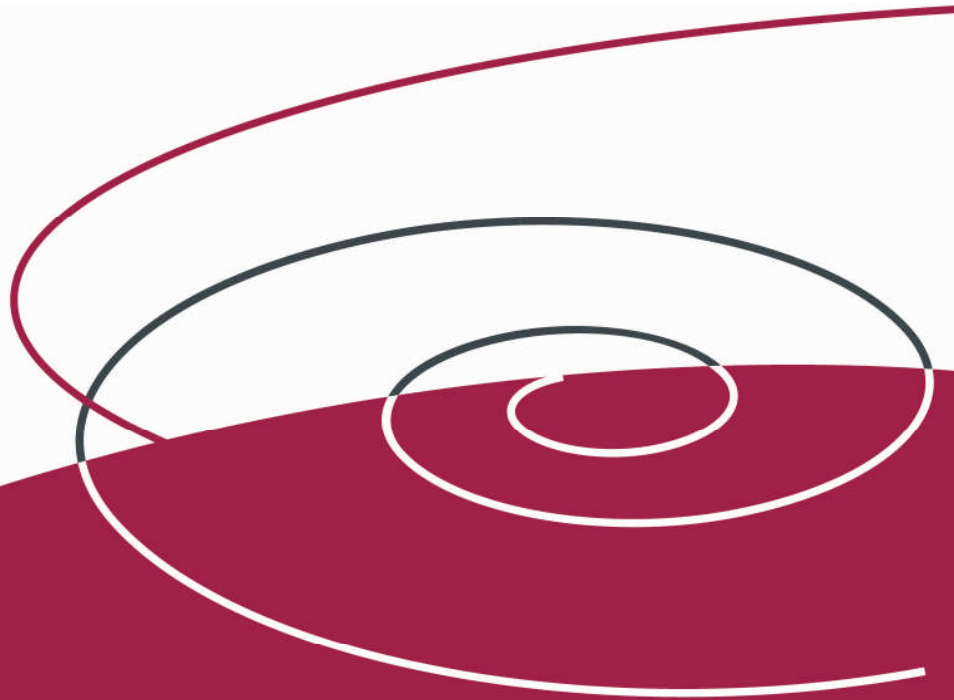




Driver Training and Monitoring: For a Cleaner Tomorrow

A White Paper by **Trapeze Group**

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Introduction

There have been numerous studies that have tried to correlate and quantify the relationship between driver training and fuel efficiency. These studies have been fairly intense and measured such driving factors as:

- pulse and coast
- RPM
- short distance acceleration
- smoother breaking and acceleration
- hard braking
- idling
- anticipation, and more.

The overwhelming conclusion of these studies showed that a universal improvement in fuel efficient driving techniques could be obtained by *proper driver training*. In fact, it was shown that even highly experienced drivers can enhance their skills with training aimed at raising fuel economy and in many cases fuel savings of between 5% and 20% could be achieved.

For example, the city of Edmonton, Alberta has employed a driver training program called Fuel Sense¹ with the goal of reducing overall corporate fuel usage by 5 to 10 percent. 700 drivers attended a 4-hour in-class session at the beginning of the program where they learned about fuel efficient operation of a vehicle. This was followed by a series of in-vehicle sessions where they were coached and evaluated on their performance. In one year, fuel consumption was down 10 to 20 percent, translating into a savings of \$175,000.

Increased fuel usage results in an increase in four major pollutants: particulate matter (PM), hydrocarbons, nitrogen oxides, and carbon monoxide.

Large amounts of carbon monoxide have been shown to trap the Earth's heat and cause global warming; and exposure to PM pollution has been associated with respiratory and cardiac problems, infections, asthma attacks, lung cancer and decreased life expectancy. In the Edmonton example cited above it was estimated that the fuel savings alone avoided 310 tons of greenhouse gas emissions in the first year of the program.

*Clearly there is a direct relationship between driving techniques and fuel consumption **and** between fuel consumption and a cleaner tomorrow.*

¹ Transport Canada, "Fuel Sense: Making Fleet and Transit Operations More Efficient," www.tc.gc.ca/programs/environment/utsp/fuelsense.htm, July, 2007.

