TRUCKING EFFICIENCY CONFIDENCE REPORT: Two-Truck Platooning

The fuel costs faced by the tractor-trailer industry have been swiftly and steadily rising over the past decade. In 2014, diesel fuel costs were $0.58 per mile, costing the industry as much per annum as the costs of drivers' wages and benefits combined. Despite recent fuel cost decreases, all indications are that fuel price volatility will continue, forcing the industry to find solutions that increase its fuel efficiency in order to stay profitable. Additionally, the U.S. EPA and NHTSA have finalized the details of the Greenhouse Gas Phase 2 regulations requiring tractor, trailer, and engine OEMs to offer and produce more fuel-efficient equipment.

Fortunately, myriad technologies that can cost-effectively improve the fuel efficiency of Class 8 trucks are readily available on the market today. Unfortunately, multiple barriers have stymied industry adoption of such technologies, including a lack of data about the true performance gains these technologies offer, and a lack of confidence in the performance-testing data that does publicly exist today. To overcome those barriers and facilitate the industry's trust in and adoption of the most promising fuel efficiency technologies, the North American Council for Freight Efficiency (NACFE) partnered with Carbon War Room (CWR) to form Trucking Efficiency. The work of Trucking Efficiency has begun by producing a series of Confidence Reports, of which this report on two-truck platooning is the fourteenth.

However, this report represents the first in a subset of reports to be published on emerging technologies. Widespread innovation and technological advances are seeing the emergence of technologies and practices that could affect decisive opportunities across the transportation industry. As novel concepts, new applications, and innovative modes of behavior reach the market, fleets and manufacturers need information on their benefits, challenges, and risks so that everyone can profit in this evolving landscape. NACFE will lead this effort, with plans to publish Confidence Reports on technologies such as variable engine accessories, waste heat recovery, powertrain electrification, and others.

"TWO-TRUCK PLATOONING IS SHOWING REAL PROMISE AS A FUEL-SAVING TECHNOLOGY, EVEN WHEN CONSIDERING THE ACTUAL PERFORMANCE IN REAL-WORLD USE."

Mike Roeth, Operation Lead, Trucking Efficiency and Executive Director, NACFE

Methodology

This report's conclusions were generated through desk research, conversations at a variety of trucking industry events around the country, and a series of structured interviews with fleets, truck OEMs, and platooning technology developers/manufacturers active in the North American market today.

This study differs from past Confidence Report efforts in which the Trucking Efficiency team reviewed products available in the marketplace. As platooning is an emerging technology, only available in limited deployment, the team is using its common approach to understanding the confidence fleets should have in adopting the devices before they become available. Thus, this work does not report known benefits and consequences of adoption, but rather what the industry believes the benefits and challenges of the new technology will be.

The goals of this Confidence Report are: (a) to give the industry a foundational understanding of two-truck platooning; (b) to put it in context with the longer-term autonomous trucking initiative; (c) to provide an unbiased overview of the benefits and challenges related to platooning; and (d) to help fleets rationalize their investment in two-truck platooning.

Truck platooning is an emerging transportation technology designed to boost fuel economy performance for tractor-trailers engaged in long- and regional-haul highway applications. Platooning combines existing commercial vehicle safety technology with emerging vehicle-to-vehicle communications and autonomous vehicle control technology to electronically "tether" tractor-trailers together in a convoy formation at highway speeds. Once a platoon of trucks is established, the vehicles' safety systems work in unison to draw the trucks together at significantly reduced following distances to overcome each vehicle's inherent aerodynamic drag.

FUEL SAVINGS OF PLATOONING

Without question, truck platooning is a valid method of reducing fuel consumption for tractor-trailers engaged in long-haul applications. Once the trucks have moved into close following distances, all of the engaged vehicles receive a significant fuel economy boost thanks to increased aerodynamic efficiencies. The lead vehicle, which bears the brunt of the aerodynamic load, typically sees only a modest fuel economy boost. But the trailing truck in a platoon, which is now operating in a low air pressure aerodynamic "sweet spot," can see significant increases in fuel economy performance at highway speeds. Moreover, overall fleet operations remain largely intact in terms of vehicle routing and operations.

The potential fuel consumption savings versus an isolated single vehicle varies depending on the separation distance of the trucks (as shown for the lead vehicle in Figure ES1). Multiple fuel consumption tests have been conducted over the past few decades to better understand this efficiency improvement. A separation distance of 40 to 50 feet could lead to average savings of about 10% for the following vehicle and 4% for the lead vehicle.

