Introduction

Trucking Efficiency is a joint effort between the North American Council for Freight Efficiency and the Carbon War Room to double the efficiency of North American goods movement by 2016 through the elimination of market barriers to information, demand and supply.

The Operation is gathering and centralizing the many existing sources of data about the performance results of different technology options and working with the industry to share previously unpublished data, when employed in a variety of vehicle models and duty cycles, and making all of that data openly accessible and more cross-comparable. In order to generate confidence on the performance claims of efficiency technologies, Trucking Efficiency is conducting a series of studies, known as Confidence Reports. The first Confidence Report focused on the available technologies for ensuring appropriate tire pressure and the second one on the use of 6x2 axles, published respectively in August 2013 and January 2014. We will be publishing additional reports on idle reduction solutions, automated transmissions and driver coaching aids.

Technology Overviews are the first step in the Confidence Report process and share readily available information on a particular technology or complementary set of technologies. Their intention is to supply a general overview on the topic and to solicit assistance, study sponsorships, to enable Trucking Efficiency to dedicate the resources for the complete Confidence Report. This overview discusses the opportunity to improve efficiency through the use of automated manuals and fully automatic transmissions for Class 8 regional and long haul tractor trailers in North America. The team is planning to conduct a deep dive Confidence Report in early 2014 on this topic, if sufficient sponsorship funds are received.

Summary Statement

High fuel costs require fleets to look at ways to improve fuel economy and to adopt solutions and technologies that fit their particular applications. One solution set is in the choice of a transmission. Switching from a manual to an automatic or automated manual transmission (AMT’s) delivers improved fuel economy. The fuel savings comes from more efficient shifting in a consistent fashion than with a manual transmission. Both types of transmissions have been in the marketplace for decades but new technology and full integration of other systems have improved them recently.

The terms automatic and automated are often used interchangeably, but they are actually quite different systems. One of the few similarities of automatic and automated manual transmissions is the two pedal design. The fundamental difference is that the automatic transmission uses a torque convertor rather than a typical two-plate manually activated clutch. Automatic transmissions use the same set of gears to produce
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the different gear ratios. Automatics in heavy truck applications typically have five or six forward speeds and one reverse.

Automated manual transmissions are a standard manual gearbox with electrical or pneumatic servos that automatically (under electronic control) execute the gear changes and manage the clutch. Beyond the electronic control and the actuation of the gear changes, the automated manual isn’t much different from its fully manual, driver-controlled version. Think of it like a robotic shifter on a manual transmission.

Around 40% of short haul trucks are utilizing AMTs already which possess attributes well adapted to frequent starting and stopping. Long haul adoption, though, has lagged - only a few percent of long haul fleets are using AMTs. This overview will focus on the long haul application of automatic and automated manual transmissions, emerging technology and related issues.

Technical Summary

New technology is often slow to be adopted and may be prone to criticism. In early applications of AMTs, drivers complained of transmissions and engines experiencing difficulty talking to one another especially in challenging conditions. The transmission and engine sent data back and forth, but due to limitations in that relatively new technology, neither unit had a complete picture of the vehicle’s state. A perception of the vehicle performing poorly resulted in negative criticism. Now, with the advent of powerful and compact electronic control modules (ECM), transmissions are better able to anticipate the correct gearing for the current conditions. Sensors and real-time communication with ECMs allow the transmission to know when, what gear, and how quickly to make a shift. The transmission and engine estimate the vehicle load and the grade of the road. With improvements in data acquisition and data sharing, automated manual transmissions continue to get better.

Driver skill greatly impacts fuel economy in the operation of a manual transmission. AMTs lessen the variable results from the driver factor. This becomes even more important in high driver turnover environments.

Automated Manual Transmission Solutions

An AMT works well because of the seamless integration of the engine and transmission. The information shared between the engine and transmission is the fuel map, the load, the grade and what the engine is trying to do. The transmission can manage all of this information and deliver the best performance possible given all those criteria. A driver can’t do that consistently. Even if the driver had all of the relevant information, a driver couldn’t process it and manage the shifts to deliver the same level of performance an automated manual transmission can.

