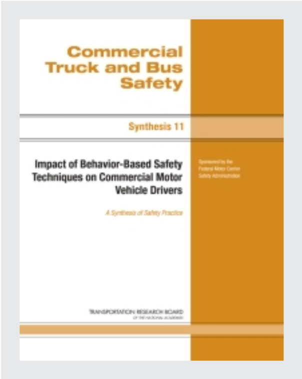

Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

CTBSSP SYNTHESIS 11

Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

Safety is a principal focus of government agencies and private-sector organizations concerned with transportation. The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999. Formerly a part of the Federal Highway Administration, the FMCSA's primary mission is to prevent commercial motor vehicle-related fatalities and injuries. Administration activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations, targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness. To accomplish these activities, the Administration works with federal, state, and local enforcement agencies, the motor carrier industry, labor, safety interest groups, and others. In addition to safety, security-related issues are also receiving significant attention in light of the terrorist events of September 11, 2001.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the FMCSA to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles the various forms of information into single concise documents pertaining to specific commercial truck and bus safety problems or sets of closely related problems

The CTBSSP, administered by the Transportation Research Board, began in early 2002 in support of the FMCSA's safety research programs. The program initiates three to four synthesis studies annually that address concerns in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings. The program is modeled after the successful synthesis programs currently operated as part of the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP).

This synthesis series reports on various practices, making recommendations where appropriate. Each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources, including a large number of relevant organizations, is analyzed.

For each topic, the project objectives are (1) to locate and assemble documented information (2) to learn what practice has been used for solving or alleviating problems; (3) to identify all ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

The CTBSSP is governed by a Program Oversight Panel consisting of individuals knowledgeable in the area of commercial truck and bus safety from a number of perspectives—commercial truck and bus carriers, key industry trade associations, state regulatory agencies, safety organizations, academia, and related federal agencies. Major responsibilities of the panel are to (1) provide general oversight of the CTBSSP and its procedures, (2) annually select synthesis topics, (3) refine synthesis scopes, (4) select researchers to prepare each synthesis, (5) review products, and (6) make publication recommendations.

Each year, potential synthesis topics are solicited through a broad industry-wide process. Based on the topics received, the Program Oversight Panel selects new synthesis topics based on the level of funding provided by the FMCSA. In late 2002, the Program Oversight Panel selected two task-order contractor teams through a competitive process to conduct syntheses for Fiscal Years 2003 through 2005.

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Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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CTBSSP OVERSIGHT PANEL

AUTHOR ACKNOWLEDGMENTS

Many individuals and organizations contributed to this synthesis project. The authors are indebted to the gracious support of survey respondents. As the surveys were anonymous, survey respondents cannot be acknowledged individually. The following organizations provided support in distributing surveys, conducting the focus groups, and providing examples of BBS checklists and/or training and education materials:

- American Bus Association
- American Trucking Associations
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- Federal Motor Carrier Safety Administration
- National Private Truck Council
- Marathon Ashland
- J. J. Taylor, LP.
- Praxair Distribution, Inc.
- TRB Committee on Truck and Bus Safety Research (ANB70)
- Virginia Trucking Association

FOREWORD

By Christopher W. Jenks
CTBSSP Manager
Transportation Research Board

This synthesis will be useful to federal and state agencies, commercial truck and bus operators, and others interested in improving commercial vehicle safety. The synthesis identifies and describes various strategies to increase safety-related driving behaviors, and decrease at-risk driving behaviors, of commercial motor vehicle drivers. It includes an extensive literature review and case study information on innovative and successful behavior-based safety practices in commercial vehicle settings. The synthesis also includes the results of a survey of motor carrier safety managers that provides information on current behavioral safety management practices in commercial motor vehicle operations and their effectiveness.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day jobs. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the Federal Motor Carrier Safety Administration (FMCSA) to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles information into single concise documents pertaining to specific commercial truck and bus safety problems.

The CTBSSP, administered by the Transportation Research Board, was authorized in late 2001 and began in 2002 in support of the FMCSA's safety research programs. The program initiates several synthesis studies annually that address issues in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings.

This synthesis series reports on various practices; each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources is analyzed.

For each topic, the project objectives are (1) to locate and assemble documented information; (2) to learn what practices have been used for solving or alleviating problems; (3) to identify relevant, ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

CONTENTS

SUMMARY

Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers

This synthesis documents current information on various Behavior-Based Safety (BBS) strategies to increase safety-related and decrease at-risk driving behaviors of commercial motor vehicle (CMV) drivers. This report includes an extensive literature review and case study information about innovative and successful BBS practices in work settings. A survey of motor carrier safety managers provides information on current behavioral safety management practices in commercial motor vehicle transport, including manager assessments of effectiveness. The study also provides recommendations for future research on BBS in CMV operations.

Although most CMV drivers are conscientious and generally employ safe driving practices, drivers may at times drive in ways that put themselves and others at risk for a vehicle crash and serious injuries. Some CMV drivers may habitually engage in such behaviors. A previous survey of motor carrier safety managers regarding major safety management problems found "at-risk driving behaviors" (e.g., speeding, tailgating) to be the single most important safety-management problem. Studies indicate that driving behaviors are a significant contributing factor of large-truck crashes, and interventions aimed at increasing safe driving behaviors and reducing at-risk driving behaviors are likely to prevent many vehicle crashes.

BBS provides robust positive results when applied in organizations seeking to reduce employee injuries due to at-risk behaviors. However, almost all prior BBS research has been applied in work settings where employees can systematically observe the safe versus at-risk behaviors of their co-workers. Truck and bus drivers work alone in relative isolation and thus may require alternative BBS processes.

Fleet safety managers' management practices and opinions of their effectiveness were assessed through a survey questionnaire on the topic. The research literature on the topic was reviewed, with emphasis on behavioral interventions to increase safe driving behaviors and, secondarily, safe behaviors in non-driving situations such as loading and unloading. CMV fleet safety managers are the principal audience for this synthesis. In addition, the study should be useful to government, industry, and academic personnel involved in formulating and conducting studies to gain new knowledge (i.e., research) and to create new tools (i.e., development) relating to this safety topic.

Surveys were distributed primarily through an email list of attendees at transportation conferences and respondents from two previous CTBSSP studies conducted on carrier safety-management methods and high-risk CMV drivers. To obtain a sample of motor coach respondents, some surveys were distributed to members of the American Bus Association Safety Council. The overall return rate of the safety manager survey was about 17%. The resulting sample consisted of 65 managers from a variety of CMV operations who, because of their voluntary participation, may be considered more safety-conscious than the overall safety manager population.

Before survey distribution, two focus groups were held with fleet safety managers. During these two focus groups, participants were asked to discuss their experiences with at-risk driving behaviors, behavioral observation techniques, safety-management techniques, and barriers to

implementing safety-management techniques (with emphasis on BBS techniques). The responses from the focus groups informed the design, questions, and terminology used in the final survey distributed to fleet safety managers.

The survey sent to safety managers had five parts. Respondents were first asked to rate their perceptions of the relationship between overall safety (e.g., injuries, illnesses, violations, and crashes) and at-risk driving and non-driving behaviors. Second, safety managers were asked to indicate current use of observation techniques (such as ride-alongs) or technologies (on-board safety monitoring [OBSM] devices) to track driving and non-driving behaviors. Third, safety managers were asked if they currently use specific BBS techniques and, if they responded "yes," they were asked to rate the effectiveness of the techniques. During the focus groups, the project team discovered that few of the focus group participants implemented a comprehensive BBS program. Fourth, safety managers were asked to indicate barriers or problems in implementing BBS techniques in their organization. Finally, safety managers were asked to provide comments regarding BBS or other aspects of the survey and to complete demographic information.

The following list summarizes the results from the safety manager survey:

- **Driving vs. non-driving behaviors:** Respondents generally rated the association between driving behaviors and crash and injury risk as much greater than the association between non-driving behaviors and injury and illness risk.
- **Ride-alongs:** Fifty-nine percent of respondents indicated they currently perform ride-alongs to observe safety-critical behaviors.
- **Covert observation:** Thirty-seven percent of respondents indicated they currently use covert observation techniques to observe safety-critical behaviors.
- **Comments from the public:** Fifty-nine percent of respondents indicated they receive and use comments from the public to observe safety-critical behaviors.
- **Observation in general:** Overall, 83% of respondents reported using some type of observation technique to observe the safety-critical behaviors of their drivers.
- **Intervention effectiveness:** The highest-rated BBS technique was training and education programs directed at specific driving behaviors, while the lowest-rated was driver self-management/self-observation.
- **Peer observation and feedback:** Sixty-three percent of respondents indicated the use of peer observation and feedback, most commonly performed monthly. Ninety-six percent of respondents reported giving drivers feedback via one-on-one meetings. Most respondents (54%) give a combination of group and individual feedback.
- **Self-management/self-observation:** Thirty-two percent of respondents encourage their drivers to use safety self-management and self-observation. Feedback to drivers is typically provided via one-on-one meetings or a combination of group and individual feedback.
- **Training on specific driving behaviors:** All respondents use training and education sessions on specific driving behaviors, most often in quarterly sessions.
- **Training on specific non-driving behaviors:** Seventy-two percent of respondents indicated using training and education sessions on specific non-driving behaviors.
- **Incentives/rewards:** Eighty percent of respondents reported using incentives/rewards with their drivers. Typical rewards include safety awards (e.g., certificate, trophy), public recognition, and cash. Most of these respondents indicated using some type of outcome measure (i.e., crash-free miles) to reward drivers, while few respondents indicated using process-based data (i.e., speed or brake).
- **Disincentives/penalties:** Eighty-eight percent of respondents reported using disincentives/penalties with their drivers. Most (88%) use a memo/letter in the driver's file. Most of these respondents indicated using crash data (93%) to punish drivers, while few respondents indicated using brake data (14%).

- **Content of new driver training:** Most survey respondents (95%) focus on training new drivers how to conduct pre- and post-trip inspections of their vehicles (76%), while few focus on proper diet, exercise, or load securement (all 2%).
- **Content of refresher training:** Most survey respondents (94%) focus on refresher training/coaching experienced drivers to drive attentively (71%), while few focus on diet, drugs, or load securement (all 2%).
- **Barriers to use of BBS:** The highest-rated barrier to the use of BBS was non-acceptance/lack of cooperation by drivers. The lowest-rated barrier/problem was driver union (or other association) opposed to it.

The survey results from fleet safety managers did not always echo the results found in previously published studies. While BBS techniques have been successful in other industrial settings, few scientific studies have used these techniques with CMV drivers. Despite the widespread use and success of BBS in other industrial settings, systematic BBS programs have not been widely embraced by safety professionals in CMV operations. This synthesis shows that respondents indicated widespread use of specific BBS techniques but little use of more comprehensive BBS programs. This lack of comprehensive BBS programs may be due to the solitary nature of driving, the difficulty of capturing and documenting key safety-critical behaviors, and/or a general lack of fleet safety manager knowledge about BBS and its potential benefits. Clearly, a significant need is to develop a set of accepted practices and guidelines for implementing and using BBS techniques in CMV operations. Future research should address (1) how to get fleet safety managers to implement comprehensive BBS programs, (2) the efficacy and applicability of BBS programs in CMV operations, (3) a comparison of the effectiveness of process- and outcome-based incentive programs in CMV operations, (4) how OBSM devices and BBS can be integrated and used effectively in CMV operations, and (5) the need for more rigorous testing on the effectiveness of safety placards.

INTRODUCTION

Background

Motor vehicle crashes are often predictable and preventable. Yet, many drivers choose to behave in ways that put themselves and others at risk for a vehicle crash and/or serious injuries. At-risk driving behaviors include speed-limit violation, excessive speed/lateral acceleration on curves, unplanned lane departures, frequent hard braking, close following distances, lateral encroachment (e.g., during attempted lane changes, perhaps due to improper mirror use), failure to yield at intersections, and general disobedience of the rules of the road. At-risk non-driving behaviors include improper lifting techniques, improper entering/exiting the truck, and poor diet and exercise. Performing at-risk driving behaviors is likely to increase crash risk while performing at-risk non-driving behaviors is likely to increase injury and illness risk.

At-Risk Behaviors

One of the most significant studies on the factors that contribute to motor vehicle crashes was the Indiana Tri-Level Study (Treat et al., 1979). To provide insight into the factors that contribute to traffic crashes, data were collected on three levels to assess causal factors as being definite, probable, or possible. The study determined that

- 90.3% involved human error, such as at-risk driving behavior, inadvertent errors, and impaired states;
- 34.9% involved environmental factors, such as wet/slick road conditions and poor weather; and
- 9.1% involved vehicle factors, such as brake failure and worn tires. Note the percentages do not total to 100% because some events were coded as involving more than a single factor.

The two most frequent human behaviors found in all of the crashes investigated were "recognition failure" (i.e., driver inattention/distraction; 20.3% of the crashes) and "decision error" (i.e., excessive speed; 14.7% of the crashes).

A more recent study by Hendricks, Fell, and Freedman (1999) tried to replicate the epidemiological method employed in the Indiana Tri-Level Study using the National Automotive Sampling System (NASS) protocol. More specifically, the researchers assessed the specific driver behaviors and unsafe driving acts that lead to crashes, and the situational, driver, and vehicle characteristics associated with these behaviors. Similar to the Indiana Tri-Level Study, Hendricks, Fell, and Freedman found human error was the most frequently cited contributing factor in these crashes (99.2%), followed by environmental (5.4%) and vehicle (0.5%) factors. Thus, it has been shown that crashes and their associated injuries and fatalities are likely to result from excessive unsafe driving behaviors and from deficits in safe driving behaviors.

Both the Indiana Tri-Level Study (Treat et al., 1979) and the study conducted by Hendricks, Fell, and Freedman (1999) clearly indicate most vehicle crashes were the result of human error (which includes at-risk driving behaviors). However, these studies were primarily focused on light vehicles. The recently completed Large Truck Crash Causation Study (LTCCS) assessed the causes of, and contributing factors to, crashes involving CMVs. While the LTCCS contains the same type of descriptive data as the primary national traffic safety databases (e.g., FMCSA's Motor Carrier Management Information System and NHTSA's General Estimates System), it also focused on pre-crash factors such as driver fatigue and distraction, vehicle condition, weather, and roadway problems. This made the LTCCS the only national examination of all factors related to causation in large truck crashes. The LTCCS was conducted at 24 data collection sites in 17 states by researchers from NHTSA's NASS and state truck inspectors. Crash data were coded in two NASS Zone Centers and reviewed by FMCSA and NHTSA personnel and national truck crash experts. The LTCCS found 87.3% of the critical reasons for crashes assigned to the large-truck driver were driver errors: 38% were decision errors (e.g., driver drove too fast for conditions), 28.4% recognition errors (e.g., driver did not recognize the situation by not paying proper attention), 11.6% non-performance errors (e.g., driver fell asleep), and 9.2% performance errors (driver exercised poor directional control; U.S.DOT, 2006). For all large-truck crashes (including both single-vehicle and multi-vehicle crashes), the critical reason for the crash was assigned to the large truck 54.6% of the time and, as noted, driver errors predominated over vehicle and environmental factors. When crashes involving only one truck and one passenger vehicle were considered, 43.9% had a critical reason assigned to the truck and, of these, 86.2% involved driver errors.

American Transportation Research Institute's (ATRI) (2005) study, *Predicting Truck Crash Involvement: Developing a Commercial Driver Behavior-Based Model and Recommended Countermeasures,* analyzed data on 540,750 drivers gathered over a 3-year time frame to determine future crash predictability. Their data showed reckless driving and improper turn violations as the two *violations* associated with the highest increased likelihood of a future crash. The four *convictions* with the highest associations with future crash involvement were (1) improper or erratic lane change, (2) failure to yield right of way, (3) improper turn, and (4) failure to maintain a proper lane. When a driver receives a conviction for one of these behaviors, the likelihood of a future crash increases to between 91 to 100%. In a summary of all crash data analyzed, reckless driving violations prompted the highest likelihood of a future crash (32.5%).

Knipling, Hickman, and Bergoffen (2003) surveyed motor carrier safety managers regarding major safety-management problems and solutions. Among 20 different safety-management problem areas rated by respondents, "at-risk driving behaviors" (e.g., speeding, tailgating) were rated as the single most important safety-management problem. These studies, in combination, indicate that driving behaviors are a significant contributing factor of large-truck crashes, and interventions aimed at increasing safe driving behaviors and reducing at-risk driving behaviors will prevent many vehicle crashes.

The primary focus of fleet safety managers is to reduce at-risk driving behaviors, thereby reducing crashes. However, at-risk non-driving behaviors are also a significant safety concern. In 2001, there were 32 million musculoskeletal injuries. Back problems remain one of the most frequent and expensive on-the-job injuries. Nearly 2% of all workers have a work-related back injury (U.S. Department of Labor, 2003). Truck drivers ranked second out of 127 jobs (accounting for 8% of the total frequency of musculoskeletal injuries) in the frequency of musculoskeletal injuries (Bureau of Labor Statistics, 2004). Heavy lifting and stepping in and out of the truck cab are likely to be daily behaviors performed by CMV drivers. Workload is a key factor in terms of risk (e.g., heavy lifting increases the risk of low back injury by 6 to 8 times). Moreover, whole-body vibration for extended periods is likely to predispose CMV drivers to back injuries (Massaccesi et al., 2003). Truck drivers are also more likely than the general population to engage in unhealthy lifestyle behaviors, such as smoking, poor diet, and physical inactivity (Roberts and York, 2000).

Behavior-Based Safety

Behavior-based safety (BBS) provides robust positive results when applied in organizations seeking to reduce employee injuries due to at-risk behaviors. Primary techniques in BBS include peer observation and feedback, training and education sessions, behavior-based incentives, prompts, and goal setting (Geller, 2001; Krause, Robin, and Knipling, 1999). Almost all prior BBS research has been applied in work settings where employees can systematically observe the safe versus at-risk behavior of their co-workers. In contrast, truck and bus drivers work alone in relative isolation and thus require alternative BBS processes such as OBSM or self-management.

BBS programs are advantageous because they are easy to implement, are easy to teach, and can be implemented in the setting where the problem occurs (Daniels, 1999; Geller, 2001). BBS programs have been successfully used to increase safety-related work behaviors in a variety of organizational settings, including pizza stores (Ludwig and Geller, 1991, 1997), a paper mill (Fellner and Sulzer-Azaroff, 1984), the mining industry (Fox, Hopkins, and Anger, 1987; Hickman and Geller, 2003a), the railroad industry (Peterson,1984), a gas pipeline company (McSween, 1995), manufacturing plants (Reber and Wallin, 1984), a chemical research laboratory (Sulzer-Azaroff, 1978), a food manufacturing plant (Komaki, Barwick, and Scott, 1978), an infirmary at a residential center for mentally disabled individuals (Alavosius and Sulzer-Azaroff, 1986), building construction (Mattila and Hyödynmaa, 1988), a telecommunication parts manufacturing plant (Sulzer-Azaroff et al., 1990), a shipyard (Saarela, 1990), and a utility company (Loafman, 1998).

In a review of 53 occupational safety and health studies covering various safety approaches, Guastello (1993) found BBS had the highest average reduction of injury rate (59.6%). Sulzer-Azaroff and Austin's (2000) review of published BBS studies found that 96.9% of the studies they reviewed showed significant reductions in work-related injuries after the implementation of BBS techniques. BBS programs have also been shown to reduce workers' compensation claims. Behavioral Science Technology, Inc. (BST) found a 70% reduction in workers' compensation claims in Year 3 after the introduction of a BBS program (BST, 1998), and Hantula et al. (2001) showed reductions in workers' compensation claims after the introduction of a BBS intervention. Clearly, BBS programs can be effective in reducing injuries and their associated costs.

While BBS focuses on workers' safety-related behaviors, this focus does not imply a one-dimensional (i.e., behavioral) view towards safety. In fact, Geller (2001) and Krause (1997) believe safety interventions that focus exclusively on reducing at-risk safety-related work behaviors without acknowledging the system in which they occur will have modest long-term success. Comprehensive BBS programs focus on three interdependent factors (person, behavior, and environment) in an organization's safety system, called the "Safety Triad" (Geller, 2001). Changes in one factor are likely to impact the other two. While specific BBS techniques have been implemented with CMV drivers, this systemic approach to BBS has not yet been adopted in CMV safety-management approaches.

Scope

The studies presented above introduce and demonstrate that at-risk driving and non-driving behaviors contribute to CMV crashes, injuries, and illnesses. CMV drivers generally drive responsibly and exhibit lower rates of most types of incident and crash involvement than drivers in general (FMCSA, 2003; Wang, Knipling, and Blincoe, 1999). BBS approaches to injury and illness reduction have been effective in reducing at-risk behaviors in industrial settings thereby reducing injuries and illnesses.

This synthesis reviewed the evidence for various behavioral strategies to increase the safety-related driving and non-driving behaviors of CMV employees. More specifically, this synthesis

- Summarized available information on BBS techniques with CMV drivers,
- Examined the effectiveness of various BBS techniques to increase safety-related driving and non-driving behaviors,
- Identified observation and BBS techniques currently used by CMV carriers, and
- Examined barriers to implementing BBS techniques in CMV carriers.

This synthesis focuses primarily on CMV drivers; however, the topics and results presented are applicable to bus drivers and other transportation operators. Most of the BBS techniques discussed in the synthesis are intended for fleet safety managers or other safety professionals working in CMV operations. The Statement of Work for the synthesis can be found in Appendix A.

Approach

Information on observation and BBS techniques was obtained through several means. The primary method for obtaining information was project surveys. A fleet safety manager survey was administered through various methods: (1) a secure Internet survey form, (2) a survey form completed on the computer and returned via email, and (3) a traditional paper-and-pencil survey form returned via facsimile or mail. Appendix B shows the computer and paper-and-pencil survey forms. Safety managers were asked if they currently used the observation or BBS technique and then, if "yes," asked to rate the effectiveness of the BBS technique. Thus, these questions yielded data on the prevalence of industry use of the observation and BBS techniques as well as subjective evaluations of BBS techniques.

Two focus groups were conducted with fleet safety managers. These focus groups were critical in informing the questions and terminology employed in the survey distributed to fleet safety managers. Further, an extensive literature review was conducted. This literature review focused on relevant observation and BBS techniques used in CMV operations or other relevant industries. The literature cited in this synthesis was obtained through the Transportation Research Information System (TRIS), other reference systems, FMCSA research publications, research journals on traffic safety, industrial safety, and behavioral publications. The last section of this report will describe the survey methodology and results, conclusions, and research and development needs.

Behavior-Based Safety Principles

The next three sections describe the literature review, including a description of BBS, BBS observation techniques, and specific behavioral safety-management techniques. The behavioral approach to safety is directly influenced by the research and legacy of B. F. Skinner (1938, 1953). Skinner believed behaviors were ideal for scientific study because they could be operationally defined and influenced based on the merit of being observable and thus reliably trackable. BBS approaches to safety focus on systematically studying the effects of various interventions on safety-related target behaviors. The DO IT process (described below) describes how most BBS programs work (Geller, 2001). BBS interventions modify either events before the behavior (antecedents or prompts) or the events that occur after behavior (consequences). For example, being late for work may prime a person to speed. The consequences of speeding may be desirable (get to work on time) or undesirable (receive a speeding ticket). Behaviors followed by desirable consequences are more likely to be repeated in the future and those followed by undesirable consequences are less likely to be repeated in the future (Daniels, 1999; Geller, 2001).

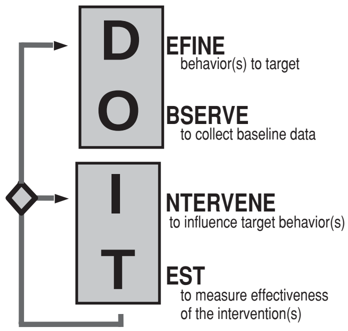
Research has shown BBS to be cost-effective, primarily because behavior-change techniques are straightforward and relatively easy to administer, and because intervention progress can be readily assessed by company personnel monitoring target behaviors (Daniels, 1999; Sulzer-Azaroff and de Santamaria, 1980). Geller (2001) developed a simple, easy-to-use BBS process for continuous behavioral improvement. Figure 1 provides a visual illustration of the DO IT process.

