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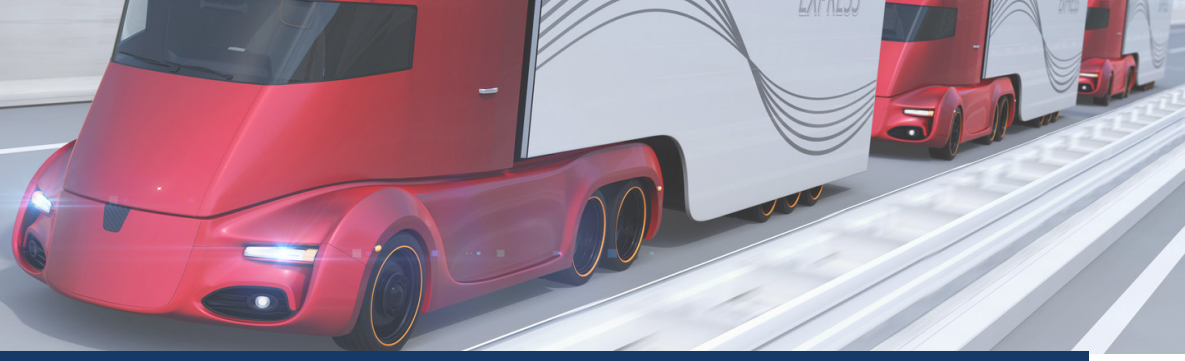
# PERSPECTIVE ON AUTONOMOUS TRUCKING



## AVS ARE ODD

*Defining the operation design domain for automated vehicles is crucial.*

Spend any time reading reports on automated or autonomous vehicles, and you quickly get deluged with acronyms. Acronyms are a curse. Elon Musk stated in a 2018 email to his employees, "Don't use acronyms or nonsense words for objects, software or processes at Tesla. In general, anything that requires an explanation inhibits communication. We don't want people to have to memorize a glossary just to function at Tesla."

Yet they seem inescapable. The U.S. Department of Transportation January 2021 release *Automated Vehicles Comprehensive Plan* contains this statement about trucking operations: "Several automated trucking companies are developing Level 4 ADSs that are specifically for use on CMVs and have an ODD of limited-access highways, either from exit-to-exit or on-ramp to off-ramp."

So back the truck up a bit. Four acronyms that show up frequently in SAE J3016 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles are:

- **DDT** — dynamic driving task
- **ODD** — operational design domain
- **DAS** — driving automation system
- **ADS** — automated driving system

Putting this in perspective of you driving your own vehicle today, the DDT is affecting what you do when you are in control of the vehicle. ODD then is the set or subset of operations you perform with the vehicle. DAS is any system that automates a function, such as adaptive cruise control. ADS is special; it is where automation accomplishes all of the DDT for a particular ODD. SAE states that ADS only applies to Level 3, 4 and 5 automation, where Level 4 can completely do some ODDs in limited conditions, and Level 5 can do all ODDs in all conditions. SAE provides both the J3016 standard and a helpful graphic on the levels for free.

Defining the operation design domain for automated vehicles is crucial. As automated vehicles begin to enter commercial operations, they will operate within specific ODDs. For example, some AV developers are aiming to have automated operation between two depots located near a freeway, where the trailers or the entire tractor-trailer will then be driven by a human to an urban warehouse. The automated vehicle does not "do it all" but does do everything once dispatched from the first depot and then traveling to the second.

That is a simplistic view of the world. Connecting to any one of the millions of existing freight trailers and container chassis today involves human interaction with the trailer connections and the landing gear, opening and closing and securing trailer doors, and performing inspections. In a future ideal world, perhaps the trailers and container chassis can do all of these things through automation, but for the immediate future, an automated tractor still will require some level of human interaction to pick up and drop off a trailer.

> "Ultimately, some method for an autonomous tractor to become an autonomous tractor-trailer combination will be needed, and until that is possible, the automated tractors will need to deal with non-automated trailers.

NACFE published a detailed report in 2019 looking at the potential to intentionally pair a specific tractor to a specific trailer titled *Intentional Pairing*. We identified that while there are some duty cycles where specific tractors and trailers stay mated, overall, the majority of industry operations rely on fairly random allocation of trailers to tractors. It's often stated that there are on average three trailers for every one tractor, but the reality is that those three trailers can be any of millions in inventory and the probability of a specific tractor being assigned a specifically configured trailer is very small.

Once connected, the tractors have no idea what trailer they are connected to. There are no special communications between the tractor and the trailer that identify any of the

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS


| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **No Automation** | **Driver Assistance** | **Partial Automation** | **Conditional Automation** | **High Automation** | **Full Automation** |
| Zero autonomy; the driver performs all driving tasks. | Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design. | Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times. | Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice. | The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle. | The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle. |

specifications of the trailer, even simple things like whether it's a 28', 48' or 53' trailer. Efforts by researchers to have enough intelligence and sensors on board the tractor to allow the tractor to reliably automatically identify trailers are still in development.

Lidar, radar, optical systems, short range data systems, etc. are all being evaluated or have been evaluated but generally each have met limitations. Placing bar codes or QR codes on the face of the trailers with imbedded trailer technical information has even been proposed for the tractor to automatically read. All of these ideas have merit looking at individual trailers, but struggle with trying to be applied to the millions of existing units in the field.

Ultimately, some method for an autonomous tractor to become an autonomous tractor-trailer combination will be needed, and until that is possible, the automated tractors will need to deal with non-automated trailers.

Part of the challenge in tackling this problem is how the trucking industry has been structured in the past, with manufacturers for tractors and completely different manufacturers for trailers. This is compounded for container hauling, where the tractor is made by one OEM, the container by another, and the chassis by a third. But "the times they are a changin'" as Dylan sings. Hyundai has become a major force in trailer manufacturing and has announced plans to enter the Class 8 tractor market in North America. That ability to design and build both parts of a tractor-trailer may open up new approaches to future freight operations.

The numbers of existing trailers in the near- and mid-term transition to automated tractors will continue to require that any new tractor technology be able to accommodate mating to existing trailers and container chassis.

***About the Author:*** *Rick Mihelic is Emerging Technologies Director for The North American Council for Freight Efficiency. He has authored for NACFE four Guidance Reports on electric and alternative fuel medium- and heavy-duty trucks and several Confidence Reports on Determining Efficiency, Tractor and Trailer Aerodynamics, Two Truck Platooning, and authored special studies on Regional Haul, Defining Production and Intentional Pairing of tractor trailers. President of Mihelic Vehicle Consulting LLC he has 38 years' experience in the trucking and aerospace industries including 20 years in commercial vehicle development for PACCAR and Peterbilt. He was involved in the development of aerodynamic vehicles and groundbreaking systems including the Peterbilt/ Cummins DOE SuperTruck and instrumental in developing compliance systems for EPA GHG regulations. He was awarded the prestigious SAE L. Ray Buckendale Award in 2016 and SAE Crawford award in 2020.*

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