However, real-world factors such as congestion, terrain, weather, and road construction will reduce these savings, so fleets will have to estimate this reduction depending upon the routes on which they plan to operate the trucks; a reasonable estimate would be a reduction of about a quarter of the savings, but very little data exists for this prediction. A fleet must also apply the percentage of operating time that the truck equipped with platooning will actually be involved in a platoon, which NACFE research suggests will be less than 100%. If that were 75%, then the real-world, expected savings would be on the order of 4% average for both trucks. Even if a truck is platooning 50% or less, it still represents significant potential improvement in fuel use for the following vehicle in a platoon.

FIGURE ES1: FUEL CONSUMPTION REDUCTION VS. SEPARATION DISTANCE—LEAD VEHICLE

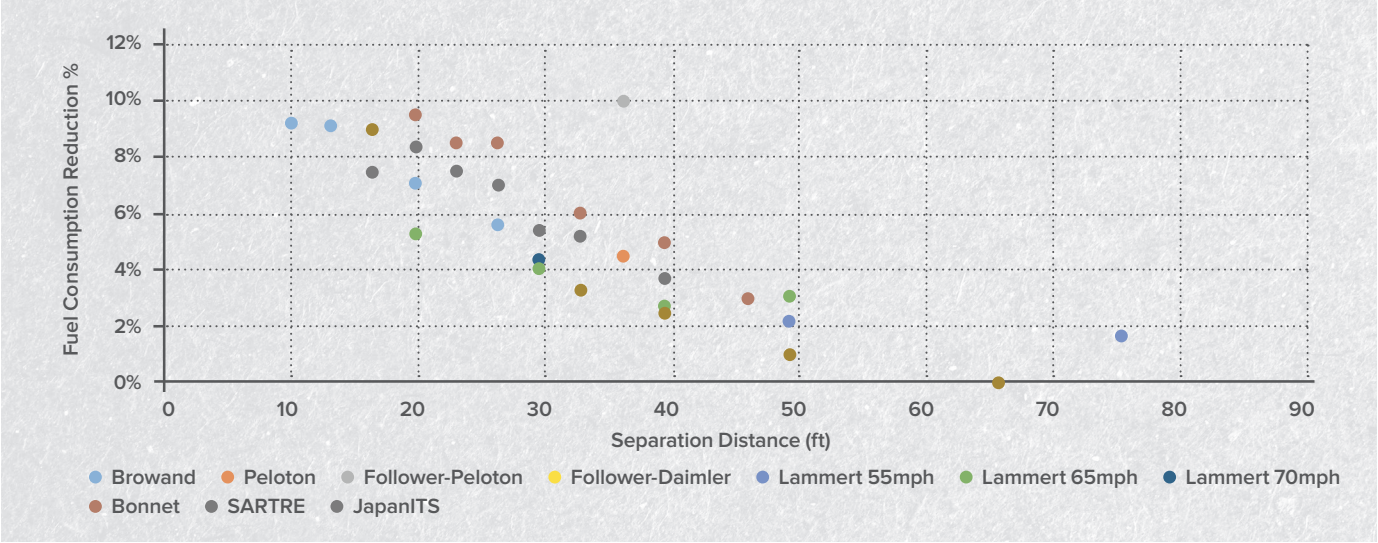


FIGURE ES2: EVOLUTION TO AUTONOMOUS TRUCKING

IMAGES, LEFT TO RIGHT: RYDER, PELOTON, DAIMLER TRUCKS, UMEA INSTITUTE OF DESIGN

PLATOONING AND AUTONOMOUS TRUCKS

Platooning is a catchall term for a broad range of possible implementations of fuel economy improvement through controlled operation of two or more trucks in tandem. The term may have different meanings for different people. One future vision is a fully autonomous vehicle with no driver that is operating in a road train.

The initial platooning steps are technology building blocks toward this eventual fully autonomous vehicle, which could be decades away. The Confidence Report includes background on where these technologies are headed to add perspective. However, NACFE's goal is to stay grounded in reality with near-term two-truck platooning opportunities where human drivers have their hands on the wheel and the technology is assisting the driver in getting better fuel economy by reducing aerodynamic drag through safely following another vehicle at shorter distances than an unassisted driver could safely maintain.

OVERCOMING PERCEIVED AND REAL CHALLENGES

The challenges of implementing two-truck platooning include:

Payback—The payback for platooning is driven by many factors, including the upfront cost for the equipment, any subscription costs for platooning, the savings in fuel, the costs to mitigate any of the challenges, and the level to which the fleet is already investing in safety technologies. A payback calculator is provided with the report.