Geller's (2001) DO IT process comprises four steps:

1. **Define target behaviors.** Identify safe and/or at-risk behaviors to be increased or reduced. Usually a review of safety records, job hazards' analyses, near-miss/crash reporting, audit findings, or interviews with employees will identify behaviors to be targeted. After selecting target behaviors, define them in a way that is easy for everyone to understand. After selecting and defining target behaviors, a behavioral checklist that includes the targeted behaviors can be developed. See Appendix C for examples of checklists used in CMV settings.
2. **Observe behavior.** Observe and record the target behaviors using a behavioral checklist or other observation technique (e.g., OBSM device). Observations continue until a stable baseline of the target behaviors is achieved.
3. **Intervene to influence target behaviors.** By studying the baseline rate of target behaviors, an intervention can be developed to increase and/or decrease target behaviors. Specific behavioral management techniques are described below. Geller (2001) recommends asking the following questions when determining how to intervene on a target behaviors(s): (a) How does the frequency of the target behavior vary among different individuals? (b) In what situations and at what times does the target behavior occur most often? (c) When and where does the behavior occur least often? (d) How often does a person have an opportunity to perform the appropriate safe behavior but does not make it? (e) What specific environmental changes occur before and after the target behavior occurs? and (f) What environmental factors are supporting a particular at-risk behavior and/or inhibiting a particular safe behavior?
4. **Test to measure effectiveness of the intervention.** Continue observations after implementing the intervention(s) to assess the success of the intervention. If goals have been achieved, set progressively higher goals or select new target behaviors and start the DO IT process over again. If goals have not been achieved, select a more achievable goal or implement a different intervention(s).

Behavioral Checklist

The first step in creating a behavioral checklist is determining which target behaviors should be included in the behavioral checklist. Target behaviors should not only include those



Source: Adapted from Geller (2001).

Figure 1. The DO IT process.

behaviors identified through crash, incident, and injury reports, but also behaviors drivers would like to address. The second step is determining how many behaviors to include on the behavioral checklist. Both Geller (2001) and Krause (1997) recommend starting small in the beginning and progressively adding more behaviors as employees become more experienced in the observation techniques. Finally, determine the anonymity of the observer and the observee (the person being observed). Again, both Geller (2001) and Krause (1997) recommend the observee should remain anonymous. This will increase participation and employees will see the process is not a "gotcha program," but rather an objective way to assess problem areas and increase safety. At first, it may be best to keep both the observer and observee anonymous. However, as the process continues and employees begin to trust that the information on the behavioral checklists is used to improve safety and not to identify problem workers, the observer may be noted on the checklist to assess participation in the process. See Appendix C for examples of behavioral checklists used in CMV setting.

Multiple Intervention Level Hierarchy

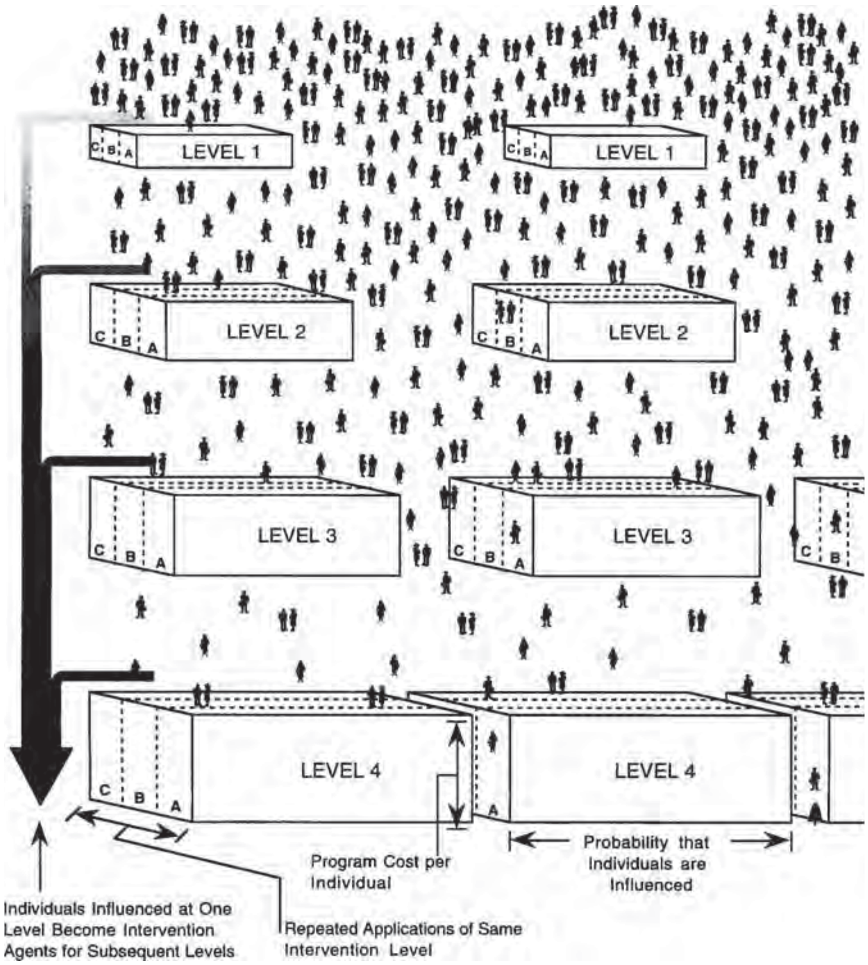
Individual differences in people suggest that some people are likely to benefit from simple interventions, while others may require more complex and intrusive interventions to achieve desired safety goals. Geller (1998) developed the multiple intervention level (MIL) hierarchy to summarize the impact, intrusiveness, and cost of various interventions. Interventions at Level 1, such as posters, signs, and other safety messages or slogans, are the least expensive and intrusive. Level 1 interventions are designed to be cost-effective and have large-scale appeal. Individuals unaffected by Level 1 interventions fall through the cracks; these individuals require a more intrusive and expensive intervention.

A Level 2 intervention may also involve signs and reminders, but these may be intensive and intrusive, such as signing and displaying a promise card to wear a safety belt. A Level 3 intervention might include peer-to-peer coaching or an incentive/reward program. A Level 4 intervention is the most intrusive and labor-intensive. An example of a Level 4 intervention is one-to-one counseling. Typically, these interventions must be implemented by a professional with extensive training and are reserved for "hard core" problem individuals who are at the greatest risk for injury and crashes. Figure 2 displays the MIL hierarchy. The height of each intervention box indicates the financial cost to participate or implement the intervention. The length of each box represents the probability that a person will be affected by the intervention (i.e., change in behavior will result). The width of each intervention level (marked A, B, C) indicates repeated applications of the same intervention (Geller, 1998).

Effectiveness of BBS

Studies showing the injury reduction potential and resultant reduction in workers' compensation claims were presented previously (BST, 1998; Guastello, 1993; Hantula et al., 2001; Sulzer-Azaroff and Austin, 2000). These tremendous gains in safety are attributed in large part to their ability to engage workers collaboratively in the improvement process. While impressive, almost all of these BBS initiatives have been implemented in manufacturing settings. While several small, well-controlled studies have assessed the efficacy of some behavioral management techniques in CMV operations (Hickman and Geller, 2003b; Krause, 1997; Olson and Austin, 2001), there remains a need to assess the effectiveness of a comprehensive BBS program with CMV drivers. A 1999 study conducted for the Office of Motor Carrier and Highway Safety (now the Federal Motor Carrier Safety Administration) addressed the applicability of implementing BBS processes with CMV drivers (Krause, Robin, and Knipling, 1999). The authors reviewed the fundamental assumptions and steps of BBS and successful BBS applications in industry, including applications to driving safety by a Canadian oil and natural gas and a U.S. glass manufacturing and distribution company. They concluded that BBS was a promising approach to enhancing CMV operational safety and should be more widely employed in the motor transport industry.

While there have been few published studies assessing the effectiveness of BBS with CMV drivers, other transportation modes, such as rail, have recently assessed how a BBS program can be successfully implemented. The Federal Railroad Administration has supported several efforts to assess the efficacy of BBS programs in the rail industry (Ranney et al., 2005). Amtrak has implemented a comprehensive BBS program with its ticket agents, gate agents, baggage handlers, and janitors in Chicago's Union Station. Injuries among these sectors over a 3-year span were reviewed to develop a list of safe behaviors.



Source: Adapted from Geller (1998).

Figure 2. MIL hierarchy.

The operational definitions for these safe behaviors were defined and a behavioral checklist was created (see Appendix C for an example of the checklist). Employees observed co-workers and recorded “safe” and “at-risk” behaviors on the checklist. The results from the checklists were aggregated and shown to employees as feedback. During Phase I, Hall (2006) reported a significant positive correlation between the frequency of observations made by employees and staff-hours between injuries. Further, in Phase II, Hall (2006) reported an 85.7% reduction in injuries. Moreover, Ricci and Hall (2006) report on a similar BBS process with rail employees at a site in the Western United States. They found a 57% reduction in the frequency of accidents, incidents, and injuries from pre-intervention to post-intervention (see Appendix C for an example of the checklist). These rail employees were able to conduct peer-to-peer coaching because none of the employees were solitary workers, which most CMV drivers are. One obvious limitation is the applicability of peer-to-peer coaching to industries and work settings involving solitary workers.

Observation Techniques

This section describes methods for observing behavior, including OBSM, ride-alongs, covert observations, and comments from the public. Note that peer observation and self-management are considered to be *both* observation and intervention techniques; they are described in the "Specific BBS Techniques" section.

On-Board Safety Monitoring Devices

New technologies are available that provide objective measures of driver behavior. These in-vehicle technologies are able to provide continuous measures on a wide variety of driving behaviors previously unavailable to fleet safety managers (for descriptions of OBSM devices, see "OBSM Devices Used by Survey Respondents"). Behavioral approaches to safety modify safe and/or at-risk driving behaviors to greatly reduce crash and injury risk. Thus, OBSM devices have the potential to be used in conjunction with behavioral management techniques to greatly reduce a variety of at-risk behaviors. Knipling, Hickman, and Bergoffen (2003) suggested the combination of OBSM techniques with other safety-management techniques (especially BBS) is likely to be one of the most powerful approaches in reducing CMV crashes. While the logic of this approach is clear, in practice the most important challenge to CMV driver safety management is likely to be achieving driver acceptance of OBSM devices. One key to achieving acceptance and ensuring positive behavior change using OBSM may be to provide frequent and positive feedback and rewards (including financial rewards) to drivers as they exhibit safe driving behaviors (Knipling and Olsgard, 2000).

Overcoming Driver Resistance

Most CMV drivers resist the idea of OBSM devices, and such resistance must be overcome for successful deployment. In more than 1,500 interviews with long-haul truck and motor coach drivers by Penn + Schoen Associates, Inc. (1995), respondents were asked about their potential acceptance of OBSM devices in comparison to five other Intelligent Transportation System (ITS) Commercial Vehicle Operations (CVO) services, most of which were related to mobility enhancement. Drivers supported those technologies that they perceived as potentially making their jobs easier but were wary of technologies perceived as invasions of privacy or as diminishing the role of driver judgment. While the drivers acknowledged the potential safety benefits of OBSM devices, the results suggest these devices were the least accepted technology. In general, drivers who had actually used a particular technology, including OBSM devices, were more accepting of it than those who had not. A recent study by Huang et al. (2005) that surveyed truck drivers' perceptions of data gathered by in-vehicle technologies on their driving behavior found more positive views toward in-vehicle technologies. Though feedback from a supervisor or manager was preferred over feedback from an in-vehicle technology, drivers desired more feedback from in-vehicle technologies as long as the feedback was positive and came from a well-designed safety-management program.

From this research, it appears that successful deployment of OBSM devices must overcome the initial bias of drivers by demonstrating the usefulness of information provided by these systems and persuading drivers that such systems will be used for positive feedback rather than negative feedback (Huang et al., 2005; Knipling and Olsgard, 2000; Penn + Schoen, 1995).

Most of these OBSM devices were used to track vehicle speed and/or hard-braking maneuvers. Currently, there are many OBSM devices available to fleet safety managers. While a detailed description of each device is beyond the scope of this report, a brief description of the OBSM devices used by safety managers who responded in this project is included below. Note this synthesis does not endorse any specific OBSM device; the intent is to describe OBSM devices currently used by fleet safety managers as reported in the surveys supporting this synthesis.

OBSM Devices Used by Survey Respondents

Tripmaster®

Tripmaster is an integrated system that records vehicle speed, acceleration and deceleration rates, engine RPMs, mileage, and vehicle location. Extra sensors can provide data on refrigeration temperatures and use of sirens or emergency lights. Data are collected each second and can be collected via wireless downloads. A small on-board sensor is installed on the vehicle, and a key can be used to identify specific drivers and control access to vehicles. Primary safety behaviors measured include extreme braking events and speeding.

XATA Application Module

The XATA Application Module (XAM) connects to the truck's J1708 bus and collects vehicle and diagnostic information. The XAM incorporates a microprocessor, wireless communications, and a 12-channel global positioning system (GPS) receiver all housed in an industrial aluminum alloy base with a UV-resistant plastic dome. Two analog inputs can monitor fuel and brakes. These data can be delivered immediately to a driver display or reported back to management. The XAM can create "learned standards" about its performance, thereby alerting fleet safety managers when a vehicle exceeds those standards. Primary safety behaviors measured include extreme braking events and speeding.

Eaton VORAD®

VORAD is a crash warning and safety system that uses radar signals to detect potential hazards (see Figure 3). VORAD emits low-power, high-frequency radar signals from the front and/or side of a truck (depending on the type of VORAD installed in the truck). When the radar detects a potential hazard, a dash-mounted display generates a visual and audible warning that gives drivers critical seconds to take evasive action and avoid a crash. The VORAD alerts drivers to objects up to 500 ft ahead and also around curves. Though the VORAD is designed as a crash-avoidance system, it can track several safety-related behaviors, such as following distance, speed, and lane-change maneuvers.

Figure 3. Monopulse lane coverage.

Qualcomm Products

OmniTRACS® is a wireless communication and satellite positioning tool that assists companies in locating truck loads and contacting drivers at any time regardless of their location. Qualcomm also offers SensorTRACS® performance monitoring, which collects information from the vehicle's data bus and provides information on fuel, engine wear, and driver performance. This information is delivered to dispatch or on demand via Qualcomm's mobile communications solutions. The data are also displayed for drivers, so they can modify driving habits immediately and meet company-set parameters.

PeopleNet

PeopleNet uses the g3 on-board computing system. The g3 allows mobile communications, multi-networking, hardware connectivity with USB support, and GPS accuracy. PerformX™ is a real-time driver and vehicle performance evaluation tool that works with PeopleNet. It monitors the vehicle's engine to assist in management of operating costs. The PerformX™ monitors a vehicle's performance by communicating with the engine's data J-bus; this information (e.g., speed and hard braking) is delivered to fleet safety managers via real-time alarms or scheduled data downloads. PeopleNet also offers on-board event recording. Traffic events can be recorded real-time with the ability to access second-by-second recorded data. Three types of event recordings are available: (1) sudden acceleration, (2) sudden deceleration, and (3) manual trigger. Events can be captured 60, 120, or 170 s before and 30 s after each event.

DriveCam®

DriveCam uses palm-sized, exception-based video event recorders mounted on the windshield behind the rearview mirror to capture driving behaviors that occur inside the truck and directly in front of the vehicle. Forces (e.g., hard braking, swerving, collision, etc.) cause the recorder to save 20 s of audio and video footage (10 s immediately before and after the triggered event). When the video event recorder is triggered, a light blinks to alert the driver. These events are saved and downloaded directly, via a wired or wireless connection, to the fleet manager's inbox. These data are supplemented with driver training procedures and coaching techniques and methodologies. This feedback loop is depicted in Figure 4.

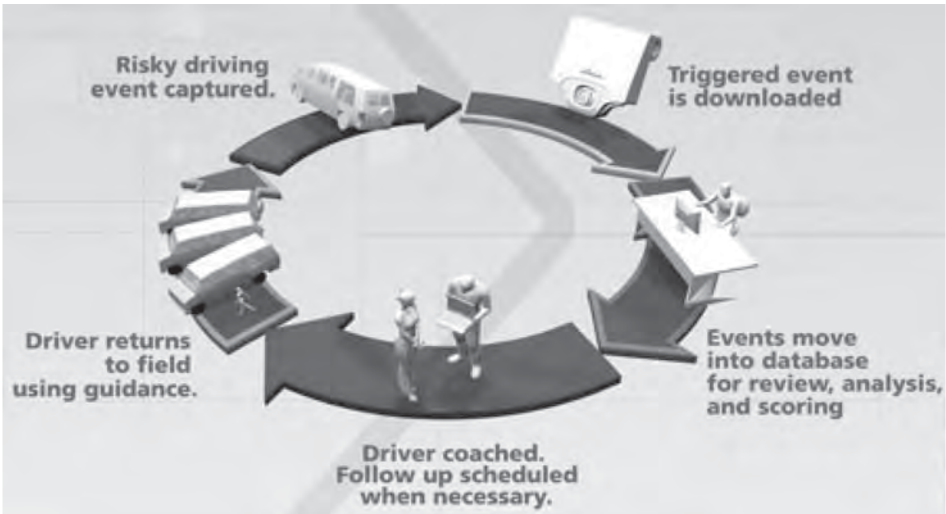


Figure 4. Feedback loop using the DriveCam system.

Cadec Mobius TTS®

The Cadec Mobius TTS uses a 32-bit RISC high-powered processor in its on-board computer. The computer interfaces with the truck's J-Bus. The Cadec Mobius TTS comes with a driver display that has an LCD graphical touch screen display (readable in sunlight and backlit for night viewing). A driver can be coached via audio and visual cues to adhere to company standards, including vehicle and route performance. Speed and braking are tracked and recorded every second and at GPS locations every 1/100th of a mile. Primary safety behaviors measured include extreme braking events and speeding.

International Road Dynamics iRESPONDER™

The iRESPONDER™ Emergency Management Information System gives fleet safety managers a set of tools needed to encourage safe driving behavior. Reports included with iRESPONDER™ include start time, pickups, stop time, sirens and warning beacons, acceleration, speed, braking, cornering, and RPM. Features of iRESPONDER™ include driver authentication and anti-theft device, flexible implementation, PC/LAN/WAN/browser, hijack alert/worker down button, RF/cellular/satellite ambulance tracking, and immediate notification to dispatch of exceptions to safe driving.

Ride-Alongs

A ride-along is an observation technique where an observer is in the vehicle with the driver while driving on the road. A checklist is used to record observations on driving behaviors, such as speed, mirror checking, turn-signal use, complete stops at intersections, etc. At the end of the session, the observer tallies the recorded observations (e.g., safe or at-risk maneuvers or behaviors). The observer may also discuss (preferably when the vehicle is parked) with the driver what his or her percentage of safe scores were for each critical behavior (this situation would be peer-observation and feedback).

Covert Observations

A peer or other observer may record behavioral observations of a co-worker without their awareness. This manner of conducting an observation has its benefits and weaknesses. The main advantage of covertly observing behavior is that the observed behavior is more "natural." When individuals know that they are being observed, they may purposefully try to behave in a safer manner. If they are being observed covertly, however, they do not have the opportunity to "act" for the observers. Perhaps the main disadvantage of covert observations is that individuals may object to being observed without their knowledge. Thus, covert observation may stifle trust and breed resentment. However, this situation may occur only with certain individuals. Common forms of covert observations in CMV operations include following the driver in a "chase" vehicle and staking out a known delivery location and/or drive location. These methods have other disadvantages; they are time-consuming for managers and do not capture all types of safety behaviors.

Comments from Public

Comments from the public can include those from clients, the general public, and/or drivers sharing the roadways (passenger or large-truck drivers). In the safety manager survey, most fleet safety managers indicated that comments from their clients usually entailed service-related behaviors (e.g., promptness, courteousness, etc). Safety placards, such as displayed in Figure 5, have become popular with fleet safety managers as a way to elicit feedback on driving behaviors from the general

How's My Driving?
1-800-XXX-XXXX
ID#022707

Figure 5. "How's My Driving" safety placard.

public and/or other drivers sharing the roadways. Such placards have become popular for several purported reasons: (1) they hold drivers accountable for their driving behavior because the drivers know they are being observed by other motorists; (2) they increase the company's prospect for reduced crash rates and costs, such as direct and indirect costs associated with those crashes; and (3) they show other motorists the company cares about safety.

Safety placards are generally affixed to the rear of the tractor or truck and display the driver's personal identification number and an 800-number. Once the 800-number is called, an incident report is created for both complaints and compliments. Incident reports are sent to fleet safety managers or supervisors for review. Typically, the driver is then asked his or her side of the story relating to the alleged incident. Driver statements are added to the incident report and corrective action is taken if necessary.

Thirty-eight respondents (58.5%) in the safety manager survey indicated they received and used such comments from the public. Safety placards can aid fleet safety managers in correcting and identifying at-risk driving behaviors before a crash occurs. These data are valuable because they can be used for *preventive* action (retraining and/or instilling proper knowledge of company safety standards) rather than punishment after the fact. Fleet safety managers can receive valuable data on driver behaviors using safety placards, and drivers who have these placards attached to their vehicles know there is some accountability for their driving performance (Knipling, Hickman, and Bergoffen, 2003).

Third-Party Monitoring

While some CMV fleets may choose to run their own monitoring service, third-party monitoring companies offer an affordable (usually $12 to $20 per vehicle per month) and convenient way to monitor drivers. These companies provide the consumer with unbiased personnel to record comments. The most comprehensive third-party monitoring services provide their customers with numerous services, including 24-7 coverage; professionally trained individuals; no answering machines or touch-tone menus; incident reports sent via email or fax within 24 hours; compilation of company, division, regional, and/or terminal statistics on safety issues; and "coaching advice" for the driver's supervisor. Some programs also offer crash analysis, information on design and implementation of safety procedures, driver's manuals, organization analysis, operational network analysis, service failure analysis, rate analysis, maintenance analysis, strategic planning, and driver qualification file management. One program offers an affordable service for small (fewer than 10 trucks) CMV fleets.

One program indicated that customers of its monitoring service report that approximately 80% of the drivers monitored receive approximately 20% of the complaint reports. The remaining 20% are responsible for 80% of the incident reports, and these drivers usually receive multiple reports. This phenomenon is referred to as the "80/20 rule." Another program estimated 65% of its monitored drivers receive no incident reports, 25% receive one incident report, and 10% get multiple incident reports. These statistics may not be precise but they are indicative of typical patterns. Approximately 85% of the calls made by motorists are complaints (speeding, tailgating, improper lane changes, etc.), 10% are compliments, and 5% are emergencies or other concerns.

Effectiveness

Several studies, mostly conducted by insurance providers, have researched the efficacy of using safety placards in improving the driving safety of CMV drivers. The Hanover Insurance Company conducted a study with 11 different trucking fleets (445 trucks total) using "How's My Driving" safety placards and discovered a 22% drop in the frequency of vehicle crashes per 100 vehicles and a corresponding 52% reduction in costs after one year (Johnson, 1998). The Fireman's Fund Insurance Company monitored close to 30,000 vehicles with "How am I Driving" safety placards. They estimated a 22% reduction in vehicle crashes (The Fund, 1999). Great West Casualty studied 78 trucking companies (10 to 300 power units per company) using "How's My Driving" safety placards and showed a 39% reduction in loss ratio, 56% reduction in vehicular crashes, and a 27% reduction in U.S.DOT reportables (Driver's Alert, 2006). Similarly, Atlantic Express, which owns approximately 5,000 school buses, estimated a 40–60% reduction in vehicular crashes after using safety placards (School Transportation News, 1999). Note these studies, while successful, did not provide adequate details on their scientific rigor, thus, caution should be used when interpreting these studies. In particular, studies of high-incident companies that do not employ control groups are subject to spurious results and interpretations because of regression to the mean. That is, the very worst groups or subjects in any sample are likely to improve somewhat in the next observation regardless of the true effectiveness of any intervention.

The reduction in costs is not surprising considering that NHTSA (2002) estimates that for every dollar in large-truck crash direct costs (property damage, medical bills, workers compensation, and insurance premiums), there is an average of $6.50 in indirect costs (production delays, time, punitive damages, administration costs, training, overtime, rescheduling, lawyers fees, and hiring a replacement). While insurance companies rarely provide discounts for implementing these programs, CMV fleets that use these programs usually lower their insurance premiums and receive a better renewal rate, thus adding to the savings afforded by fewer vehicular crashes (The Fund, 1999).

Conclusion

It appears that safety placards are a worthwhile safety-management tool, although there is no rigorous documentation of their effectiveness. The combination of feedback and accountability for one's driving performance provides drivers and fleet safety managers with valuable information on their safety-related driving behaviors, increased attention towards safety, identification of risky drivers, and information as the basis for corrective action (e.g., training, education, reprimand, or termination).

