Session Number 618

In-Vehicle Technology: Managing Crash Risk Before the Crash Occurs

David Melton, CRSP, CDS
Director, Transportation Technical Services
Liberty Mutual Research Institute for Safety

"How effective is my fleet safety program?" This is a common question. Unfortunately, answering it is often difficult, especially when attempting to use the cost of crashes as the sole method of determining program effectiveness. As we all know, measuring only crash or incident occurrence is relying on indicators of lagging performance.

Measuring the traffic crash (or worker accident) that does not occur is a real problem and one that managers have struggled with for many years. Simply put, how can we measure crashes that don't happen? If we do not measure accidents or crashes that do not happen, how do we know if we are having any impact on the numbers?

The answer is not simple—you cannot measure the crash that doesn't happen, but you *can* measure activities and events that lead to a crash. Reducing the number of those events will almost certainly lower the number of crashes and accidents.

Should We Use Crash Costs as a Measure?

There are many reasons why fleet managers and business owners insist on using cost of crashes as the primary measure of their program's effectiveness:

- The data are easy to get—just ask the insurance company and they will produce a report that itemizes crash loss costs. The dollars reported are those for which you have insurance coverage. Some companies forget or choose not to add in the deductible dollar amounts paid.
- When self-insured, many companies keep good records of the dollar amounts they pay out when crashes occur.
- Dollars have credibility. Regardless of the size of business, successful managers and owners usually insist on relating all details of the business back to the bottom line. Measuring the impact of crashes on the bottom line is clearly necessary and using dollars as the measure is, therefore, appropriate.

- Dollars are consistent. A dollar today is a dollar tomorrow or next year, although the impact of inflation must be considered, especially in the end. Measuring costs over more than three years using dollars requires setting a base rate. Economists do this by applying inflation factors and reporting costs in dollars for a certain year. (e.g., 2002 dollars, or 2008 dollars, etc.)

What's Wrong With Using Dollars?

Nothing! That is, there is nothing wrong with using dollars of loss to measure performance if managers understand the limitations of doing so. Some of the more obvious drawbacks are:

- Often, only insurance loss costs are considered while neglecting such things as cost of deductible, employee injury costs (Workers Compensation), group medical costs, and uninsured costs such as administrative expenses, hiring and training replacement workers, employee morale, equipment down time or replacement, employee morale, etc. Managers who insist on using loss costs to measure safety results must understand that there are many other costs to their business that are less easy to identify and quantify. Safety professionals often use the analogy of an iceberg to describe indirect costs—as with icebergs, the largest expenses are almost always below the waterline. Most experts agree that these "uninsured costs" are between 4 and 12 times the insured costs. *Exhibit 1* offers a graphic rendering of this basic safety premise.
- Auto liability claims may have very long "tails." This means a serious crash resulting in fatalities or severe injury may take years to reach conclusion and have the final costs known. When comparing costs of crashes, some companies fail to track these on-going costs and assign them back to the year and profit center in which the crash occurred.
- Costs resulting from a vehicle crash can be radically different depending upon where the crash occurred. The legal climate in some states may greatly affect the ultimate cost of a crash. For example, some states allow the cost of serious crashes to be assigned to a non-negligent driver who was only slightly involved. In some states, jury verdicts are much more liberal than in others. The implication is that two crashes of exactly the same type, resulting in exactly the same injuries, may be very different in terms of final cost in dollars. This fact alone makes it difficult to accurately compare crash costs from year to year, or location to location.

