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When technology tells you how you drive—truck drivers' attitudes towards feedback by technology

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Abstract

Behavior based safety approaches have proven effective in reducing accidents in industrial settings, but cannot easily be extended to commercial driving. For considerable periods of working time, truck drivers are alone, and do not interact with peers. It might be possible to use data gathered by new in-vehicle technology to provide real-time and post-shift feedback to drivers about their driving behavior. This paper reports the results of focus group interviews conducted with subject matter experts from the trucking industry (truck drivers, supervisors, managers, and other involved persons, such as insurance industry safety professionals). The focus groups discussed safety critical behaviors in commercial driving, the best way to provide feedback to truck drivers, and benefits of feedback by technology as well as concerns drivers and operators may have regarding monitoring and feedback systems. The focus group discussions showed that, in general, drivers would like to receive more feedback and that feedback by technology is acceptable, if designed and implemented properly. In addition, the participants had many suggestions on how to properly design and implement such systems.

Keywords: Behavior based safety; Focus group; In-vehicle technology; Trucking industry

1. Introduction

Behavior based safety (BBS) is a set of methods "to improve safety performance by engaging workers in the improvement process, teaching them to identify critical safety behaviors, perform observations to gather data, provide feedback to encourage improvement, and use gathered data to target system factors for positive change" (Krause, Robin, & Knipling, 1999, p. 1). BBS, like all

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other approaches relying on the behavior of a person, should only be initiated after the technical and organizational requirements for the safety of work have been satisfied (e.g., Luczak, 1998). The application of BBS has proven effective in reducing accidents in industrial settings (for recent reviews see Grindle, Dickinson, & Boettcher, 2000; Sulzer-Azaroff & Austin, 2000). Thus it seems sensible to try to apply this approach to commercial driving (Krause et al., 1999).

Typically, BBS approaches are implemented in industrial environments where workers are in groups and can observe each other's behavior. However, a significant number of BBS approaches have been successful with "lone workers," like maintenance and repair workers or lumbermen (Pinney, 2002). Most truck drivers work alone for considerable amounts of time, so one substantial component of the BBS approach, feedback from peers, must be replaced. In BBS approaches in industrial settings with lone workers, the workers acted as their own observers, using self-observation (Krause et al., 1999; Olson & Austin, 2001). Recent developments of in-vehicle technology allow the monitoring of many components of the driving task that might be safety relevant. So, in addition to self-observation, technology might be used to observe safety critical behaviors of truck drivers.

Currently, a number of in-vehicle technologies that can collect data on safety relevant aspects of driving behavior are available in trucks as original equipment or as after market products or will be available in the future. Measures for safety relevant aspects of driving behavior include, among others, speed of the vehicle, headway distance, erratic steering behavior, obstacle detection, and driver alertness. Table 1 gives descriptions of a selection of such technologies.

Recent studies and reports support the application of BBS in the trucking industry. Krause et al. (1999), in a report for the US Department of Transportation, conclude that "BBS methods ... have tremendous potential for improving safety and productivity in the trucking industry" (p. 5). They based this conclusion on their experience with over 850 BBS initiatives not only in manufacturing settings but also in transportation departments and organizations, the knowledge of new in-vehicle technologies, and a series of seminars with researchers, regulators and trucking company personnel. Wouters and Bos (2000) report the results of the introduction of driver monitoring with vehicle 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 analyzed the accident 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%. It might be expected that the accident reduction would be even higher, if the technology would be used to provide feedback to the drivers about their driving performance.

2. Purpose and focus of the study

Trucking operations can be distinguished as being long haul, line haul or short haul. The different operations are characterized by the length of travel between destinations. Long haul truck drivers are on the road for days, weeks or even months in a row. Line haul drivers operate on regular schedules and specific routes. Line haul drivers return home regularly. Short haul operations are characterized by short distances between destinations and a greater number of

Table 1
In-vehicle technologies that can provide data on safety relevant aspects of driving behavior

Technology	Description
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, for example, by a tone, a warning light or a head-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, the 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. They utilize the 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 event data recorder (EDR) or "black box"	EDRs are devices which constantly record information related to vehicle performance. These data might include information such as the driver and passenger belt usage, the driver's steering and brake input, airbag and seat belt tensioners' data, information from the ABS system, the speed and deceleration information of the vehicle, and the location of the vehicle. In addition, the system might also trigger an automatic collision notification.

destinations served per day. Short haul drivers often have a regular shift schedule and return home on a daily basis.