However, there are three significant drawbacks in using this type of process for safety management with CMV drivers. The first, and most obvious, is drivers will only receive feedback if a call is made by another motorist. Not only must the driver display some safe/at-risk driving behavior, but also another motorist must see this behavior and then decide to call the 800-number. How often this number is accessed per safe/at-risk driving behavior remains unknown. A reasonable assumption is that motorists contact the 800-number only when an extreme act (safe or at-risk) is committed. Thus, this process is less sensitive to less extreme, but more prevalent, at-risk or safe safety-related driving behaviors. Second, the accountability and increased attention towards safety the driver initially feels may dissipate over time, a term called habituation (Geller, 2001). Some third-party monitoring services have acknowledged that crash rates plateau after the program has been active for some time, but they also claim that removing the safety placards results in a return to pre-safety placard crash rates. Finally, if roughly 85% of the calls received by a third-party monitoring service or the company's in-house monitoring department are complaints, the driver is left with the impression he or she will only receive negative feedback. Drivers may become accustomed to receiving feedback on their misdeeds instead of their safe driving performances. This situation may lower driver morale and retention rates. To combat these fears, Geller (2001) suggests "fact-finding" instead of "fault-finding." Managers are not on a "witch hunt" to ascertain blame, but on a path to correct mistakes in order to keep them from reoccurring in the future. This approach leaves the driver with the impression the manager is trying to help rather than punish.

Specific BBS Techniques

Activators/Prompts

Prompts or cues can be verbal or written messages (such as stickers, posters, signs, and slogans) and are generally much easier and less expensive to implement than other BBS techniques.

Using Prompts

Geller, Johnson, and Pelton (1982) suggest the following in the use of prompts: (1) state the prompt in proximity to the opportunity to perform the response, (2) specifically state the desired response, (3) make the desired response convenient, and (4) state the response in polite, non-demanding language. Moreover, Geller (2001) recommends the following six principles for increasing the impact of prompts:

- **Specify behavior.** Signs with general messages (i.e., drive safely) and no specification of a desired behavior that should be performed have little impact on actual behavior. A sign that refers to a specific behavior (i.e., please buckle-up) can be beneficial. However, too much specificity can bury a message. Overly complex signs are usually overlooked.
- **Maintain salience with novelty.** Even well-worded signs lose their effectiveness over time. Most signs will lose their impact over time, an effect termed habituation (i.e., people learn to not respond to an event that occurs repeatedly over time). By altering the design or colors in the sign, managers can maintain novelty. Figure 6 shows how the presentation of a safety sign can be altered to reduce habituation.

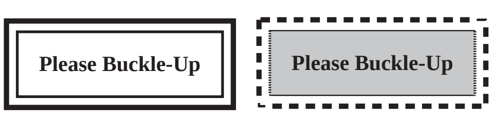


Figure 6. Example of how to add novelty to a safety sign.

- **Vary the message.** Just as changing the design or coloring of the sign can maintain novelty, so can changing the wording of the sign. Figure 7 shows an example of how to vary the message in a safety sign.

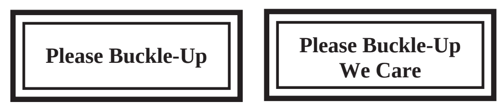


Figure 7. Example of how to vary the message in a safety sign.

- **Involve the target audience.** When individuals contribute to safety, they take ownership of and make a commitment to increase safety. Let employees select target behaviors, choose safety slogans, and design the signs.
- **Activate close to response location.** The most effective signs occur at the time and place the target behavior should occur. A "please buckle-up" sticker placed in the vehicle is more effective than a "please buckle-up" poster placed in the driver's lounge.
- **Implicate consequences.** While prompts have been shown to be effective with relatively simple, convenient behaviors, more complex behaviors are likely to require more intrusive interventions, such as rewards. Incentives or disincentives are prompts that signal the availability of a reward or penalty contingent on specific behaviors.

Effectiveness

While there are no published studies that assess the effectiveness of prompts in directing driving and non-driving behaviors with CMV drivers, there is a voluminous amount of research that shows prompts are effective in increasing safety belt use across a variety of settings (Berry et al., 1992; Cox, Cox, and Cox, 2000, 2005; Scheltema et al., 2002). Using prompts to increase safety belt use is an ideal application because this behavior is relatively simple and convenient.

Further, safety belt use among CMV drivers is very low. An FMCSA (2003) study of CMV driver safety belt use estimated overall safety belt usage among CMV drivers at 48% (compared to overall vehicle usage rates of 79%). Large national fleets averaged a usage rate of 54% while independent and local fleets were estimated to be 44%. Bergoffen et al. (2005) provides a review of commercial driver safety belt use, including BBS practices to increase use.

Training and Education Programs

Background

Training and education are the foundation of industrial safety. Unfortunately, the demand for commercial drivers has outpaced what driver training schools are currently producing, and companies are left to hire inexperienced and untrained drivers. Given the increasing demands on CMV fleets to deliver goods and services coupled with new technological innovations and congested roadways, effective training and education programs are critical elements in any fleet's safety-management system. This inability of driver training schools to keep pace with demand requires companies to become more dependent on in-house training and education. These programs must be tailored for not only novice drivers, but also experienced drivers who require additional education and training because of poor driving habits and unfamiliarity with new technology. In *CTBSSP Synthesis 5,* Staplin et al. (2004) reviewed commercial driver training program content and strategies, as well as the training directed toward various specific driving skills and knowledge areas.

Entry-level training of CMV drivers is widely regarded as deficient in relation to the safety requirements of the job. Only 31% of entry-level truck drivers receive adequate entry-level training (FHWA, 1995). This poor level of training among entry-level truck drivers has pressed many motor carriers to rely heavily on their own training programs with new hires. For example, almost all fleets in the I-95 Corridor Coalition Coordinated Safety Management study (Stock, 2001) reported training new drivers in company polices and procedures. In addition, 75% required new drivers to train with an experienced driver before driving solo, 23% required attendance at defensive driving courses, and 83% of respondents rated their in-house training programs as important to carrier safety. In-house training programs for new hires typically focus on

- Administrative policies and procedures,
- Equipment loading and operation and customer relations, and
- Driving safety and skills training.

Survey respondents in this synthesis indicated the two most prevalent non-driving behaviors emphasized in training and education programs for new drivers were pre- and post-trip inspection (75.8%) and completing paperwork (25.8%), while the two most prevalent driving behaviors worked on were driving inattentively (54.8%) and speeding (54.8%).

In-house programs employ the following teaching techniques to train and educate drivers:

- **Classroom.** Knowledgeable professionals or former drivers instruct new hires on the rules of the road, usually in a lecture/discussion format (Horn and Tardif, 1999). Increasingly, interactive computer teaching programs (e.g., CD-ROMs) are replacing classroom lectures. These programs are very cost efficient and present the information using a multimedia experience (Ryder, 2000).
- **Practice range.** Experienced drivers instruct new hires how to handle a truck and allow them to experience driving the vehicle on a closed-off driving course/range. The training vehicle usually has three to four extra seats in the sleeper cab so the trainer can teach several other new hires through feedback, observation, and commentaries (Horn and Tardif, 1999). While still in its infancy and too expensive for widespread adoption, virtual reality training simulators offer a tantalizing glimpse into the future. Simulators are able to monitor each driver's performance and create a database to help classify each driver's style, and training sessions can be standardized and repeated. Further, simulators can throw drivers into dangerous driving situations and poor weather or road conditions where tricky maneuvers are required, all in a risk-free environment (Gordetsky, 2000; Robin et al., 2005).
- **On-the-road driving.** This technique is similar to the practice range, except new hires drive on the road with other vehicles. This technique may include the instructor and new hire going on long-haul trips (Horn and Tardif, 1999).

Although safety practitioners and fleet safety managers usually refer to training programs as encompassing training and education, the distinction between the two should not be lost. Training entails imparting knowledge, skills, and information to another individual on *how* to perform certain tasks correctly and safely. Education entails imparting a rationale to another individual on *why* they are performing the task or behavior. People think and reason and, therefore, want to know more than just the "how," they want to know "why." An effective training and education program for CMV drivers not only will provide drivers with valuable safety skills, but also will present them with a rationale for performing those safety skills.

A training program can be only as good as the individual conducting the training. Carriers need to develop effective and qualified trainers. Trainers need to be able to identify weak spots in drivers' skills and know how to address those weak spots. Moreover, trainers need to be able to objectively grade each driver's performance. The Interstate Truckload Carriers Conference (ITCC) has developed a week-long program for driver trainers. The ITCC program teaches motivational techniques, constructive criticism, and guidance in the mental aspects of being a trainer (Wiggins, 1990). See Appendix D for examples of training and education presentations.

Retraining and Education Programs for Experienced Drivers

Although unsafe drivers should be terminated from employment, retraining may be appropriate for marginal drivers. Retraining may reduce turnover rates, crash rates, and operating costs. Bad driving habits may develop over time, with or without the driver's knowledge. The goal with retraining is not to punish the driver, but rather to help the driver improve his or her driving behavior. It is estimated that retraining marginal drivers can save fleets $5,000 to $6,000 in recruitment, drug-testing, and Commercial Driver's License (CDL) qualification costs per driver (Siegel, 1992).

Training and Education for Dispatchers

Pay and time away from home are two triggers related to high driver turnover, yet when a driver moves to another fleet he or she usually receives similar pay and time away from home. Drivers' attitudes toward dispatchers may be another trigger that influences their decision to remain with the fleet. A study conducted by Keller and Ozment (1999) provided evidence that dispatchers who are friendlier and respond more effectively to driver concerns have resulted in lower driver turnover rates. The study suggests that training for dispatchers must extend beyond traditional task orientation to include interpersonal relations with drivers and driver problem-solving (Keller and Ozment, 1999).

A Cautionary Note: Training and Education Is Necessary But Not Sufficient

Training and education programs have long been considered the standard for reducing vehicle crashes. Some training programs are geared only toward drivers obtaining their CDL. Other programs focus on increasing psychomotor skills and physiological functions and mastering traffic situations. The rationale behind training and education programs is that increased driving skill will translate into safe driving, thereby reducing crashes and their associated injuries and fatalities. However, many driving behaviors (such as use of safety belts and speed selection) are performed intentionally. While education increases knowledge, the expanded knowledge does not always result in behavior change (Insurance Institute for Highway Safety, 2001). On the surface, drivers are aware that driving without a safety belt and faster than the speed limit is wrong, yet these behaviors still occur with some frequency (NHTSA, 2004). While both knowledge and skills may be *necessary* components for safe driving, they are often not *sufficient.* The point is that training and education programs should not be implemented as a stand-alone safety-management technique. BBS and other safety-management techniques should be incorporated into a comprehensive CMV safety program to achieve desired results.

Peer Observation and Feedback

A popular BBS technique is peer observation and feedback (Geller, 2001; Krause, 1997; McSween, 1995), which involves both the individual performing the target behavior(s) (i.e., the observee) and a peer (i.e., the observer) who observes the behavior, records information based on these observations on a behavior checklist, and delivers feedback to the observee. In transportation, peer observation may occur during a ride-along or in a static environment, such as when a driver inspects his or her vehicle or is loading/unloading cargo.

Peer observation is usually planned and consensual. With the permission of the observed driver, the observer watches him or her perform a particular task and/or group of tasks. Each of the safety behaviors involved in a task is recorded by the observer as either "safe" or "at-risk" on the checklist. For example, a lane change involves several behaviors: (1) activating a turn signal, (2) checking mirrors for other vehicles, and (3) slowly merging into the new lane. Whether each of these behaviors was performed safely is recorded on the checklist and serves as a point of discussion during the feedback session between the observer and driver. The feedback is intended to support the safe behaviors observed and to offer constructive and corrective feedback regarding any at-risk behavior (Daniels, 1999; Geller, 2001). See the section on feedback below for a discussion of various feedback methodologies.

Benefits of Peer Observation and Feedback

Having fellow workers conduct the peer observation process with each other is beneficial for several reasons (Boyce and Geller, 2001; Krause, Seymour, and Sloat, 1999). First, it may increase workers' sense of personal control and ownership by actively involving them in the safety process. When individuals feel they are involved in something, their commitment and motivation to remain involved increases (Geller, 2001). Second, individuals who are similar to each other (e.g., in job title) generally make the greatest impact when attempting to influence behavior because they view each other as more likeable and trustworthy (Cialdini, 2001). If drivers know their peers are observing them for the sake of keeping them safe, as opposed to some ulterior motive (i.e., punishment), it will help to maintain a positive attitude toward the safety process. Trust in co-workers was found to be one of the greatest predictors of success in BBS programs in a study of 20 organizations (DePasquale and Geller, 1999). Third, fellow workers are most familiar with job tasks—another reason why trust may be strongest amongst peers. When the driver knows the observer is experienced in the same line of work, he or she will value that person's opinion more than that of someone who may have never actually completed the task themselves. Finally, another benefit of peer observation is that it is less expensive than hiring someone external to the working environment or having someone else within the organizational hierarchy conduct the observations (Geller, Roberts, and Gilmore, 1996). Since peers are often in the same environment, they can observe performance more closely and more often than can most supervisors, managers, or outside consultants.

Static Environments

Static environments such as loading bays, delivery warehouses, garages, and vehicle inspections may be the most applicable settings to conduct peer observations. Again, the process is the same (recording observations of whether behaviors were performed safely), but the target behaviors change. For example, a peer can watch a co-worker perform a vehicle inspection of his or her vehicle and record observations of behaviors like checking tire pressure, etc. Safe lifting behaviors (bending legs, keeping the object close to the body, keeping the spine in alignment) can be observed and recorded when a driver is handling cargo. Finally, in the example of getting in and out of the vehicle, a peer could observe whether each step is used, if the observee uses the handrails, etc.

Mandatory Peer Observation and Feedback

As mentioned previously, peer observation is generally voluntary. However, sometimes participation is mandatory. In a survey of employees from 20 organizations using BBS observation and feedback, DePasquale and Geller (1999) compared responses between those involved in voluntary versus mandatory programs. Employees in a mandatory BBS program reported higher scores on several questions related to BBS success than those involved in voluntary programs. For example, compared to those involved in a voluntary program, those involved in mandatory programs reported significantly higher rates for giving and receiving positive feedback, significantly lower rates for giving and receiving negative feedback, more trust in co-workers and management, and greater overall satisfaction with the BBS process.

Feedback

Once the observation and recording of behaviors on a checklist is complete, the observer gives the observee feedback. As stated previously, feedback should support the safe behaviors observed and offer constructive and corrective feedback regarding any at-risk behavior (Daniels, 1999; Geller, 2001). The manner in which the feedback occurs can vary widely. For example, feedback can be written, verbal, private, public, individual, group, or some combination of these. In addition, feedback may include prompts or consequences (e.g., praise, reward, punishment). The type of feedback (i.e., individual, group, or combination of the two) should match the goal. People who set a group goal should receive feedback about the group's performance. Conversely, people who set individual goals should receive feedback about their individual performances (Locke and Latham, 1990).

Alvero, Bucklin, and Austin (2001) reviewed the feedback literature from 1985 to 1998 describing 64 applications of performance feedback in occupational settings. In their study, they classified different types of feedback and factors related to effectiveness. Key results of this review follow:

- **Medium:** The most consistently effective medium was a combination of written feedback, graphs, and verbal feedback.
- **Privacy:** A combination of public and private feedback was more effective than either alone.
- **Content:** Interventions involving feedback paired with antecedents (prompts) produced the most consistently effective results.

Does feedback motivate people? Bandura (1986) suggested that dissatisfaction with one's prior attainments can motivate increased effort and vigilance. Without goals, individuals do not have a standard with which to compare prior behavior; without feedback, individuals do not have information to gauge progress toward the goal. For example, if a driver is given feedback that he or she performed an at-risk driving behavior, does that imply he or she will alter his or her subsequent behavior? If the individual has no related goal, then behavior will not change. Conversely, if the same individual sets a specific safety goal but receives no feedback on his or her performance, there is no way of assessing if the behavior is moving in the desired direction. It is the combination of goals and feedback that allow people to evaluate and appraise their behaviors (Bandura and Cervone, 1983).

In a study involving an instrumented car and feedback on different driving behaviors, Locke and Bryan (1969) found that participants improved only on those driving behaviors for which the experimenter assigned goals. Similarly, Cervone and Wood (1995) presented participants with feedback and goals, only a goal, or only feedback. Participants in the goal-plus-feedback group outperformed both the goal- and feedback-only groups in managing a simulated business organization. It appears the combination of both a specific goal and feedback regarding one's performance toward the goal are most successful for behavior change.

Driver Self-Management/ Self-Observation

Geller and Clarke (1999) suggest a self-management approach to increase safety-related work behaviors when peer-to-peer coaching is not feasible or is impractical. A self-management intervention motivates employees to choose the safe alternative and holds them accountable for selecting the safe alternative. Similarly, when Knipling, Hickman, and Bergoffen (2003) reviewed effective safety-management techniques for CMV drivers, they also suggested that self-management may be one of the most applicable BBS techniques for CMV drivers.

As stated in Knipling et al. (2004), the benefits of self-management techniques have been demonstrated in numerous clinical settings; however, the advantages of using self-management techniques to improve safety-related work behaviors have only recently been evaluated. The authors reported three published studies that successfully used self-management techniques with bus divers (Olson and Austin, 2001), short-haul truck drivers (Hickman and Geller, 2003b), and CMV drivers (Krause, 1997).

Self-Management Strategies

People have self-regulatory capabilities allowing them to motivate and regulate their behavior through internal standards and self-evaluation of their behavior (Bandura, 1986, 1997). The process of self-regulation follows the general order of (1) self-observing one's behavior; (2) comparing the behavior to some personal standard, norms, and/or behavior of others; (3) determining the value of the activity; (4) attributing control of the performance to be within or external to one's self (i.e., "was I responsible for the behavior or not?"); and (5) reacting positively or negatively toward the self with rewards or penalties (Bandura, 1997). These rewards or penalties can be tangible (such as money) or intangible (such as self-statements like "I did a good job").

As reported in Knipling et al. (2004), five self-management strategies are required for optimal behavioral improvement: (1) prompt management, (2) social support, (3) goal setting, (4) self-monitoring and self-recording, and (5) self-rewards. Prompt management involves identifying environmental, behavioral, and personal factors that precede the occurrence of safe and at-risk behaviors. Strategies are then employed to eliminate antecedents that precede at-risk behaviors and add prompts that will increase the probability of safe behaviors. Goal setting can increase the impact of a self-management intervention. Goals should be set by the individual, focused on specific behavior, set high yet achievable, and include tracking of progress (Geller, 2001).

The techniques of self-monitoring, feedback, and goal setting may fall short if implemented separately but will generally be effective if combined into a complete self-management program. Locke and Latham's (1990) review on the effectiveness of goal setting found that combined effects far exceeded individual ones.

Self-monitoring may lack the accuracy and reliability of external observations, as well as the context of standards of acceptable behavior. Indeed, people have to learn how to observe and record their own behavior. The accuracy of self-monitoring can be influenced in several ways. Bandura (1986) states, "since people's attentiveness to their ongoing behavior fluctuates widely, they are not always all that self-observant" (p. 337). As many safety-related driving and non-driving behaviors are repetitive and habitually performed, concurrent events may compete for attention and result in inaccurate self-observations.

If possible, employees should be provided with both objective feedback reflecting their actual safety performances and personal feedback from self-monitoring. The addition of objective feedback is beneficial for two reasons: (1) employees can compare actual and self-reported safety performance to increase the accuracy of their self-observations, and (2) objective feedback provides an accurate evaluation of program effectiveness. The addition of other sources of feedback in conjunction with self-monitoring may be most beneficial in the early stages of the self-management program as drivers learn how to observe their own behavior.

The self-management for safety (SMS) model in Figure 8 displays the three necessary components of a successful self-management program (i.e., self-monitoring, goal setting, and objective feedback).

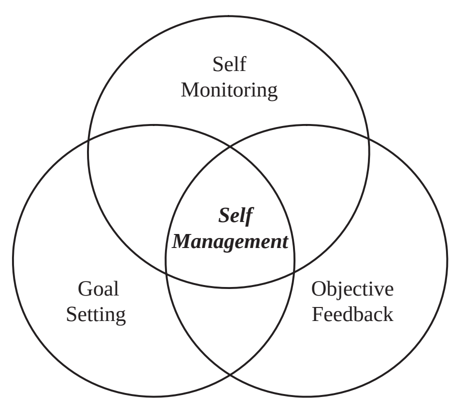


Figure 8. The SMS model.

Implementing Self-Management Programs

Recording the occurrence of safe and at-risk behaviors provides an objective record of current safety performance, while charting progress toward reaching specific goals provides feedback on accomplishment and identifies areas for improvement. Regularly engaging in the self-monitoring and self-recording of specific behaviors is also a key component of self-management (Kazdin, 1993).

Ludwig and Geller (1997, 2001) suggest that involving participants in the selection of target behavior(s) will increase the effectiveness of self-management programs. They compared the behavioral impact of goals chosen by workers versus goals assigned by management on one targeted and two non-targeted behaviors. The participative goal-setting had a positive effect on both the targeted and non-targeted behaviors, while assigned goal-setting only affected the targeted behaviors and negatively impacted some non-targeted behaviors. Once target behavior(s) are selected, a self-management strategy is developed. Certain strategies are available (see above), and the success of self-management is positively correlated with the number of strategies used (Watson and Tharp, 1993). While drivers should be involved in developing their own self-management strategies, the inclusion of goal-setting and the self-monitoring and recording of behavior are essential components. In general, the greater the frequency of self-observing and recording, the greater the impact (Baker and Kirschenbaum, 1993).

Summary

Self-management is most applicable where peer observation and feedback is impossible. Most other types of BBS programs do not lend themselves to solitary workers. Because most employees who operate a vehicle as part of their job duties work alone, and because of the large human and economic costs associated with large-truck crashes, there would be great potential benefit from research on developing practical self-management techniques for CMV drivers. If self-management activities can be integrated with other job activities, fleet safety managers would have an effective tool for improving safety-related behaviors that occur when there is little or no opportunity for interpersonal observation and feedback.

Consequences: Rewards and Penalties Based on Behaviors and Outcomes

Behavioral consequences include positive reinforcement for good behaviors (rewards) and punishment or penalties for bad behaviors. This section examines the application of rewards and penalties to CMV driving. In addition, positive or negative consequences for CMV drivers may be based on driving behaviors per se (process based) or on involvement in crashes, violations, or other incidents (outcome based). This section examines these approaches and their relative effectiveness in driver management.

Monetary consequences for outcomes or processes are likely to be influential safety-management systems because economic factors are one of the most important determinants of behavior in CMV drivers. This contention is supported by Belzer, Rodriguez, and Sedo's (2002) analysis of pay and safety in CMV drivers. They found that increasing drivers' pay decreased the likelihood of drivers working more hours and vice versa. Further, for every 10% more in mean driver compensation, carriers experienced 9.2% fewer crashes.

As stated in Knipling, Hickman, and Bergoffen (2003), CMV drivers are usually paid by the unit distance (mi or km), not per hour or load delivered. Thus, at-risk behaviors may, unfortunately, be fostered by economic factors (Wilde, Saccomanno, and Shortreed, 1996). Intuitive logic suggests that if economic factors motivate CMV drivers to drive unsafely, then economic factors may be necessary to offset these behaviors. Indeed, incentive/reward programs are very popular among CMV fleets. In a study conducted by Barton and Tardif (1998), 28 of the 40 (70%) trucking firms had an incentive/reward program.

An incentive/reward safety program strengthens the motivation for people to behave safely. The incentive is a pre-announced reward to potential recipients provided they meet some specific level of performance (Barton and Tardif, 2002). The reward, which can be anything from cash, gift certificates, or recognition, is given to the recipient when the level of performance (i.e., goal) is attained. This distinction is necessary because, initially, the incentive is enough to alter behavior. Yet, if no reward is given contingent on the specified goal, performance will not move in the desired direction (Geller, 2001).

Creation of a Successful Incentive/Reward Program

While many fleets use incentive/reward programs as part of their overall safety packages, less is known about which elements are necessary to develop and administer an effective approach. Companies and fleet safety managers wishing to implement an incentive/reward program with their fleets should read Barton and Tardif (1998), whose report outlines the steps needed to develop, administer, and implement an incentive/reward program. The following paragraphs summarize key elements described in their research:

- **Creating a solid foundation: policy, budget, management responsibility, employee involvement.** Effective programs have strong commitment from top management and owners. Employees must believe management cares about the objectives of the incentive program. Development of a sufficient and realistic budget which will also include provisions for long-term growth is also critical. Most successful programs designate a safety manager supervisor to coordinate all aspects of the program. Employee involvement is critical; they should be involved in all aspects of the process (e.g., recommendations on promotion, goals, reward selection, and participation).

