Fleet Concept of Operations for Automated Driving Systems (ADSs): Demonstrations and Public Outreach Activities to Educate, Engage, and Share with the Public

ERIN MABRY

Virginia Tech Transportation Institute. Ph.D. in Clinical Exercise Physiology, Virginia Tech University. Senior Research Associate, Division of Freight, Transit, & Heavy Vehicle Safety.

ANDREW J. KRUM

Virginia Tech Transportation Institute. M.S. in Human Factors and Ergonomics, Wright State University. Group Leader, Division of Freight, Transit, & Heavy Vehicle Safety.

RICHARD J. HANOWSKI

Virginia Tech Transportation Institute. Ph.D. in Human Factors Engineering, Virginia Tech University. Director, Division of Freight, Transit, & Heavy Vehicle Safety.

ADITI MANKE

Virgnia Tech Transportation Institute. Ph.D. in Public Affairs, Rutgers University. Research Associate, Division of Freight, Transit, & Heavy Vehicle Safety.

CHRISTIE RIDGEWAY

Virginia Tech Transportation Institute. M.Eng. in Human Factors Engineering, Virginia Tech University. Research Associate, Division of Freight, Transit, & Heavy Vehicle Safety.

REBECCA HAMMOND

Virginia Tech Transportation Institute. M.S. in Human Factors Engineering, Virginia Tech University. Group Leader, Division of Freight, Transit, & Heavy Vehicle Safety.

.

Abstract
To provide the trucking industry with clear information on how to implement Automated Driving System (ADS)-equipped trucks among mixed fleets, VTTI hosted a series of roadshows and public outreach with support and participation from ADS and grant partners. The hands-on ADS roadshows allowed end users, stakeholders, and the public to experience ADS technology on closed test tracks. The roadshows demonstrated how ADS can be implemented in trucking fleets in a manner that is safe, repeatable, and commercially viable. The roadshows, hosted at national and international industry conferences across the country, engaged the public with driving automation systems to share information about their functionality, benefits, and limitations and glean public attitudes and perceptions of ADS-equipped trucks. The approach to conducting these demonstrations ensured results translate directly to real-world settings of practical importance to the trucking industry, regulators, and the public.
Keywords: automated driving systems; autonomous; freight; trucking; outreach

FLEET CONCEPT OF OPERATIONS FOR AUTOMATED DRIVING SYSTEMS (ADSs): DEMONSTRATIONS AND PUBLIC OUTREACH ACTIVITIES TO EDUCATE, ENGAGE, AND SHARE WITH THE PUBLIC

1. Introduction

The introduction of Automated Driving Systems (ADS) technology on heavy trucks is expected to increase safety, productivity, and efficiency (Krum, 2024). This will significantly affect all commerce in the United States, as over 70% of our goods are moved by trucks (American Trucking Association, 2023). However, it is yet unclear how ADS-equipped trucks should be integrated into fleet operations with conventional trucks. Further, the technical progress in ADS technology is moving at a faster pace than truck fleets and associated industries can keep track. As a result, stakeholders in the road freight ecosystem (for-hire and private truck fleets, shippers, brokers, truck manufacturers, and service and maintenance providers) do not have a clear picture of how ADS should be implemented into their daily operations. This drawback may adversely affect its adoption, thereby delaying the improved safety, productivity, and efficiency benefits of ADS-equipped trucks. Hence, there is a need to understand the real-world operational impacts of ADS technology and fill the existing knowledge gap on how trucking executives can gradually and successfully integrate ADS into their fleet operations by providing current stakeholders and new entrants in the trucking industry with data-driven guidance.

The Virginia Tech Transportation Institute (VTTI) assembled a team of experts in the field of ADS, data collection, safety data analysis, naturalistic driving, roadway infrastructure, data repositories, statistical methods, and truck fleet operations to develop and demonstrate a Trucking Fleet Concept of Operations (CONOPS). The CONOPS documents and describes ADS characteristics from the viewpoint of truck fleets and provides the trucking industry with clear guidelines on how to safely implement and benefit from ADS-equipped trucks. Overall, the CONOPS is intended to (1) provide commercial motor vehicle (CMV) fleets with practical information on how to integrate ADS-equipped trucks into their operations, (2) demonstrate the safe integration of ADS-equipped trucks into the U.S. on-road transportation system, and (3) investigate public and stakeholder attitudes towards ADS-equipped trucks.

The research adopted an iterative process of collecting information on existing ADS trucking practices, demonstrating the operations of ADS technologies on trucks under naturalistic and controlled environments, and sharing the lessons learned from these previous steps with stakeholders to update existing practices (Figure 1). The “Demo” stage involved both immersive demonstrations of ADS-equipped trucks for public interaction and realistic operational use case deployments. The demonstration methods, results, and observations are the focus of this publication. Given the tremendous potential safety, efficiency, and productivity benefits of automated trucks, and the fact that most consumer goods are delivered via trucks, the activities performed in the CONOPS are expected to benefit all road users and consumers, in addition to those working in the trucking industry.