From a 'rubber to the road' perspective there are obviously a number of practical mechanical measures that can and are being taken to reduce emissions and create a cleaner environment such as²:

- ongoing vehicle maintenance
- routine tune-ups (e.g. injector cleaning, air filter, fuel filter and oil filter cleaning / replacement)
- retrofitting in-use vehicles with oxidation catalysts, particulate traps, alternative fuel kits
- moving to cleaner fuels/lube inspections/ reporting to reduce adulteration, lube substitution, fuel additives
- improving in-use vehicle emission standards.

As the technology becomes more and more sophisticated it will undoubtedly result in more efficient engines and cleaner fuel emissions.

From another perspective fuel savings, and hence exhaust emissions, can also be realized by promoting good driving techniques. In a number of studies it has been shown that driver training programs that teach such fundamentals as:

- smoother braking and acceleration
- speed control, and
- anticipatory driving

can reduce fuel consumption by 5% to 20%.

In another publication, *Clean School Bus USA*³, it was estimated that school buses alone emit approximately 3,000 tons of toxic soot, 95,000 tons of smog-forming pollutants and 11 million tons of global warming gases. *Even using with conservative estimate of a 5% savings there would be a compelling argument that the fuel reduction achieved by a comprehensive driver training course would represent a substantial contributor to a cleaner environment.*

² Developing Integrated Emission Strategies for Existing Land Transport, "Analysis and/or Testing of Polices and Technologies: General Guidelines," http://infofile.pcd.go.th/air/DIESEL_ppt_analysis.pdf, February, 2004.

³ United States Environmental Protection Agency, "Clean School Bus USA", www.epa.gov/cleanschoolbus, October, 2007.

Accepting the fact that efficient braking, acceleration, idle reduction and progressive shifting are practices that should be routinely followed irrespective of the mode of transportation, other factors that are important in reducing fuel consumption such as 'awareness' or 'anticipatory driving' are particularly relevant for the domain of public transit. Here the service offered normally consists of a number of fixed routes/patterns with a standard set of known turns, stops, and potential road 'hazards'.

The relatively stable and repetitive nature of a fixed route operation make it particularly suited to train drivers in efficient driving procedures. *Furthermore, an analysis of employees driving habits over time and the ability to compare a driver to an 'expert' under similar road conditions and topography offers a unique tool to improve driver confidence, awareness, and pride which will ultimately lead to less fuel consumption and a cleaner environment.*

It is the purpose of this paper to present a practical approach to driver training; one that includes not only 'on-board' and 'off-board' activities but also shows how driver monitoring can be used proactively to point out potential issues. The individual fuel savings and the associated reduction in toxic emissions that is obtained by a comprehensive training program, combined with ongoing technological improvements, can provide a formidable cost savings and offer a holistic formula for a cleaner tomorrow

What is Driver Training?

Traditionally, driver training is conducted on-board the vehicle. Here the instructor either gives direct instructions to the driver or records the driver's performance for a later review.

With new and affordable technology that is currently available, the training process can be augmented with GPS-stamped video capture in which a number of cameras on the vehicle are strategically placed in order to record both the route and the driver's actions. Each frame in the video is 'stamped' with the location coordinates as well as the time of capture. The examiner would have a PC Tablet on which to 'electronically' register comments (geographically linked to the video) and the whole process would be re-played and reviewed afterwards.

Vehicle metrics can also be captured throughout the journey and are again linked geographically to the video and hence to the position on the route (see Figure 1).

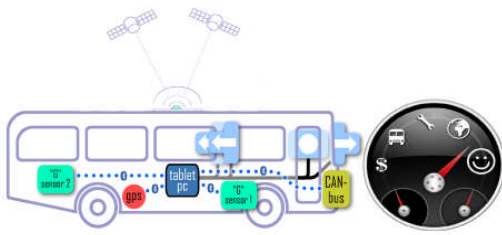


Figure 1. GPS and vehicle metrics.

There is a host of information that can be obtained from the CANbus connection but of particular significance for driver training are the following:

- G-forces - braking, accelerating
- cornering and “jerky” driving
- fuel usage,
- RPM
- fuel flow
- vehicle speed
- throttle
- turn signal.

After the driving results have been collected and processed, the operator is taken through a review of their performance using the digital video footage of the bus route, and the relation of the footage to both the route and the engine metrics (see Figure 2).