- **Forming a team to drive the program.** Teamwork is essential for program longevity and success. The team should meet regularly and consist of members from all areas of the company to discuss problems, solutions, and action plans. The team should meet regularly with top management to assess progress.
- **Expecting the program to evolve.** Few programs will meet success on their first attempt. Companies must be willing to make changes to improve and refine their programs. Employee feedback is critical for this evolution to occur.
- **Developing a communication plan.** The incentive/reward program must be understood by all employees. Employees should know how the program works and how they can earn maximum benefits. The employee manual should include a copy of the rules and dedicated meetings should be scheduled to discuss any issues.
- **Preparing for negative feedback.** A small number of employees may respond negatively to the program. They may have tried a similar program, without success, at another fleet, or they may see the program as exploitation. Time and effective communication usually silences these critics. Once management has answered these drivers' questions and they see other drivers being rewarded, they may also be motivated to join the program.
- **Designing rewards.** While management sets the budget for the program, recipients need to be actively involved in deciding on the types of rewards and in designing the structure for the reward system. Rewards can be based on individual performance, group performance, or both. Common rewards include cash, recognition, merchandise, special assignments, promotions, and celebratory events. When deciding on these types of rewards, the incentive/reward coordinator should always consider the following elements:
  - Perceived value (should be high but not too high; see further discussion below in "What Should be Rewarded")
  - Duration of performance (e.g., 10 years of targeted performance should be 10 times the reward)
  - Fairness and consistency
  - Attainability (goals should be set at high but attainable levels to avoid discouragement)
  - Graduated rewards (considered better than "all or nothing")
  - Tax implications
  - Involvement of drivers in the program so they feel ownership
  - Assessment time periods (keep them relatively short; e.g., quarterly)
  - Immediacy of rewards (delayed rewards are less effective)
- **Implementing the program.** Once program details have been finalized, develop an action plan for implementation. The employee manual should be developed and distributed to all employees and should include the policy statement, objectives, operating procedure, communication routes, types of rewards, and easy-to-understand rules of the program. Companies should be prepared for potential negative reactions and effects and address them as they arise.

Incentive programs should be evaluated regularly to ensure effectiveness. Typically, the evaluation is a before-and-after comparison of costs and benefits. However, an incentive/reward program usually takes 6 to 12 months before becoming fully effective.

Rewards versus Penalties

Most safety professionals agree that rewards are better than penalties in increasing motivation to perform safety-related behaviors for the long term (Wilde, Saccomanno, and Shortreed, 1996; Barton and Tardif, 1998, 2002; Geller, 2001). Giving something valued contingent on success (e.g., money, extra privileges, or recognition for crash-free driving) is better than taking away something valued contingent on failure (e.g., docking pay, removing privileges, or negative recognition for crashes or violations). Use of penalties can create a climate of resentment, uncooperativeness, and antagonism. Labeling people with undesirable characteristics may prompt individuals to behave as if they had these characteristics (i.e., self-fulfilling prophecy). Further, penalties may motivate individuals to engage in the very behavior the company is trying to prevent because they feel they are being controlled; this behavior is sometimes called counter-control or reactance (Wilde, Saccomanno, and Shortreed, 1996; Geller, 2001). In contrast, using rewards creates an atmosphere where individuals strive for success (Geller, 2001) and their behavior is molded or shaped in that direction. This is not to say that penalties should never be used or that they are ineffective in reducing unwanted behaviors. In fact, they can be very effective in reducing specific unwanted behaviors. However, most BBS programs accentuate increasing safe behaviors when possible.

Kalsher et al. (1989) compared an incentive/reward to a disincentive/penalty program at two large Navy bases. At one

Navy base, a direct and delayed incentive/reward program was implemented whereby observers would record the license plate numbers of vehicles in which drivers were buckled-up. The license plates were then entered into a public drawing and prizes were raffled off. At the other Navy base, employees were told if they were caught driving without their safety belts they would lose their base driving privileges. Both programs significantly increased safety belt use, but the disincentive/penalty program was more effective than the incentive/reward program in increasing safety belt use among base employees. However, further review of the data revealed the disincentive/penalty program was effective only when officials were visibly present; otherwise, there was no change in safety belt use. Perhaps the superiority of disincentives in this case was due to their greater magnitude (i.e., automatic loss of driving privileges compared to being entered in a raffle, a relatively weak and uncertain reward).

As the above study illustrates, penalties can be more effective than rewards under some circumstances. However, punishment in general has several adverse consequences, such as (1) inhibiting learning and constructive interaction, (2) aggression, (3) apathy, and (4) reactance or counter-control. The Kalsher et al. (1989) study demonstrated that disincentive/penalty programs are likely to motivate drivers to wear their safety belts, but only when they believe they are being observed. The authors hypothesized that drivers may react to these interventions by wearing their safety belts when they believe they are being observed, but taking them off soon after to regain feelings of control.

What Should be Rewarded

While some safety professionals suggest using outcome-based measures (i.e., crash-free miles) in determining rewards (Wilde, Saccomanno, and Shortreed, 1996; Barton and Tardif, 1998, 2002), others suggest that process-based measures (i.e., specific safety-related driving behaviors) should be used to determine rewards (Geller, 2001). The most common outcome-based measure in CMV operations is the per-mile or per-kilometer rate of "preventable" crashes. Typically rates vary from 0.5 to 3¢ per mi/km. Additional bonuses may be awarded for any driver having no crashes (preventable or not) (Wilde, Saccomanno, and Shortreed, 1996; Barton and Tardif, 1998). Opponents of outcome-based measures suggest this type of approach rewards and motivates individuals to neglect incident reporting. If having an injury or a crash causes one to lose a reward, there is pressure to avoid reporting an injury or crash. Barton and Tardif (1998) and Wilde, Saccomanno, and Shortreed (1996) suggest using some form of penalty for underreporting of crashes or injury to combat "cheating." Also, this type of approach does not inform individuals about what they need to do to reduce the likelihood of injuries and crashes (Geller, 2001). As crashes are rare occurrences, it is quite possible that many drivers who frequently engage in at-risk driving behaviors are still rewarded because they are not involved in a crash.

Process-based measures reward individuals for performing specific safety-related behaviors, such as following at a safe distance, wearing safety belts, or maintaining safe driving speeds. These types of process-based measures specify which behaviors the individual should perform (Geller, 2001). Opponents of process-based measures suggest that these programs are cumbersome and difficult to implement, and that all safety-related behaviors cannot be rewarded (Wilde, Saccomanno, and Shortreed, 1996; Barton and Tardif, 1998). Furthermore, without OBSM devices, observation of each driver's behavior is difficult. Yet, the BBS research literature suggests that increases in targeted safety-related driving behaviors can lead to increases in non-targeted safety-related driving behaviors. This phenomenon is termed *response generalization* (Ludwig and Geller, 1997). The phenomenon of response generalization allows safety professionals to target a few specific driving behaviors with benefits across many more non-target behaviors, thus a less cumbersome application.

Krause and McCorquodale (1996) argue against the use of incentive/reward programs for increasing safety performance. They believe incentive/reward programs harm safety performance objectives, extract a high bottom-line cost, are ridiculed by employees, and distort expectations (i.e., employees come to see incentives as "entitlements"). They believe these programs sometimes reward the wrong behaviors and the wrong individuals. Further, they believe incentive/reward programs drive reporting of injuries and crashes underground, and the use of rewards fosters reliance on extrinsic (cash or other items) rather than intrinsic reinforcement (an internal pride or satisfaction with one's work).

While Krause and McCorquodale (1996) make cogent arguments against the use of incentives, the problems they refer to may be indicative primarily of poorly planned and implemented incentive/reward programs. No incentive/reward program is perfect—even the best programs may reward the wrong behaviors and the wrong individuals at times. However, this is not ordinarily the case. Moreover, the use of relatively small, yet meaningful, incentives induces individuals to alter their behaviors and attitudes without the risk of large inequities. When incentives are kept relatively small, individuals justify their behavior change to internal causes rather than external causes (i.e., "I'm driving the speed limit because I want to be safe—not to earn a reward."). Rewards can be kept relatively small indefinitely; the use of ever-increasing incentives shifts behavioral and attitudinal change to external causes (Wilde and Murdoch, 1982; Geller, 2001). For example, a 1¢ per-mile safety bonus would result in a crash-free, 100,000-mile-per-year driver receiving $1,000 annually or

$250 quarterly. This amount is tangible and meaningful, but not so high that gross inequities might be created by flaws in the system.

Effectiveness

Outcome-Based Measures

A few published studies have shown the effectiveness of outcome-based rewards. LaMere et al. (1996) used an incentive/reward program for the safety performance of truck drivers and found a 27.3% reduction in the frequency of crashes. The transportation division (600 power units) of a German food company had a 14% reduction in culpable crashes and a 25% reduction in all crashes following the introduction of an incentive/reward program, and maintained this reduction over several years. Direct crash costs were reduced by more than two-thirds at this plant during that time span (Wilde, Saccomanno, and Shortreed, 1996). Barton and Tardif (2002) reported on a trucking fleet (80 power units) that reduced the number of annual crashes by 25% and experienced a benefit-cost ratio of 3.8 to 1 after implementing an incentive/reward program.

Process-Based Measures

Incentives/reward interventions have been successful in increasing safety belt use across diverse settings (Elman and Killebrew, 1978; Rudd and Geller, 1985; Geller et al., 1989). Hickman and Geller (2003b) found significant reductions in two safety-related driving behaviors (overspeeding and extreme braking) with short-haul truck drivers using a combination of rewards and BBS techniques. Incentives have been used successfully with pizza delivery drivers to increase targeted safety-related driving behaviors. These studies also discovered beneficial behavior change in non-targeted safety-related driving behaviors. While pizza delivery drivers are not true commercial drivers, they are under similar time constraints. They represent a high-risk group because of their age and lack of driving experience (Ludwig and Geller, 2001).

Conclusion

Research has shown that incentive/reward programs, used in combination with other safety-management systems, have been beneficial in reducing crash rates and the costs. Unfortunately, no study has assessed the comparative effectiveness of an incentive-reward program based on outcome or process measures for CMV drivers. Yet, there is an existing body of literature available for CMV safety managers to consult on how to plan, implement, and evaluate incentive/reward programs. Barton and Tardif (1998, 2002) provide excellent recommendations for implementing successful incentive/reward programs. Following these recommendations helps safety managers avoid the pitfalls associated with unsuccessful incentive/reward programs.

Survey Method and Results

Method

The main tool for collecting information on fleet safety managers' opinions on BBS techniques was a survey. The survey was distributed to safety managers through several different methods, including (1) a secure Internet survey form, (2) a survey form completed on the computer and returned via email, and (3) a traditional paper-and-pencil survey form returned via facsimile or mail. Appendix B shows the computer and paper-and-pencil survey forms. This section describes the survey methodology in more detail, and the next section of this chapter provides principal results.

Survey Design and Content

The project team conducted two focus groups to identify specific behavioral safety-management techniques currently used by CMV carriers. One focus group was held at the annual Virginia Trucking Association Safety Managers meeting in Williamsburg, VA, while the other focus group was held in Knoxville, TN, at a local CMV operation. The discussions addressed targeted behaviors and performance measures (including those captured by OBSM devices) and behavioral safety-management practices used by carrier safety managers. These practices included prompts (e.g., signs, posters, reminders) and consequences (i.e., rewards and punishments) among other behavioral interventions. As BBS encompasses a variety of different techniques, procedures, and terminology, these focus groups were critical in identifying current behavioral management practices in CMV operations (including the terminology safety managers use in describing these practices). Analogous to the results found in the LTCCS, most of the at-risk driving behaviors identified by focus group respondents were decision and recognition errors (see "Principal Survey Results, Part 1: Safety-Critical Behaviors"). The focus groups confirmed the project team's hypothesis—that few focus group respondents implemented a comprehensive BBS program. Further, focus group respondents indicated they use specific behavioral management techniques but did not identify these techniques as "BBS." The information gleaned from these focus groups was essential in developing the survey for fleet safety managers, including terminology, specific behavioral management techniques, driving and non-driving behaviors, observation techniques, and barriers/problems in implementing BBS techniques.

Commercial truck operations have very high driver turnover rates, thus accentuating the need to implement effective safety-management techniques. Both the focus groups and survey questionnaire addressed how BBS techniques can affect retention positively or negatively. A practical reality is that most motor carriers will not implement techniques that have adverse impacts on retention, even if there are safety benefits.

Appendix E displays an example of the focus group presentation. The focus group presentation was used as a guide for the presenter, but also as a way to elicit responses from the focus group attendees. The focus group discussions were conducted similarly to the four steps in implementing BBS techniques (described previously in "Behavior-Based Safety Principles"):

1. Identify safety-critical driving and non-driving behaviors
2. Perform observations to gather data
3. Provide feedback to encourage improvement
4. Use gathered data to identify factors promoting positive change

The dialogue began with a discussion identifying the most critical safety behaviors (mostly driving behaviors but some non-driving behaviors such as loading/unloading), proceeded to a discussion of how safety managers gathered information on these behaviors (e.g., ride-alongs, surveillance, OBSM devices), talked about ways to provide feedback and related contingencies, and then discussed management policies and practices put into place based on this process. This structure was simple and lent itself to a non-technical discussion of specific management practices.

The focus groups included safety managers who have tried various specific BBS techniques and who were willing to provide case-study information on their experiences for the project report. The emphasis was on successful applications but lessons may be learned from unsuccessful ones as well.

Based on the literature and focus group discussion, the fleet safety manager survey form contained 48 questions. These were divided into five parts:

1. **Safety-Critical Behaviors.** Questions 1–22 listed safety-critical driving and non-driving behaviors. Safety-critical behaviors were those behaviors that impacted overall safety (e.g., injuries, incidents, and crashes). Using a 5-point scale (0 = No Relationship and 4 = Strong Relationship), respondents were asked to rate how strong the relationship was between each of the safety-critical behaviors with driver crash risk and non-driving-related illnesses and injuries.
2. **Observation of Safety-Critical Behaviors.** Questions 23–26 asked respondents to indicate if their organization currently used the observation technique listed.
3. **Specific BBS Techniques.** Questions 27–35 asked respondents to indicate if their organization currently used the specific BBS technique. Then, the instructions stated, "If 'Yes,' please rate its effectiveness."
4. **Barriers/Problems to Implementing BBS.** This section consisted of seven questions (Questions 36–42). Using a 5-point scale (0 = No Barrier/Problem and 4 = Serious Barrier/Problem), respondents were asked to rate how strong the barrier/problem was in implementing BBS.
5. **Comments/Respondent Information.** Questions 43–48 asked respondents to comment on BBS and/or any questions in the survey. Blank spaces were provided to write these comments; this information on the completed forms was reviewed separately and reported selectively in this synthesis. There were also four questions regarding survey respondent demographics: two questions on the safety manager's years of personal experience and two questions on the size and operation type of his/her fleet. The last question in the survey asked respondents if the research staff could contact them directly to discuss their organization's BBS programs.

Survey Distribution and Analysis

The survey forms were primarily distributed via email. Potential fleet safety manager respondents were identified from attendees at the 2005 International Truck and Bus Safety and Security Symposium in Alexandria, VA, and the 2005 Virginia Truck Association Safety Manager meeting in Williamsburg, VA. Other survey recipients were respondents from previous CTBSSP studies for whom contact information was available. Further, members of the National Private Truck Council were contacted. All survey forms were accompanied by a cover email explaining the survey. Altogether, approximately 400 fleet safety manager survey forms were distributed.

While the pool of potential survey respondents was generated from a sample of North American respondents, the current sample is best described as a sample of convenience as survey respondents were self-selected. Project resources did not allow the research staff to obtain a representative sample of CMV operations. Note that all survey responses were confidential and no attribution is made to these responses unless permission was granted by those parties.

Principal Survey Results

Part 1: Safety-Critical Behaviors

Respondents were asked to rate 22 safety-critical driving and non-driving behaviors with regard to their strength of association with crash, injury, and illness risk. The scale went from "0" (no relationship) to "4" (strong relationship); thus, the higher the number the greater the association between the non-driving and driving behaviors and risk (i.e., crashes, injuries, and illnesses). Respondents rated 12 non-driving safety-critical behaviors (such as poor lifting techniques, improper cargo securement, etc.) and 10 safety-critical driving behaviors (such as careless backing, speeding, etc.).

The highest-rated associations for driving behaviors were improper following distances (mean rating of 3.7), speeding (mean rating of 3.6), and high speeds on curves and ramps (mean rating of 3.6). As can be seen in Table 1, the highest-rated driving behaviors reiterate the results found in the LTCCS (i.e., decision errors were the most frequent critical reason). The lowest-rated associations for driving behaviors were inappropriate left turns and inappropriate right turns (mean ratings of 2.8 and 2.9, respectively). The highest-rated associations for non-driving behaviors were drugs and alcohol (mean rating of 3.3) and failure to inspect vehicle pre-/post-trip (mean rating of 3.2). Note also that these highest-rated items are non-driving behaviors but have relevance to driving safety. The lowest-rated associations for non-driving behaviors were for improper docking of the truck, smoking, and poor diet (mean ratings of 2.1, 2.3, and 2.3, respectively). The safety-critical driving and non-driving behaviors, mean ratings (to the nearest tenth), and rankings are presented in order in Table 1. When there were ties in the mean ratings, rankings were determined by looking at additional decimal places. However, for simplicity, these are not shown in the table.

As can be seen in Table 1, respondents rated the association between driving behaviors and crash and injury risk (ranging from 2.8 to 3.7) much greater than non-driving behaviors and injury and illness risk (ranging from 2.1 to 3.3). Most driving behaviors were rated as "moderately strong" to "strong," while non-driving behaviors were rated as "moderate" to

Table 1. Mean degree of association with risk for safety-critical driving and non-driving behaviors.

Safety-Critical Behaviors	Fleet Safety Managers (*n* = 65)	
	Mean	Rank
Driving Behaviors		
Improper following distances (i.e., tailgating)	3.7	1
Speeding (i.e., maximum cruising speeds)	3.6	2
High speeds on curves and/or ramps	3.6	3
Driving while fatigued	3.5	4
Careless lane changes	3.5	5
Disregard of traffic signals (e.g., stop sign, red light, etc.)	3.5	6
Careless backing	3.4	7
Attention to roadway (e.g., engaging in distracting activities)	3.4	8
Inappropriate right turns	2.9	9
Inappropriate left turns	2.8	10
Non-Driving Behaviors		
Drugs and alcohol	3.3	1
Failure to inspect vehicle pre-/post-trip	3.2	2
Behaviors that lead to slips, trips, and falls	3.1	3
Improper attachment of the trailer to the tractor	3.0	4
Poor lifting techniques	2.9	5
Improper cargo securement	2.7	6
Improperly entering/exiting truck	2.6	7
Failure to plan trip	2.6	8
Poor exercise habits	2.5	9
Poor diet	2.3	10
Smoking	2.3	11
Improper docking of the truck	2.1	12

"moderately strong." These ratings make intuitive sense as fleet safety managers are primarily responsible for addressing the on-road safety of their employees. Support for this contention is found below.

Part 2: Observation of Safety-Critical Behaviors

Part 2 presented three questions regarding observation techniques used by respondents to monitor safety-critical driving and non-driving behaviors. If respondents indicated using the observation technique, they were asked several follow-up questions, which varied depending on the technique. These follow-up questions concerned (1) the device the organization uses, (2) what behaviors the device tracks, (3) the frequency with which the organization conducts ride-alongs or covert observations, and (4) who conducts the ride-alongs.

OBSM Devices

Question 23 asked respondents if they currently use an OBSM device. Twenty-seven respondents (41.5%) indicated they currently use some form of an OBSM device to observe safety-critical non-driving and/or driving behaviors. Table 2

Table 2. OBSM devices used by survey respondents and the safety-critical behaviors observed.

OBSM Device	% Use (out of 27)	Safety-Critical Behaviors
Tripmaster®	4.4%	Speed, hard braking
XATA	21.7%	Speed, brake applications
Qualcomm®	43.5%	Speed, hard braking
Eaton VORAD®	8.6%	Following distance, lane changes
PeopleNet	4.4%	Speed, hard braking
DriveCam®	4.4%	Speed, hard braking, inattention-related behaviors, fatigue
Cadec Mobius TTS®	8.6%	Speed, hard braking, erratic driving
International Road Dynamics	4.4%	Speed, hard braking

Note: The devices used are based on reported survey results. The CTBSSP and TRB do not endorse products.

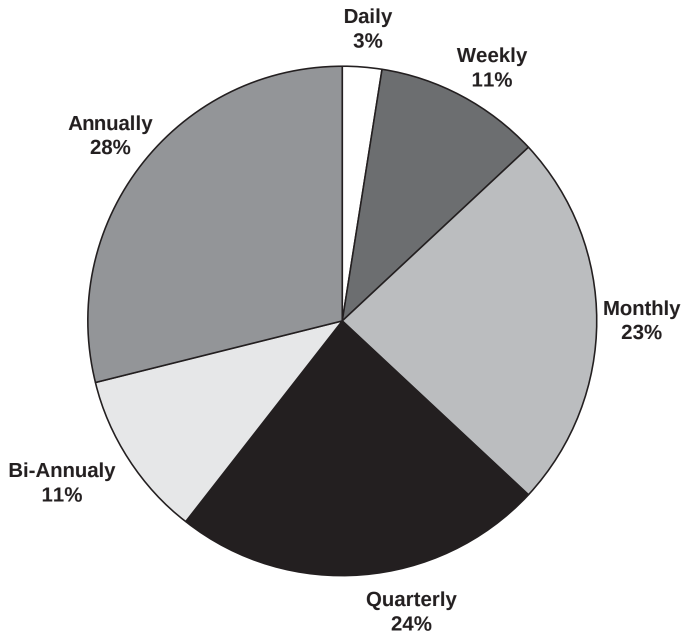


Figure 9. Frequency of ride-alongs among "yes" respondents.

shows the different OBSM devices used by respondents and what safety-critical behaviors these devices observe and record. As can be seen in Table 2, most OBSM devices are used to track the speed and braking behaviors of drivers.

Ride-Alongs

Question 24 asked respondents if they currently conduct ride-alongs with their drivers. Thirty-eight respondents (58.5%) indicated they currently perform ride-alongs to observe safety-critical driving and/or non-driving behaviors. Figure 9 shows the frequency that respondents indicated performing ride-alongs. As can be seen in Figure 9, most respondents indicated performing annual ride-alongs with their drivers (28%), while few reported performing daily ride-alongs (3%). Table 3 displays what personnel conducted these ride-alongs. As can be seen in Table 3, most respondents indicated the driver's supervisor (65.8%) is responsible for performing the ride-alongs. Most BBS programs suggest a co-worker be the individual performing the observation. Studies suggest peer observation increases camaraderie among workers, trust in the observation (as co-workers are more aware of the daily job difficulties than management), and fact finding rather than fault finding. The percentages in Table 3 do not sum to 100% as respondents were able to select multiple personnel.

Covert Observations

Question 25 asked respondents if they currently use covert observations (e.g., hidden camera or observers). Twenty-four respondents (36.9%) indicated they currently use covert observation techniques to observe safety-critical driving and/or non-driving behaviors. Figure 10 shows the distribution of how often respondents indicated performing covert observations. As can be seen in Figure 10, most respondents indicated performing quarterly, weekly, and daily covert observations with their drivers (21%, 21%, and 20%, respectively), while few reported performing bi-annual covert observations (4%).

Comments from the Public

Question 26 asked respondents if they currently receive comments from the public (e.g., from 1–800 "How's my Driving" phone service or from clients). Thirty-eight respondents (58.5%) indicated they receive and use comments from the public to observe safety-critical driving and/or non-driving behaviors. Overall, 54 respondents (83.1%) reported using some type of observation technique to observe the safety-critical driving and non-driving behaviors of their drivers. Note that 11 respondents (16.9%) reported using none of the observation techniques listed. If and how drivers in these organizations get feedback on their driving and/or non-driving behaviors is not known.

Part 3: Specific Behavioral Management Techniques

Part 3 presented nine questions regarding specific behavioral management techniques. Questions 27 to 33 asked fleet safety managers to first indicate whether they use the specific behavioral management techniques, and then, if "yes," to rate its effectiveness in reducing unwanted or at-risk driving and non-driving behaviors. Further, if respondents indicated using the specific behavioral management technique, they were asked several follow-up questions, which varied depending

Table 3. Personnel who conduct ride-alongs.