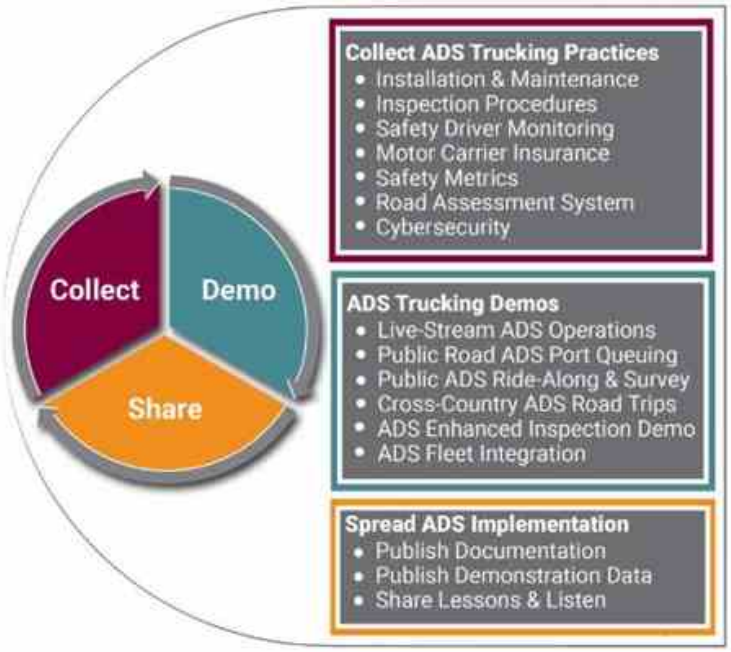

Figure 1. Diagram. CONOPS approach to continuous cycling of new technology innovation, application, and dissemination.

2. Objective

To support the mission of the CONOPS project and provide the trucking industry with clear information on how to implement ADS-equipped trucks among mixed fleets, the Virginia Tech Transportation Institute (VTTI) organized and hosted a series of roadshows and public outreach events. These events were supported by ADS and industry partners, including Pronto.ai, Kodiak Robotics, Commercial Vehicle Safety Alliance (CVSA), Drivewyze, the Florida Department of Transportation (FDOT), the Texas Department of Public Safety (DPS), and the Texas Highway Patrol.

3. Method

A crucial aspect of implementation is demonstrating the applications of ADS technology in day-to-day truck-driving tasks to fleet personnel and the general public to provide first-hand experience with ADS and to showcase how this technology can improve truck driving safety, support drivers, reduce human errors, and optimize fleet operations. To achieve this, three roadshow events were conducted to demonstrate the functionality, benefits, and limitations of ADS, as well as to provide policy insight to government, insurance companies, inspection agencies, and the public. The roadshows demonstrated how ADS can be implemented in trucking fleets in a manner that is (1) safe, (2) repeatable, and (3) commercially viable. Since ADS are new and most fleets have yet to encounter or operate an ADS, the outreach and roadshows provided an opportunity for direct interaction with the different technology solutions under development.

Three conferences and meetings were selected for the outreach and roadshow events: the Intelligent Transportation Society of America (ITS America) Annual Conference (2021), the Technology Maintenance Council (TMC) Annual Meeting (2022), and the Commercial Vehicle Safety Alliance (CVSA) Annual Conference and Exhibition (2023). These events focused on commercial fleet operators and provided the opportunity to meet ADS technology

developers. The events also offered attendees opportunities to participate in hands-on technology activities, such as in-vehicle and closed-road demonstrations. The research team worked closely with conference organizers and ADS and industry partners to plan, organize, and implement ADS demonstration activities that were timely, applicable, and relevant to the theme, goals, and attendees of each professional event. Key considerations, including space and infrastructure supports and limitations were taken into account. Demonstration details, protocols, procedures, staffing, and equipment were documented throughout planning and developed into an event run-of-show which guided the implementation of each event.

To collect data on attitudes and acceptance of ADS, demonstration attendees completed surveys to document their expectations of ADS technology and what applications of the technology would be attractive to their operations. The surveys helped the team better understand attendees' perception and acceptance of the technology and obtain insights on the potential use cases for deployment and additional data collection, as well as to document concerns that might be addressed in the CONOPS.

4. Results

This section provides a summary of the three roadshows, including the participating technology developer for each, exhibition booth experience, technical sessions, closed-course demonstration setup, and survey data collection on perception of the technology. Each demonstration resulted in guidance and instruction for the research team for future ADS trucking use-case deployments. The demonstrations also helped define metrics and variables for collection.