Eaton is the principal provider of AMTs today. Ultrashift Plus and Ultrashift HV are the fully automated solutions available. The Ultrashift is built upon the Fuller 10-speed manual; it uses an electronic clutch actuator to provide faster shifting and smoother engagement. Another AMT product is the Autoshift; the driver uses the clutch for starting and stopping. Once the vehicle is in motion, the transmission operates like an automatic. In some fleet situations, this can improve the maintenance expense of the truck by prolonging the life of the clutch. http://www.eaton.com/Eaton/ProductsServices/Truck/Transmissions/
Volvo developed its own AMT, a down speeding variety with its XE13 powertrain package. Its I-Shift technology offers a next generation micro-processor that delivers intelligent features that improve drivability, safety and fuel efficiency. By continuously monitoring the changing grade, vehicle speed, acceleration, torque demand, weight, rolling and air resistance, the I-Shift can instantly predict and select the most efficient utilization of the engine. 

Mack offers its SuperEconodyne drivetrain using the mDrive AMT. The MACK mDRIVE is designed and engineered to work exclusively with MACK MP series engines. The mDRIVE transmission features Mack’s industry-leading, two-speed reverse, which better controls speed and engine RPMs.

Detroit Diesel offers the DT10 automated manual transmission. It is a 12-speed automated manual transmission with shorter gear steps. It was designed with a number of innovative features to achieve optimal fuel economy. Optional Direct Drive - in top gear the transmission operates as a direct drive, sending engine input directly through the main shaft, eliminating parasitic gear mesh losses of power and increasing fuel efficiency. eCoast maximizes fuel efficiency by allowing the vehicle to coast down grades. The engine operates at idle speeds while maintaining momentum. Sophisticated transmission electronics ensure safe operations in all driving conditions. Skip Shift increases shifting efficiency, the electronic powertrain controls automatically skip unnecessary gears. This helps increase acceleration to achieve cruising speed quickly and smoothly. The Transmission Control Module (TCM) calculates the torque wind-up in the driveline and regulates with engine torque control for enhanced driving comfort and less driveline wear. The TCM limits torque in severe surface conditions, protecting the driveline.

**Automatic Transmission Solutions**

Fully automatic transmissions provide improved fuel economy combined with the reliability, durability and productivity. These transmissions select the optimum shift points based on load and terrain to automatically improve fuel economy or provide more power as needed.

Allison offers the TC10 which provides a blended architecture with full-power shifts, a torque converter and a twin countershaft gear box. Its 10 forward speeds and two reverse make the TC10 ideal for distribution applications where the tractor-trailer splits its work cycle between city and highway conditions. It’s targeted toward regional applications with lots of shifting. Rated up to 600 horsepower and 1,700 lb-ft of torque at launch, the TC10 comes equipped with Allison’s newest generation of electronic controls, which provide superior fuel economy features, prognostics to eliminate unnecessary oil and filter changes and enhanced shift selector functionality.

In 2012 Allison Transmission invited members of the press to a ride and drive event in Indianapolis to showcase the new Allison TC10. Two Peterbilt 384 daycab tractors were provided – one with the new Allison product, the other with an Eaton Fuller Ultrashift Plus 10-speed. The test was conducted in Indianapolis. The results can be found at [http://www.truckinginfo.com/channel/equipment/article/story/2012/04/test-drive-allisons-tc10-is-a-future-tense-tranny.aspx](http://www.truckinginfo.com/channel/equipment/article/story/2012/04/test-drive-allisons-tc10-is-a-future-tense-tranny.aspx).
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OEM Offerings / Integrated Solutions

**Cummins Eaton Smart Advantage** ([http://smartadvantagepowertrain.com/](http://smartadvantagepowertrain.com/))

Cummins Eaton Smart Advantage is a 10-speed automated manual transmission paired with the Cummins ISX15 engine and is available at multiple tractor original equipment manufacturers. Providing significant benefits across the board for line haul and regional haul fleets, the engine and transmission share critical data, determining the torque curve and power level needed to match real-time load demand. This optimizes performance and fuel economy as a total unit. Cummins estimates that drivers can achieve between three and six percent improved fuel economy.