	Driver from Same Terminal	Terminal Manager	Driver's Supervisor	Independent Observer	Other Manager
% (of 38 "yes" respondents)	26.3%	36.8%	65.8%	15.8%	34.2%

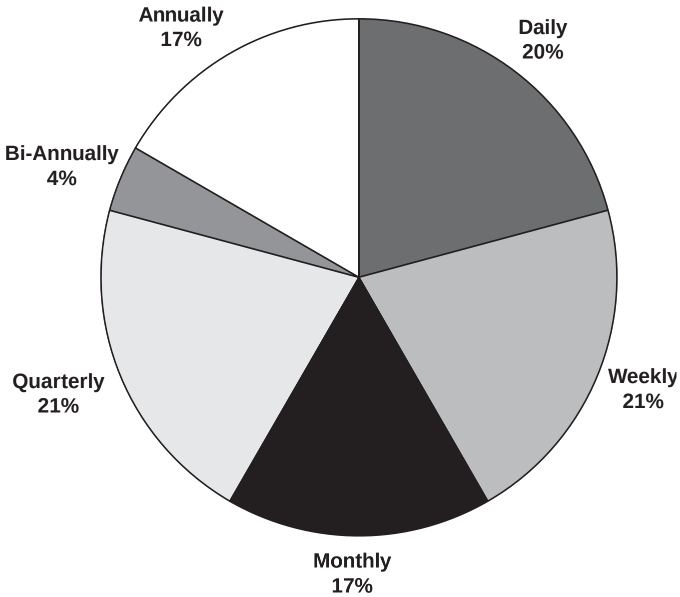


Figure 10. Frequency of covert observations among "yes" respondents.

on the specific behavioral management technique. These follow-up questions concerned (1) the frequency with which feedback is given to drivers, (2) how feedback is given to drivers, (3) the type of feedback given to drivers, (4) the frequency with which the organization holds training and education sessions, (5) the types of rewards or penalties given to drivers, and (6) what data the reward or penalty are based on. Questions 34 and 35 asked respondents to indicate the five driving or non-driving behaviors their organization focuses on during training of new drivers and refresher training with experienced drivers, respectively.

The specific behavioral management techniques, mean ratings, and rankings are presented in order in Table 4. When there were ties in the mean ratings, rankings were determined by looking at additional decimal places. However, for simplicity, these are not shown in the table. Table 4 shows the percentage of respondents who use specific behavioral management techniques and the effectiveness of the techniques. The scale went from "0" (highly ineffective) to "4" (highly effective); thus, the higher the number, the greater the effectiveness of the specific BBS techniques in reducing unwanted or at-risk driving or non-driving behaviors. The highest-rated behavioral management technique was training and education programs directed at specific driving behaviors (mean rating of 2.9). The lowest-rated behavioral management technique was driver self-management/self-observation (mean rating of 2.3). Most of the specific behavioral management techniques were rated as neutral to effective.

Peer Observation and Feedback

Question 27 asked respondents three follow-up questions if they indicated using peer observation and feedback. One follow-up question asked respondents to indicate the frequency of the feedback given to drivers when using this behavioral management technique. Of the 41 respondents who indicated using peer observation and feedback, 14.6% gave daily feedback, 12.2% weekly, 34.2% monthly, 22% quarterly, 2.4% bi-annually, and 14.6% annually. There is consensus in the literature indicating the frequency of feedback is related to the effectiveness of the feedback. That is, feedback given more often will produce more behavior change than feedback given less often (Alvero, Bucklin, and Austin, 2001). Table 5 shows the effectiveness of peer observation and feedback by the frequency of feedback as indicated by survey respondents. As can be seen in Table 5, survey responses did not vary enough to support or refute this hypothesis.

Another follow-up question asked respondents to indicate how often feedback was given to drivers. Of the 41 respondents who indicated using peer observation and feedback, 96% of respondents reported giving drivers feedback via a one-on-one meeting with the safety manager, 48.8% via private

Table 4. Use of specific behavioral management techniques by survey respondents and the effectiveness and rankings of the techniques.

Specific Behavioral Management Techniques	Fleet Safety Managers		
	% Who Use (out of 65)	Mean	Rank
Training and education on specific driving behaviors (e.g., mirror use, lane changes, following distance, etc.)	100%	2.9	1
Peer observation and feedback	63.1%	2.8	2
Disincentives/punishment	87.7%	2.6	3
Training and education on specific non-driving behaviors (e.g., lifting techniques, diet, exercise, etc.)	72.3%	2.6	4
Incentives/rewards	80%	2.5	5
Prompts	89.2%	2.4	6
Driver self-management/self-observation	32.3%	2.3	7

Table 5. Effectiveness of peer observation and feedback by frequency of feedback.

	Frequency of Feedback					
	Daily	Weekly	Monthly	Quarterly	Bi-Annually	Annually
Effectiveness	2.7	3.0	2.6	3.0*	3.0	2.6

* Effectiveness rating based on one data point
Number of respondents = 41

memo/letter, and 24.4% via public display (note the sum does not equal 100% as respondents could select more than one choice). The last part of Question 27 asked respondents to indicate the type of feedback given to drivers. Of the 41 respondents who indicated using peer observation and feedback, 39% of respondents reported giving drivers individual feedback regarding their driving and non-driving behaviors, 7.3% reported giving group feedback, and 53.7% reported giving a combination of group and individual feedback. Examples of behavioral checklists used in peer observation can be found in Appendix C.

Self-Management/Self-Observation

Question 28 asked respondents three follow-up questions if they indicated using driver self-management/self-observation. One follow-up question asked respondents to indicate the frequency of the feedback given to drivers when using this BBS technique. Of the 21 respondents who indicated using self-management/self-observation, 19.1% gave daily feedback, 14.3% weekly, 47.6% monthly, 9.5% quarterly, and 9.5% bi-annually (no respondents reported annual feedback). Table 6 shows the effectiveness of self-management/self-observation by the frequency of feedback as indicated by survey respondents. As can be seen in Table 6, effectiveness decreases as feedback becomes less frequent. However, because of the small sample size, these data should be interpreted with caution.

Another follow-up question asked respondents to indicate how feedback is given to drivers. Of the 21 respondents who indicated using self-management/self-observation, 76.2% of respondents reported giving drivers feedback via a one-on-one meeting with the safety manager, 28.6% via private memo/letter, and 19.1% via public display, while 14.3% reported having drivers chart their own feedback. (The sum does not equal 100% because respondents could select more than one choice.) The last part of Question 28 asked respondents to indicate the type of feedback given to drivers. Of the 21 respondents who indicated using self-management/self-observation, 42.9% of respondents reported giving drivers individual feedback regarding their driving and non-driving behaviors, 9.5% reported giving group feedback, and 47.6% reported giving a combination of group and individual feedback. Note that the percentage for individual feedback is low. As the premise behind self-management is that the individual is self-accountable for recording and reviewing his/her own feedback, results for individual or combination of individual and group feedback should be close to 100%. These results suggest a deviation between practice and published BBS research. Examples of behavioral checklists that can be used to facilitate driver self-management can be found in Appendix C.

Training and Education with Driving Behaviors

Question 29 asked respondents one follow-up question if they indicated using training and education sessions on specific driving behaviors. This follow-up question asked respondents to indicate the frequency of the training and education sessions on specific driving behaviors. Of the 65 respondents (100%) who indicated using training and education sessions on specific driving behaviors, 10.8% held weekly sessions, 26.2% monthly, 33.8% quarterly, 20% bi-annually, and 9.2% annually (no respondent indicated daily training and education sessions). Table 7 shows the effectiveness of training and education sessions on specific driving

Table 6. Effectiveness of self-management/self-observation by frequency of feedback.

	Frequency of Feedback					
	Daily	Weekly	Monthly	Quarterly	Bi-Annually	Annually
Effectiveness	2.75	2.3	2.5	2.0	1.0	*

* No data points
Number of respondents = 21

Table 7. Effectiveness of training and education session on specific driving behaviors by frequency of sessions.

	Frequency of Sessions					
	Daily	Weekly	Monthly	Quarterly	Bi-Annually	Annually
Effectiveness	*	3.57	3.0	2.8	2.6	3.2

* No data points
Number of respondents = 65

behaviors by the frequency of sessions as indicated by survey respondents. As can be seen in Table 7, effectiveness generally decreases as the training and education sessions become less frequent, with the exception of a rise for annual training. Examples of training and education programs can be found in Appendix D.

Training and Education with Non-Driving Behaviors

Question 30 asked respondents a follow-up question on frequency if they indicated using training and education sessions on specific non-driving behaviors. Of the 47 respondents who indicated using training and education sessions on specific non-driving behaviors, 8.5% held sessions weekly, 23.4% monthly, 40.4% quarterly, 14.9% bi-annually, and 12.8% annually. Table 8 shows the effectiveness of training and education sessions on specific non-driving behaviors by the frequency of sessions as indicated by survey respondents. As can be seen in Table 8, effectiveness slightly decreases as the training and education become less frequent (although the rating of effectiveness for annual training and education sessions was higher than bi-annual training and education sessions). Survey respondents rated training and education with specific driving behaviors more effective than with non-driving behaviors. Further, training and education sessions on specific driving behaviors were held more frequently than with non-driving behaviors.

Incentives/Rewards

Question 31 asked respondents two follow-up questions if they indicated using incentives/rewards with their drivers. One follow-up question asked respondents to indicate what types of rewards their organizations give to their drivers. Table 9 displays the percentage of survey respondents who use each type of reward. (The sum does not equal 100% as respondents could select multiple rewards.) Most respondents indicated using some type of safety award (73.1%), such as a certificate or trophy to reward drivers, while few reported using paid leave (1.9%).

Respondents were also asked to indicate what type of data is used to determine rewards. Table 10 displays the percentage of respondents who use each type of data to determine rewards. (The sum does not equal 100% as respondents could make multiple selections.) Most respondents indicated using crash-free miles (86.5%) to reward drivers, while few respondents indicated using brake or speed data (7.7% and 9.6%, respectively). Respondents were also free to indicate selections that were not included in the survey (i.e., “other”); these responses included rewarding drivers for injury-free days and attendance at safety meetings. As indicated previously, most BBS programs stress process-based incentives rather than outcome-based incentives. These data can be interpreted in several ways: (1) outcome-based data are the only type of data available to respondents, (2) respondents were unaware of the

Table 8. Effectiveness of training and education session on specific non-driving behaviors by frequency of sessions.

	Frequency of Sessions					
	Daily	Weekly	Monthly	Quarterly	Bi-Annually	Annually
Effectiveness	*	2.8	2.9	2.6	2.2	2.5

* No data points
Number of respondents = 47

Table 9. Use of rewards by survey respondents.

	Type of Reward						
	Cash	Paid Leave	Private Recognition	Safety Trinkets	Public Recognition	Tokens	Safety Awards
% Use (of 52 “yes” respondents)	57.7%	1.9%	30.8%	32.7%	63.5%	3.8%	73.1%

Table 10. Data used by survey respondents to determine rewards.

	Type of Data						
	Crash-Free Miles	Incident-Free Miles	Violation-Free Miles	Customer/Public Comments	Speed Data	Brake Data	Other
% Use (out of 52)	86.5%	71.2%	44.2%	38.5%	9.6%	7.7%	11.5%

potential benefits of process-based measures, (3) outcome-based measures are much easier and less time consuming to assess than process-based measures, and (4) some combination of the three.

Disincentives/Penalties

Question 32 asked respondents two follow-up questions if they indicated using disincentives/penalties with their drivers. One follow-up question asked respondents to indicate what type of penalty their organizations give to drivers. Table 11 displays the percentage of respondents who use each type of penalty. (The sum does not equal 100% as respondents could select multiple penalties.) Most respondents indicated placing a memo/letter in the driver's file (87.7%) to punish drivers, while none (0%) of the survey respondents reported using public reprimands.

Respondents were also asked to indicate what type of data they use to determine penalties. Table 12 displays the percentage of respondents who use each type of penalty. (As previously, the sum does not equal 100% as respondents could make multiple selections.) Most respondents indicated using crash data (93%) to punish drivers, while few respondents indicated using brake data (14%). Respondents were also free to state data sources that were not included in the survey (i.e., "other"). Responses (not shown in the table) included hours-of-service violations and idle time.

Comparisons between data sources used for penalties (Table 12) to those for rewards (Table 10) are notable. Respondents were much more likely to use a variety of different data sources to assess penalties compared to rewards. Further, they were more willing to use performance data (i.e., speed and brake data) to punish drivers than to reward them. Again, fleet safety managers deviated from published BBS research and preferred outcome-based measures rather than process-based measures to assess penalties and rewards.

Training/Coaching New Drivers

Question 34 asked respondents to select five driving or non-driving behaviors they focus on the most when training/coaching *new* drivers. Table 13 shows the percentages for the five most important driving and non-driving behaviors while training new drivers as indicated by survey respondents. (The sum does not equal 100% as survey respondents could select up to five driving and non-driving behaviors.) Most survey respondents focus on training new drivers how to conduct pre- and post-trip inspections of their vehicles (75.8%), while few focus on proper diet, exercise, or load securement (all 1.6%). Overall, most respondents focus their training with new drivers on driving behaviors rather than non-driving behaviors. Interestingly, two of the three most common driving behaviors addressed in these training and education sessions with new drivers (i.e., inattention and speeding) were also the two most frequent human behaviors found in all the crashes investigated at the three different levels in the Indiana Tri-Level Study (Treat et al., 1979). Inattention was also the most prevalent recognition error, and speeding was the second most prevalent decision error in the LTCCS.

Table 11. Use of penalties by survey respondents.

	Type of Disincentives				
	Memo/Letter in Driver's File	Points (Earned or Deducted)	Private Reprimand	Public Reprimand	Cash
% Use (out of 57)	87.7%	21.1%	86%	0%	14%

Table 12. Data used by survey respondents to determine penalties.

	Type of Data						
	Crashes	Incidents	Violations	Customer/Public Comments	Speed Data	Brake Data	Other
% Use (out of 57)	93.0%	87.7%	89.5%	65.0%	42.0%	14.0%	7.0%

Table 13. Driving and non-driving behaviors as the primary focus in training/coaching new drivers.

Safety-Critical Behaviors	% Use (out of 62)
Driving Behaviors	
Driving inattentively	54.8%
Speeding	54.8%
Following distances	54.8%
Using mirrors	45.2%
Lane changes	45.2%
Driving fatigued	41.9%
Backing maneuvers	37.1%
Turning maneuvers	32.3%
Identification of blind spots	12.9%
Non-Driving Behaviors	
Pre- and post-trip inspection	75.8%
Completing paperwork	25.8%
Lifting techniques	12.9%
Proper diet	1.6%
Proper exercise	1.6%
Other: load securement	1.6%

Table 14. Driving and non-driving behaviors as the primary focus in refresher training/coaching experienced drivers.

Safety-Critical Behaviors	% Use (out of 61)
Driving Behaviors	
Driving inattentively	70.5%
Speeding	59.0%
Following distances	55.7%
Driving fatigued	49.2%
Lane changes	45.9%
Using mirrors	34.4%
Backing maneuvers	31.1%
Turning maneuvers	26.2%
Identification of blind spots	14.8%
Non-Driving Behaviors	
Pre- and post-trip inspection	55.7%
Completing paperwork	14.8%
Lifting techniques	13.1%
Proper exercise	3.3%
Proper diet	1.6%
Other: load securement	1.6%
Other: drugs	1.6%

Training/Coaching Experienced Drivers

Question 35 asked respondents to select five driving or non-driving behaviors they focus on the most when using refresher training/coaching with *experienced* drivers. Table 14 shows the percentages for the five most important driving and non-driving behaviors while refresher training/coaching experienced drivers. (Again the sum does not equal 100% as survey respondents could select up to five behaviors.) Most survey respondents focus on refresher training/coaching experienced drivers to drive attentively (70.5%), while few focus on diet, drugs, or load securement (all 1.6%). Overall, most respondents focus their refresher training/coaching with experienced drivers on driving behaviors rather than non-driving behaviors. In fact, this focus was more pronounced with experienced drivers compared to new drivers. As noted regarding training new drivers, the two most common driving behaviors (inattention and speeding) addressed when training experienced drivers were also the two most frequent behaviors found in crashes investigated at the three different levels in the Indiana Tri-Level Study (Treat et al., 1979). Again, as noted previously, inattention was also the most prevalent recognition error, and speeding was the second most prevalent decision error in the LTCCS.

Part 4: Barriers/Problems to Implementing Behavioral Management Techniques

The specific barriers/problems in implementing behavioral management techniques, mean ratings (to the nearest tenth), and rankings are presented in order in Table 15. When there were ties, rankings were determined by looking at additional decimal places. However, for simplicity, these are not shown in the table. The scale went from "0" (no barrier/problem) to "4" (serious barrier/problem); thus, the higher the number, the greater the barrier/problem in implementing behavioral management techniques. The highest-rated barrier/problem was non-acceptance/lack of cooperation by drivers (mean rating of 1.7). The lowest-rated barrier/problem was driver union (or other association) opposed to it (mean rating of 0.5). Most of the barriers/problems were rated very low, from slight barrier to neutral. Of course, given the sample was likely skewed toward managers who have actually implemented such programs, these data do not necessarily reflect the importance of these barriers for fleets in general.

Part 5: Comments/Respondent Information

In Part 5, a space was provided for respondents' written comments. Approximately one-third of survey respondents made such comments. The comments focused on a variety of issues and expressed many different views. Some of the comments are provided below:

- "After searching for some time for a BBS approach, we recently started piloting BBS using a driver self-inspection checklist at a few terminals. So far we are pleased with the results. Drivers participate in developing the checklist to cover key at-risk behaviors for their local operation. It is essentially a 'post-trip' checklist for their safety behaviors that day. We do not spend much effort on graphing the results for the terminal, use simplified Excel graphing for general trends by item at that terminal. We don't spend any time graphing combined terminal results since all the

Table 15. Barriers/problems in implementing behavioral management techniques.

Barriers/Problems	Fleet Safety Managers	
	Mean	Rank
Non-acceptance/lack of cooperation by drivers	1.7	1
I and/or other company safety managers don't know enough about it	1.2	2
BBS takes too much time to implement	1.1	3
Not enough money/budget to support it	1.1	4
We tried BBS techniques, but they have not worked well	0.9	5
Company top management doesn't support it	0.8	6
Driver union (or other association) opposed to it	0.5	7

Number of respondents = 65

checklists are somewhat different. Employee support and ownership has been positive so far. Visible benefits are increased daily focus on safety behaviors, improvement through self-coaching, increased interaction among peers pointing out at-risk behaviors they observe co-workers committing and significant reduction of safety failures where we have it up and running."

- "The killer problem with BBS in the trucking environment is trying to find observation opportunities for lone workers many miles from the terminal working 24/7. We think the next best thing is to sell them why it helps them protect themselves by reviewing their actions during the shift and recording the data they see. Thus, the self-observation checklists. We make a couple of assumptions about our co-workers in this process. They don't want to experience safety failures any more than we do. They are essentially honest people who will admit they are human, record their self-observations and coach themselves to become the safest operator possible."
- "Drivers are lone workers. They represent a unique challenge in introducing and sustaining a BBS process. Empowerment and effective leadership are the keys to BBS."
- "I really like BBS, unfortunately there is not a whole lot out there that is easy and simple to implement. Our insurance carrier has a great one that I use a lot."
- "Our company is a very safety oriented company. Our safety program is supported strongly by upper management, and our drivers."
- "We have introduced Driver Scorecards which are basically a quality measurement of each driver. Training modules reduce the score while violations, accidents, motorist complaints, etc., add points. If drivers hit a certain threshold, we look at the points and determine if the driver needs to be terminated or if remedial training can salvage the driver. In addition, we've instituted a formal annual driver appraisal where we sit down with each driver and review their performance, establish training schedule, and solicit their feedback. We have elected to spend additional $ to retain drivers, not just the trinkets and picnics, but enhanced communication, driver involvement in problem solving, and some incentive programs (imagine an airline Frequent Flyer Program) where 'points' can be redeemed from a comprehensive catalog."
- "We currently have a BBS program and have been successful with it."
- "BBS can only be successful with management buy-in."
- "We currently have a BBS program and have been successful with it."
- "Began BBS a year ago. Still shaking down the BBS system and implementation with personnel in the organization due to new software, new incident investigation forms and techniques, and observation and feedback are all new."
- ". . . everyone makes BBS decisions all the time . . . without awareness and techniques training we miss opportunities to help 'shape' the BBS decisions toward safe behavior."

Survey respondents were also asked to provide general demographic information about themselves and their fleets. The 65 fleet safety manager respondents had been safety managers at their current fleet for an average of 11.7 years (range: 1 to 42) and had an average of 23.2 total years of experience in CMV operations (range: 1 to 44). Fleet size varied widely, ranging from 2 to 7,500 power units. The median fleet size was 101 power units. Respondents were also asked to characterize their fleet's primary operation by selecting one of seven major truck and/or bus operation types or writing in an alternative. Results are shown in Table 16. (The sum is more than 100% as some fleets had more than one operation type.)

As can be seen in Table 16, private fleets were likely over-represented in the sample. Thus, readers should be mindful of this over-representation when interpreting the results presented in this synthesis. One possible interpretation of this over-representation is that private fleets are more likely to

Table 16. Safety managers' fleet operation types.

Operation Type	# Fleet Safety Managers	% Fleet Safety Managers
For hire: long haul/truckload.	12	18.5%
For hire: long haul/less-than-truckload (LTL)	4	6.2%
For hire: local/short haul (most trips < 100 miles)	5	7.7%
Private industry: long haul	16	24.6%
Private industry: local/short haul (< 100 miles)	22	33.8%
Passenger carrier: long haul/motor coach	6	9.2%
Passenger carrier: local/transit	3	4.6%

implement BBS program (no data could be found to support this claim); however, it's also possible these types of CMV operations were over-sampled in the synthesis.

Key Findings

- Few focus group and survey respondents have implemented a comprehensive BBS program; rather they have implemented behavioral management techniques in a piecemeal fashion.
- The highest-rated driving behaviors (tailgating, speeding, and speeding on curves) with respect to crash risk were similar to those identified in major crash database studies (e.g., LTCCS and Indiana Tri-Level study).
- More than one-third (35.4%) of survey respondents use some type of OBSM device to observe driver behaviors.
- Almost all survey respondents (83.1%) use some type of observation approach to observe driver behaviors.
- All respondents used some type of behavioral management approach to improve the safety of their drivers.
- Training and education with respect to driving behaviors was the highest-rated behavioral management technique (2.9 out of 4.0).
- There were several discrepancies between research (the BBS research literature) and practice (as indicated by survey respondents), including
  - Frequency of feedback and
  - Type of data used to determine incentives and penalties.
- Training and education of new drivers focus primarily on pre- and post-trip inspection and several driving behaviors (driving inattentively, speeding, and following too close).
- Training and education programs with experienced drivers, also called refresher training, focus mostly on critical driving behaviors (driving inattentively, speeding, and following too close).
- Respondents do not view the barrier/problems to implementing behavioral management techniques as significant impediments, perhaps because all survey respondents have implemented some type of behavioral management techniques with their drivers.

Research and Development Needs

This synthesis presents findings from a number of studies supporting the view that BBS techniques are an effective safety-management method for reducing at-risk driving and non-driving safety behaviors and increasing safe behaviors. However, the survey results from fleet safety managers did not always echo the results found in the published studies presented in this report. This discrepancy underlines the most significant problem in using BBS techniques in a CMV setting: fleet safety managers may not be correctly implementing behavioral management techniques. While behavioral management techniques have been successful in other industrial settings, there have been few scientific studies of these techniques used with CMV drivers. Further, while the use of specific behavioral management techniques in CMV operations is prevalent, few survey respondents reported using a comprehensive BBS *program.* Instead, they implemented behavioral techniques in a piecemeal fashion, which may have affected their results.

The survey results presented in this synthesis highlight the need for more research. Several authors (see Knipling, Hickman, and Bergoffen, 2003; Krause, Robin, and Knipling, 1999) have advocated research be conducted in assessing the efficacy of BBS programs in CMV setting. While there have been several well-controlled, piecemeal research studies assessing behavioral management techniques in CMV operations (see Hickman and Geller, 2003b; Krause, 1997; Olson and Austin, 2001), a more comprehensive long-term study assessing the potential safety benefits of BBS in CMV operations is greatly needed. BBS techniques are relatively easy to implement, but this ease of use leads managers with little knowledge or experience to implement them haphazardly. While at-risk driving behaviors were rated as strongly related to crash and injury risk, the BBS methods and techniques employed by fleet safety managers did not always coincide with recommended practice. Clearly, a significant need is to develop a set of accepted practices and guidelines for implementing and using BBS techniques in CMV operations. This synthesis outlines some of those recommended practices and guidelines but is in no way a comprehensive guide to achieve the desired results.