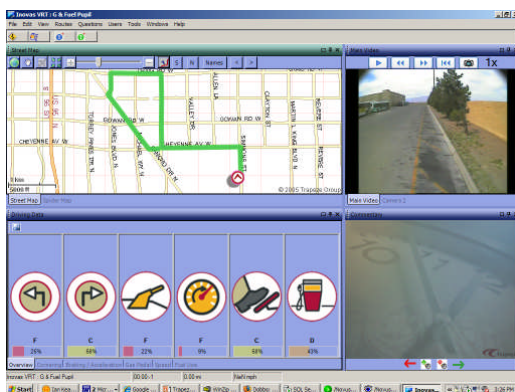
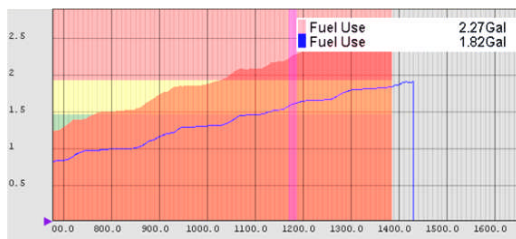


Figure 2. Review of driving performance displaying the street map with a Pattern Trace, a video recording of the Pattern, a ‘dashboard’ to view Engine Metrics and room for the examiners comments and/or highlights.

Any corrective action to improve fuel efficiency can be addressed with the operator at this time and hence, actions can be proposed and initiated to achieve more fuel efficient driving.

A natural progression to the one-on-one approach described above would be to compare the driving output of a route for the trainee operator to that of a master operator where a master or expert operator for a route may be an individual driver or a collection of the best drivers over the modular portions (node-to-node) of a route.

For example, in Graph 1 we compare the actual fuel usage of a 'novice' driver (identified in red) to an 'expert' driver (benchmarked in blue.)



Graph 1. Fuel usage of expert driver vs. novice driver.

As can be seen in this example, the novice driver used more fuel (0.45 gallons) than the 'expert' to traverse the same route trip under similar driving conditions. If we conservatively assume that the trip is performed 5 times a day and 100 days a year then simple arithmetic will graphically demonstrate the extent of the potential savings (0.45 gallons * 5 * 100 = 225 gallons) for one driver on one route.

The on-board approach to driver training can be time consuming since it requires the 'dedicated' allocation of a vehicle and an instructor. Instead of sending an operator out with an instructor, most driver training solutions may be presented in a classroom thus enabling operators to quickly familiarize themselves with a route and its potential hazards.

Audio commentary and supporting visuals highlight local situations and explain potential challenges such as pedestrian crossings, interchanges and special lanes. Here the ability to add 'highlights (points of importance)' to a route and to insert text and videos clips in the appropriate places greatly enhances the presentation and can be very effective in the classroom training process. Formal exams can be prepared and as the trainee views the route, questions can be posed to ensure that they have a thorough understanding.

Another useful real-time 'refresher' course that can be used is the introduction of kiosks at the depot or garage. These kiosks contain the videos and highlights of all the routes in the transit system. The kiosks have a more robust screen with 'touch control' permitting the driver to review a route prior to driving it. The ability

to rapidly scan the important aspects of a route as well as the potential danger areas makes such an approach practical and effective.

Finally, a DVD of a route with all the components as presented in the classroom training sessions can also be prepared and given to a driver so that it can be viewed at a time that may be more convenient.

Performance Analysis

When combined with a driver training program, performance monitoring and analysis tools enable transit authorities to perform detailed studies of both operators and vehicles.

Performance monitoring is a natural extension to the training module and involves capturing the same engine data that is obtained during an in-vehicle driver training session, however, the data is captured for the entire fleet of selected vehicles.

Whenever a vehicle is in service, vehicle and driver performance data is captured. Upon pull-in into the garage the data captured on-board the vehicle is wirelessly transferred to the back-office database where it is used for analysis. By capturing performance data on such a large scale, historical comparisons can be made quickly in order to identify exceptions and proactively deal with issues before they become more serious. In this way, for example, it is possible to identify the operators that may best gain from a re-training exercise and vehicles that may require early maintenance.

The Benefits of a Driver Training and Monitoring Solution

In addition to providing a positive impact on the environment through reduced fuel consumption and emissions, driver training and monitoring solutions can also reduce vehicle operating costs and boost operator morale.

Even highly experienced operators can improve their skills and enhance driving performance through driver training programs. Just a few simple changes can produce sizable fuel savings and improve the passenger experience. Creating optimal performance profiles targets for both operator and the vehicle can lead to a cleaner tomorrow.