Due to the length of time spent working alone, the application of in-vehicle technology to provide feedback to drivers may be particularly suited to long haul operations.

Before starting an experimental intervention study introducing technology to provide feedback to the driver about his or her driving behavior into the daily operation of a trucking company, we wanted to gather information about the attitudes and concerns of drivers and other involved persons toward such technology.

To date, such issues as what is the best way to provide feedback to truck drivers (e.g., positive vs. negative, immediate vs. time delayed, or frequency of feedback: fixed or random) are not well researched. Furthermore, the concerns drivers may have regarding such feedback technology and who else might have access to the data sampled by these systems needs further exploration. We, therefore, conducted focus groups with subject matter experts from the trucking industry. The groups consisted of long haul truck drivers, our primary population of interest, line haul and short haul drivers, supervisors, managers, and other involved persons, such as insurance industry subject matter experts.

This study is the first phase of a broader project to evaluate whether feedback to drivers from in-vehicle technology can improve the safety of trucking operations. Before conducting a longitudinal research study using a quasi-experimental design, this needs assessment phase was necessary to evaluate the feasibility of such an approach. A combined qualitative and quantitative approach was used. This paper reports the results of the qualitative data collection. Based on the results of this data collection effort we developed a questionnaire to provide quantitative data. The questionnaire will be distributed to a wider sample of the professional driver population.

3. Method

3.1. Participants

A total of 66 drivers, supervisors/managers, and insurance industry safety professionals participated in a total of nine focus groups (see Table 2).

Long haul drivers ($n = 35$) were recruited at a major truck stop located off an interstate in rural Connecticut, USA. Short haul drivers ($n = 5$) were recruited from an international package delivery company and line haul drivers ($n = 8$) were recruited from a national package delivery company. Each participant received US $100.00 for the participation in his or her off-duty time. One group of managers/supervisors ($n = 5$) was recruited from a national package delivery company. A second group of managers/supervisors ($n = 7$) was recruited from the participants in a transportation safety training course. Both groups participated during normal working hours and received a polo shirt as additional compensation for their time. The insurance industry safety professionals ($n = 6$) were recruited from a different transportation safety training course and received a t-shirt for their participation. The focus group took place during their working time.

3.2. Focus groups

Focus groups have been found helpful as part of a needs assessment process, during the developmental stage of constructing questionnaires, developing plans, or testing new programs and ideas (Fern, 2001; Krueger & Casey, 2000; Newman, 2002; Patton, 2002). Therefore, they seem to be a particularly well suited approach to our research question.

The use of individual interviews or of questionnaires was considered as alternative methods, but rejected. Individual interviews were expected to generate fewer responses than focus group discussions, due to the missing interaction within the groups. The use of a questionnaire with closed format questions was deemed to be too restrictive at this stage of the research and we were advised by experts working with truck drivers that open format questions are not well suited for this particular group.

Table 2
Description of the participants of the different focus groups

	Drivers			Supervisors and managers	Insurance industry subject matter experts
	Long haul	Line haul	Short haul		
Number of focus groups	4	1	1	2	1
Number of participants	35	8	5	12	6
Male	89%	100%	100%	92%	67%
Female	11%	0%	0%	8%	33%
Mean age (years)	40.66 (SD 8.69)	45.00 (SD 13.09)	41.00 (SD 3.74)	47.67 (SD 10.23)	
Experience (years)	10.95 (SD 10.98)	19.97 (SD 12.21)	13.5 (SD 5.27)	16.92 (SD 7.70)	16.50 (SD 12.96)
Knowledge of technology					
None	20%	0%	60%	42%	
Some	63%	100%	40%	33%	
A lot	17%	0%	0%	25%	
Mean hours working per week	65.00 (SD 9.19)	57.14 (SD 10.75)	30.5 (SD 9.74)		
Mean miles driven last year	115.576 (SD 44.062)	113.125 (SD 21.866)	51.000 (SD 2.236)		
Ownership of truck					
Owner operators	49%	37.5%	0%		
Company drivers	51%	62.5%	100%		
Driving ...					
Single	71%[a]	75%	100%		
In a team	29%	25%	0%		

[a] Only 24 of the 35 long haul drivers were asked this question.