One aim of this synthesis was to assess potential barriers for implementing BBS techniques. As most respondents did not view the list of barriers presented in the survey as significant detriments in implementing BBS techniques, more research should be conducted to assess why BBS techniques have not been widely accepted in the CMV industry.

This synthesis describes the promise of BBS but also highlights obstacles that must be overcome. There are many fundamental research questions relating to the potential safety applications of BBS techniques in CMV operation:

- **Common BBS myths:** There should be studies exploring why behavioral safety-management techniques are not widely used in CMV fleet safety. The result of such research would be a manual delineating common myths held by safety managers and others, as well as describing how these techniques should be properly applied.
- **Efficacy of BBS techniques in CMV operations:** A broad-based, long-term naturalistic study assessing the efficacy and applicability of using BBS techniques in CMV operations is needed. The study would determine if current BBS techniques can be readily applied in CMV operations or whether these BBS techniques need to be adapted. The study could assess the applicability of a traditional peer-observation and feedback approach and self-management techniques. The result of such a study would be a standardized manual describing the necessary and sufficient techniques to be used in CMV operations.
- **Research vs. practice:** This synthesis found discrepancies between fleet safety manager practice in the real world and published research. The reasons for these discrepancies should be assessed before any large-scale study assessing BBS techniques in CMV operations. Are these discrepancies the result of poor communication, lack of training, or

noteworthy difficulties in implementing BBS techniques in the real world?

- **Process-based vs. outcome-based incentives:** No studies have compared the relative effectiveness of process-based (e.g., driving safety behaviors) and outcome-based (e.g., crash involvement) incentive programs. Most prior research and this synthesis indicate that outcome-based incentives programs are the most common programs in CMV operations. The behavioral approach suggests process-based incentives programs are likely to be as effective as outcome-based incentive programs with less negative side effects. A study comparing the two could also aid in the development of a comprehensive, easy-to-use manual for fleet safety managers.
- **BBS and OBSM devices:** A study assessing the efficacy of incorporating OBSM technology with BBS techniques is needed. OBSM is the only systematic and reliable method for gathering observational data on CMV driver behaviors and thus is likely a necessary component of any comprehensive BBS application in CMV transport.
- **Effectiveness of OBSM devices:** Given the relative novelty of using OBSM devices in safety management, field or naturalistic driving studies should assess the effectiveness of various OBSM technologies. These studies could also aid in
  - Developing guidelines/benchmarking OBSM data for optimal safety benefits,
  - Assessing generalization or spread of effect to other driving behaviors not directly targeted by OBSM,
  - Overcoming driver resistance to OBSM technologies, and
  - Developing techniques for incorporating established behavioral safety-management techniques with existing and emerging OBSM technologies.
- **Time expenditure of OBSM devices:** Many OBSM devices require significant time expenditures in processing the data because of the large amounts of data generated by these systems. Procedures and related software for reducing the time required to analyze the data should be explored.
- **Safety placards:** Given the lack of rigorous experimental methods in assessing the effectiveness of safety placards, well-designed studies assessing the benefits of safety placards should be implemented. Most notably, such studies should use control groups to prevent regression to the mean effects from being incorrectly perceived as true safety benefits. These studies could also assess how feedback is provided to drivers and how managers conduct corrective follow-up activities.

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APPENDIX A

Statement of Work for Synthesis Report on the Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers

Objectives and Scope

This synthesis project will review the evidence for various behavioral strategies to increase the safety-related driving behaviors of commercial motor vehicle (CMV) employees, including: (1) the effectiveness of using behavior-based safety (BBS) techniques to increase the safety-related driving behaviors of CMV drivers; (2) the practicality of using various BBS techniques with CMV drivers and their acceptance of them; (3) the applicability and impact of self-management techniques within the context of a BBS framework; (4) innovative and cost-effective methods for institutionalizing BBS interventions in CMV driving settings; and (5) the use of on-board safety monitoring (OBSM) devices, such as cameras and on-board data recorders as a means of gathering detailed and objective data on CMV driver behaviors. The synthesis will conduct focus groups with fleet safety managers and other experts in CMV safety to identify BBS techniques and on-board safety monitoring technologies used in CMV operations. The information gleaned from these focus groups will inform a survey given to professional fleet safety managers to assess the use and perceived effectiveness of specific behavioral safety management practices in CMV settings. Finally, the study will report findings, including case studies and identification of needs for future research using BBS techniques in commercial transport settings.

Focus Groups to Identify Behavior-Based Safety Techniques

The project team will conduct two or three focus groups to identify specific behavioral safety management techniques currently used by CMV carriers. The discussions will address targeted behaviors and performance measures (including those captured by OBSM) and behavioral safety management practices used by carrier safety managers. The practices may include antecedents (e.g., signs, posters, reminders) and consequences (i.e., rewards and punishments). As BBS encompasses a variety of different techniques, procedures, and terminology, these focus groups will be critical in identifying current BBS practices in CMV operations (including the terminology safety managers' use in describing these practices). The information gleaned from these focus groups will be essential to developing the planned survey of fleet safety managers.

One way to structure the focus group discussions is by the four steps of BBS, such as:

1. Identify safety-critical behaviors
2. Perform observations to gather data
3. Provide feedback to encourage improvement
4. Use gathered data to identify factors promoting positive change

The discussion could begin with a discussion identifying the most critical behaviors (mostly driving behaviors but potentially including some non-driving behaviors such as loading/unloading), proceed to a discussion of how safety managers gather information on these behaviors (e.g., ride-alongs, surveillance, on-board monitoring), talk about ways to provide feedback and related contingencies, and then talk about management policies and practices put into place based on this process. This structure is simple and lends itself to a non-technical discussion of specific management practices.

APPENDIX B

Fleet Safety Manager Survey

Cover Letter/Email Sent to Fleet Safety Managers

Dear Fleet Safety Manager,

Under sponsorship of the Transportation Research Board, the Virginia Tech Transportation Institute (VTTI) is conducting a review and survey of Effective Behavior-Based Safety Techniques in Commercial Vehicle Operations. This study will identify major commercial vehicle operations (CVO) at-risk driving and non-driving behaviors of concern, and describe and assess behavior-based approaches to reduce these problematic behaviors.

As a fleet safety manager, your knowledge and opinions are of great interest and importance to this study. This survey seeks your input on various CVO safety problems and behavior-based solutions. The survey, which will take about 20 minutes to complete, asks you to rate the safety significance of specific at-risk driving and non-driving behaviors and the effectiveness of various solutions. There is also a space for your comments and suggestions. **All survey responses are confidential.**

The following link, **https://survey.vt.edu/survey/entry.jsp?id=1148318887480**, will take you to a secure and confidential site where the survey can be completed. However, if you so choose, a MS Word version of the survey has been attached that can be completed on your computer and returned via email. You may also print the Adobe pdf version of survey and complete with a pencil or pen. Should you choose this last option, please send the completed survey to the following address: Jeff Hickman, 3500 Transportation Plaza, Blacksburg, VA 24061.

If you provide your contact information, you will be sent a FREE copy of the project final report to be published in Spring 2007, entitled, *Impact of Behavior-Based Safety Techniques in Commercial Motor Vehicle Operations*. Survey respondents will also be sent information on how to obtain free electronic (pdf) copies of various reports on motor carrier safety management.

Thank you for your time, and for sharing your knowledge and experience!

Sincere regards,

Jeffrey S. Hickman, Ph.D.
Ron Knipling, Ph.D.
Bob Inderbitzen, Certified Transportation Professional

Fleet Safety Manager Survey

Motor vehicle crashes are often predictable and preventable. Yet, many drivers choose to drive in ways that put themselves and others at risk for a vehicle crash and serious injury. Behavior-based safety consistently provides positive results when applied in organizations seeking to reduce employee injuries due to at-risk behaviors. However, the use and effectiveness of specific behavior-based techniques has not been evaluated in commercial vehicle operations. This survey, which takes about 20 minutes to complete, focuses on at-risk driving and non-driving behaviors and specific behavior-based techniques to reduce these at-risk behaviors.

Thank you for your participation and support!

Part 1. Safety-Critical Behaviors
In Part 1, please indicate which of the listed driving and non-driving behaviors you consider "safety critical". Safety-critical behaviors are those behaviors that impact overall safety (e.g., **injuries**, **incidents**, and **crashes)** in an organization. For your organization, HOW STRONG IS THE RELATIONSHIP of each of the following behaviors with driver crash risk and non-driving-related illnesses and injuries? Your responses will reflect those behaviors you consider to be "safety-critical" in your organization. *Check the box that indicates the appropriate strength of the relationship.*

	No Relationship		Moderate Relationship		Strong Relationship
1. Improper cargo securement	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
2. Improper docking of the truck	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
3. Improper attachment of the trailer to the tractor	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
4. Failure to plan trip	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
5. Failure to inspect vehicle pre-/post-trip	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
6. Improper following distances (i.e., tailgating)	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
7. Speeding (i.e., maximum cruising speeds)	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
8. High speeds on curves and/or ramps	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
9. Driving while fatigued	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
10. Careless backing	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
11. Careless lane changes	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
12. Disregard of traffic signals (e.g., stop sign, red light, etc.)	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
13. Attention to roadway (e.g., engaging in distracting activities)	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
14. Inappropriate right turns	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
15. Inappropriate left turns	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
16. Improperly entering/exiting truck	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
17. Behaviors that lead to slips, trips, and falls	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
18. Poor lifting techniques	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
19. Poor exercise habits	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
20. Poor diet	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
21. Smoking	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
22. Drugs and Alcohol	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

Part 2. Observation of Safety Critical Behaviors
For each of the observation techniques listed below, please MARK "**YES**" if your organization currently uses the observation technique. As your organization may use several observation techniques, please record answers for all observation techniques used by your organization.

23. Onboard safety monitoring device (i.e., electronic monitoring) ☐ NO ☐ YES

IF YES
a. What device does your organization use (please indicate)?
b. What behaviors does it track (please indicate)?

24. Ride-alongs ☐ NO ☐ YES

IF YES
a. How often does your organization conduct ride-alongs (select one)?
☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually
b. Who conducts the ride-alongs (mark all that apply)? ☐ Driver from Same Terminal ☐ Driver from Different Terminal ☐ Terminal Manager ☐ Driver Supervisor ☐ Other Manager ☐ Independent Observer

25. Covert observations (e.g., hidden video cameras or observers) ☐ NO ☐ YES

IF YES
a. How often does your organization conduct covert observations (select one)?
☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually

26. Comments from public (e.g., 1-800 "How's my Driving" phone service, clients) ☐ NO ☐ YES

Part 3. Specific Behavior-Based Safety (BBS) Techniques
For each of the specific BBS techniques listed below, please MARK "**YES**" if your organization currently uses the BBS techniques. Then, IF "**YES**", MARK YOUR RATING on its level of safety effectiveness in your organizations' fleet safety. In other words, do you believe the BBS technique is a viable and effective tool in reducing unwanted or at-risk driving and non-driving behaviors (see Part 1 above) in your fleet? As your organization may use several BBS techniques, please record answers for all observation techniques used by your organization.

	Highly Ineffective	Ineffective	Neutral	Effective	Highly Effective
27. Peer observation and feedback (e.g., ride-alongs) ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. How frequent is feedback given to drivers in your organization (select one)?
☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually
b. How is feedback given to drivers in your organization (mark all that apply)?
☐ One-on-one w/Safety Manager ☐ Private Memo/Letter ☐ Public Display
c. What type of feedback is given to drivers (select one)?
☐ Individual ☐ Group ☐ Combination of individual and group

	Highly Ineffective	Ineffective	Neutral	Effective	Highly Effective
28. Driver self-management/self-observation ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. How frequent is feedback given to drivers in your organization (select one)?
☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually
b. How is feedback given to drivers in your organization (mark all that apply)?
☐ One-on-one w/Safety Manager ☐ Private Memo/Letter ☐ Public Display ☐ Chart their Own
c. What type of feedback is given to drivers (select one)?
☐ Individual ☐ Group ☐ Combination of individual and group

	Highly Ineffective	Ineffective	Neutral	Effective	Highly Effective
29. Training and education sessions on specific <u>driving behaviors</u> (e.g., using mirrors, lane changes, following distance, etc.) ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. How often does your organization hold these training and education sessions (select one)?
☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually

30. Training and education sessions on specific non-driving behaviors (e.g., lifting, diet, exercise, etc.) ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. How often does your organization hold these training and education sessions (select one)? ☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Bi-Annually ☐ Annually

31. Incentives/rewards ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. What type(s) of reward(s) does your organization give drivers (mark all that apply)? ☐ Cash ☐ Safety Trinkets ☐ Paid leave ☐ Tokens ☐ Awards ☐ Public Recognition ☐ Private Recognition
b. What data is the reward based on (mark all that apply)? ☐ Crash-free Miles ☐ Incident-free Miles ☐ Violation-free Miles ☐ Customer or Public Comments ☐ Speed Data ☐ Braking Data ☐ Other (please specify)

32. Disincentives/punishment ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

IF YES
a. What type(s) of punishment(s) does your organization give drivers (mark all that apply)? ☐ Cash ☐ Points (earned or deducted) ☐ Memo/Letter in Driver's File ☐ Public Reprimand ☐ Private Reprimand
b. What data is the punishment based on (mark all that apply)? ☐ Crashes ☐ Incidents ☐ Violations ☐ Customer or Public Comments ☐ Speed Data ☐ Braking Data ☐ Other (please specify)

33. Prompts (e.g., posters, reminder stickers, company memos) ☐ NO ☐ YES	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

34. While training/coaching new drivers, which of the following driving behaviors do you focus on the most (mark up to 5 driving behaviors)? ☐ Driving Inattentively ☐ Driving Fatigued ☐ Speeding ☐ Using Mirrors ☐ Lane Changes ☐ Turning Maneuvers ☐ Lifting Techniques ☐Proper Diet ☐ Proper Exercise ☐ Identification of Blind Spots ☐ Pre/Post-Trip Inspection ☐ Completing Paperwork ☐Docking ☐ Backing Maneuvers ☐ Following Distances ☐ Other (please specify

35. In your refresher training/coaching with experienced drivers, which of the following driving behaviors do you focus on the most (mark up to 5 driving behaviors)? ☐ Driving Inattentively ☐ Driving Fatigued ☐ Speeding ☐ Using Mirrors ☐ Lane Changes ☐ Turning Maneuvers ☐ Lifting Techniques ☐Proper Diet ☐ Proper Exercise ☐ Identification of Blind Spots ☐ Pre/Post-Trip Inspection ☐ Completing Paperwork ☐Docking ☐ Backing Maneuvers ☐ Following Distances ☐ Other (please specify

Part 4: Barriers/Problems in Implementing BBS
In Part 4, what are the barriers/problems in implementing BBS techniques in your organization? For your organization, HOW STRONG IS THE PROBLEM/BARRIER for each of the following statements? *Check the box that indicates the appropriate strength of the problem/barrier.*

	No Barrier/Problem		Neutral		Serious Barrier/Problem
36. Company top management doesn't support it	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
37. Not enough money/budget to support it	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
38. Non-acceptance/lack of cooperation by drivers	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
39. Driver union (or other association) opposed to it	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
40. BBS takes too much time to implement	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

41. I and /or other company safety managers don't know enough about it	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4
42. We tried BBS techniques, but they have not worked well	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

Part 5: Comments

43. Please write any comments on BBS or any part of this survey:

44. The approximate number of years you have been a safety manager (for carrier motor operations):
45. Your approximate total years experience in motor carrier operations:
46. Current number of power units in your organizations' fleet:
47. How would you characterize your fleet's primary operation (select one)?
☐ For hire: long-haul/truckload ☐ For hire: local/short-haul ☐ Private industry: long-haul ☐ Private industry: local/short-haul ☐ Passenger carrier: long-haul ☐ Passenger carrier: local transit ☐ Other (please specify)
48. Can we contact you about your organization's BBS program? ☐ Yes ☐ No
IF YES, how can we contact you (please provide contact info):

Questions or comments regarding this survey can be directed to: Dr. Jeff Hickman, Virginia Tech Transportation Institute, 3500 Transportation Research Plaza, Blacksburg, VA, 24061. Dr. Hickman can also be contacted via phone at 540-231-1542, fax at 540-231-1555, and email at **jhickman@vtti.vt.edu**.

Should you wish to provide your contact information (as noted in the cover letter/email), you will be sent a FREE copy of the project final report to be published in Spring 2007, entitled, *Impact of Behavior-Based Safety Techniques in Commercial Motor Vehicle Operations*. Survey respondents will also be sent information on how to obtain free electronic (pdf) copies of various reports on motor carrier safety management.

If you wish to receive the final report and/or pdf copies of other reports on motor carrier safety management, please provide your contact information below:

Name: **City:** **State:**
Address: **Email:**

APPENDIX C

Behavior Checklists

Behavioral Checklist Contributed by Roy Nester at J. J. Taylor

J. J. Taylor

DISTRIBUTING FLORIDA, INC.
FORT MYERS BRANCH
DELIVERY DRIVE WITH CHECKLIST

Date: ______________, ______

Delivery Person: ____________________________ **Supervisor:** ________________________________

Appearance:
- Clean full uniform ☐
- Clean dark steel toe shoes ☐
- Shaved and clean cut ☐

Customer Service:
- Greeted customer upon entering business in a cordial manner ☐
- Resolved issues, if any, with customer ☐
- Reviewed order prior to start unloading ☐
- Stacked beer in designated area ☐

Absenteeism/tardiness:
- Showed up on time ☐
- No excessive tardiness/absenteeism in previous 6 weeks ☐

Other:
- Maintain clean tractor cab ☐
- Cleaned trailer at end of day ☐

Settlement:
- T-com everyday ☐
- Print copies of valid and voided invoices ☐
- Explain all overages/shortages, product/money ☐

Merchandising:
- Refilled and Build new displays ☐
- Rotation of product in display and shelf ☐
- Rotation of product in cooler ☐
- Rotation of product in backroom ☐
- Used of POS as required ☐
- Pricing as required ☐

Safety:
- Performed full pre/post trip inspection ☐
- Used stoppers on raillift ☐
- Tied down load during the day ☐
- Secured damages in separate pallet ☐
- Obeyed traffic signals ☐
- Maintained posted speed limits ☐
- Park properly in customers premises ☐
- Proper use of handcarts ☐
- Pallet jack certified ☐
- Stacked down product in bays/pallets ☐
- Used safe box in tractor for cash ☐
- Pallet truck inspection form ☐

Driver Signature: __________________________

Date: ____________________

Behavioral Checklists Contributed by Marathon Ashland

PERSONAL PROTECTIVE EQUIPMENT

SAFE	AT RISK	
		Head
		Wearing proper head protection - hardhat, bumpcap.
		Head protection in good condition and worn properly.
		Eyes/Face
		Wearing approved safety glasses for routine work.
		Wearing face shield for product unloading, grinding.
		Wearing chemical splash goggles for chemical handling or work on liquid systems.
		Welding goggles if needed. Welding screens in place to protect others.
		Ears
		Wearing proper hearing protection all high noise areas.
		Hearing protection correct type (NRR) and worn properly.
		Hands
		Wearing proper type of glove for the associated task.
		Gloves in good condition.
		Feet
		Wearing safety shoes for routine work.
		Metatarsal protection worn if required.
		Shoes in good condition.
		Clothing
		Wearing appropriate clothing for weather and working conditions.
		Wearing flame retardant clothing in all required work environments.
		Harness
		Wearing appropriate fall protection when working above 6 ft. without proper railing.
		Respirator
		Using proper respiratory equipment as required.

MATERIAL HANDLING

SAFE	AT RISK	
		Physical Lifting
		Inspect the load for sharp objects or slippery substances prior to attempting the he lift.
		Test the load's weight to ensure that it is within your lifting capacity.
		Use teamwork when lifting heavy loads.
		Get a firm footing prior to lifting the load.
		Back straight to maintain strength.
		Center body over feet.
		Feet positioned shoulder width apart.
		Pull the load close to body.
		Bend knees and lift with legs, not with the back.
		Always walk forward when carrying a load or pulling hoses.
		Ergonomics
		Proper body positioning used - neutral wrist, straight back, etc.
		Work station adjusted to correct position.
		Is job rotation required and being followed.
		Avoid use of excessive force
		Mechanical Lifting
		Use cylinder cart or appropriate device for moving heavy objects
		Secure all loads before transporting.
		Use appropriate rating and length of strap or cable when lifting.
		Use tag line when lifting a load with crane apparatus.
		Transport loads as low as possible when using mechanical lifting devices.
		Lower forklift tines to the ground prior to dismounting the equipment.
		Never leave a suspended load unattended.
		Transporting
		Never transport load over personnel.
		Secure gas cylinders, with protective caps in place, when transporting.

TOOLS AND EQUIPMENT

SAFE	AT RISK	
		Proper Tools
		Use the proper tool for the job.
		Use properly insulated tools when performing electrical work.
		Ensure tools are in good working condition.
		Proper Use
		Secure tools when working overhead of other employees.
		Make sure hoses are depressurized prior to disconnecting.
		Always cut away from your body when using a knife or other cutting instrument.
		Lockout/Tagout
		Use lockout/tagout when required.
		Isolate source prior to disconnect.
		Body Mechanics/Position
		Position your body clear of any potential energy release.
		Position your arms, hands, fingers and other body parts to avoid pinch points.
		Keep clear of moving parts when equipment is running or operating.
		Situation Awareness
		Set up jobs to prevent potential tripping hazards.
		Ensure proper permit procedures are followed for confined space work.
		Ensure proper fire extinguisher equipment is within 10 ft of all potential fire hazards.
		Ensure proper spill protection is in place when breaking a seal.
		Use LEL meter when entering a potential hazardous environment.
		Fuel all equipment in well-ventilated area.
		Use proper ventilation when working near hazardous vapors, working in the lab or prior to performing hot work in confied spa
		Place cords, hoses and buckets out of walk ways.
		Use proper bonding and grounding.
		Properly barricade and mark hazardous areas when appropriate.

DRIVING & TRANSPORTATION

SAFE	AT RISK	
		Preparation
		Do walk around of vehicle for visual inspection prior to entering.
		Check tire inflation
		Secure hoses, fittings, chocks or other equipment prior to moving.
		Maintain control of fueling nozzle at all times when fueling trucks.
		Check mirrors for proper alignment
		Check 5th wheel for proper connection.
		Occupant Protection
		Properly fasten safety belts prior to driving.
		Starting/Stopping
		Come to complete stop, with flashers on, at all railroads crossings when hauling hazardous materails.
		Perform smooth, slow stops and anticipate safe braking distance.
		When stopped at a traffic light or stop sign keep a safe distance between your vehicle and the vehicle in front of you.
		Following Distance
		Maintain assured safe distance - minimum three second rule.
		Adjust to road and weather conditions.
		Backing
		Sound horn prior to backing.
		Turning
		Use turn signals when turning and making lane changes.
		Turn signal should remain on until the entire trailer is in line with the cab and the lane change is complete.
		In-Motion
		Check traffic in side mirrors every 10-12 seconds.
		Maintain speed within posted speed limits.
		Adjust speed to road and weather conditions.
		Turn on flashers until reaching speed of traffic flow.
		Exit ramp speed minimum of 10 MPH less than posted speed for product vehicles.

SLIPS, TRIPS AND FALLS

SAFE	AT RISK	
		Climbing
		Use handrails when ascending/decending stairs.
		Use 3-point contact when ascending/descending ladders or entering and exisitng the cab of a truck.
		Properly secure ladder on a level surface and tie off when necessary.
		Use tether rope to raise and lower tools and equipment when ascending or descending vertical ladders.
		Keep your eyes on path when ascending/descending stairs.
		Face the interior of the cab when entering and exiting the truck.
		Always use handrails while climbing or descending stairs.
		Don't carry heavy or awkward loads on stairs.
		Walking
		Always walk forward and maintain eyes on path - don't read while walking.
		Remove or avoid hazards in walking path by walking around potential slipping and tripping hazards.
		When walking on icy surfaces, keep your feet low, take small steps and keep your hands free for balance.
		Visibility
		Use supplemental lighting when working in low lit areas.
		Housekeeping
		Keep work areas and pathways clear.
		Post wet or slippery floors, hoses or other tripping hazards with proper warning signs or barricades.
		Keep file and cabinet drawers closed when not in use.