**Navistar** ([www.Navistar.com](http://www.Navistar.com))

"At Navistar we continue to evaluate technologies aimed at reducing the cost of operations for our customers, but the greatest variable today in fuel economy is the driver," said Bill Kozek, president of North America Truck and Parts, Navistar. "Our portfolio of fully automated transmissions reduces the variance between expert drivers and first-timers by electronically monitoring vehicle speed, grade, weight and more to select the best gear for the engine. This not only improves efficiency, but it will extend the life of the driveline." Oct. 21, 2013 /PRNewswire/

The company’s portfolio of fully automatic and automated manual transmissions includes Cummins Eaton Smart Advantage, Eaton UltraShift® Plus® LSE and Allison TC10 transmissions.

Eaton’s UltraShift® Plus® LSE transmission is designed exclusively for Navistar. The new 16-speed direct drive automated mechanical transmission maximizes fuel efficiency in line haul applications and Eaton testing has validated drivers can achieve six percent improved fuel economy. Designed with a small 17 percent step between gears, the transmission optimizes a diesel engine’s most efficient RPM zone to reduce fuel consumption. The UltraShift Plus LSE has 16 forward gears and two reverse gears, and an overall ratio of 14.40. [http://media.navistar.com/index.php?s=43&item=652](http://media.navistar.com/index.php?s=43&item=652)


Production of the first AMT in a Freightliner Cascadia for the North America market began in 2013. First offering the 2,050-pound-foot version of the DT12 matched up with the DD15 engine. Then they offered the 1,650 pounds-foot version of the DT12 matched with a DD13 engine. The DT12 will be available with the DD16 engine in 2014. [http://www.ccjdigital.com/detroit-bringing-automated-manual-transmission-to-north](http://www.ccjdigital.com/detroit-bringing-automated-manual-transmission-to-north)

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Volvo/Mack (www.volvotrucks.us.com and www.macktrucks.com)

The Volvo I-shift is now a standard offering on all North America Volvo powered trucks. It was designed to work seamlessly with Volvo Power engines D11, D13 and D16. The Mack mDrive is available on MACK® Pinnacle™ model highway tractors powered by the MP7 and MP8 engines.

Fleet Experiences

From the September 2013 issue of World Industrial Reporter, the publication shares a few experiences with automatic and automated manual transmissions. Delivering fuel to gas stations throughout northern Virginia, Washington, D.C., and Baltimore metropolitan areas, Fleet Transit has a fleet of 50 tractors. The company was looking for ways to lower maintenance costs, eliminate driveline problems and increase fuel economy, notes Ken Glover, maintenance supervisor. It also wanted to improve safety and enhance driver recruitment and retention.

Today, Fleet Transit believes that is has found part of the answer for addressing all of those challenges in Allison automatic transmissions. Since buying six Allison-equipped tractors in 2010, the company has added 16 more, including four in the first half of 2013. “With a manual transmission, our average fuel economy on those trucks is 6.2 MPG,” Glover relates. “On the Allison-equipped trucks it’s 6.7 MPG, an 8.1% improvement.”

Glover also points out that the first six of Fleet Transit’s Allison-equipped Mack tractors now have approximately 225,000 mi. With an average clutch life of 200,000 mi. and an average cost of clutch replacement at about $4,000, the company estimates it has saved $24,000 on clutches so far.

Usher Transport, based in Louisville, Ky., specializes in short and midrange tanker loads with a fleet of 300 Freightliner and Volvo tractors. Usher Transport is now specifying Eaton UltraShift PLUS Linehaul Active Shifting (LAS) automated transmissions. Keith Judd, maintenance director, states the fleet is seeing as much as a half of a percentage point in fuel consumption improvement as well as improved safety.