To ensure a quality outcome of the focus group data collection, the researchers must be able to enlist the cooperation of participants who are representative for the larger group and be able to gain their trust. Further, the focus groups should be facilitated by experienced and effective moderators and conducted at a suitable site (Newman, 2002). For our research we had the help of an active truck driver and former Captain of the American Trucking Associations America's Road Team in approaching the participants for our focus groups. Two members of the research team, experienced in moderating group discussions, took turns in facilitating the focus groups. To ensure consistency in the conduction of the focus groups, both facilitators attended the sessions of the other facilitator whenever possible.

A set of questions was developed for the focus group discussions. The questions follow the well-established pattern of opening questions that draw the participants into the discussion, transition and key questions that focus on the research objective, followed by an ending question that ties the session together and brings closure (Newman, 2002). The development process was iterative and included piloting the questions with people not involved in the research project, experts from transportation industry and truck drivers. Based on the experience with the first focus group, the number of questions was reduced by rewording and combining questions. Minor changes were introduced after the second focus group. The final set of questions for the remaining seven focus groups is given in Table 3.

The first question asked the participants for their name and spare-time activities and was intended to make them feel comfortable and give everyone the chance to talk. The following introductory questions asked the participants to discuss the issues of safety and feedback. A transition question was intended to move the discussion to the issue of in-cab technology. The key questions asked the participant for their opinions about the benefits and drawbacks of receiving comments on their driving performance from in-cab technology and how they would like to receive them. The ending question tried to capture the most important aspects of the preceding discussion by asking the participants what advice they would give to a company that wants to develop a program to use in-cab technology to provide comments on driving performance. An additional question relating to the focus group itself asked the participants for any suggestions or comments to improve the future focus groups.

Prior to the start of each focus group discussion, the facilitator stated that the objective of the focus group was to gather information about the various aspects of using in-cab technology to provide comments on driving performance in order to improve safe driving. The participants were reminded that there are no right or wrong answers and encouraged to discuss any point raised in the group. All participants signed an informed consent form as approved by Liberty Mutual

Table 3
The final set of questions for the focus groups

(1) Tell us your name, where you live, and what you most enjoy doing when you are not driving a truck.
(2) What makes a truck driver a good and safe driver?
(3) Please tell us about comments on your driving performance you have received that were
    (a) helpful to you.
    (b) not helpful to you.
(4) What in-cab technology can help in safe driving?
(5) How would you feel about getting comments on your driving performance by in-cab technology.
    (a) What would be the benefit of receiving comments on your driving performance from in-cab technology? (benefit)
    (b) What would be the drawback (concerns) of receiving comments on your driving performance from in-cab technology? (concerns, restriction)
(6) How would you like to receive comments on your driving performance from technology?
(7) If a company wants to develop a program to use in-cab technology to provide comments on driving performance, what advice do you have for them?
(8) Do you have any suggestions or comments about the focus group?

Research Institute for Safety's Internal Review Committee. The focus group discussion, including a short break every hour, lasted approximately three hours (except for the insurance industry safety professionals' focus group, which lasted approximately 1.5 h due to other time constraints). The focus group facilitator captured major points of the discussion on a flip chart throughout the discussion and at least one other member of the research team took detailed notes. Audio recordings were made of all focus group sessions.

3.3. Data analysis procedure

The analysis is based on the notes taken during the focus group sessions. The audio tapes were consulted when necessary to clarify the notes.