Driver acceptance—Drivers must learn, and become comfortable with, an entirely new operational dynamic behind the steering wheel. However, despite widespread industry concerns of driver physiology and safety, it appears that platooning technology and its integrated safety systems are powerful and fast enough to substantially overcome reduced driver fields of view and reaction times. Platooning also has an extremely shallow learning curve and requires minimal additional training for drivers to become proficient.

Platoon integrity—A commonly cited concern is how the platooning trucks and the individual drivers will react if passenger cars move into the gaps between platooning trucks to get out of a passing lane or get to a highway exit ramp. However, each vehicle's active safety systems would react exactly as they would if a vehicle cut a single truck off in traffic today: The brakes would immediately engage and slow the truck until it achieves a safe following distance behind the intruder vehicle. Likewise, any trucks behind the threatened truck would react accordingly.

System security—In order to prevent "hackers" from breaking into platooning communications systems, security will be paramount. Primary concerns will be to develop encryption that will protect systems from hackers looking to obtain proprietary information about a specific vehicle or fleet specifications as well as prevent the ability to disable safety systems or assume control of autonomous vehicle systems with the intent to deliberately crash or divert a vehicle.

Amount of viable platooning time—It is an open question whether platooning might be a viable option only a small percentage of the time and whether any fuel savings would justify the outlay in acquisition and operational costs. This cannot be answered until more information concerning platooning's durability, flexibility, and ease-of-use in day-to-day fleet operations has been gathered.

Legislative efforts and public awareness—Changes to traffic laws that reflect the impact this new technology will have on our highway transportation need to be considered on both the state and federal levels. OEMs and platooning technology developers are working with the American Trucking Association and state-level trucking associations to raise awareness about truck platooning and its potential fuel-saving benefits with lawmakers. On September 20, 2016, the U.S. Department of Transportation issued its Federal Automated Vehicle policy, which will facilitate technology research, testing, and implementation, including aspects of two-truck platooning.

Sharing fuel savings—A concern is how competing fleets will compensate each other to maximize the benefits of fuel economy credits. Solutions range from a cloud-based "banking" system that would record overall platooning participation and allocate credits, to relying on the law of averages to even out penalties and benefits for fleets that regularly engage in platooning operations.

Reliability—Reliability of platooning technology systems remains unknown, as there is little field history on these systems. This is critical because as platooning separation distances decrease, reaction times required for safe operation become too short for the human driver to be a viable back-up system. However, on-highway platooning research demonstrations will evolve into production systems and reliability will improve based on feedback from actual use.

Litigation—Imbedded in operating costs is a need to address the potential impact of litigation. While a detailed discussion is beyond the scope of the Confidence Report, NACFE has identified key operating cost questions needing clarification for platooning to progress.

TECHNOLOGIES

NACFE's focus with this report is on the potential for fuel economy improvement with near-term two-truck platooning that makes use of current production driver-assistance systems and emerging vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication systems. These are real-world systems that fleets will be encountering in the next five years rather than futuristic visions.

Required technology to enable platooning includes:

- **Collision avoidance system:** The ability to safely brake the vehicle faster than human reaction times, and to sense surrounding traffic conditions.
- **Adaptive cruise control:** A system for maintaining a set distance (or time) to a lead vehicle using a variety of methods such as laser and radar systems.
- **MPG optimization systems:** Software, sensors, and hardware that can optimize individual vehicle fuel economy performance based on surrounding traffic and environmental conditions.
- **Vehicle transmission of sensor data:** Ability to transmit collision avoidance and adaptive cruise information to other vehicles.
- **Vehicle reception of sensor data from other vehicles:** Ability to receive and process the sensor data from other vehicles.
- **Platooning software:** Software that makes use of the other vehicle's sensor data to adjust performance of your vehicle.
- **Platoon MPG optimization software:** Software that allows two vehicles to perform even better by concurrently optimizing their individual performance knowing they are in a group.
- **Enhanced platoon MPG optimization software:** Software that allows a group of vehicles to optimize performance as a group.

Many of these systems are already being spec'd on North American tractor-trailers in large numbers, and purchasing trends indicate the "take rate" for these systems is growing. Equally important is NACFE's strong suspicion that many—if not all—of these safety systems will be mandated as standard equipment on all new Class 8 vehicles in the near future, as will V2V communication systems. Moreover, it is extremely likely that similar safety systems and V2V communication systems will be mandated for all new passenger cars and vehicles in the same general timeframe as well. Therefore, it is extremely likely that in the near future, Class 8 tractors will be sold as platooning capable "right out of the box," making it extremely easy for fleets to take advantage of platooning as a fuel-saving technique.