Date: ______ Time: ______ ☐ AM ☐ PM

Observer #: ______ Job Activity #: ______

Activity Observed: ______

Location: ______ # of employees observed: ______

Personal Protective Equipment

S	AR		S	AR	
☐	☐	1 Head	☐	☐	6 Clothing
☐	☐	2 Eyes/Face	☐	☐	7 Harness
☐	☐	3 Ears	☐	☐	8 Personal Flotation Device
☐	☐	4 Hands	☐	☐	9 Respirator
☐	☐	5 Feet	☐	☐	10 Other ______

Slips, Trips & Falls

S	AR		S	AR	
☐	☐	11 Climbing	☐	☐	14 Elevated Work
☐	☐	12 Walking	☐	☐	15 River Work
☐	☐	13 Visibility	☐	☐	16 Other ______

Tools and Equipment

S	AR		S	AR	
☐	☐	17 Proper Tool	☐	☐	20 Body Mechanics/ Position
☐	☐	18 Proper Use	☐	☐	21 Situational Awareness
☐	☐	19 Lockout Tag Out	☐	☐	22 Other ______

Material Handling

S	AR		S	AR	
☐	☐	23 Physical Lifting	☐	☐	26 Communications
☐	☐	24 Mechanical Lifting	☐	☐	27 Chemicals/Product
☐	☐	25 Transporting	☐	☐	28 Other ______

Transportation

S	AR		S	AR	
☐	☐	29 Pre-Trip	☐	☐	33 Backing
☐	☐	30 Occupant Protection	☐	☐	34 Turning
☐	☐	31 Starting/ Stopping	☐	☐	35 In-Motion
☐	☐	32 Following Distance	☐	☐	36 Other ______

Was Feedback Given? Yes No

MAP TT&M
Observer Instructions

Enter the date including the month, day and year of the observation (Ex. 03/14/00)

Enter the time (in military format if possible)

Indicate AM or PM

Enter your Observer number

Enter the Job Activity number of the person being observed (from the last page)

Describe the activity being observed

Enter the location code (from the last page)

Enter the # of employees being observed

Enter "0" if self-observation

Complete the observation by checking ONLY the appropriate Safe and At-Risk boxes

Indicate whether or not you gave feedback by checking YES or NO

On the back of the card:

For any at-risk behavior observed indicate the coinciding # for that behavior and explain the at-risk behavior

Ex. For improper tool use

17 – employee used a wrench to hammer a nail

List the reasons given by the observed on why the activity was performed at-risk

Explain how the job could have been done more safely according to the person(s) observed.

Check the appropriate box for safety suggestion, Unsafe Condition or Near Miss and explain

Record any comments if applicable

BACK →

Explain any unsafe behavior observed:

______

Why did the unsafe behavior occur?

______

List corrective actions to ensure future safe behavio[r]

______

☐ Safety Suggestion ☐ Unsafe Condition

☐ Near Miss

Comment / Action Taken

______

Behavioral Checklists Contributed by Praxair

PRAXAIR

SOS Safety Observation System
Summer Safety on the Job

	S	AR	N/A	
1				Always wear required PPE. (safety glasses, gloves, etc)
2				Tools are stored in proper location and not laying around.
3				Tools have protective guards in place and maintained.
4				Keep floors clean from oil and other slippery materials.
5				Power tools are turned off and stored safely when not in use.
6				Work completed, clean up and maintain good housekeeping.
7				Use the right tool for the job & don't use excessive force.
8				Follow the Hazardous Work Permit procedure.
9				Cylinder use - chained, cart used to move, caps in place.
10				Cylinder valves are closed when not in use.
11				Test potential hazardous atmospheres (O2/Flam/Toxic)
12				Power tools are ground fault protected or double insulated.
13				Post warning signs/barricades for slip/trip hazards.

	S	AR	N/A	
1				Keep file and desk drawers closed when not in used.
2				Ensure electrical receptacles are not overloaded.
3				Lift twice, once with your head and then with your body.
4				The telephone is not cradled on shoulder.
5				I know who to contact and where to go in an emergency.
6				I correct or report unsafe conditions to my Manager.
7				Use proper stool and not a chair for reaching high up.
8				Know what to do if you receive a bomb threat on the phone.
9				Ascend/descend stairs using the handrail and don't run.

S = SAFE; AR = AT RISK; N/A = NOT APPLICABLE

Name:__________________ **Location:**________________

SOS Safety Observation System

OFFICE - HOME - DRIVING

CRITICAL BEHAVIORS PRAXAIR

	S	AR	N/A	
				DRIVING
1				Prepare/Plan Best Route
2				Check Vehicle, Make Adjustments
3				Fasten Seat Belts, Secure Loose Items
4				Lights On - Raining, Low Visibility, Rural Terrain
5				Look Before Backing
6				Stay Focused/Avoid Distractions, i.e., phones
7				Anticipate - Expect the Unexpected, Be Defensive
8				Observe/Comply with Signs, Postings, Limits
9				Use Signals for Passing, Turns
10				Speed Control: Factor road conditions, weather, etc.
11				Passing Only Where Allowed
12				2-Lane Roads - slow on curves, hills, at night
13				Space Between Vehicles (1 car length per 10mph)
14				Use Mirrors Prior to Lane Change
				SLIPS, TRIPS, and FALL PREVENTION
15				Always Look where Walking, Stepping
16				Be Attentive, Avoid Distractions
17				Use Handrails
18				Observe/Adjust for Changes in Walking Surfaces
19				Use Small, Short Steps on Icy Surfaces
20				Wear Proper Footwear
21				Keep Walking Areas Clear, File Drawers Closed
22				Slow Around Corners, Through Doorways
				ERGONOMIC WORK STATION
23				Computer Monitor at Eye Level
24				Keyboard/Mouse: Wrist neutral, elbows at 90o angle
25				Minimize Awkward Positions, Repetitive Motion
26				Take Frequent Rest Breaks
				LIFTING
27				Size Upload, No Over-Lifting
28				Good Grasp, Lift with Legs
29				Keep Spine Straight - No Twisting or Rotating
30				Use Mechanical Assistance or Get Help
				HOME TOOLS/EQUIPMENT USE
31				Secure Ladders, Use 4:1 Height to Base Ratio
32				Use Insulated Tools with Guards in Place
33				Isolate Energy/Electrical
34				Avoid Tool Strike Zone, "Pinch Points"
				P P E (Personal Protective Equipment)
35				Eyes, Face, Head Protection
36				Hearing Protection
37				Hands (Gloves)
38				Feet (Safety Shoes)
				EMERGENCY PLAN
39				Post Emergency Phone Numbers
40				Follow Plan

S = Safe

AR = At Risk

N/A = Not Applicable

Self-Management Checklist Used in Hickman and Geller (2003b)

Completed after starting your shift for the day

***Date:*__________**

Driver #________________

_____% of the time I *drove* today without **Overspeeding** (please estimate)
#_____of times I had an **Extreme Braking** incident today while driving (please estimate)

Comments:___________________________________
____
____
____

Self-Management Checklists Contributed by Anonymous Respondent

While working today I did the following:	**Always**	**Not Always**
1. Wore my seat belt		
2. Used three-point stance on tractor and trailer		
3. Drove the posted speed limit or less on all roads		
4. Used G.O.A.L. when backing or maneuvering close to fixed objects		
5. Your ARB choice…………		
6. Your ARB choice…………		
Totals		

Employee Signature: _________________________________ Date ____/____/_______

While working today I did the following:	**Always**	**Not Always**
7. Wore my seat belt		
8. Used three-point stance on tractor and trailer		
9. Used handrail on all steps		
10. Wore all required PPE (gloves, Nomex, hardhat, safety shoes, etc..)		
11. Wrote up hazardous lease reports for all hazards I discovered		
12. Drove the posted speed limit or less on all roads		
13. Inspected truck & trailer when stopped to load, unload or take break		
14. Drove slowly through cattle guards or near fixed objects		
15. Used G.O.A.L. when backing or maneuvering close to fixed objects		
16. Scanned intersections for cross traffic as I approached them		
17. Checked that valves were in proper position and hoses were securely connected before operating pump		
18. Checked liquid level in tanks before pumping into them		
19. Stay by pump controls and level indicator during the entire loading process		
20. Worked oil per the procedures in crude oil manual		
21. Wrote up mechanical defects and safety defects on the equipment I operated		
22. Turned my face away from tank hatches when first opening them		
23. Watched for tripping hazards, eliminated those I could and wrote up remainder		
24. Avoided answering phone or radio when I was in the middle of driving, loading or unloading		
25. Started procedure or task over again if I was distracted		
26. Gave right of way to all other vehicles on roads		
27. Closed off valves and stowed hoses when leaving unloading/loading locations		
28. Observed co-workers operating near me and coached them if I noticed a possible shortcut or missed procedure		
29. Securely tied open gates that I drove through before entering		
30. Positioned my truck to avoid backing whenever possible		
31. Circled truck to make sure valves, hoses, fittings, tools, etc. were properly stored before driving away from loading or unloading site		
Totals		

Employee Signature: ___________________________________ Date ____/____/_______

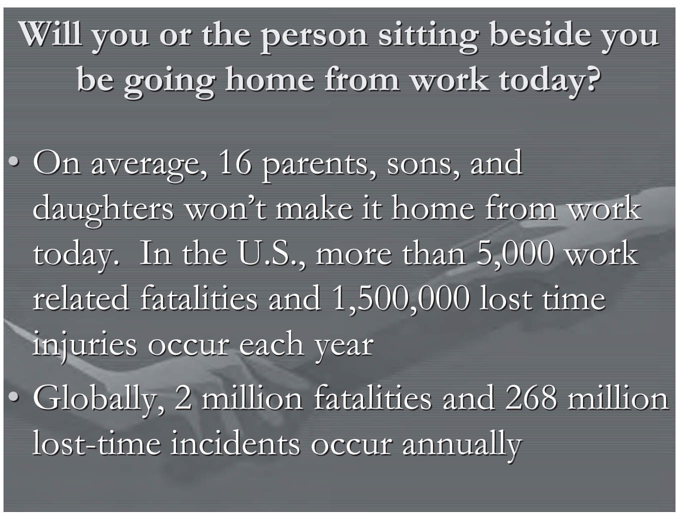
APPENDIX D

Training and Education Presentation Slides

Training and Education Presentation Slides Contributed by James Atkinson at Metal Building Components LP

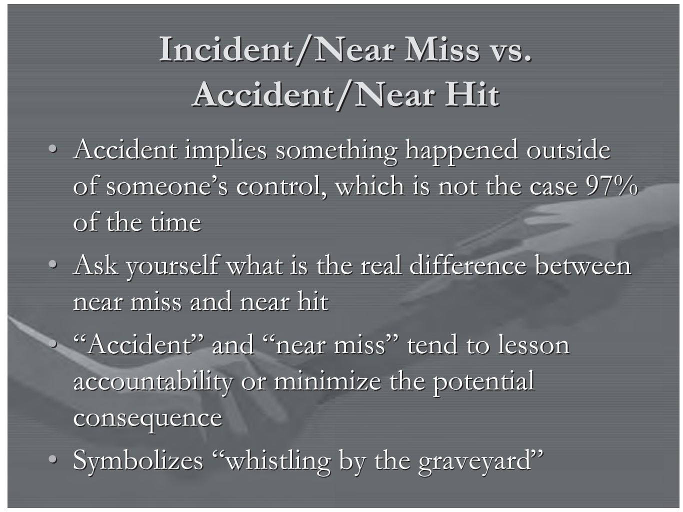
Slide 1

Slide 2



Slide 3

Slide 4



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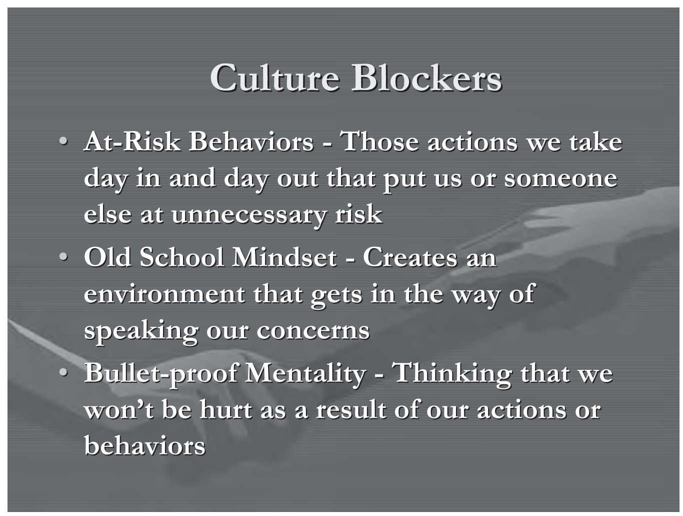

Slide 6

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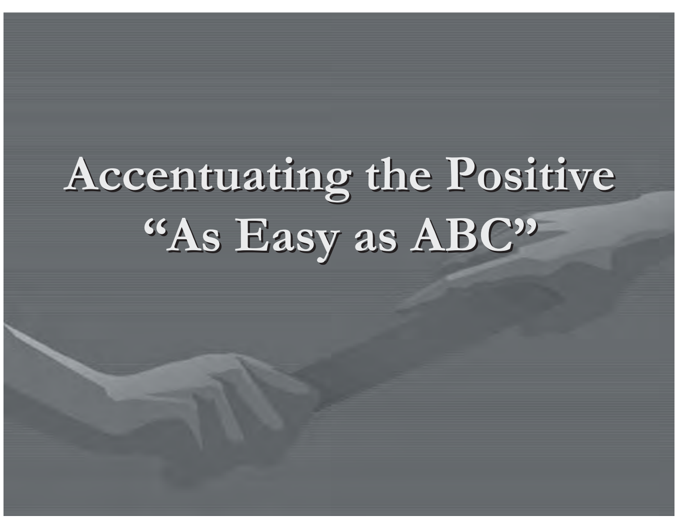

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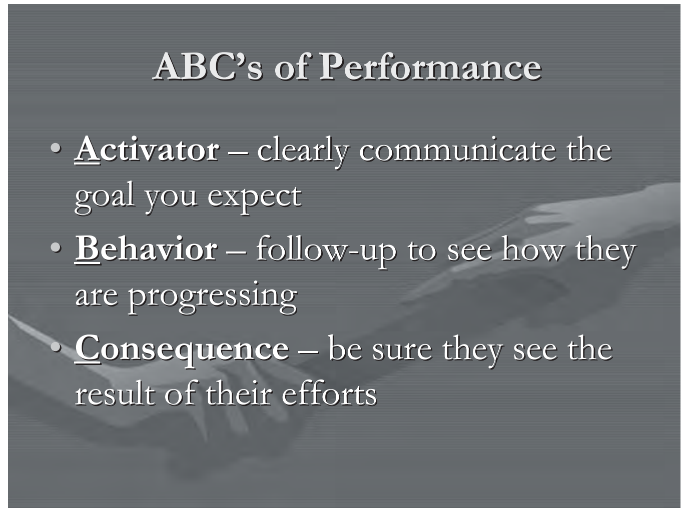
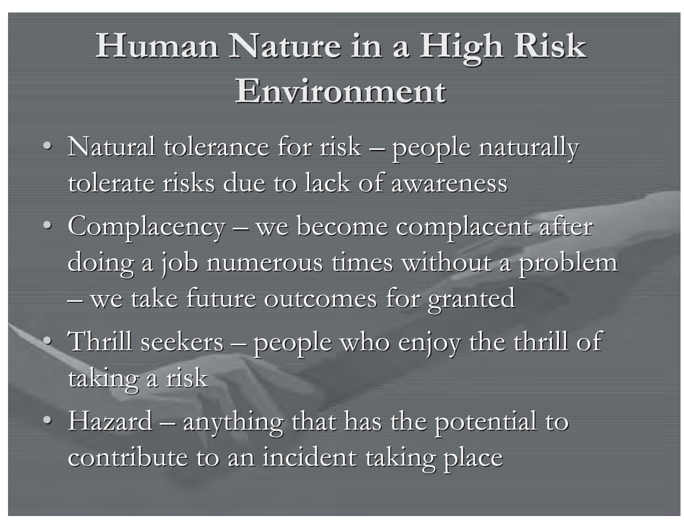


Slide 11

Slide 12



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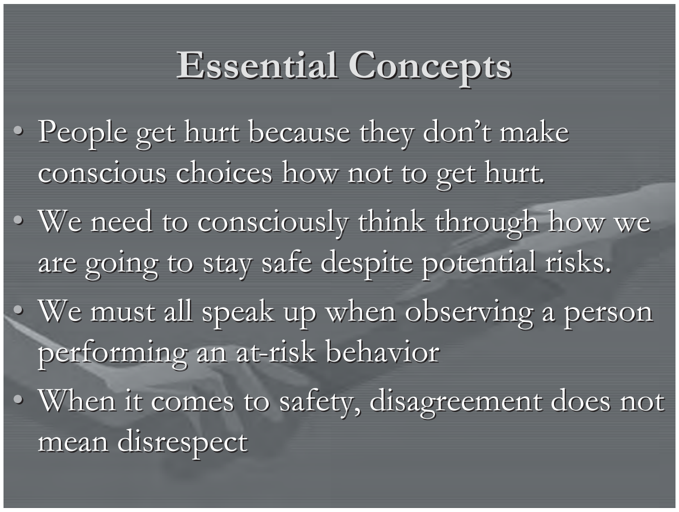

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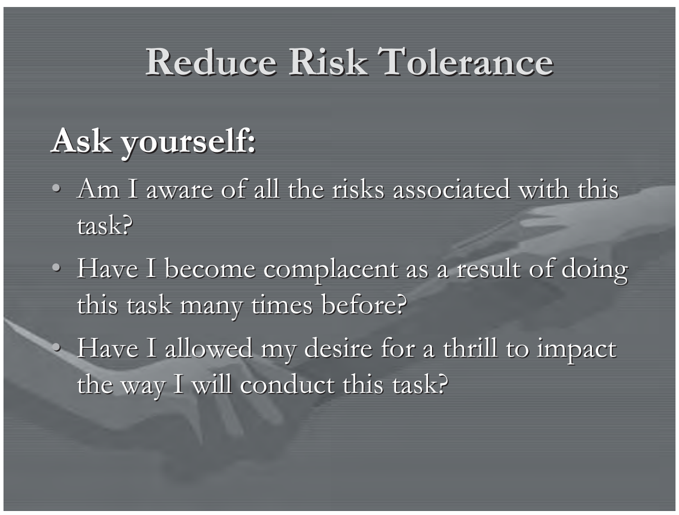

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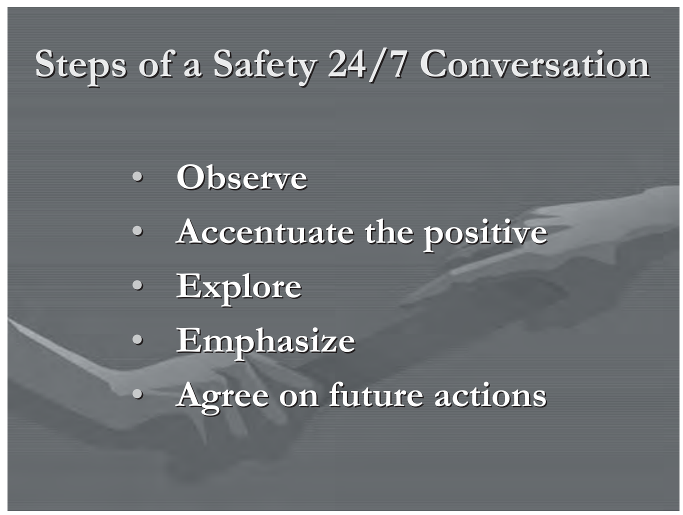
Slide 16

Slide 17



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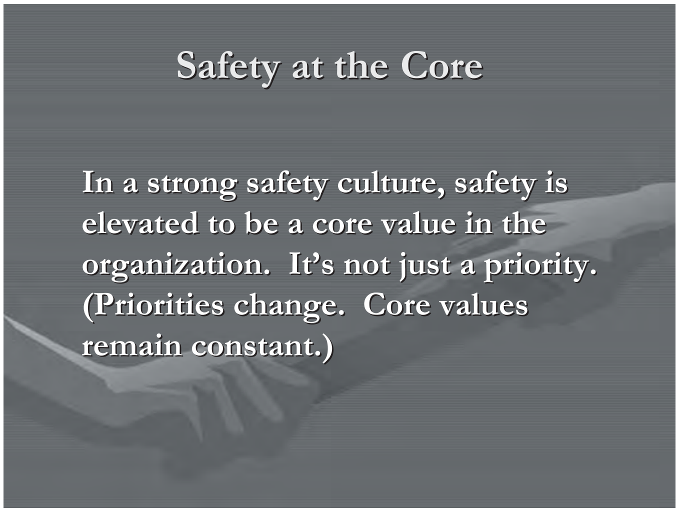
Slide 19



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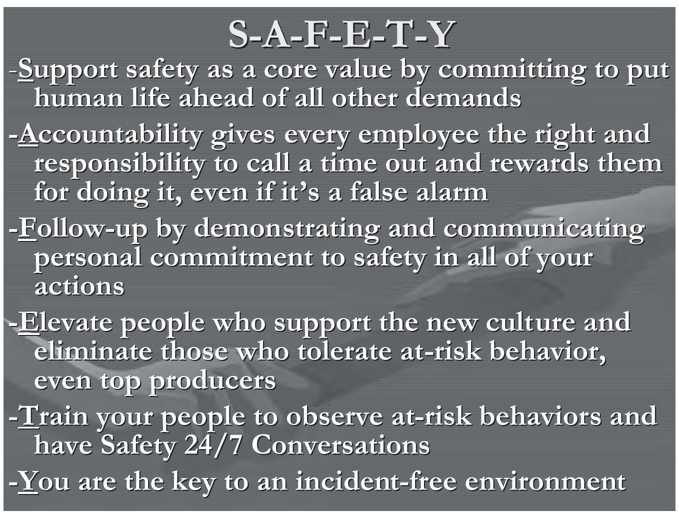

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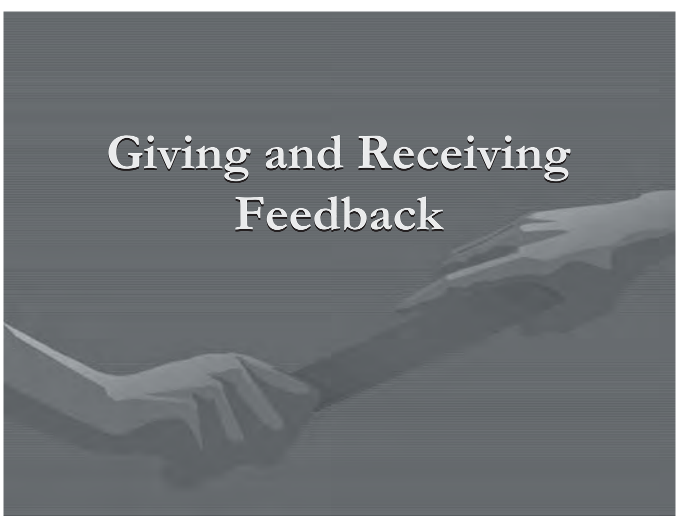

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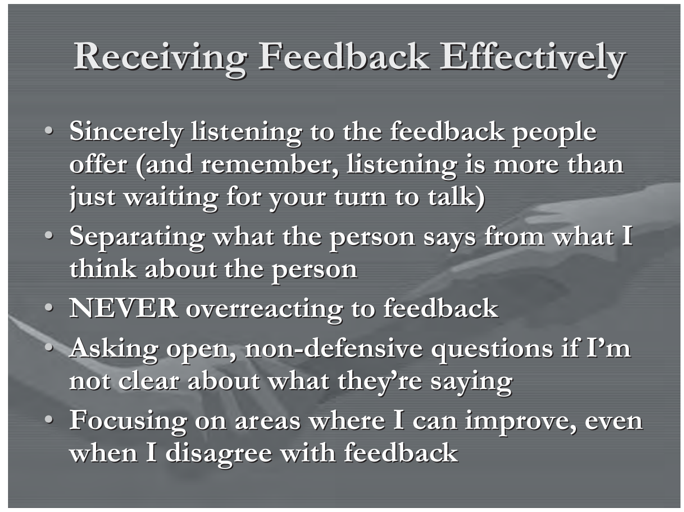

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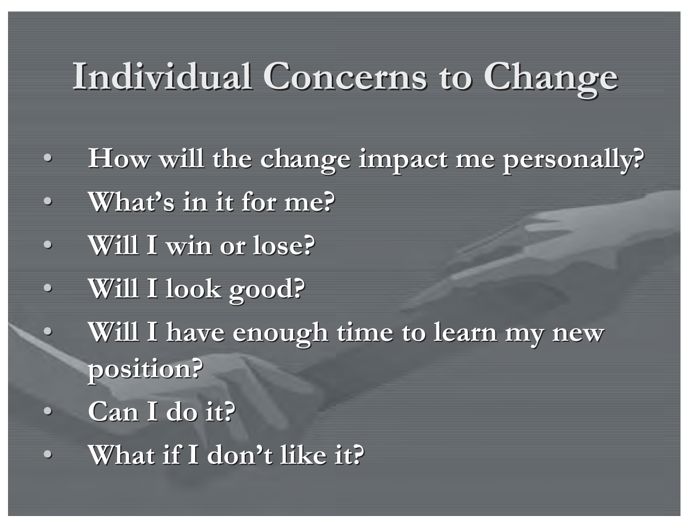
Slide 24