4.1 Intelligent Transportation Systems (ITS) America Annual Meeting

The ITS America Annual Meeting held in December 2021 in Charlotte, North Carolina, was a significant event for the intelligent transportation industry. The theme of the 2021 meeting was "Reimagining Transportation," focusing on creating safer, greener, and smarter transportation systems. The conference attracted a diverse audience from both the public and private sectors of the transportation industry. Attendees included architects, consulting firms, educational institutions, engineers, innovative urban mobility players, investors, mobility on demand specialists, planning organizations, public sector agencies (including state Departments of Transportation and cities), research analysts, and transportation operators and manufacturers. This mix of professionals served as an important platform for demonstrating the deployment of automated trucks at ports and major freight corridors.

Demonstration

A prototype truck ADS database and map, created from data collected during cross-country operations, was presented to the attendees as an interactive visualization (Figure 2). This tool allowed participants to virtually experience the ADS truck navigating various Interstate highways, assessing the availability, quality, and strength of the necessary supporting infrastructure. Additionally, behind-the-scenes presentations showcased the cross-country operations, including preparation, planning, training, and data inputs, alongside real-world applications. Information about fleet instrumentation, setup, and metric measurements was shared through real-time data streams and performance metrics from the ADS-equipped trucks. Attendees also had the chance to interact with a Pronto engineer monitoring the live data collection from the truck's cab. Finally, a slideshow highlighted the ongoing port queueing deployment, demonstrating how ADS-equipped trucks can alleviate significant congestion in daily port operations (Krum, 2024).

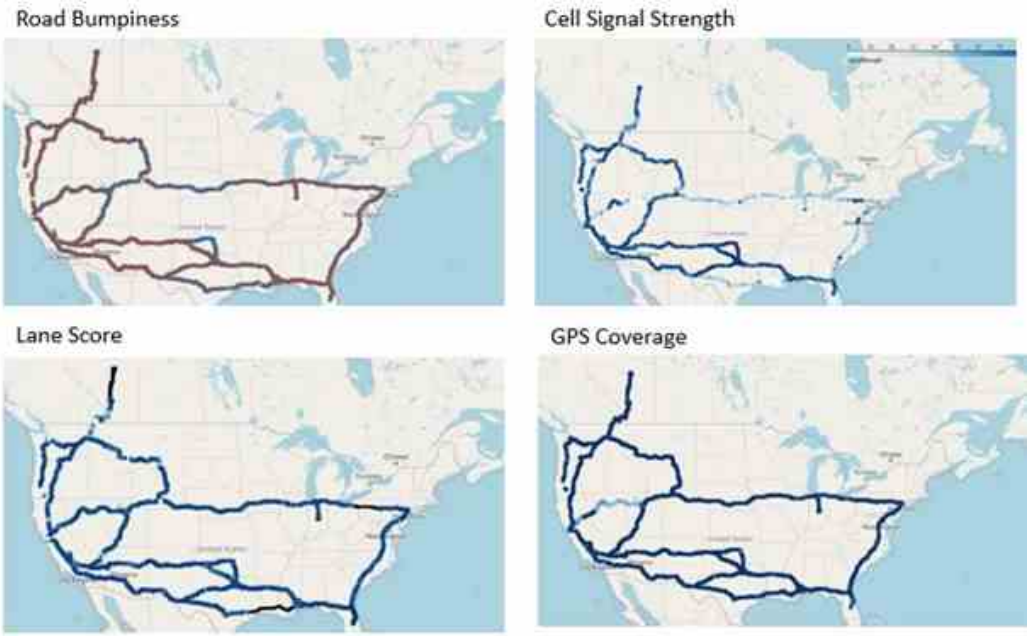

Figure 2 – Interactive visualization of ADS database and map collected during cross-country operations

Booth Activities

The CONOPS Roadshow Demonstration at ITS America also featured an exhibitor booth that highlighted the research and real-world applications being investigated. At the exhibitor booth, visitors could view a video summarizing the division's projects and priorities, interact with researchers, and receive research summaries, project pamphlets, and promotional items.

Materials and Resources Developed

As part of the outreach effort, research briefs were created for the CONOPS project that were distributed during the ITS America demonstration. The CONOPS study overview brief provides a comprehensive plan covering ADS installation, maintenance, inspection procedures, and cybersecurity best practices among others (Krum, 2024). It detailed a series of demonstrations across the U.S. to showcase the integration of ADS in real-world trucking operations, emphasizing safety, commercial viability, and repeatable deployment strategies. The Cross-Country Dataset brief highlighted the creation of a nationwide dataset for truck ADS deployments, spearheaded by VTTI in partnership with Pronto.ai (Krum, 2024). The dataset aims to address the knowledge gap regarding the readiness of the U.S. highway infrastructure for autonomous truck operations. The Port Queuing brief described the demonstration at the Port of Oakland, where ADS-equipped trucks effectively participated in daily port queueing activities, addressing congestion points and improving operations outside the port fence (Krum, 2024). The demo highlighted how ADS can potentially increase driver productivity and overall operational efficiency by allowing trucks to operate autonomously in queues.

