Considerations on the Future of Human-Automation Teaming in the Transit Workforce

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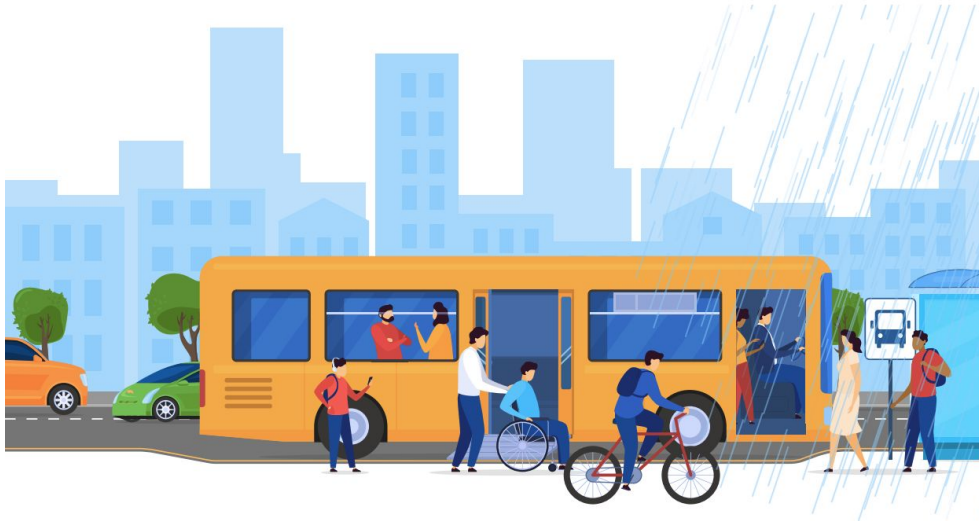Traffic21
Carnegie Mellon University

How to Make Sense of Bus Transit Automation?

Considerations for policy makers on the future of human-automation teaming in the transit workforce

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Link to full report:
tinyurl.com/transitworkforce

Current Applications of Vehicle Automation in Transit

Positive Train Control in Commuter Rail

Grade of Automation (GoA) Level 4 Driverless light rail vehicles

Driverless Slow Speed Shuttles (6-12 passenger capacity)

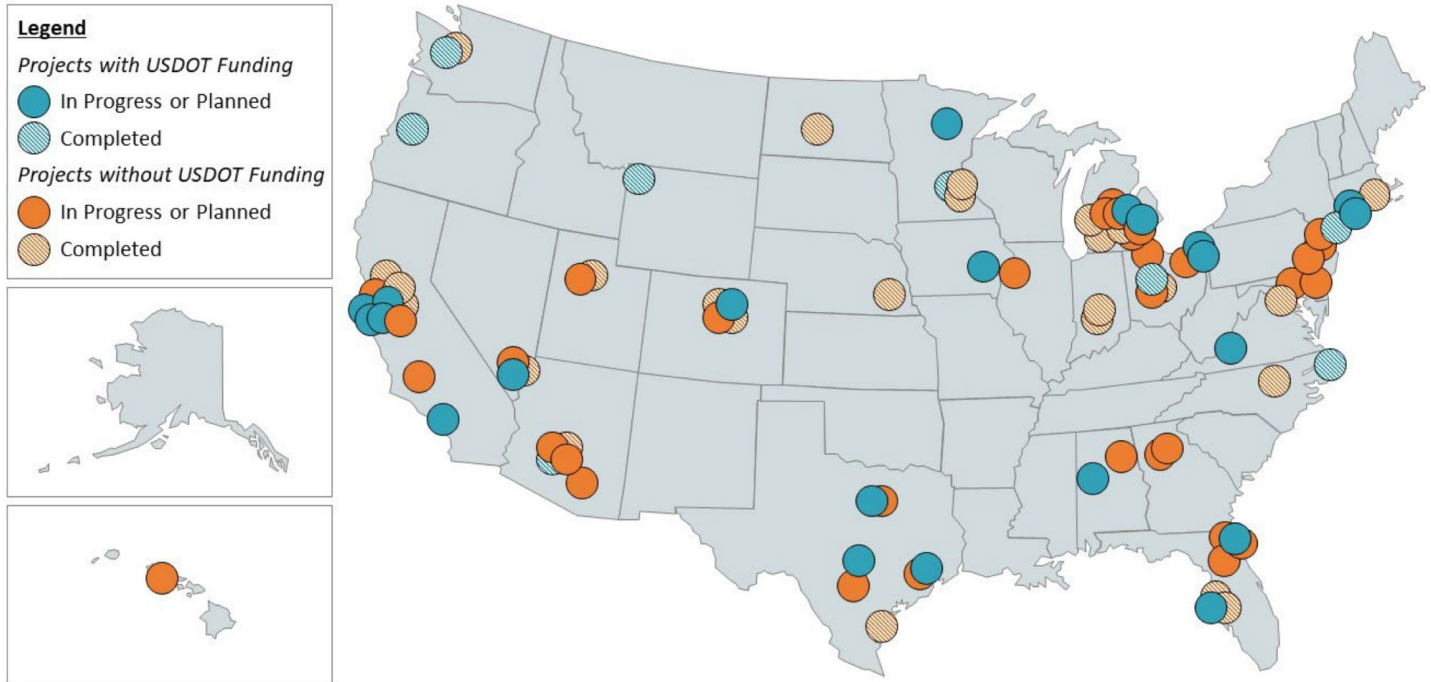**Automated vans** (passenger vehicles like Waymo, Cruise)