"SAFETY SYSTEMS ON THE TRUCK REACT MUCH, MUCH FASTER THAN A HUMAN DRIVER CAN."
Jack Roberts, NACFE Study Manager

CONCLUSIONS AND RECOMMENDATIONS

Given the current availability of information on two-truck platooning, the study team found:

- The real-world fuel savings of two-truck platooning is likely to be a 4% average across the two trucks.
- The bulk of the required technology is currently available and being purchased by many fleets.
- Intervals of 40 to 50 ft. will likely have sufficient payback for early adopting fleets, and then shorter distances, with their higher fuel savings, can be implemented with product improvements.
- Two-truck platooning is not fully autonomous/driverless trucking and it is actually being improperly grouped with that concept.
- Driver stress will likely be less than perceived to date.
- Platooning will accelerate the adoption of other technologies such as collision avoidance and adaptive cruise control.

The recommendations for the industry to focus on and expedite the speed with which platooning is introduced and adopted include:

- Evaluate the real-world fuel economy possible with platooning in a set of tests with real trucks on real routes with varying levels of truck and passenger car congestion.
- Expedite standard communication protocols and security measures within the groups already working on them.
- Expand OEM and fleet testing to ensure appropriate functionality and reliability of all system components.
- Develop driver education to increase the understanding and performance of driving trucks in platoons.

IMAGE: MERITOR WABCO

- Ensure all costs and benefits are monetized and improved in total cost of ownership and payback analyses.

Over time, as both industry and general-public comfort levels concerning platooning rise, it is likely the scope and scale of platooning as an industry practice will grow and fleets will see the percentage of time trucks spend in platooning mode rise accordingly. Therefore, NACFE predicts that initial platooning operations in North America will be limited to intra-fleet activity until the industry has a better feel for how platooning works in the real world and concerns regarding data transmission between vehicles have been alleviated.

