Transit Authority trial, the steering wheel on one of the buses equipped with driver- assist technology locked up, failing completely and causing a potentially unsafe situation with passengers on board. Fortunately, no one was injured.[lvii] Despite the advantages assistive automation can provide, it is vital that all transit agencies continue to require the same level of skill and certification of their bus operators.

Driver assist technology will also affect work performed by transit agencies' maintenance departments. Undoubtedly, mechanics will need to learn new skills to maintain and repair new AV technology components. As the FTA automation assessment states, "Transferring existing automation systems from other vehicle formats is not straightforward… the transit bus industry will need to implement foundational and interfacing systems that can support electronic actuation."

Whether workloads increase or decrease with the advent of driver assist technology is unclear. On the one hand, if the technology helps to decrease the number of collisions, there should be an accompanying decline in the amount of vehicle repair and parts replacement required. On the other hand, if and when crashes do occur, the repair likely will be more complicated and time consuming. For example, even a minor fender bender might necessitate not only the replacement of the bumper, but also new radar equipment, along with ADAS recalibration. And, replacing a windshield or mirror with ADAS sensors makes that process more complex.[lviii]

***Public Safety Impacts***

Public transit already is an extremely safe mode of transportation; for example, in 2018, there were just 251 transit fatalities.[lix]

However, the addition of driver-assist technologies is expected to help increase the safety of both transit passengers and those sharing the road with transit vehicles.

In one study, undertaken by the Washington State Transit Insurance Pool (WSTIP), which consists of 25 public transit agencies in the state, 38 buses were outfitted with ADAS technology, including sensors to monitor the road ahead and blind spots. The driver-assist system analyzed the risk of collisions with other vehicles, cyclists and pedestrians, as well as unintended lane departures, and following times. The ADAS then provided visual and audio alerts to the operator when potential threats were detected. The accuracy rate of the system was found to be 96% for buses equipped with ADAS, and none of these vehicles were involved in collisions with pedestrians or rear-end collisions with other motorists during the testing period.

Concurrent with the decrease in potential injuries and vehicular damage, the study found a significant economic advantage related to the driver-assist technology. Buses equipped with ADAS reportedly experienced a 58.5% potential reduction in vehicular and pedestrian collision claims (by value) compared to the larger pool of buses insured by insurance pool.[lx]

Because driver-assist technology (unlike AV technology) does not eliminate the bus operator from the vehicle, transit passengers could expect to experience an even safer ride while continuing to benefit from all the additional services operators provide. These include watching out for criminal activity, responding to passenger health emergencies, and offering assistance with boarding and directions, just to name a few.

***Threats to Prudent Public Investment***

Given the potentially significant workforce and public safety implications of new transportation technologies, it is incumbent upon decision makers to consider if the potential benefits outweigh the risks. Will these investments make transportation safer? Enhance services? Cut travel times? Ensure greater reliability? Allow for faster, easier connections? Attract more passengers? Will they help fight climate change?

While some existing driver-assist technologies may provide public benefits, such as reductions in collisions, there are no truly driverless vehicles that are capable of operating safely without human intervention. The technology is simply not there.

However, many cities and transit agencies have jumped on the technology bandwagon, taking a “shiny new object” approach in which they experiment with new technologies with no clear plan for how they will provide any benefit to the public. For example, an autonomous shuttle pilot in Paris recently came to an end after the novelty wore off and people lost interest in the service, which most judged to be too slow.[lxi]

Beyond the cost of purchasing the new technology and/or vehicles, transit agencies must also ensure that their existing facilities and infrastructure are prepared to accommodate the new buses and equipment they acquire in order to maximize their utility.

For instance, a report analyzing the implementation of electric buses (e-bus) in a number of cities around the world, including Philadelphia, noted that the Southeastern Pennsylvania Transportation Authority (SEPTA) “… did not initially create a detailed analysis of the costs to install e-bus infrastructure, because it originally decided on an e-bus that would charge en route and not have a major impact on its facilities. Only after deciding to update its e-bus specifications to a depot-charging bus did the agency fully explore all of its new infrastructure challenges.”lxii The report went on to say that, “…although these infrastructure costs are substantial, this barrier was not adequately identified during the planning stages of the e-bus programs. For example, charging issues led to implementation delays in Philadelphia, where the cost of investment…led the transit agency to limit the size of its second e-bus pilot.”[lxiii]

In addition to cost, space also presented a problem for SEPTA. The installation of charging docks and a substation at one of the agency’s depots necessitated the removal of a storage area and a change in the depot’s operations.[lxiv]

Beyond planning for and investing in technology, vehicles and infrastructure, transit agencies also must ready the workforce to operate, service, and repair the new equipment. Explaining why Chicago’s transit system likely would take years to upgrade to an electric bus fleet, a spokesman for the Chicago Transit Authority (CTA) said, “It requires a significant commitment of planning, engineering, design, construction — basically creating a whole new bus system…

There's also an equipment, repair, maintenance and training component."[lxv] This is why TWU has created the following policy principles for the federal government to work with labor and ensure a successful transition to new technologies. They are nimble enough to also be adopted by state and local governments as well.