Technical Session

The technical session was conducted as an informational briefing by a Pronto.ai engineer (Figure 3). It offered a synopsis of the current deficiencies in the development of ADS technology, highlighting the lack of a comprehensive public dataset for evaluating the deployment ability of ADS-equipped trucks and the reliance of policymakers and ADS developers on indirect data for the development of automated vehicles (AVs). Subsequently,

the goals of the CONOPS project were presented, including its ambition to bridge these gaps by creating a pioneering national dataset on infrastructure readiness, developing necessary ADS performance metrics for autonomous operations, and showcasing an automated truck navigating from coast to coast across the United States. The method of collecting ADS data, which involved operating automated trucks on various routes under different road conditions (traffic, weather, time of day) to assess infrastructure quality and sharing this data, was explained to the audience. The session also covered key infrastructure metrics (connectivity, lane marking quality, road surface smoothness, and GPS satellite coverage) essential for ADS integration on these routes, along with measurement and evaluation methods. The session concluded with a question-and-answer period, and participants were encouraged to monitor the project's progress on its website.

Figure 3 – Interactive Presentation at ITS America Annual Meeting

Survey

During the demonstrations, surveys were distributed to explore opinions on truck automation, identify scenarios where automation could enhance safety and economic efficiency, and examine how truck drivers and the general public might interact with ADS. These surveys also collected demographic information to analyze the perspectives of the public regarding ADS. Due to a low response rate, survey results are not reported here; however, the survey data can be publicly accessed at the CONOPS Dataverse page (Krum, 2024).

4.2 Technology Maintenance Council (TMC) Annual Meeting

In March 2022, the TMC held their annual meeting at the Orange County Convention Center in Orlando, Florida. TMC prides themselves on setting best practices to help trucking companies specify and maintain their fleets more effectively while also guiding manufacturers in the design of their equipment (TMC, 2022). The 2022 annual meeting served as a place for truck drivers, vendors, researchers, fleet managers, and other stakeholders to experience advancements in safety, technology, and standards within the trucking industry. This conference was selected as an outreach event for the CONOPS project as it presented an opportunity to demonstrate an ADS-equipped vehicle scenario to the project's target audience. The conference also provided the opportunity to discuss and learn through collaborative technical and educational sessions where the team could receive feedback and insights from attendees. The research team showcased an ADS-equipped tractor running closed-course demonstrations, an exhibitor booth, and a technical session at the conference.

Demonstration

To allow end users, stakeholders, and the public to experience ADS technology, a closed-course demonstration involving an ADS-equipped tractor was designed for the event. The ride-and-drive demonstration provided an opportunity for the research team to share information about the functionality, benefits, and limitations of developing ADS technology in heavy vehicles. Attendees had the opportunity to ride in a Pronto ADS truck (accompanied by a safety operator) as it followed a lead truck on a closed-course route (Figure 4). The route was conveniently located in front of the TMC venue to ensure accessibility for participation.

Figure 4 – Ride-and-drive Demonstration Route Around Orange County Convention Center

The closed course consisted of various maneuvers, including left turns, right turns, mandatory lane changes, acceleration, and stopping. The ride-and-drive included two real-world scenarios that an ADS-vehicle may need to navigate: a work zone and an unexpected pedestrian crossing. The work zone consisted of traffic cones lining a portion of the route with work vehicles placed outside of the vehicle path (Figure 5.). The work zone was designed and executed with the support of the FDOT.

Figure 5 – Work Zone Scenario for Ride-and-Drive Demonstration

Within the work zone, a "road worker" mannequin unexpectedly crossed the path of the ADS truck as it traversed the work zone (Figure 4). The attendees watched as the truck identified the road hazard and reacted by bringing the vehicle to a complete stop a safe distance before the

pedestrian. These two scenarios illustrate a typical safety-critical and complex driving environment an ADS vehicle may encounter in real-world driving conditions.

Over the two-and-a-half-day conference, VTTI and Pronto conducted 54 ride-and drive trips with a total of 161 attendees. Of the 161 attendees, 29.7% held a commercial driver's license, 17.8% worked as a CMV driver currently, and 70.3% had not previously experienced a commercial truck equipped with ADS technology. Attendee employment included fleets, suppliers, government sector, maintenance personnel, manufacturing sector, and law enforcement. The research team collected pre- and post- ride-and-drive questionnaires from attendees to understand their opinions, perceptions, and attitudes towards ADS applications in the trucking industry. The results from the data collection effort are included below.

Booth Activities

Inside the exhibit hall, the team hosted a booth to showcase the CONOPS project and active deployments. The deployment videos included ADS port queueing operations and the ADS cross-country road testing. Research team members networked and interacted with attendees to answer questions about ADS technology and gain insights about other work happening in the trucking industry. The exhibit booth further supported the goal of the CONOPS project to collaborate with a broad group of individuals representing government entities, university and research institutes, trucking associations, and private partners. The research team created a handout highlighting truck crashes in work zones to support the safety benefits of using ADS in work zones as an operational use case. For example, the handout mentioned that Florida is a state with one of the highest rates of work-zone-related crashes involving large trucks along with statistics about crash rates.