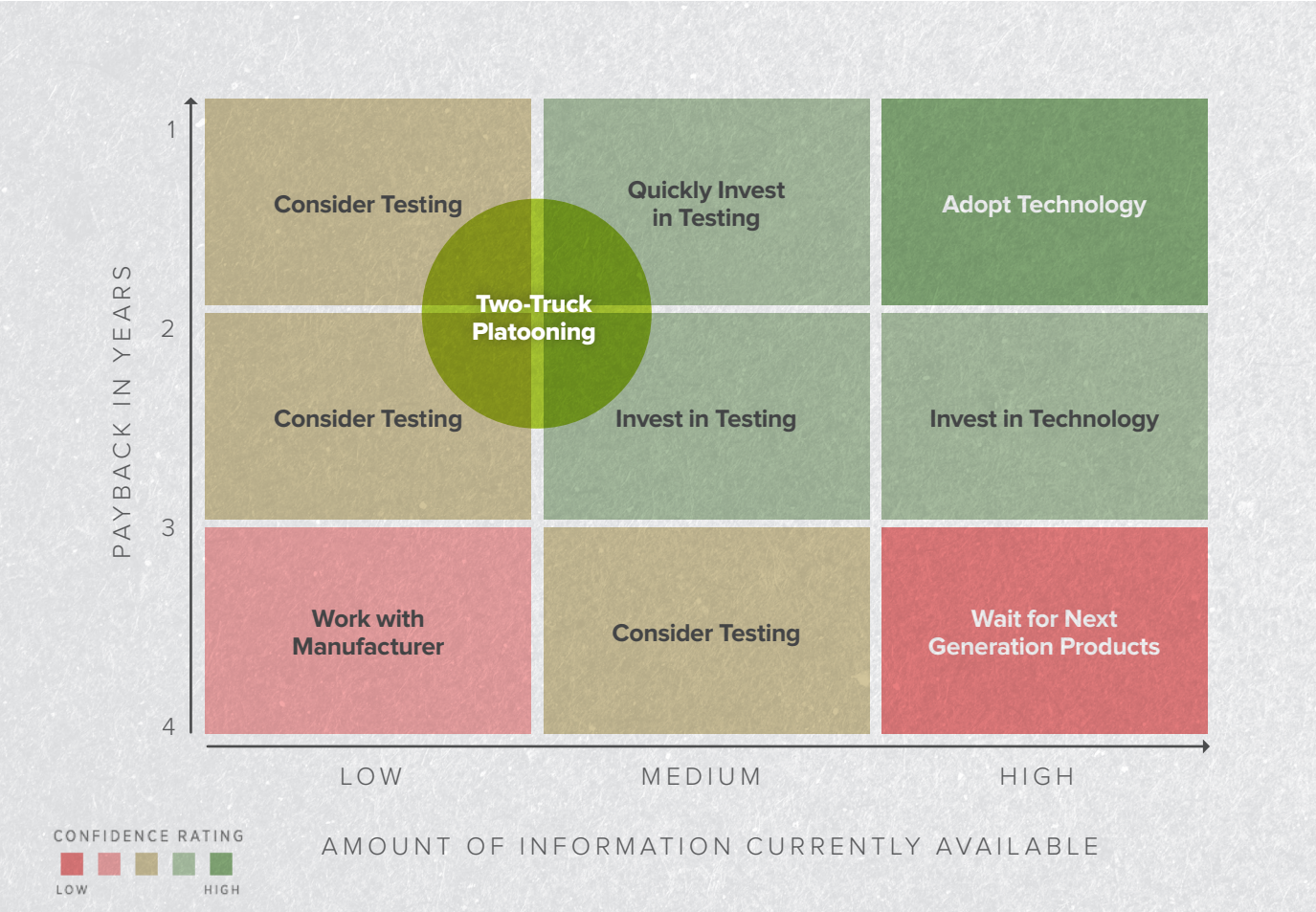
CONFIDENCE RATING

For each of the Confidence Reports completed by Trucking Efficiency, the various technologies assessed therein are plotted on a matrix in terms of their expected payback in years compared to the confidence that the study team has in the available data on the performance of that technology—that is, not only how quickly fleets should enjoy a payback on their investment, but how certain Trucking Efficiency is in the assessment of that payback time. Technologies in the top right of the matrix have a short payback, usually thanks to their low upfront cost and, moreover, are found to have enough performance data that fleets can be highly confident in those short payback times, usually because the technology is more mature or otherwise has a more substantial track record of results.

Trucking Efficiency is confident that the potential for fuel savings with platooning is strong, but it is likely that platooning opportunities in real-world fleet operations will initially be extremely limited. Early platooning adopters will be large, dedicated fleets with numerous trucks operating on a given stretch of highway. The potential for some fuel savings for regional and super-regional fleets pulling similarly enclosed trailers exists, but will likely not materialize until platooning becomes a widely accepted industry practice and opportunities for extra-fleet platooning become commonplace.

Trucking Efficiency is always seeking to expand the data or case studies that we can provide to the industry. We invite you to share your own experiences with tractor aerodynamic technologies.

CONFIDENCE MATRIX: TWO-TRUCK PLATOONING



TRUCKING EFFICIENCY

Trucking Efficiency is a joint effort between NACFE and Carbon War Room to double the freight efficiency of North American goods movement by eliminating barriers associated with information, demand, and supply.

Worldwide, heavy-duty freight trucks emit 1.6 gigatons of CO_2 emissions annually—5.5% of society's total greenhouse gas emissions—due to the trucking sector's dependence on petroleum-based fuels. With fuel prices still commanding nearly 40% of the cost of trucking, the adoption of efficiency technologies by all classes of trucks and fleets offers significant cost savings to the sector while reducing emissions. These technologies are relatively cheap to implement and widely available on the market today.

Trucking Efficiency provides detailed information on cost-effective efficiency technologies, including data from across a variety of fleets and best practices for adoption. This Confidence Report series from Trucking Efficiency aims to serve as a credible and independent source of information on fuel efficiency technologies and their applications.

In order to generate confidence on the performance claims of efficiency technologies, Trucking Efficiency, via these reports, gathers and centralizes the multitude of existing sources of data about the performance results of different technology options when employed in a variety of vehicle models and duty cycles, and makes all of that data openly accessible and more easily comparable. Furthermore, we assess the credibility of the available data, and provide an industry-standardized ranking of confidence in performance results, including ROI and efficiency gains.

www.truckingefficiency.org

Trucking Efficiency welcomes outside views and new partners in our efforts to help accelerate the uptake of profitable, emission-reducing trucking technologies.

CARBON WAR ROOM

Carbon War Room (CWR) was founded in 2009 as a global nonprofit by Sir Richard Branson and a group of likeminded entrepreneurs. It intervenes in markets to accelerate the adoption of business solutions that reduce carbon emissions at gigaton scale and advance the low-carbon economy. CWR merged with Rocky Mountain Institute (RMI) in 2014 and now operates as an RMI business unit. The combined organization engages businesses, communities, institutions, and entrepreneurs to transform global energy use to create a clean, prosperous, and secure low-carbon future. The combined organization has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

www.carbonwarroom.com

NACFE

The North American Council for Freight Efficiency works to drive the development and adoption of efficiency-enhancing, environmentally beneficial, and cost-effective technologies, services, and methodologies in the North American freight industry by establishing and communicating credible and performance-based benefits. The Council is an effort of fleets, manufacturers, vehicle builders, and other government and non-governmental organizations coming together to improve North American goods movement.

www.nacfe.org