Telling an individual how well they perform a task compared to what the expectations are is a fundamental aspect of most companies and organizations. People want to know “how they’re doing” compared with others who are performing the same task, and we all want to know what doing well looks like.

Changing our behavior in response to feedback is also fundamental to virtually everything we do.

This Reference Note describes the results of the first phase of a research study to evaluate how commercial vehicle operators will respond to in-cab technology “telling” them in real time how well or how poorly they are performing the driving task. There is no question that current technology exists that can “speak” to drivers, whether auditory or visually, and tell them how they are doing. The question our research hopes to answer in the future is more complex: How will drivers respond to a machine in their vehicle telling them “nice job” or “be careful?” Will their driving performance improve?

“Behavior Based Safety”

Providing individualized feedback to workers regarding their performance is critical to improving job performance. In safety, a commonly used method is Behavior Based Safety (BBS). Regardless of what it is named, the concept is simple: identify behaviors that are critical to safe job performance, look for those behaviors in the workplace, and offer constructive feedback to workers when the behavior is or is not seen. A key principle is that peer co-workers, themselves, provide the feedback. Another key principle is not all organizations are culturally “ready” for this level of performance feedback.

BBS approaches have proven effective in reducing accidents and incidents in industrial settings, but cannot be easily extended to commercial driving. For considerable periods of working time, commercial vehicle drivers are alone and do not interact with peers. Thus, they are unable to receive real-time, peer-to-peer feedback, which is the most effective aspect of behavioral safety programs.

Based upon research completed by Liberty Mutual’s Research Institute for Safety, data gathered by new in-vehicle technology might be used to provide real-time and post-shift feedback to drivers about their driving behavior. The research showed that, in general, drivers want to receive more feedback, and that feedback delivered by in-vehicle technology is acceptable, if properly designed and implemented.

Currently, a number of in-vehicle technologies are or soon will be available that collect data on safety-relevant aspects of driving behavior. These technologies are in trucks and some automobiles as original equipment, as after market products, or they will be available in the future. These technologies offer several measures for safety-relevant aspects of driving behavior:

- average speed of the vehicle
- RPM range
- headway (following) distance
- erratic or violent steering behavior
- hard braking
- time in cruise
- fuel mileage
- obstacle detection
- driver alertness
- lane tracking
- etc.

Appendix A gives descriptions of a selection of such technologies.

There are other measures of driver performance and driver behavior behind-the-wheel that technology can identify. In some cases, although feedback is not immediate, these measures are very relevant to how efficiently and safely the driver controls the vehicle. These include:

- brake wear and replacement cycle frequency
- tire wear and replacement cycle frequency
- fuel or gas mileage
- shock and suspension system wear
- unexplained dings or scrapes, etc

Comparing all or some of these measures to a corporate or work-group average enables managers, supervisors, or other drivers opportunities to provide feedback on how an individual is doing compared to their peer group and to performance expectations. That feedback is based upon measurable data and drivers can be praised and rewarded for exceeding expectations or counseled when they do not.

It is important to differentiate between these driver-assistive technologies and those that record driving parameters at the exact instant of a crash. Event Data Recorders or “black boxes” are not intended to offer feedback to the driver on a real-time basis.

**Research Findings**

Recent studies and reports support the application of BBS in the trucking industry. Krause et al. (1999), in a report for the U.S. Department of Transportation, conclude that “BBS methods … have tremendous potential for improving safety and productivity in the trucking industry.”

Wouters and Bos (2000) report the results of the introduction of driver monitoring with event data recorders (so called “black boxes”) into different fleets in Belgium and the Netherlands. The drivers knew that their vehicle was equipped with such a device, but feedback about their driving performance based on the data collected was not part of the design of the study. Wouters and Bos (2000) analyzed the crash occurrence of 840 vehicles, of which 240 were equipped with a data recorder. They estimate that the simple presence of data recorders led to an accident reduction of some 20%. Researchers theorize that the crash reduction would have been even higher if the technology had been used to provide feedback to the drivers about their driving performance.

**Liberty Mutual Research Institute for Safety – What Drivers Say They Want**

In research conducted at the Liberty Mutual Research Institute for Safety, information was gathered from over 300 commercial vehicle drivers. A common theme was that they did not receive enough feedback about their driving performance. Drivers want feedback that is specific, constructive, respectful, and individualized. Feedback is especially welcome if it is positive and accompanied by signs of recognition, like a bonus or an award. Drivers want feedback from persons whom the drivers respect and perceive as knowledgeable about their job. Feedback is less desirable if it comes from persons whom the driver does not respect or from someone who does not understand the job.

The participants pointed out that there are certain things to avoid when feedback is given. One was “beating a dead horse,” i.e. coming back to the same event and discussing it again and again. Negative feedback in public, referred to as “public beating,” was similarly perceived as not helpful. And receiving negative feedback for doing something “wrong” but not being told how to do it “right” was also seen as not helpful.
Driver Perception of Benefits and Drawbacks of Using Technology to Give Feedback on Driving Performance

Our findings pointed out that drivers have fairly strong opinions regarding feedback from technology. Most drivers expected improvements in their driving performance. They also expected improvements in driving efficiency and a reduction in driver stress. Some of the participants felt there would be a decrease in operating costs due to fewer crashes and subsequent lower insurance rates, as well as other cost savings from maintenance-related items. An important finding was that some drivers felt data from technology could be used to vindicate drivers in the event of an incident or crash.

Drivers felt that when used effectively, technology might allow them to compensate, to some extent, for the unsafe actions of other drivers.