Materials and Resources Developed

To summarize the work being done for the CONOPS project, the TMC ride-and-drive was included in a research brief developed after the conference (Krum, 2024). The brief was designed to be a synthesis of the goals of the CONOPS project and how the team's work at TMC helped meet these goals. For example, the CONOPS project sought to collect information about trucking best practices, demonstrate current ADS technology, and publish documentation about the findings. In addition to the research brief, a video was created to showcase the project and educate those who were unable to attend about the steps VTTI is taking through the CONOPS project to advance ADS technology into the trucking industry (Krum, 2024).

Technical Session

The technical session featured a panel of experts from the CONOPS project, moderated by Tom Keane, the Associate Administrator of the Office of Research and Registration at FMCSA. The panel comprised specialists in the automated commercial trucking sector, addressing key issues related to fleets, shippers, brokers, state governments, and service/maintenance providers for planning ADS deployment. Dr. Rich Hanowski, the Division Director of DHVY at VTTI, provided an overview of the ongoing research efforts included in the CONOPS project. Additionally, he highlighted environments where automation could enhance driver performance and safety, such as in port queueing and exit-to-exit transportation. Jeff Loftus, the Division Chief at FMCSA Technology Division, discussed FMCSA's role in supporting and guiding ADS trucking deployment. Jessica Kearney, the Assistant Vice President at the Traveler's Institute, spoke about the future of insuring ADS-equipped trucks given their unique challenges. Will Schaefer, the Director of Safety Programs at CVSA, emphasized the importance of maintaining ADS-equipped trucks through appropriate

electronic and manual interactions. Mike Gomes, the Vice President of Maintenance at Bison Transport, shared his fleet's experience with driver assistance features. Lastly, Ognen Stojanovski, Chief Operating Officer and Co-founder of Pronto, who has long observed the development of ADS vehicles, discussed the origins of automation and its potential to enhance safety and efficiency for fleets.

A poll was given to audience members during the panel with observations that may be interesting to stakeholders. Respondents stated they would consider using ADS technology mostly for safety and utilization benefits. The main concerns for deployment would be technical support and return on investment for such a costly technology. The respondents' perceptions of ADS success were influenced by factors such as insurance considerations, driver feedback, and locations of deployment. These themes align with many topics covered by the CONOPS project and support further investigation into stakeholder insights for successful deployment.

Surveys

To collect information from attendees about their opinions, perceptions, and attitudes towards ADS applications in fleet operations, the VTTI team collected questionnaires both before and after attendee participation in the ride-and-drive. This allowed researchers to observe any changes in opinions and perception that could be attributed to their experience during the demonstration. A total of 101 paired pre- and post-ride questionnaires were collected from participants. Figure 6 presents survey responses evaluating participant's perceptions of the system before (pre-drive) and after (post-drive) use. Participants rated various aspects of the system on a 1 to 5 scale, where lower values indicate a more favorable perception (e.g., useful, safe, effective) and higher values indicate a less favorable perception (e.g., useless, unsafe, superfluous). The mean values in the figure represent the average response for each survey question, providing insight into overall participant sentiment. Comparing pre-drive and post-drive means helps identify shifts in perception, where a lower post-drive mean suggests improved opinions after using the system.

In general, feedback from participants on ADS opinions and acceptance was positive and did not change drastically before and after the demonstration participation (Figure 6). Questions about whether the technology was effective/superfluous, raising alertness or sleep inducing, unsafe or safe, cost-effective or expensive, acceptable or unacceptable, performs well or performs poorly, and if training was difficult or easy received more positive responses after the demonstration. Questions about whether the technology was useful or useless, bad or good, irritating or likable, assisting or worthless, and undesirable or desirable received a slightly less positive response. This could mean that more exposure to use cases is required to have a better judgment of the technology. No changes were observed in the other survey responses. However, in all cases, the responses were positive.