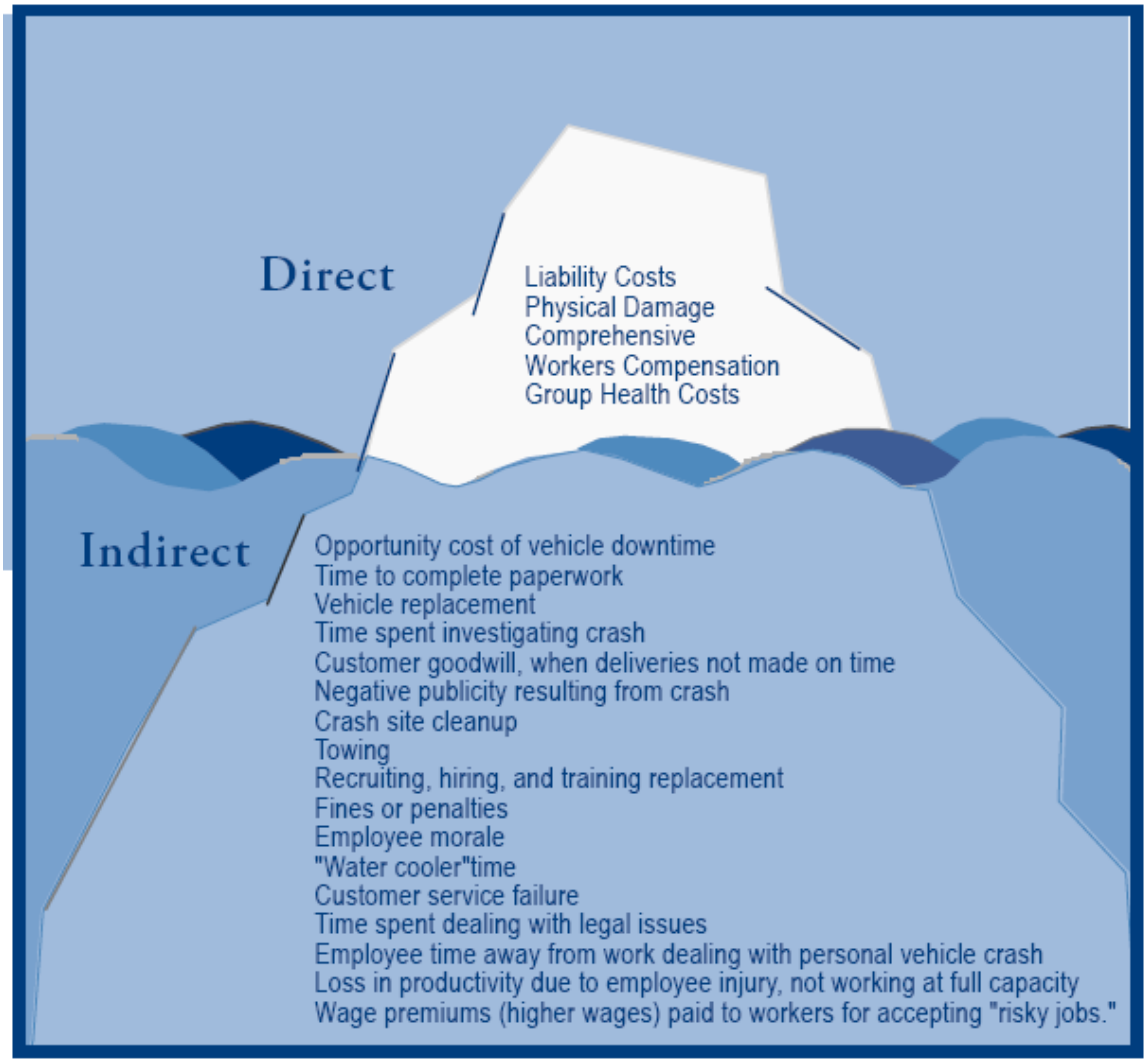


Exhibit 1.

While the above points represent obvious drawbacks to only using dollars of loss to measure program effectiveness, there are other, less obvious problems:

- Measuring only loss costs offers a historical perspective—it measures how unsafe we were. It does not help business managers answer the critical question: *"How safe are we now?"*
- Measuring loss costs can lull managers into thinking that these easily obtainable data are the only costs associated with crashes.

One of the most striking reasons against using only loss cost as a measure of program effectiveness is that it essentially measures failures. Managers must literally wait for a crash to occur before they can use it as a measure. This is a particularly important concept in managing fleet operations because crashes are, hopefully, infrequent occurrences.

How Often Do Crashes Occur?

Exhibit 2 contains data published by the Federal Motor Carrier Safety Administration (FMCSA) in January 2003, and pertains to heavy truck crashes, only. (≥10,000 GVW) Note that the data are based upon a rate of 100,000,000 Vehicle Miles Traveled (VMT).