On the negative side, some drivers reported that they felt mistrusted by their companies and/or by law enforcement officers. Some drivers felt that possibly, the data created by technology might be used against them.

One concern consistently voiced by the drivers involved privacy issues. Participants reported they would not feel comfortable being watched by technology and were concerned how their driving performance data would be used. Some participants viewed the introduction of technology as a threat to the profession, as only technology-literate drivers would be able to work with such systems and, consequently, continue working as truck drivers. Others felt that technology that makes the driving task “easier” would allow unqualified drivers into the profession.

Another concern was that some drivers may over-rely on technology and no longer engage in safe driving habits on their own. Related to this are reliability issues of the technology itself.

Finally, some owner-operators were concerned that the initial cost of the technology would be too high.

When Should Feedback Be Given?

Timing of feedback was another issue that produced a variety of different opinions. Drivers consistently said that warnings (e.g., collision or rollover warnings) should be given immediately.

There was no consistent opinion about the right time and frequency for reviews of “general” driving performance. Some participants wanted feedback whenever they requested it (“pull principle”). Others preferred the information be delivered to them by the system itself (“push principal”) at the end of the trip, shift, or day. Others preferred a weekly or monthly schedule. There was no consistent opinion among the participants regarding the frequency and timing of feedback, whether random or regular. This suggests that a feedback system should be adaptable to the preferences of the individual driver except in cases where immediate warnings are necessary.

Most drivers agree that at times it is necessary to receive negative feedback (warnings were considered negative feedback by the drivers). But in their opinion, negative feedback should be in the minority and should be combined with positive feedback and be delivered in a constructive way.

In short, drivers felt they would be more comfortable if they were given the ability to specify how and when less critical information is presented to them.
Participants’ Advice to A Company Wanting to Develop A Program Using In-Cab Technology To Provide Driving Performance Feedback

The drivers offered a number of suggestions for developing and implementing programs that use in-cab technology to provide feedback on safe driving performance:

- When developing and introducing such a program, personnel at all levels in commercial fleets need to be involved; including drivers, management, dispatchers, and trainers.
- The organizational culture must be supportive of such a system.
- Drivers should be involved at all levels of development and implementation. Drivers felt they should participate in pilot testing new in-cab technology.
- Technology should not interfere with the driving task and should not be a distraction.
- Technology should be reliable and cost effective (i.e. affordable and provide measurable benefits).
- Thorough training on new technologies and procedures is important.
- When in-cab technology provides feedback, consistent feedback from peers and managers is also necessary.
- Negative feedback should be in the minority, and when given, be constructive and combined with positive feedback. Most drivers reported working for carriers where there are too many punishments and not enough rewards.
- Rewards for “good driving” performance should be timely and meaningful to the drivers.
- Finally, give drivers full disclosure regarding the use of data obtained from in-vehicle technology. Using the data in a way other than described in the disclosure would be a grave mistake. (NOTE: Researchers heard this comment frequently – drivers reported that employers introduced programs with stated objectives but changed those objectives which resulted in a negative impact on employees.)

Conclusion

Commercial vehicles are being equipped with many sophisticated technologies. Many of those are designed to simply warn drivers when they are operating in an unsafe manner. In most cases, however, these same technologies are collecting and storing data. Using those data in a proactive manner to give drivers real-time feedback on how well they perform the driving task may be a more effective use of the technology leading to fewer crashes and incidents, as well as improvements in fleet safety measures.

Appendix A

Collision Avoidance/Warning System. Sensors installed at the front of a vehicle constantly scan the road ahead for vehicles or obstacles. When an obstacle is detected, the system determines if the vehicle is in immediate danger of crashing. If so, the driver is warned by a tone, a warning light, or a heads-up display.

Adaptive (Intelligent, Smart) Cruise Control. A combination of collision warning technology and existing cruise control. The system will maintain separation distance behind a followed vehicle using an adjustable range control feature.

Rollover Detection and Prevention System. Using either in-vehicle sensors or highway-mounted sensors, this system alerts the driver to the fact that he or she may be exceeding the speed at which a rollover or load shift may occur.

Lane Tracking or Lane Departure Warning. If a vehicle moves to the edge of the roadway an audible alarm in the vehicle is sounded to alert the driver. Some systems track the highway lane markers and give an alarm if the driver crosses a lane marking without the appropriate turn signal. These systems can also be used to sense the driver’s level of alertness by watching for erratic steering or weaving.
**Side Sensing (Proximity) Devices.** Using technology similar to collision avoidance systems, these systems monitor the close proximity (sides) of the vehicle. The system gives an alarm to assist in preventing sideswipe crashes if it senses an object.

**Vehicle and Cargo Tracking Systems.** Systems that electronically track the locations of vehicles. These systems utilize satellite-based Global Positioning System (GPS) to track the vehicle and broadcast its position to the transportation company. The company is thus enabled to track the progress of the vehicle and the driver’s performance.

**Driver Alertness Monitors.** Systems that use eyelid movement, blink rate, head movements, or steering wheel movement (or a combination thereof) to monitor driver alertness and warn the driver if they are outside pre-established personal benchmarks.

**In-Vehicle Camera Systems.** Small cameras mounted on the windshield are constantly viewing the scene ahead of the vehicle. Video is stored in memory only when there is a sudden change in velocity as in an abrupt maneuver. Some systems allow the driver to press a record button if he or she observes an unsafe situation.

These and other systems can constantly create and record data regarding the driver’s performance. The data can be used to help drivers improve and to recognize drivers who do well.