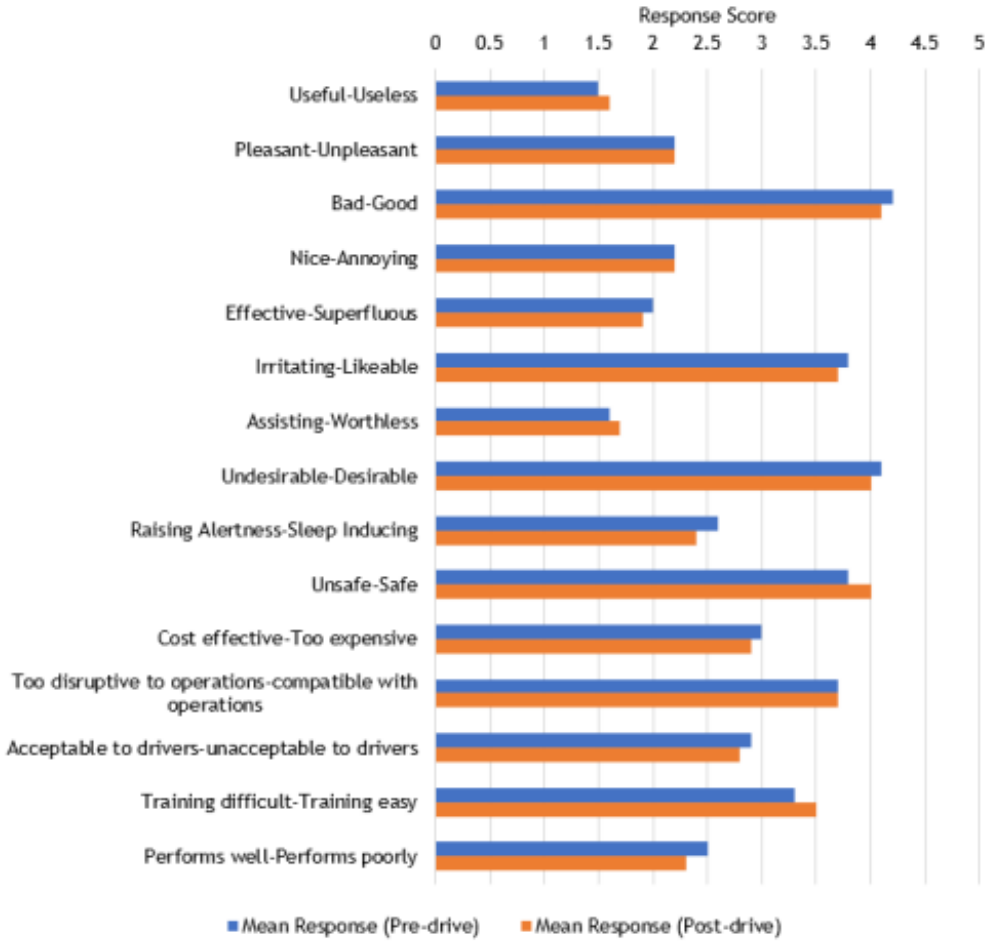

Figure 6 – Pre- and Post-drive Survey Results Regarding Attendee Opinions, Perceptions, and Attitudes of ADS

To capture what use case demonstrations participants would like to see in the future, a multi-point select question was presented to participants. The majority of the 84 participants who answered these questions selected automated trailer parking (n = 62) and intermodal yard operations (n = 43) most frequently. Only 14 participants were interested in seeing queuing operations.

4.3 Commercial Vehicle Safety Alliance Annual Conference

In September 2023, the Commercial Vehicle Safety Alliance hosted its annual conference and exhibition in Grapevine, Texas. CVSA commits itself to making a difference in transportation industry through continuous improvement and innovation in the trucking sector (CVSA, 2023). The 2023 annual meeting attracted a diverse audience, including government officials, enforcement personnel, industry leaders, safety advocates, and commercial motor vehicle operators from across Canada, Mexico, and the United States. The conference served as a platform for these stakeholders to come together and engage in discussions that guide the transportation industry. This annual meeting was selected as an outreach event for the CONOPS project for the chance to network with peers and experts in the field to encourage the exchange of ideas within the CMV community. Additionally, the event provided an opportunity to showcase inspection policies being developed in the realm of ADS trucks, which

is a multifaceted topic. The research team showcased an enhanced CMV inspection program demonstration, an enhanced CMV inspection program presentation to a committee meeting, and an exhibitor booth at the conference.

Demonstration

The main roadshow event showcased how ADS developers are integrating the CVSA enhanced CMV inspection standard into their operational frameworks. VTTI transported their newly upgraded Peterbilt truck and CONOPS trailer to Texas, presenting them in the CVSA exhibit hall. Partnering with Kodiak Robotics, VTTI and Matthew Cearnal, Kodiak's Head of Service and Support and Manager of Hardware, demonstrated the implementation of the enhanced CMV inspection within Kodiak's fleet and daily operations (Figure 7). Mr. Cearnal, who also contributed to the development of the CVSA enhanced CMV inspection training and certification program, is a certified inspector. His presentation and live demonstrations were designed to engage attendees and provoke thoughtful questions about the program. Participants were encouraged to consider various aspects of the enhanced inspection process, such as the specific procedures and protocols implemented at maintenance shops, the overall business model supporting these inspections, and the distinctions between in-transit and dispatch inspections. Additionally, the demonstration highlighted how certified inspectors are able to perform the inspections efficiently, ensuring both safety and compliance. The demonstration was accessible during the opening reception, exhibit hall hours, and during lunch and midday breaks throughout the conference.