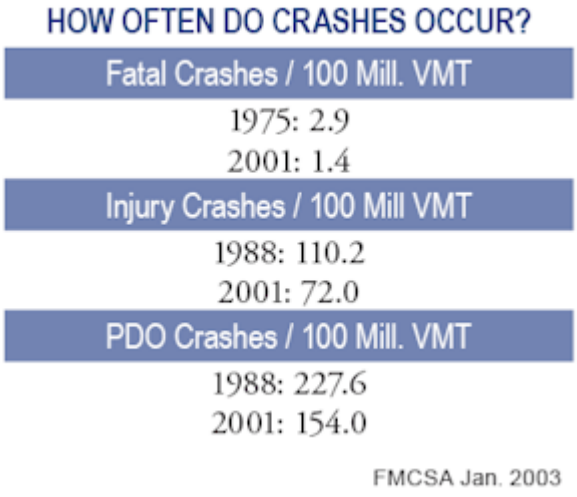


Exhibit 2.

The numbers are clear. Fatal injury and property damage only (PDO) crashes do not occur very often. In addition, the rate of decline over the last several years is significant. Thus, waiting for a crash to occur before we can use it as the only measure of fleet safety program effectiveness is unrealistic.

In summary, when using dollars of loss or crash frequency rates as indicators of safety effectiveness, we are emphasizing the past, measuring things that don't happen very often, and measuring things that are indicators of failures! None of which answer the question, *"How safe are we now?"*

What Should We Measure? I Have It – Let's Use Measures of Crash Risk!

Virtually everyone agrees that crashes happen when several things in succession go wrong. Crashes are a succession of events that lead up to the impact between vehicles and other objects. If we understand what events most often lead to crashes, we can begin to understand those things we can measure that will tell us, *"How safe are we now?"*

Instead of waiting for crashes to occur in order to measure their cost or frequency, progressive companies understand they need to measure driver behaviors on as close to a real-time basis as

possible. However, because the driving task is usually done away from managers or peers, individual driver behaviors are difficult to track if you depend on observation. Today, in-vehicle technologies are offering several new ways to "observe" driver behavior.

Typically, unsafe drivers commit the same unsafe behaviors over and over again. Rarely do crashes occur the first time a person commits an unsafe driving event. If you accept the premise that crashes occur because of a succession of unsafe behaviors and events, and that eliminating those behaviors or interrupting one or two of those events will prevent the crash, there are several things we can measure that help us understand, *"How safe are we now?"*

In-Vehicle Event Recorders

Over the last several years, new in-vehicle technologies have become available whose purpose is to enable fleet managers to know *"How safe they are, now."* Several of these devices rely on in-vehicle accelerometers that measure changes in velocity (ΔV) above preset thresholds to identify "events." The thresholds are typically established at 0.6g, which is considered to be a significant braking or accelerating threshold. In a crash situation, the threshold is much greater.

Vendors of these devices specifically target motor vehicle fleets because they understand the financial implications of reducing costs of crashes and injuries. Unfortunately, in the beginning, most vendors did not complete empirically driven evaluations of their products by outside agencies or researchers. To be sure, their marketing literature usually reported impressive results in numbers of crashes "prevented" by comparing one calendar period to a subsequent one after their product is put in place.

As these vendors have become more sophisticated, they are beginning to understand that measures of upstream performance, leading indicators, are more effective.

Researchers, too, have begun to look at these devices and are reporting positive results. In a 2007 study, "The Impact of Event-Triggered Video Intervention on Rural Teenage Driving," the University of Iowa reported the following conclusions:

- Parental involvement in management of teen driving positively affects safety
- Direct feedback regarding behaviors will reduce number of safety-relevant driving errors
- Real-time feedback shows promise
- High risk teens show dramatic decline in the rate of events that persists after feedback is removed
- Teens modified their driving behavior to avoid triggering events

However, teenagers driving on rural roads are not equivalent to truckers on the nation's highways. A 2007 Transportation Research Board report, "Commercial Truck and Bus Safety: Synthesis 11examines the impact of behavior-based safety (BBS) techniques on commercial motor vehicle drivers and reports the following:

- On-board safety monitoring (OBSM) provides objective data regarding driving behaviors

- In effective programs, drivers get reports on successes not only negatives
- OBSM provides data for incentive programs
- OBSM can augment or costly ride-alongs
- Drivers get real-time feedback – or whenever needed
- Addresses safety behaviors upstream, before crashes, incidents or violations

In a Liberty Mutual Research Institute for Safety, 2003, study, "When Technology Tells You How to Drive: Truck Driver's Attitudes Toward Feedback by Technology," we concluded that CMV drivers:

- Are OK with feedback from OBSM
- But, prefer feedback from their direct supervisor
- Want more frequent positive feedback
- Don't want management to change horses in mid-stream – in other words, don't introduce a program saying it is intended to improve their performance and instead use it to catch them doing something wrong

The 2007 Transportation Research Board report also described barriers to implementing "BBS-like" techniques in commercial vehicle fleets. Those barriers are typical of what one would expect in any kind of operation, not only fleets. They included:

- Drivers are unwillingness to accept or cooperate in the program
- Company safety managers don't know enough about the process
- It takes too much time to implement
- There was a past bad experience with BBS
- Senior management did not support

There are other, technology related, upstream measures of safety performance.

Fuel mileage: measuring fuel mileage on a per-driver per mile basis offers an opportunity to understand how well drivers are doing at managing the space around their vehicle. Drivers who consistently get better-than-fleet-average fuel mileage are probably doing a better job of anticipating traffic changes, coasting to stops, not "jackrabbiting" away from controlled intersections, etc. Put simply, good drivers get better fuel mileage than poor drivers do.

Maintenance costs: some fleets measure the frequency of brake replacements, wheel alignments, tire replacements, or other types of maintenance that can be attributed to how well the vehicle is being driven. Measuring the rate-of-replacement or work done to a vehicle and comparing that to an overall fleet average, will help identify consistently good drivers. This measurement will also identify drivers whose habits and driving behaviors are probably affecting the condition of the vehicle. For example, having to replace brakes or do brake maintenance more frequently than the corporate average may be a clear indication that drivers are not looking well ahead of their vehicle and anticipating traffic flow changes.

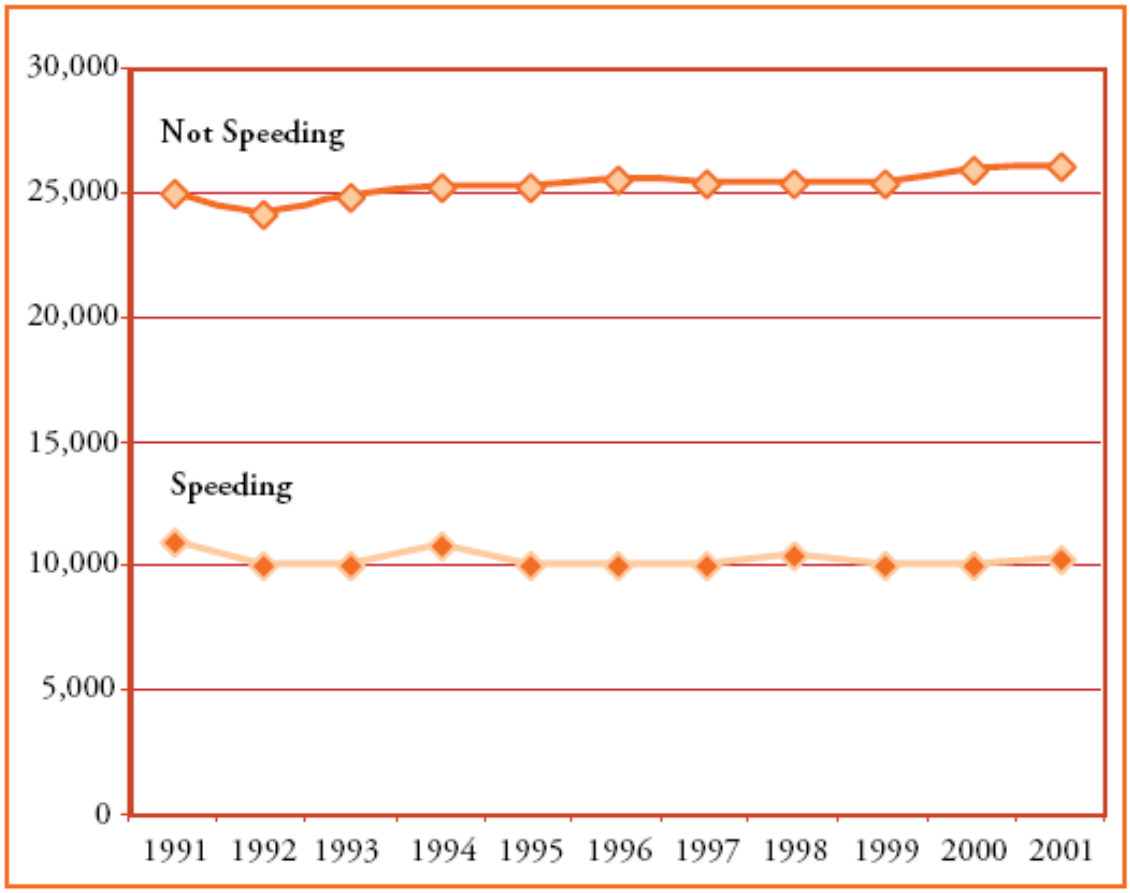
Engine management system data: most vehicles are now equipped with Event Data Recorders, also known as "black boxes," that capture information which, if used, helps to understand driver