The analysis procedure consisted of five steps and is a computerized version of the "long-table approach" (Krueger & Casey, 2000). In the traditional long-table approach the transcripts of all focus groups are cut into individual quotes and similar quotes are grouped together. As part of this process, quotes not saying something of importance about the topic are set aside and some quotes might be grouped with those answering other questions. In the computerized version, the sorting process was done with a text file instead of the paper clippings.

First, the individual notes and the flip charts were aggregated into one set of notes for each focus group. The notes were then aggregated into three sets, one each for the drivers, the supervisors/managers and the insurance industry subject matter experts. These aggregated notes for the nine focus groups are more than 40 printed pages and contain over 1800 statements. Next, three members of the research team individually sorted the statements and identified major categories in these notes. This was an iterative process. As the researchers worked through the notes they sorted the individual statements into one of the existing categories or added a new category that better reflected the thoughts presented by the participants. If a new category was added, sometimes some resorting was necessary since the new category might better suit a statement previously sorted into another category (cf. Newman, 2002). Due to the fact that the number of groups was small and there were no obvious distinguishable differences in the responses of different groups of experts, the data from the nine focus groups were merged. Finally, the investigators met and identified the major themes. The major themes are characterized by one or more of the following: Their relevance to the research question, the importance the theme had for the participants, the frequency of them being mentioned and the consistency of them being mentioned by participants of different focus groups.

4. Results

The major themes identified range from issues that influence safe and unsafe driving, over the feedback drivers do—or rather do not—receive about their driving performance, to technologies that can help in safe driving. Further, the benefits and drawbacks of technology giving feedback on driving performance were discussed as well as how feedback by technology on driving performance should be given. And finally, the participants' advice to a company wanting to develop a program to use in-cab technology to provide comments on driving performance is summarized.

4.1. Safe and unsafe driving

When asked "What makes a truck driver a good and safe driver?" respondents mentioned many safe behaviors and good driving habits (e.g., checking mirrors regularly) as well as certain personality traits (e.g., respect or patience). Similarly, unsafe behaviors (e.g., speeding) and unsafe personality traits (e.g., aggression) were mentioned.

Another noteworthy point is the fact that truck drivers consistently reported that other drivers are often equally or more responsible for unsafe behaviors of truck drivers. These include "4-wheelers" (automobile drivers), who were said to need better education about how to drive in the vicinity of large trucks and hold misconceptions about trucks and truck drivers.

Some participants stated that supervisors and dispatchers do not know enough about the day-to-day challenges of driving a large truck. They suggested that supervisors should accompany truck drivers for at least a week to get accustomed to the demands of a truck driver's job. Some drivers reported that dispatchers demanded them to deliver loads that were impossible to accomplish if they complied with Department of Transportation (DOT) hours of service requirements. They also reported that some dispatchers insisted on scheduling drivers even when they called in sick.

The inconsistency of rules and regulations and the inconsistent enforcement of federal laws in the 48 states was another aspect mentioned by the drivers. In particular, lower speed limits in some states and confinement of trucks to specific lanes were mentioned.

DOT officers were accused by some participants of "working for the treasury" (i.e. interested only in the revenues generated by fining truck drivers) and examples were given where police officers forced drivers to leave parking areas and continue driving although they were no longer allowed to drive legally for that day.

Finally, a lack of secure rest areas and the closing of rest areas in some states were mentioned. This, again, forces drivers to continue driving although they are tired or no longer legally allowed to drive for that day.

4.2. Feedback about driving performance

In the focus group discussions it was a recurring theme that drivers complained about not receiving 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. Feedback is wanted from persons the drivers respect and perceive as knowledgeable about their job. Feedback was felt to be less desirable if it came from persons the driver does not respect.

The feedback received by the drivers in part reflects the safety climate of the company. Some drivers reported that they hardly ever receive feedback, that their supervisors do not know their names, and that it is sometimes hard for them to contact anybody at the company. Other drivers reported a much more positive attitude from their company. Examples were given where these companies conduct regular safety meetings, drivers receive feedback about safety developments and have good relationships with their superiors.

The participants pointed out that certain things should be avoided 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 mentioned as not being helpful feedback.