Figure 7 – VTTI and Kodiak Robotics Demonstrate the Implementation of the Enhanced CMV Inspection Within Kodiak's Fleet and Daily Operations

Booth Activities

One of the highlights of attending the CVSA annual conference was the opportunity to engage with conference attendees in the exhibit hall. The VTTI booth was staffed by knowledgeable project personnel throughout the event in order to support the enhanced CMV inspection demonstration. Those who stopped at the booth learned about the CONOPS projects and how the CVSA enhanced inspection program and electronic roadside communication initiatives align with CONOPS goals. VTTI promoted the demonstration, which took place during the

CVSA reception, ensuring that attendees were well-informed and excited about the demonstration. This engagement booth was a chance to connect with experts, gain insights into cutting-edge safety initiatives, and see firsthand advancements in CMV safety. The booth also supported networking opportunities to gain supporters of the project and spread awareness of ways to improve ADS deployment.

Materials and Resources Developed

One major resource developed from this outreach effort was a video documenting the enhanced inspection process and interviews with experts in the field (Krum, 2024). Content for the video was collected from two site visits in Texas prior to the conference. During the first site visit, the VTTI and FMCSA research team collaborated with Kodiak, the Texas Department of Public Safety, and Drivewyze to film demonstrations of electronic roadside verification communication procedures along Interstate 45 and at the Wilmer weigh station in Texas (Figure 8). These demonstrations showcased the practical applications and integration of the enhanced inspection standard, with the Kodiak ADS-truck wirelessly communicating its inspection status to a DPS trooper via the Drivewyze platform. Multiple cameras captured various angles inside the truck cab, and the Drivewyze interface was documented to show information transmission and reception.

Figure 8 – Electronic Roadside Verification Communication Along Interstate 45 and Wilmer Weigh Station in Texas

On the second day, the team visited Kodiak's facilities in Lancaster, Texas, to document their internal enhanced inspection procedures as part of the CVSA Enhanced CMV Inspection Program. The VTTI team recorded a CVSA-certified inspector from Kodiak conducting a full enhanced inspection on a Kodiak truck, focusing on five key areas: interior checks, undercarriage and brake inspection, rear lighting inspection, 5th wheel securement, and ADS component checks (Figure 9).

Figure 9 – CVSA-certified inspector from Kodiak conducting a full enhanced inspection on a truck

To complement the demonstrations, brief interviews were conducted with members of the Texas DPS and Drivewyze teams to gather their insights on the purpose, value, and future steps for the ADS enhanced inspection and electronic roadside verification activities. The interviews highlighted Drivewyze's approach to roadside screening of ADS-equipped trucks, including the development of the inspection client software, which aligns with CVSA's enhanced pre-trip inspection procedures. This software ensures a defect-free inspection before dispatch. The approach also includes inspection forms and application programming interfaces for data transfer from ADS developers to the Drivewyze AV database that are used for pass/fail screening decisions. The expected benefits of this technology include reducing crashes caused by human errors and improving overall highway safety. Additional interviews with the VTTI and FMCSA teams provided insights into how these demonstrations support the CONOPS project's research objectives and the future of ADS trucking.

Based on the information gathered from site visits and the CVSA annual meeting, a research brief was developed about the role of the inspection process in the CONOPS project. The brief provides an overview of the enhanced inspection procedures for ADS-equipped CMVs (Krum, 2024). It outlines the collaboration between VTTI, FMCSA, and CVSA to develop and implement these procedures. The summary highlights the importance of thorough inspections to ensure the safety and reliability of ADS-equipped trucks, detailing the steps involved in the inspection process, and the role of electronic roadside communication in verifying inspection status. This initiative aims to improve highway safety by reducing crashes related to human errors and ensuring that ADS-equipped CMVs operate within their designated parameters and roadway domain.

Technical Session

The second part of the CONOPS roadshow at CVSA featured a collaborative presentation during the Enforcement and Industry Modernization Technical Committee meeting. This session allowed ADS developers, OEMs, and fleet operators to discuss their experiences with the enhanced CMV inspection program, including the certification and training processes. The presenters were Tom Kelly from FMCSA, Andrew Krum from VTTI, Brett Fabbri and Matt Cearnal from Kodiak, and Miranda Leadbeater and Todd James from Drivewyze. FMCSA kicked off the session with an overview of their research initiatives, including the CONOPS project. VTTI followed with a detailed presentation on the CONOPS project, showcasing a comprehensive video from the site visit highlighted in the enhanced inspection program and electronic roadside communication activities. Kodiak and Drivewyze concluded the presentation by discussing their involvement, sharing insights, results, and future steps from their pilot programs. The presentations sparked discussions on various ADS inspection topics, such as internal policies for ADS sensor and perception processor checks, secure electronic communication of vehicle inspection status, and interactions between ADS-equipped trucks and roadside enforcement during emergencies. The committee received the presentation positively, leading to engaging and thoughtful discussions both during and after the meeting.