behavior. Used most often after a crash, some companies are beginning to analyze the data from these devices by downloading it regularly. Measuring these data and comparing to a corporate or location average will help identify good drivers and those whose driving behaviors exhibit all the signs of a crash waiting to happen. It is relatively simple to establish rates using these data. For example, company average number of hard braking events per 1,000 miles, or company average time in cruise control per "X" miles. Some of the data-points include:

- Average speed
- Number of hard braking episodes
- Hard lateral acceleration
- Turn signal use
- Time in cruise control

Speed

Speeding is one of the most prevalent factors contributing to traffic crashes. According to the National Highway Traffic Safety Administration (NHTSA) estimates, the economic cost to society of speeding-related crashes is $40.4 billion per year. In 2001, speeding was a contributing factor in 30 percent of all fatal crashes, and 12,850 lives were lost in speeding-related crashes. In 2001, 86 % of speeding-related fatalities occurred on roads that were not Interstate highways. *(Exhibit 3).*



Fatal Crashes by Speeding Status, 1991–2001
(NHTSA Traffic Safety Facts, 2001)

Exhibit 3.

The number of non-fatal crashes and near misses attributed to speeding is, obviously, much higher.

Because speeding is so clearly a cause of both serious and non-serious crashes, fleet managers should use excessive speed as one of the *most important data points* for measuring pre-crash driver behavior. Again, there are opportunities to use in-vehicle technology to measure speeding events. Many commercial vehicles are equipped or optioned with driver-management computers that can track and report on speeding events. Other technologies that can identify speeding events are Global Positioning Satellite (GPS) tracking systems. Mangers can determine a fleet average for the number of speeding excursions above a pre-established mile-per-hour and measure all drivers against that fleet average. Many fleet managers mandate a corporate speed limit.

Fleets can measure such things as “speeding events greater than X miles above corporate average per 1,000 miles driven.” Or “number of speeding events per X miles.” In each case, comparing

drivers to a pre-established company baseline and established expectations will enable managers to counsel drivers who do not meet standards and reward those drivers who do.

Knowing if your drivers habitually exceed safe speeds is one way to know *"How safe are we now?"*

Restraint Use

Research has found that lap/shoulder safety belts, when used, reduce the risk of fatal injury to front-seat passenger car occupants by 45%, and the risk of moderate-to-critical injury by 50%. For light truck occupants, safety belts reduce the risk of fatal injury by 60% and moderate-to-critical injury by 65%. (NHTSA, Traffic Safety Facts, 2001)

Traffic crashes are the leading cause of death in the workplace and a leading cause of work-related disabilities (Bureau of Labor Statistics, 2001). There is evidence that many motorists do not wear seat belts on the job and recent research findings indicate that belt use among those driving for work may be lower than among other vehicle operators.