# Policy Principles for Lawmakers


These policy principles are nimble enough to apply local, state, and the federal government. This multi-level approach ensures that these policies positively affect local transit. P*hoto courtesy of Nick Youngson CC BY-SA 3.0 Alpha Stock*

The public transit sector faces massive technological changes in the coming years. While the U.S. and many state Departments of Transportation have previously acted as cheerleaders, ignoring threats to safety and employment that we have outlined in this paper, we urge a new direction vis-à-vis technology and its effect on public transportation, as well as establishing new frameworks that ensure these industry-changing technologies are not only pro-innovation and pro- consumer, but pro-worker.

***Transparent Planning & Reporting***

a) Require mandatory reporting and budgeting plans be published for public comment prior to the implementation of any autonomous technology.

b) Require a project timeline of when and where the new product or service would be phased into existing operations and plans for formal procurement.

c) Require a comprehensive analysis of the impacts of the new product or service on existing workers, including workers who may be deskilled, required to learn new skills, or fully displaced by these technologies.

d) Establish formal processes that mandate transit agencies take workers' views into account in the planning and implementation phase.

Transit agencies around the country are cash constrained – especially with the ongoing public health costs. Promises of cheap solutions to local connectivity problems or ridership declines can be alluring, including unproven options that may negatively affect specific communities. Even large, well-managed agencies sometimes suffer from poor decision-making processes in response to budgetary or political pressures. These errors can result in costly, delayed, or under-utilized projects that drain resources rather than provide needed services. This problem can be especially significant when it involves new technologies that may be unproven or require significant cultural or staffing changes to be implemented successfully.

Training and transitioning employees are too often an afterthought in these processes but are essential to the successful integration of new products and services. Human capital is the most flexible and most valuable part of any operation and utilizing the existing workforce to implement new technologies or service options should be a priority for all transit organizations. Retraining and/or transitioning workers as a result of new services or products paid for with federal funds also is required by law. Planning and budgeting for this process gives transit agencies an honest assessment of the true cost of new technologies, as well as helping operators and workers to minimize the overall costs across the lifetime of the project.

To ensure that our public funds are always utilized in the most efficient, productive manner possible, transit agencies and municipalities planning to introduce new technologies or replace existing services with new service options must be required to produce and make public their plans for transitioning to the new products or type of service.

These requirements should activate before an agency exceeds 5% of its total vehicle-miles- traveled utilizing the new technologies, equipment or services. This threshold would allow operators to experiment with new ideas, determine their viability within their existing systems, and decide on the pace of transition without endangering the larger planning process. Many transit agencies will be able to make these determinations at much lower thresholds.

***Public Safety & Security***

a) Require that every vehicle automation system be able to detect a malfunction, a degraded state, or operation outside of its intended domain and safely transition to a condition which reduces the risk of a crash or other related physical injury.

b) Require mandatory fail-safes for when the technology does not work as intended. For commercial vehicles, these should include a requirement to have onboard a human operator with a commercial driver's license, and other certifications necessary for traditional operation.

c) Establish a framework of safety standards that vehicles must be required to meet before they are allowed to operate on roadways.

d) Reject exemption applications for autonomous systems which fail to meet existing safety, labor, and environmental standards.

While transit is, by nature, a local priority, the safety of vehicles and our roadways is governed by national standards. Municipalities and transit agencies do not have the resources necessary to conduct the comprehensive safety assessments needed to ensure new transit models meet minimum safety requirements. Especially when looking at new, untested technology, it is essential that federal regulators maintain their leadership in this area.

The safety standards in place today are the result of hundreds of thousands of accidents, injuries, and deaths in our transportation system. New technology has the great promise to make our commutes safer, but only if it lives up to the existing standards we have in place. Safety claims must be based on proven records and data rather than hypothetical gains or public narratives developed and pushed by those who stand to gain the most financially from these new technologies.

In order to maintain and improve upon public safety, local transit agencies and municipalities must resist calls to create their own safety regimes that fall below federal standards or allow exemptions from existing standards. For instance, no autonomous bus or shuttle has been approved by any federal agency for passenger transportation operations without a human on board. Allowing such vehicles on the road in one state or one city would open our system to additional risk and needlessly undermine public safety. Until a vehicle has been tested and approved for operation without a human at the controls, transit managers must prevent any human-less vehicles from operating as part of their systems.

