AUTOMATION IN FREIGHT AND GOODS MOVEMENT IN TRUCKING

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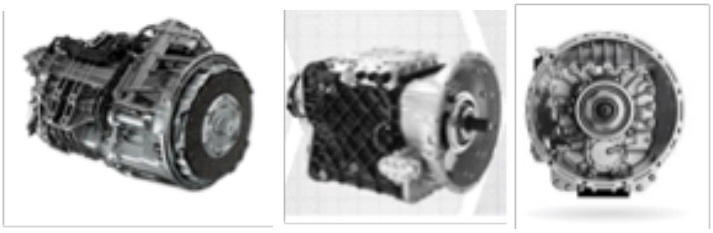
There is considerable potential for the automation of vehicles to vastly transform the freight and goods movement industry. Vehicle automation, particularly with respect to trucking, may present opportunities to lower labor costs, improve safety, and increase fuel efficiency among other benefits. The freight industry is subject to a number of unique dynamics that make it distinct from the constraints and needs of passenger transportation. For example, the processes of parking trucks, docking trailers at berths, and changing trailers present unique challenges apart from those faced by light duty vehicles. Automation in freight requires consideration of not only the tractor unit, but also for the cargo container it pulls which can vary in dimension and weight. Existing research and development in this area has focused on enacting automation in specific situations, such as a highway platoon of trucks, mining operations, and military applications as initial steps. Further research is exploring the possibility of enacting truck and freight automation in more unconstrained environments.

2014 – CURRENT

Current vehicle automation technology in trucks probably best fits within the NHTSA classification of Level 1 autonomy. Many trucks use manual transmissions. Automatic transmissions have long been available in light duty vehicles and while they exist for trucks, they are less ubiquitous. A common alternative to automatic transmissions is called "automated manual transmissions", which still allow driver input to initiate a gearshift on a manual gearbox, but the change is electronically driven (Roberts, 2013).

Advanced Transmissions for Trucks



Source: Freightliner, 2014; Mack, 2014; Volvo, 2014

Automation of the transmission also extends into computerized optimization for fuel efficiency. Advanced transmission systems are integrated into the powertrain to maintain low rpms at highway speeds. Further, transmission systems engage in advanced torque management, again with an emphasis on maintaining lower torques for fuel efficiency, but enabling the switch to high torques when demanded by the driver.

Advanced Stability Control for Trucks

Source: Volvo, 2014

Some trucks, such as high-end models produced by Volvo, also have a number of advanced features commonly associated with Level 2 autonomy. For example, trucks can now be equipped with automated stability control, which will simultaneously lower the torque and apply brakes to individual wheels to mitigate catastrophes such as rollovers and jack knifes. In addition, lane departure warning systems track road markings and can warn the driver if it detects unintentional drift. Finally, trucks can now be equipped with radar that provides drivers with warnings if they are too close to a vehicle ahead of them, and further de-throttle and apply the brakes if necessary.

2020

Much of the work in autonomous freight truck transport has been done in the context of automating 'platoons' of trucks. One of the key benefits of platoons is improved fuel efficiency due to lower drag on platoon members.

Truck Platooning

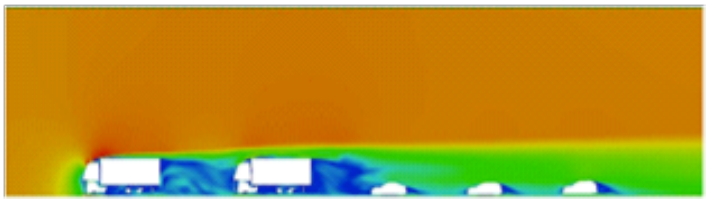
Other benefits include safety improvements due to elimination of human error, as well as more rest time for drivers in moving trucks. Automated platoons operate by allowing the movements of the lead truck to completely control the trucks following it. This would most closely match a situation-specific implementation of NHTSA Level 3 automation, in that the drivers behind the lead truck can cede and retake control at their discretion. Outside the platoon, the trucks are still human controlled at Level 1 or Level 2 automation. Some industry research is also in the process of developing dynamic platoons that can form and dissolve for part of a journey based on demand. In all cases, however, the lead vehicle is always still controlled by a human.