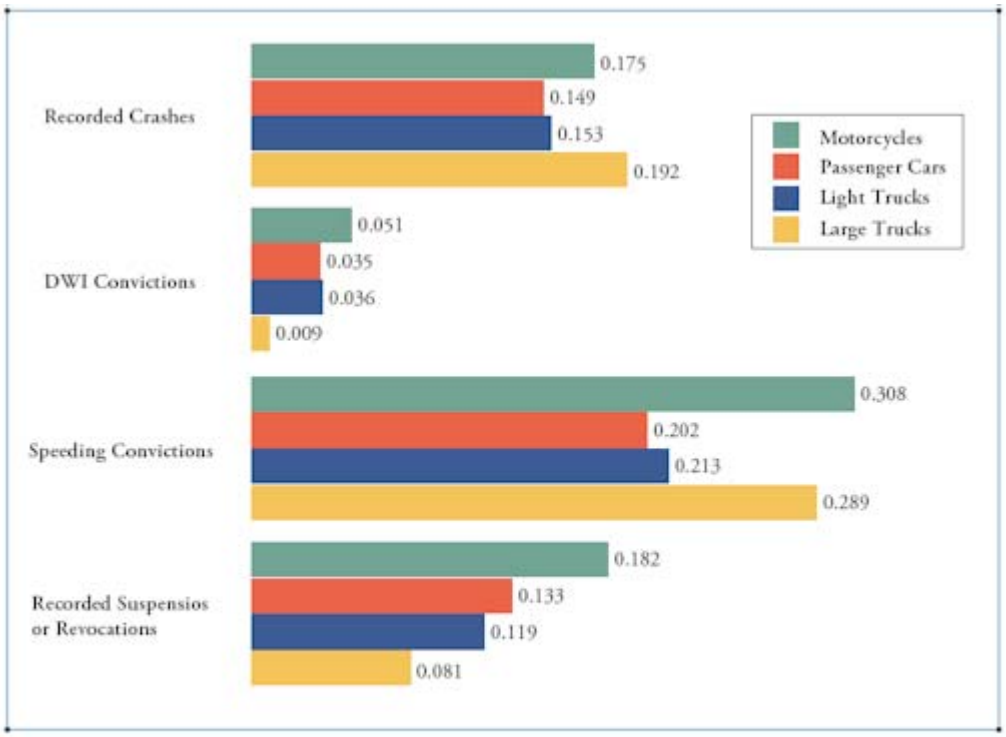
According to NHTSA:

- Ejection from the vehicle accounted for 29% of all passenger vehicle occupant fatalities in 2001.
- Nearly two-thirds of the passenger vehicle occupants killed in traffic crashes in 2001 were unrestrained.

Fleet managers can easily determine one answer to *"How safe are we now?"* by simply measuring the percentage of their drivers currently wearing seatbelts. Then institute a campaign to encourage or require employees to wear their belts, and measure the improvement over time. A number of organizations, including the National Safety Council and the Network of Employers for Traffic Safety have simple tools that help employers understand how to implement seat belt programs and measure their effectiveness.

Percent Drivers With Clear MVRs

Another effective way to determine, *"How safe are we now?"* is to ask the question, "How safe are the *drivers* I'm hiring now?" Progressive fleet managers understand that no matter how effective their safety programs and systems are, if they consistently hire drivers with a poor driving history, they're going to have a high frequency of serious crashes.



PREVIOUS DRIVING RECORDS OF DRIVERS INVOLVED IN FATAL TRAFFIC CRASHES, BY TYPE OF VEHICLE, 2001
(NHTSA, TRAFFIC SAFETY FACTS, 2001)

Exhibit 4.

Exhibit 4 points out that drivers involved in fatal traffic crashes very often have previous records of traffic violations. For example, in the chart, 15.3% of light truck drivers had previously been involved in crashes. Less than one percent of large truck drivers had previous DWI or OUI convictions. 20.2% of passenger car drivers had previous speeding convictions.

The implication is obvious—drivers with a past history of poor driving typically repeat their behaviors.

To measure *"How safe are we now?,"* some fleets establish a goal that 70% of drivers (anyone who drives on company business) must have a clear Motor Vehicle Record (MVR) for at least the previous 3 year period. Those fleets measure their current percentage and measure their progress towards achieving the 70% goal.

Where Do We Go From Here?

Knowing the answers to "How are we doing, now?" is not enough. Knowing what to do now, is!

Understanding what the data tells you can help identify where changes are necessary. There is a simple set of rules:

- What you can directly observe you can objectively define
  - You can observe and define driver behaviors using these concepts and you can define expectations.
- What you can objectively define you can accurately measure
  - These unique measures, when used effectively, will help you understand what needs to be fixed, not simply what has happened in the past.
- What you can accurately measure you can effectively manage
  - If you can manage it, on a real-time basis, you can get improved results.

How Safe Is Your Fleet Now?

Understanding and reporting the cost and frequency of crashes is important. But, understanding how safe your fleet is now, *before* those crashes occur, is critical!

Using technology now available to most fleet managers, measure and report events and behaviors that cause crashes, take action to control or eliminate them, and watch crash costs go down.