Additionally, transit agencies and municipalities must acknowledge the many different roles transit workers have in the system. Bus drivers, for instance, not only operate their vehicle; they serve as important safety and security officers inside of that vehicle. They alert police to potential threats along their routes and deliver lost children to protective custody.

They aid elderly passengers and direct tourists through crowded streets. If, and when, the day comes that a truly driverless vehicle is certified as safe, it still should have a transit worker on board.

***Workforce Involvement***

a) Require a formal notice, similar to WARN Act notices, be sent to the workforce prior to procurement of a new product or service that would significantly impact their work.

b) Require employers create a comprehensive plan to transition, train, or retrain employees within all potentially affected classifications (e.g., bus operators, mechanics, technicians, etc.) so that they are prepared to fill new positions created by the new service orproduct.

c) Require beginning of collective bargaining negotiations over the terms and implementation of new products or services prior to procuring such technology. These negotiations must begin with enough time to reasonably conclude before any new technology would be adopted.

d) Ensure transportation workers are represented on all technology related working groups, task forces, and committees. Include worker protections and jobs goals in the mission statement for all these groups.

As we have seen time and again, the most successful integrations of new equipment, technologies, and services result when there is direct input from frontline workers who are ultimately responsible for implementing them. Ideas that are great on paper often require countless adjustments, many of which may not be obvious to planners who do not work in the system they are changing, in order to work in the real world. Any major change to a transit agency's operations should incorporate workers' viewpoints and experiences as early in the process as possible to result in a truly positive outcome.

Early notification is essential to obtaining productive feedback. Change is often difficult and positive effects of new technologies may not be obvious at the outset. Likewise, poorly conceived or problematic ideas may require deeper analysis to consider their negative effects. Bringing the frontline workforce into the conversation at an early stage increases the number of perspectives on the proposed changes and their impacts, ultimately resulting in better ideas that maximize the utility of new services and products.

Simply flagging planned changes, however, is not enough. Transit agencies and municipalities must be willing to adjust their vision in response to input from the workforce. Where workers are organized into unions, implementation plans for new technologies must be a mandatory subject of collective bargaining. Where frontline workers do not have a union, there must be a formal public comment period that allows affected individuals to raise concerns and propose alternatives. In combination, these requirements would allow for a flexible, locally driven system of implementation for new technologies and processes. Notification and bargaining do not mandate any particular outcome. Rather, they will allow agencies to identify the best solutions for their communities and systems. Taken together, these requirements would result in more pro-innovation, pro-consumer, and pro-worker solutions to our transportation challenges.

***Privacy & Cybersecurity***

a) Establish clear, uniform, and enforceable safety and privacy standards for the development and implementation of new technologies. These standards must be at least equal to existing standards for human-operated vehicles.

b) Require that automated vehicles be subjected to cybersecurity requirements to prevent hacking and to ensure mitigation and remediation of cybersecurity events.

c) Require robust data collection and privacy safeguards for all AVs, and assisted driving (ADAS) equipped vehicles, on public roads, while ensuring that any personally identifiable information (PII) that is collected is anonymized or be shared only for the purposes of delivering a service requested by the consumer or for the purposes of an accident investigation by the proper authorities.

It is essential for the federal government to establish clear, uniform, and enforceable safety standards for privacy and cybersecurity in order to keep frontline workers, passengers, and the traveling public safe.

Our current security regime, built for un-connected vehicles which provide little to no opportunity for hackers to co-opt the operational controls, is not adequate to address the new threats presented by connected autonomous vehicles. The DOT, in conjunction with DHS and other stakeholders, must develop specific regulatory benchmarks and enforce them as checkpoints that must be crossed before new technology can be deployed into our public space.

The government must see past the glossy, rose-colored version of this technology presented by the AV industry and take serious steps to prepare our transportation sector for the negative consequences these vehicles will have if left unregulated. The federal government has a responsibility to take actions and establish a strong framework that ensures any transition to new transportation technologies does not fuel large scale, lasting unemployment, undermine the safety and security of our system, or degrade service for the travelling public.

TWU members have been at the forefront of change during decades of transportation innovation. Our members have been hard at work as passenger and freight transportation has powered and transformed our economy, fueled middle class job creation, and redefined our mobility – often enabled by new technology. However, during decades of change and transformation we have always fought to uphold the highest standards of service to ensure the public safety, as well as the creation of good-paying jobs. Innovating and keeping good jobs in our industry are not incompatible propositions if the government we elect remains focused on both objectives.

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