4.3. Technology to help in safe driving

When asked, "What in-cab technology can help in safe driving?" the participants responded with a long list of different technologies. Among the most frequently mentioned technologies were collision-warning systems. Not all technologies mentioned are capable of providing feedback to the driver. Very often improvements were mentioned that increase vision and visibility of the drivers, like better lights, self-darkening glass to reduce glare or heated mirrors. Discussed by most groups were technologies to monitor the physical condition of the driver, for example fatigue or drowsiness monitors, monitors for diabetic drivers or monitoring the cardiac activity of the drivers to detect, for example, a heart attack. Among the other technologies mentioned were location tracking, communications systems, administrative technologies like paperless logs and trip planning software tools, and in-vehicle data recorders, so-called "black boxes."

4.4. Benefits and drawbacks of technology giving feedback on driving performance

When discussing the drivers' attitudes towards receiving comments on their driving performance, the participants of the focus groups expected improvements in driving performance. In addition to safer driving performance, they also expected improvements in driving efficiency. Other perceived benefits of in-cab technology included a reduction in driver stress. Some of the participants saw a decrease in operating costs by such technologies, due to fewer crashes and lower insurance rates. Some drivers reported that they felt mistrusted by their companies and by officers of the Department of Transportation. In such situations some of the participants saw the possibility that the data created by technology might aid them. But an even more important aspect in the discussions was the potential use of data to vindicate drivers in the event of an incident or crash.

One concern consistently voiced in the focus groups involved privacy issues. Participants would not feel comfortable with being watched by technology and were concerned how their driving performance data would be used. Some participants saw 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 area of concern is the fear that at least some drivers will over-rely on technology and no longer engage in safe driving habits on their own. Related to this are reliability issues of the technology. In addition, some participants were concerned that the initial cost of the technology will be too high.

4.5. How feedback by technology on driving performance should be given

The participants discussed how they would like to receive feedback on their driving performance from technology. One point of discussion was receiving feedback from a machine vs. a human. It seemed to be a consensus that when feedback is given by a machine, additional human feedback is wanted.

Different modalities of feedback were also discussed. Participants agreed that the type of feedback generally dictates the mode in which it should be delivered. For example, warnings need to be given with an audible or visual alarm, whereas a review of driving behavior could be given in other ways for which a variety of preferences among the participants existed. Some would prefer an artificial voice, others a message on a computer screen or a printout, and still others suggested an email message sent to the driver. In short, drivers feel more comfortable if they are given the ability to specify how less critical information is presented to them.

Timing of feedback was another issue that produced a variety of different opinions. Although it was consistent 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 driving performance. Some participants wanted it to be delivered whenever they requested it ("pull principle"), others preferred the information delivered to them by the system ("push principal") at the end of the trip, shift or day, and again others preferred a weekly or monthly schedule. There was no consistent opinion among the participants regarding the frequency and timing of feedback (random or regular). This suggests that a feedback system should be adaptable to the preferences of the individual driver.

Most participants seemed to accept that at some times it is necessary to receive negative feedback (e.g., warnings, like a collision warning, were considered negative feedback by the drivers). But in their opinion, negative feedback should be in the minority; it should be combined with positive feedback and be delivered in a constructive way.

Participants discussed who should be given access to the data collected by in-vehicle technology. Many participants were concerned about how the data would be used by their supervisors/management and the Department of Transportation. A suggestion was made that an independent entity handles the data that could be linked to an individual driver.

4.6. Participants' advice to a company wanting to develop a program to use in-cab technology to provide comments on driving performance

Finally, the participants provided a number of suggestions for developing and implementing programs that use in-cab technology to provide comments on safe driving performance. It was stated that when developing and introducing such a program, all levels in commercial fleets need to be involved; not only the drivers, but also management, dispatchers, and trainers, and the organizational culture must be supportive of such a system. Drivers should be involved at all levels of development and implementation. For example, it was suggested that drivers should participate in pilot testing new in-cab technology. Further comments suggested that the technology should not interfere with the driving task and should not be a distraction. The technology should be reliable and cost effective (i.e. affordable and provide measurable benefits). Appropriate and thorough training on new technologies and procedures would also be needed.

