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NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

PERSPECTIVE ON AUTONOMOUS TRUCKING

NACFE'S THREE LAWS OF AUTONOMOUS TRUCKING

The autonomous trucks of the future likely will need some permutation of Asimov's Three Laws of Robotics to guide their decisions in complex daily life and to deal with "edge" scenarios.

Autonomous truck headlines are seemingly daily events. The magnitude of investment levels is staggering, well into the billions. Visionaries firmly believe they can provide safe and efficient automated driving. SAE in its ubiquitous SAE J3016 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles goes into some detail about how "autonomous" is not the correct term, rather it is automated and connected. However, the industry, media, politicians, marketers and the public seem fixated on jumping to "autonomous" in describing future vehicles, so let's go there.

I'm going to let my inner geek out for a moment. I grew up in the 1960s. For anyone born later, let me explain that meant we played pick-up football, basketball and baseball in any available green space, we watched any of three television stations, we listened to AM radio, played board games, went to school, did homework, and a big day was going shopping at something new called a "mall." There was no internet, no video games, no personal computers, movies were expensive and rare, every long-distance phone call seemed expensive. Choice in phone service was a monopoly of one. Researching anything typically meant going to a library and hunting down books through something called a card catalog.

Reading paperback science fiction became a thing for me. Visionaries like Wells, Verne, Bradbury, Clark, Heinlein, Bova and Asimov paved a lot of fertile ground for innovators. One milestone for autonomous trucks for me clearly is Asimov's Three Laws of Robotics, which I have shamelessly modified and repurposed for our freight use here:

1. An autonomous truck may not injure a human being or, through inaction, allow a human being to come to harm.
2. An autonomous truck must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. An autonomous truck must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Asimov predicted that truly autonomous, i.e. self-thinking, robots were in our future, able to operate more-or-less independently. Humans may have created them, but once created for a role, they were pretty much self-directed. Yes, I am horribly simplifying this, but that's what "autonomous" means. Asimov found the need to provide some foundational ethics to guide these robots in their lives.

Our autonomous future freight trucks likely will need some permutation of these laws to guide their decisions in complex daily life. Today software programmers are working to define algorithms to address typical operational scenarios, and they label the statistically rarer ones as edge or even corner cases. My feeling is there are a lot of corners, so I prefer edge.

I was reflecting on this as I was driving in Texas on an interstate in a "typical" Texas rainstorm. Now I grew up in Oregon, where rain is more like a mist compared to Texas. Texas rain usually includes qualifier terms like deluge or flood. Visibility in my vehicle at times was down to a few car lengths. While I could see the car in front of me and the lines on the highway, barely, the sensors in my car could not, hence all the advanced driver assistance systems (ADAS) were essentially useless, no lane keeping assist, no adaptive cruise control, no front or side collision warning system functionality.

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Later after the roads dried out, there I was in the left lane on a

divided stretch of highway sharing it with a couple other cars and a semi-truck in the right lane. All three lanes had vehicles side by side ahead of me, all happily doing the 75-mph speed limit. Out of nowhere, a series of four motorcycles shot between the cars at well over a 100 mph, intently followed by a police car vainly trying to catch up to them. The human drivers of the cars did their best to keep going perfectly straight in their lanes so as not to cause the motorcycles to crash, they then parted to allow the racing police car to keep up the chase. Everything then returned to "typical" driving.

These two examples of edge cases occurred for me within one hour of each other on a drive I've taken frequently. I would say they are not unusual occurrences for me. I would bet truck drivers averaging over 80,000 miles a year probably have a lot of experience with edge cases.

The first example with weather highlights that our autonomous future trucks are only as good as the sensors on them. The decision point on a sensor is first, can it do the job, and secondly, can it do the job reliably, and third, can I afford it. There are a remarkable number of trade-offs in those three simple objectives. As a society, hopefully we all want perfection, but rarely can we afford it, and rarely is it perfect forever.

Sensors require constant monitoring for health, they require occasional calibration and tuning, they require cleaning, and they require replacement. Sensors also are subject to false positives and false negatives — those instances where the sensor either doesn't see something or imagines something that isn't there. Airplanes have a lot of automation and sensors, and decades of experience finding faults in these systems through accidents. Limited media exposure of automotive examples has occurred over the last few years as well.

The second example with the motorcycles highlights that real-world traffic includes people that mostly follow the rules, and others that choose not to. Software engineering around specific rules seems fairly straightforward: rules are generally clearly defined boundaries. But the real-world traffic is not bounded. Free will tends to interfere with that.

Picture a future world where all the vehicles are autonomous, all on a crowded freeway. All going the same speed with similar gaps. I expect someone will want to arrive faster at their destination. That person may pay more to be able to do that. Suddenly one of the lanes of traffic has to move faster than the others to make this possible. We are not so inclined to be herded. Take it further, someone with nefarious motives may even want to be able to outrun others and may modify their vehicles to do so. This is what started stock car racing in the days of prohibition. Still others may want to do harm, and security is a major topic of its own.

In the near- and mid-future, traffic will consist of a variety of vintages of vehicles and drivers, a mix of technologies ranging across decades of vehicle types, making it even more complex to predict the variables encountered in daily situations.

I have always liked Asimov's construct of the three laws of robotics. Decision making for vehicles will be complicated, and I truly admire those innovators making progress in tackling the challenges. I expect it will be a learning curve for all of us.

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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