5. Discussion

This project approached the fast-paced and constantly changing space of heavy vehicle automation by collecting, demonstrating, and sharing information and data in an iterative manner. This approach allowed the team to learn about innovations or challenges in one area

of ADS-equipped CMVs that fed other areas. These findings were shared with the public. Feedback from the demonsrations guided the project and lessons were shared with stakeholders and back to the public in real time.

Outreach allowed the research team to obtain insights into the public opinion on how ADS technology could impact trucking safety, productivity, and efficiency. While the results were positive, as demonstrated during the roadshow activities conducted in this research, the team also observed that real-life demonstrations of the potential use cases of the technology further improved its perception and acceptance by the public. This indicates that there is need to improve existing public knowledge of ADS through showcasing its practical applications and informing both truck drivers and decision-makers on how this technology can improve their operations.

History has demonstrated a consistent move towards automation that is driven by a societal desire to increase productivity and improve the lives of workers and consumers. The world is at an important inflection point in the application of automation in general and in transportation specifically. The automation of freight transportation is likely to grow in many places along the supply chain among production, warehousing, and consumer distribution. Much of that progress has been made necessarily within the confines of proprietary development where the knowledge of the strengths and challenges have been limited to investors, engineers, and a few select leaders in freight operations. The demonstration activities in the CONOPS project sought to record and share the rapid progress that is occurring in trucking automation. It is possible that critical operational and business challenges will be overcome in the near future. This project informed stakeholders that the ultimate success of these deployments will be based on the actual and perceived advantages it brings to society, not just the technological barriers that are overcome.

6. References

Krum, A.; Mabry, E.; Hanowski, R.; Stojanovski, O.; Manke, A.; Adebisi, A.; Hammond, R.,…Thapa, S. (2024). Trucking Fleet Concept of Operations for Automated Driving System-equipped Commercial Motor Vehicles. Accessed from https://www.vtti.vt.edu/projects/conops-report.html

American Trucking Association. (2023). Economics and Industry Data. Accessed from https://www.trucking.org/economics-and-industry-data

7. Acknowledgements

This project was funded by a U.S. Department of Transportation Automated Driving System Demonstration Grant from 2020-2024 (FM-ADS-0001-20-01-00) and managed by Tom Kelly with the Federal Motor Carrier Safety Administration.

We would like to express appreciation to the following organizations for granting permission to and providing information and material support used in the performance of the project and reporting:

Commercial Vehicle Safety Alliance
Drivewyze

Kodiak Robotics
Travelers Institute

We would also like to acknowledge the following organizations and State Departments of Transportation for their support:

Florida Department of Transportation
Hub Group
I-95 Corridor Coalition
National Private Truck Council
Pennsylvania Department of Transportation
Penske
Schneider
Tennessee Department of Transportation
Texas Department of Public Safety
Virginia Transportation Research Council
West Virginia Department of Transportation
Wyoming Transportation Department

8. CONOPS Demonstration Resources

8.1 Briefs

CONOPS General Project Research Brief
https://www.vtti.vt.edu/PDFs/conops/Tech-Brief.pdf

ADS-Equipped Trucks' Inspection Procedures
https://www.vtti.vt.edu/PDFs/conops/ADS-CVSA-Brief.pdf

Port Queuing Brief
https://www.vtti.vt.edu/PDFs/conops/Port-Queuing-Brief.pdf

Securing Fleet Operations: Navigating the Cybersecurity Landscape
https://www.vtti.vt.edu/PDFs/conops/Cybersecurity.pdf

Cross-Country Demonstration Brief
https://www.vtti.vt.edu/PDFs/conops/Cross-Country.pdf

Travelers' Insurance Autonomy Executive Summary
https://www.vtti.vt.edu/PDFs/conops/Travelers.pdf

8.2 Events

ITS America Roadshow (2021)
https://www.vtti.vt.edu/PDFs/conops/ITS-Roadshow.pdf

TMC Annual Meeting (2022)
https://www.vtti.vt.edu/PDFs/conops/TMC-Roadshow.pdf

8.3 Videos

2022 TMC Annual Meeting-CONOPS Project
https://www.youtube.com/watch?v=eBnlxkS7i_4

2022 TMC Annual Meeting-Ride and Drive
https://www.youtube.com/watch?v=djWIsFFWw08

2023 CVSA Annual Conference and Exhibition-AV Trucking Enhanced Inspection Pilot
https://www.youtube.com/watch?v=djWIsFFWw08

Port of Oakland-Autonomous Queuing Demonstration
https://www.youtube.com/watch?v=djWIsFFWw08

8.4 CONOPS Dataset and Final Reports

VTTI CONOPS Dataverse
https://dataverse.vtti.vt.edu/dataset.xhtml?persistentId=doi:10.15787/VTT1/ZYMSEM

CONOPS Final Report and Chapter Reports
https://www.vtti.vt.edu/projects/conops-report.html