Those are two of many stories that point out the value that fleets are realizing by spec’ing automatic and automated transmissions, which are now available from a number of truck OEMs and component manufacturers.

Regulations

Emissions regulation in engines has been in place now for many years and engines were included in the first ever Greenhouse Gas Emissions for commercial trucks. In 2011, the National Highway Traffic Safety Administration (NHTSA) and the U.S. Environmental Protection Agency (EPA) jointly published a Federal Register notice finalizing rules to establish a comprehensive Heavy-Duty National Program to reduce GHG emissions and fuel consumption for on-road MHDVs (the ‘Phase 1 Rule’). This rule is now in effect in 2014. Phase 2 discussions have begun with the proposal to add additional areas to the regulation including possible more than just the engine in the powertrain. Future regulations could include transmissions.
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**Economics**

All this technology is fascinating, but where it really matters is the bottom line. Data shows that AMTs can lead to a 3% to 6% reduction in fuel consumption. Let’s assume an average of 120,000 miles on the road annually, 6 mpg and diesel fuel at $4.00 a gallon. The fuel savings with automated manual transmission use on fuel economy of 3% is $2,300 annually per vehicle. This can really add up for fleets.

AMTs can cost almost as much as fully automatic transmissions but claim superior fuel economy. The additional cost of an AMT or automatic transmission over a manual transmission is a tradeoff for improved fuel economy, improved maintenance costs and good resale.

The AMT and automatic transmissions prolong the life of the driveline and the clutch which provides value from a maintenance perspective. Another deciding factor is residual value or resale. Although a manual transmission offers a substantial cost savings initially, the initial price advantage over an automatic transmission will likely be diminished at the time of resale.

Automatic and Automated transmissions also provide benefits in terms of driver recruitment and driver retention. This technology makes driving easier, decreases the learning curve and is generally accepted by drivers.

**References**


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Please consider sponsoring the Confidence Report on Automated Transmissions

Help us transform the entire industry. Fuel-efficiency technologies abound, but the claims providers make about their technology’s efficiency-improving values are equally numerous, and fleet owners need proof of the validity of performance data before adopting. Trucking Efficiency has been created as a trusted, unbiased source of information on fuel-saving technologies, their applications and potential solutions for financing their adoption. The NACFE and the CWR are developing a two-pronged strategy, addressing both informational and financial barriers, that will build credibility and fast-track the adoption of fuel-saving technology by class 8 commercial vehicles in the United States. This effort is driven by the fleets included in the NACFE technical advisory group, shown to the right. They along with every tractor and trailer end user are the primary customers of these confidence reports.

Project sponsorship is needed to complete the confidence report. Sponsorships are available as shown below. Contact either Mike Roeth, NACFE Executive Director at mike.roeth@nacfe.org or Ann Davlin, CWR Director, Development at adavlin@cabonwarroom.com.
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About the Carbon War Room
The Carbon War Room is a global nonprofit, founded by Sir Richard Branson and a team of like-minded entrepreneurs, that accelerates the adoption of business solutions that reduce carbon emissions at gigaton scale and advance the low-carbon economy. The organization focuses on solutions that can be realized using proven technologies under current policy landscapes. Working collaboratively in sectors where we have proven that profitable emission-reduction opportunities exist, the Carbon War Room aims to create well-functioning, high-growth, and low-carbon marketplaces by launching Operations in those sectors. The War Room’s current Operations include Maritime Shipping Efficiency, Green Capital for Energy Efficiency in the Built Environment, Renewable Jet Fuels, Smart Island Economies, and Trucking Efficiency. For more information, please visit www.carbonwarroom.com.

About NACFE
The North American Council for Freight Efficiency will 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-government organizations coming together to improve North American goods movement. More can be learned about the NACFE at www.nacfe.org