Basic Platooning

Basic and Dynamic Platoons:
Basic platoons consist of 2 to 4 homogenous trucks. Peloton Technology is a Silicon Valley-based company that has created 2-truck platoons. The trucks travel between 6 to 23 meters (20 to 75 feet) apart (Peloton, 2014). Peloton's system boasts a 10% fuel savings for the rear truck and 4.5% savings for the lead truck. Similarly, the New Energy and Industrial Technology Development Organization (NEDO) in Tsukuba City, Japan managed to demonstrate platoons of 4 trucks traveling up to 80 km an hour with a gap of 4 meters between platoon members (BBC, 2013).

A dynamic platoon system can include both trucks and cars that can form and dissolve on the road based on demand. This is a much more complex system, where drivers may choose to join a platoon for some time

Aerodynamic Profile of SARTRE Platoon



Source: Sartre Final Report, 2012

and then can leave whenever they so choose. Two prominent projects exploring this type of system are the Companion Project and SARTRE. The Companion Project is led by a consortium of European companies with trucks supplied by SCANIA, a Swedish truck company. It plans to develop a system that forms, maintains, and dissolves platoons on highways at various times based on individual driver destinations, as well as weather and traffic conditions.

The Safe Road Trains for the Environment project (SARTRE) has demonstrated platoons comprising two trucks followed by three cars. The distance between the vehicles can also be as low as 4 meters and the system can accommodate non-platoon vehicles that enter in the middle. The project envisages a system where vehicles can take turns leading and following the platoon and vehicles on the highway can dynamically join the platoon. Researchers forecast that truck platooning may increase safety due to an estimated reduction of road accidents by 50%, as well as a 10% decrease in fuel consumption

2035

By 2035, we may see broader applications of NHTSA

Autonomous Caterpillar Mining Vehicle

Source: Wall Street Journal, 2013

Level 4 autonomy in freight activity. While there have currently been no commercial implementations of Level 4 automations in truck freight, there have been experimental implementations of autonomous machines in special circumstances such as mining technology. For example, Caterpillar, through its MinestarTM system, has implemented near Level 4 automation at an Australian mining operation.

Autonomous Military Vehicle

Source: Tech Times, 2014

Level 4 Autonomy has also been experimented with in trucks for military applications. Lockheed Martin has partnered with the United States military to experiment with driverless conveys that can navigate supply deliveries through long-haul and hostile environments. These specialized applications comprise just some of the cutting-edge experimental applications of autonomous trucks. Further development of these technologies will likely extend to freight applications mixed with regular traffic. Policy is also likely to play an important role in the coming years and cross several jurisdictions. While the four levels of automation have been established NHTSA, trucks in the United States are regulated by the Federal Motor Carriers Safety Administration (FMSCA). While FMSCA currently has no separate classification system for autonomous trucks, the overlap of truck autonomy with other areas of jurisdiction such as Hours of Service regulation suggest that FMCSA may have a role in developing distinct regulations and classifications for autonomous trucks.

2050

By 2050 and beyond, we may see a more complete integration of Level 4 autonomy into freight activity. This could include the development of specialized vehicles capable of implementing the full operational life cycle required of trucking. Such specialized vehicles may be designed like aerial drones, with limited seating, but still capable of traveling continuously through the automated location of fuel and automated refueling. With centralized instructions or through artificial intelligence, these vehicles may proceed to drop and hook trailers independently, and fully navigate highways, ports, and urban environments non-stop throughout the day and night as needed.

GLOSSARY

Automated Manual Transmission: A transmission that is manually operated with a mechanical gearbox, but is electronically controlled (no clutch).

Federal Motor Carriers Safety Administration: Federal safety administration in charge of regulating trucks

National Highway Transportation Safety Administration: Federal safety administration in charge of highway safety, and in charge of safety regulations related to light-duty vehicles.

Platoon: A group of trucks driving together, generally for the purposes of increased fuel efficiency.

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