Full-size (40-ft), highly automated electric buses (with steering, precision docking, and platooning capabilities)

Bus platooning

SAE Level 1 and 2 partial automated systems (e.g., forward collision warning, blind spot detection, lane keeping, pedestrian detection, automatic emergency braking)

Current and Planned Automated Transit Pilots

U.S. Transit Bus Automation Testing Activities

Legend

Projects with USDOT Funding
- In Progress or Planned
- Completed

Projects without USDOT Funding
- In Progress or Planned
- Completed

Source: USDOT Volpe Center, July 2023

Recommendations

1. **New training programs based on human-automation teaming research should be developed for bus operators working with automated systems**

2. More research on active and passive systems that can improve a transit operator's ability to maintain safety on the road

3. New oversight measures to ensure safety isn't degraded as transit systems consider autonomous buses and vans marketed as capable of operating without a human operator on-board

4. Local authorities conduct their own hazard analyses as part of their Public Transportation Agency Safety Plan

5. Invest in infrastructure innovations to support data collection, sharing among agencies, and oversight of automated transit operations.

Additional Burdens on Transit Operators

- ***"Automation surprise"*** - operator expectations about an automated system are violated, leading to conflicts

- ***Mode error*** - operators do not know what mode of automation they are in

- ***Authority Control*** - Studies on the transfer of control to automated systems point to a negative perception of one's ability and loss of control

- ***Skill atrophy*** - A lack of proper training and a shift to operators supervising rather than driving can lead to the degradation of a worker's driving skills when they are needed

[Funkhouser and Drews 2016; Palmer 1995; Pettigrew, Fritschi, and Norman 2018; Sarter and Woods 1995]

"New Crashes"

[NTSB 2019]

[Shivdas and Kelly, 2021]

Need for Continued Expertise and Training

Level of Automation	Pro	Con
0 - No Automation	Current status quo, no new training required	Missed opportunities for safety improvements and driver quality of life improvements
1 - Driver Assistance	Improved safety and quality of life for drivers, similar to features in passenger vehicles	Misinterpretations of system capabilities
2 - Partial Automation	Improved workload reduction for things such as cruising and lane centering	Limited use in complex urban environments
3 - Conditional Automation	Increased physical workload reduction for drivers	Increased cognitive load from vehicle monitoring New crashes caused by autonomy-operator interaction
4 - High Automation	Drivers reduce much of their active driving time and efficiency and safety may increase	Operator skill atrophy Driver intervenes during hard situations requiring more readiness (e.g., training, practice).

Who manages problems when they arise?

On the Road

- **Today, bus operations are safer than personal vehicle operations**; an average of 40 occupant fatalities take place on all types of buses per year (vs 23,000/yr in light-duty passenger vehicles)

On the Bus

- Operators attend to the needs of elderly passengers and people with disabilities who require assistance

- Operators regularly manage on-board situations such as assaults or medical situations

Still, there are **opportunities to incorporate novel active safety technologies to enhance driving** so riders, pedestrians and cyclists traveling alongside transit vehicles continue to travel without incident

We should not develop and implement automated systems without the oversight of trained operators.

"It was only following a concerted effort to educate pilots about the automation, about themselves, and about the concept of a human-automation team that we reached the near-zero crash rate we enjoy today in the airline industry."

[Casner and Hutchins 2019]

Open Questions

What kinds of complexity do you foresee with increased usage of AV and ADAS technology in public transportation?

How might we co-develop new ADAS technologies and workforce training together?