In the opinion of the participants, the introduction of such a program provides an opportunity to change the ratio of reward and punishment. Currently, their perception is that there are too many punishments and not enough rewards. This could be changed so that there would be more acknowledgements of safe and efficient driving performance. They also cautioned that the reward needs to be meaningful to the driver.

Finally, the participants cautioned that drivers should be given full disclosure regarding the use of data obtained from in-vehicle technology and using the data in a way other than described in the disclosure would be a grave mistake.

5. Discussion and future research

One recurring theme throughout the focus group discussions was the concern that drivers currently do not receive enough feedback about their driving performance. Very often when feedback is given, it is not from individuals the drivers respect or consider knowledgeable about driving. They report that the majority of the feedback received was negative. Drivers would like to receive more feedback, both positive and negative. Most drivers are willing to accept technology and agree that technology, if designed and introduced properly, can provide useful feedback to improve safe driving.

The results of the focus groups confirm the approach we are planning to take in the future parts of the research. The drivers would like to receive more feedback and we plan to use technology to provide it. Although the drivers would prefer feedback from a human, feedback by technology is acceptable if designed properly and if supplemented by human feedback.

In the context of this research project, it is interesting to note that for some of the safety critical behaviors mentioned, there are already technologies available to capture them and potentially provide feedback to drivers (see Table 4).

The participants expect that their driving performance will improve with technology providing feedback on driving performance. They expect not only improvements in driving safety but in driving efficiency as well.

One result of the focus group discussions was that such a program will only succeed if it not only addresses drivers, but also management, dispatchers, trainers and the organizational culture of the company. This is in agreement with what is known about BBS processes in general. The first step of a BBS initiative is the assessment of the organizational readiness of an organization. Among many other items, the significant leaders must show interest and willingness to commit resources and to be involved themselves; they must show effective leadership in safety; a sufficient level of trust between employees, supervisors and managers must exist and the formal and informal cultures of the organization must be supportive to the BBS initiative (cf. Matthews, 2002).

When we asked drivers about unsafe driving behaviors, they mentioned many other groups (e.g., other drivers, supervisors, dispatchers) and circumstances (e.g., inconsistent regulations and

Table 4
Behaviors relating to technology

Behavior	Example of technology
Speeding	Cruise control
Driving drowsy	Drowsiness detection
Following too closely	Intelligent cruise control
Not being aware of surroundings	Collision avoidance or warning system

lack of safe rest areas) that contribute to unsafe actions. Therefore, BBS approaches in the trucking industry must consider the safety risks posed by other users of the transportation system. In industrial settings all workers can be involved in a BBS program and the safety risks posed by non-employees are very limited. Our approach will initially be restricted to a very small number of participants. Nonetheless, driver experience, training and participation in a BBS program may allow drivers to compensate for the unsafe actions of other road users.

There are some limitations to this study. First, participation in this study was regionally limited; therefore, caution should be used when generalizing the results to the entire industry. Second, the results of this study are based on self-reported information collected in a group setting. Participants may not have been willing to answer with complete candor. Finally, because a hypothetical system was discussed by the participants in the focus groups, and the participants had different knowledge of existing in-vehicle technology, their responses may have been based on their perception of how the technology might work, rather than on actual experience with such a system.

In conclusion, the results from the focus groups provided valuable information for designing a program to use in-cab technology to deliver comments on driving performance. A systems approach should be used, looking beyond the driver and the design of the technology providing feedback. The usability and reliability of the technology are critical success factors. Drivers should, therefore, be involved in the development of the technology. Negative feedback should be in the minority, and if given, made constructive and combined with positive feedback. Warnings are important and should be given immediately. The feedback from technology should be supplemented with feedback from a person the drivers respect. The purpose of such a system should be clearly communicated. Introducing such a system will be greatly facilitated if drivers are involved early on. The data gathered by such a system are very sensitive and they should not be used for purposes other than those originally intended.

The next step in this multipart investigation is an experimental intervention, introducing in-cab technology that provides feedback to drivers to the daily operations of a trucking company.

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