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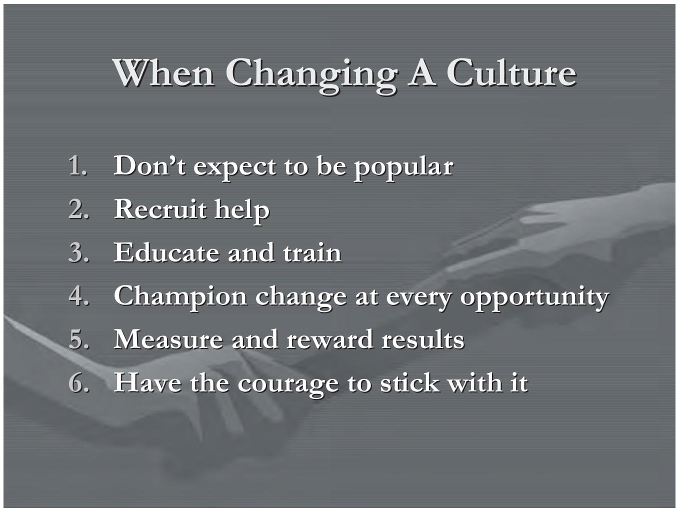

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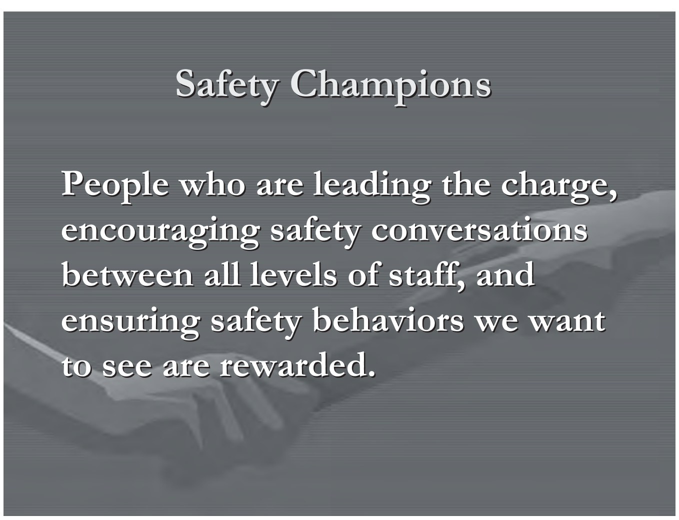
Slide 27



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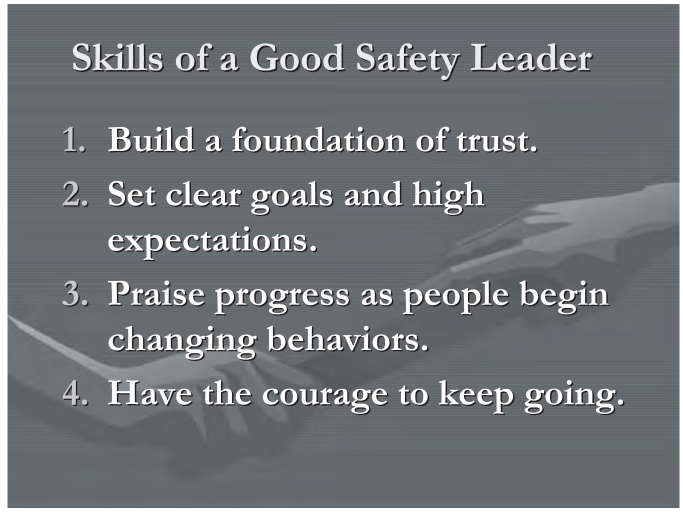
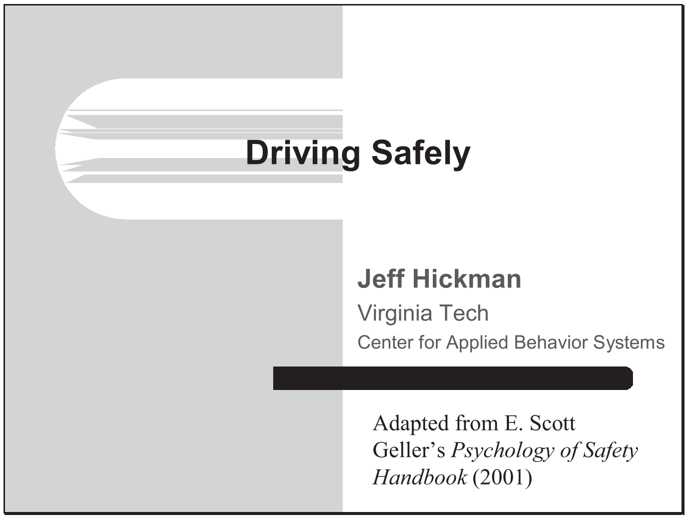


Slide 29

Training and Education Presentation Slides from Hickman and Geller (2003b)

Slide 1



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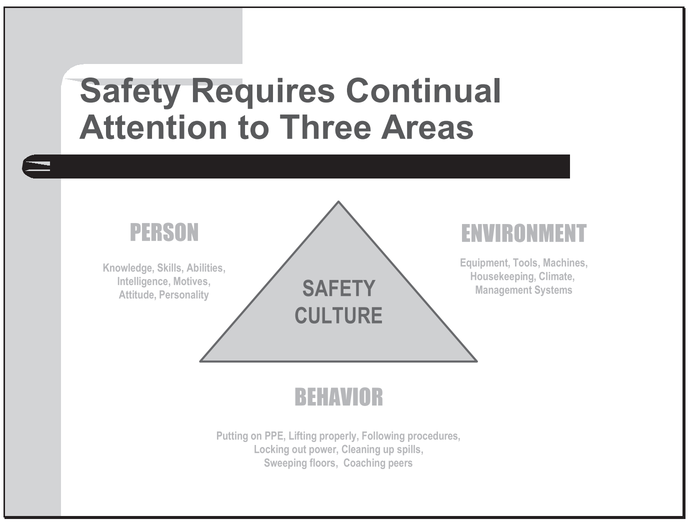

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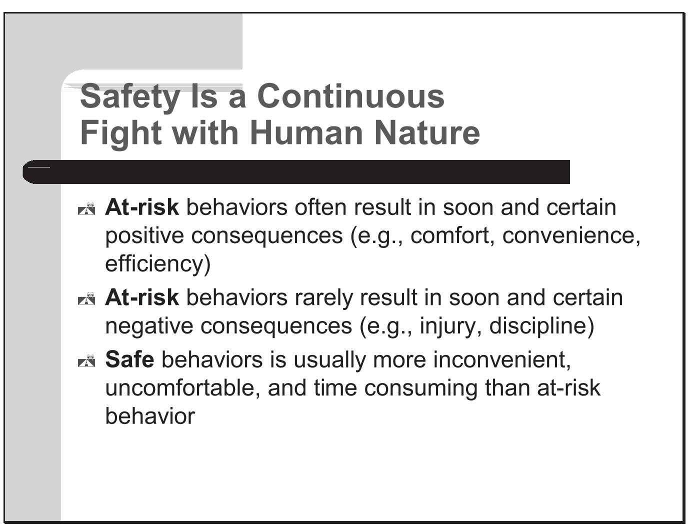

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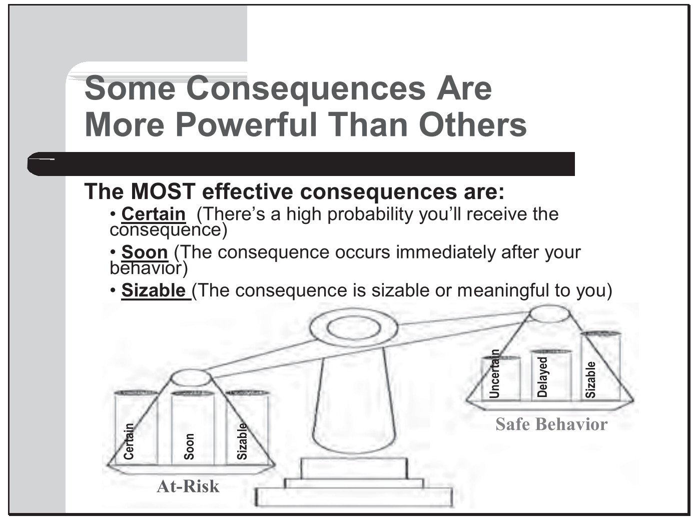

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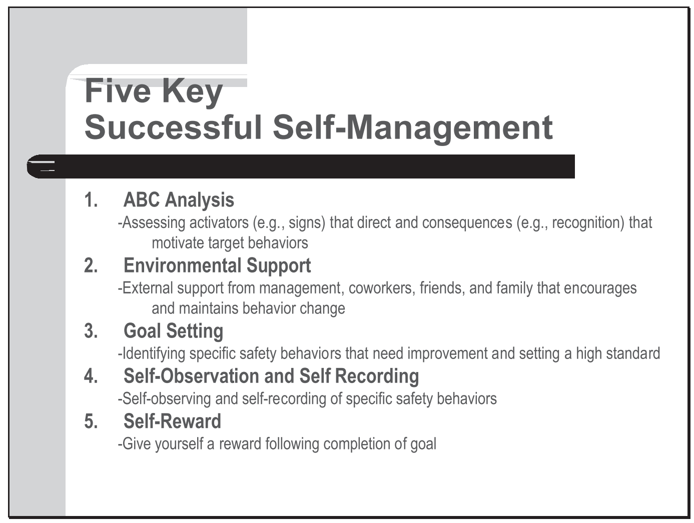

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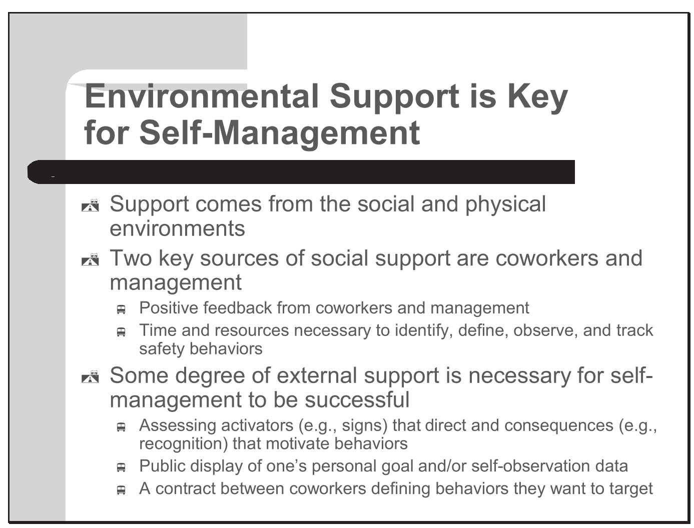

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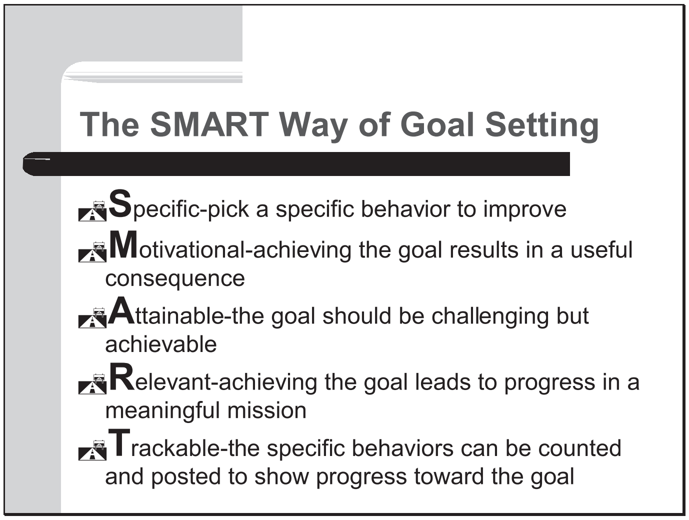

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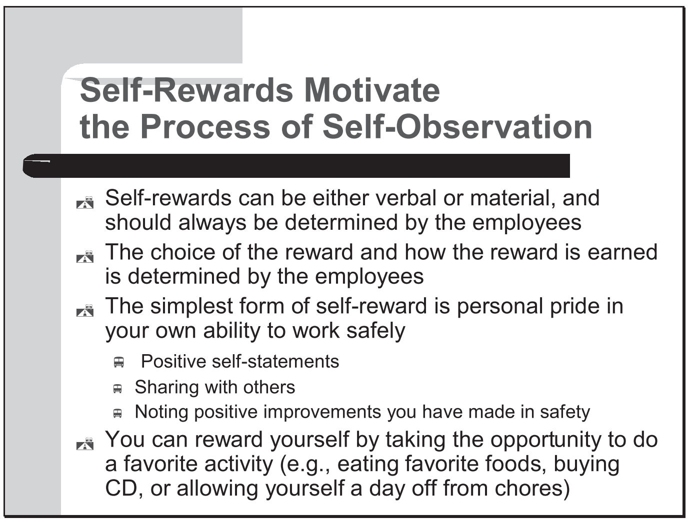

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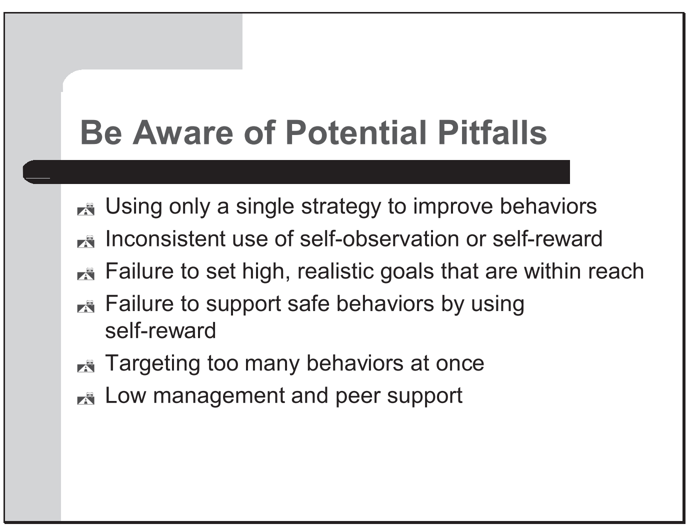

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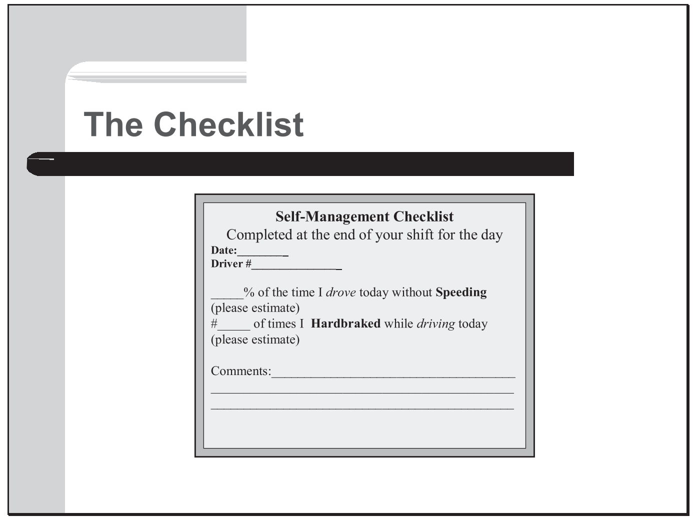

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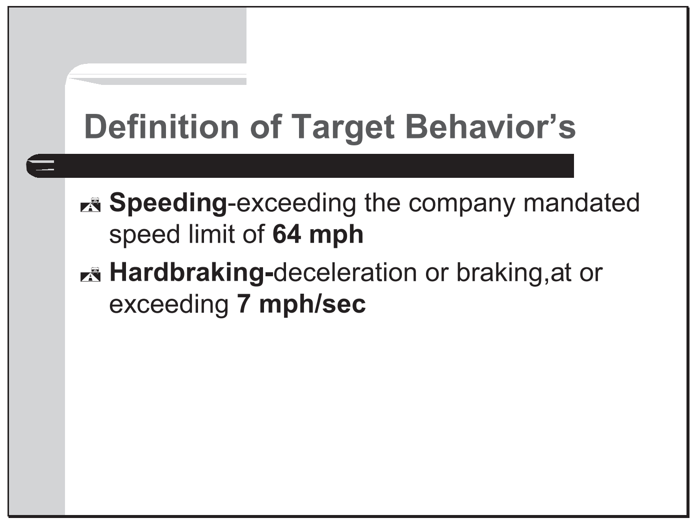

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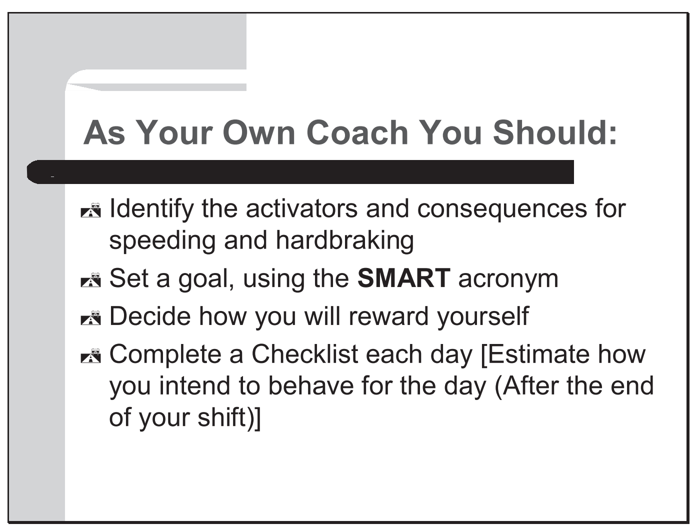
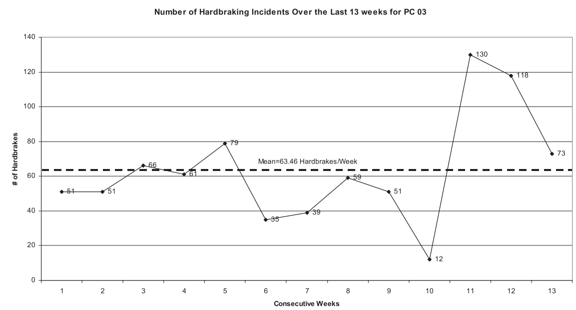


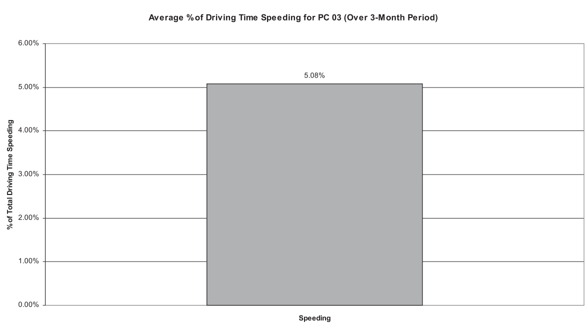
Slide 13

Hardbraking Results



Slide 14

Speeding Results



Slide 15

I Need Your Help

- Participation is voluntary, though this program does benefit you and your coworkers
  - No consequences from management if you decide not to participate
- No data about your driving performance will ever be publicly posted

Slide 16

What Do You Have To Do?

- Complete one CBC each day after you finish your shift for the day
- Place the CBC into the lock box
  - Collect your $$$$ at the end of the project
- Your done!

Slide 17

Incentive/Reward Process

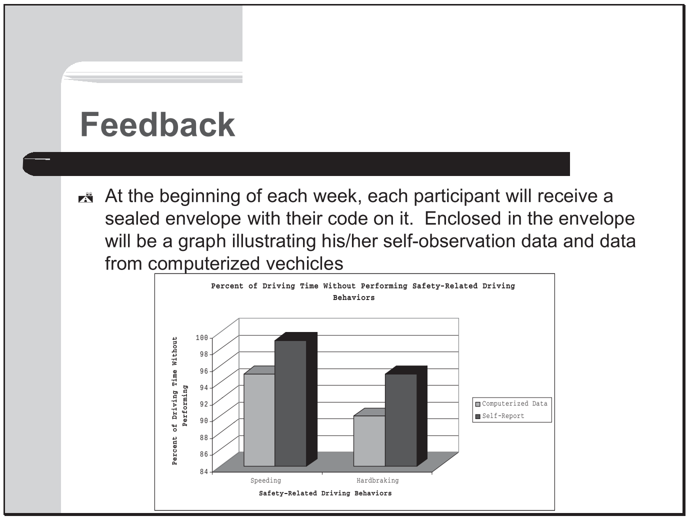
- For each completed checklist, D.M. Bowman will pay you $1.00
  - 4 weeks X 5 days a week X $1.00= $20.00 (for approximately 20 minutes work)
- A raffle will be held at the end of the project. The winner will be selected from all the completed CBCs. The winner(s) will receive $50.00
  - The more entries the more chances to win

Slide 18

Reward

- To control for “pencil whipping” each CBC will be reviewed
  - Self-observations which deviate by more than 10% from instrumented truck data will be considered incomplete
  - Incomplete CBCs will not receive the reward and will not be entered into the raffle

Slide 19



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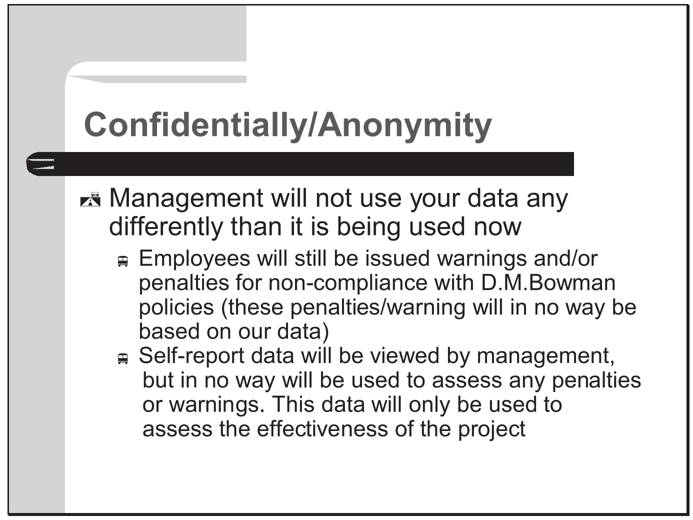

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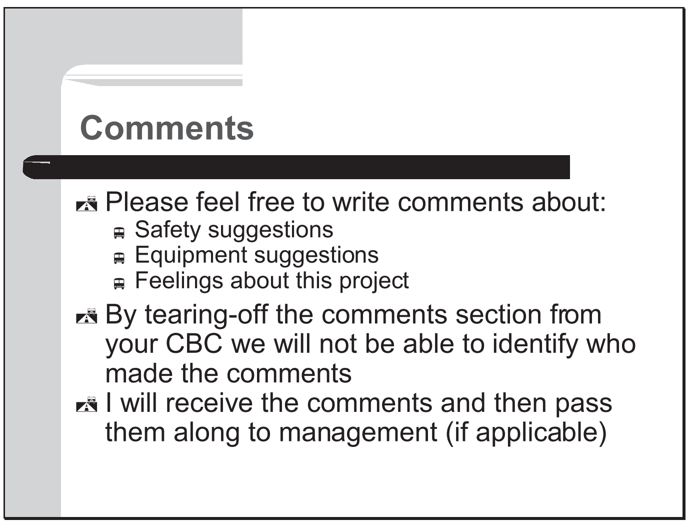

APPENDIX E

Focus Group Presentation Slides

Slide 1

Behavioral Safety Management for CMV Operations

Ronald R. Knipling, Ph.D.
Jeffrey S. Hickman, Ph.D.
Virginia Tech Transportation Institute

Virginia Trucking Association Meeting
Williamsburg, April 6, 2006

Virginia Tech TRANSPORTATION INSTITUTE

Slide 2

Transportation Research Board Commercial Truck & Bus Safety Synthesis Program (CTBSSP)

- Develop Synthesis Report on the Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers
- Methods:
  – Literature Review
  – Focus Groups
  – Survey
- To be completed in early 2007.

Virginia Tech TRANSPORTATION INSTITUTE

Slide 3

Other Relevant VTTI Studies

- Synthesis Report on CMV Safety Management*
- Synthesis Report on "High Risk" Commercial Drivers*
- Studies of Commercial Driver Safety Self-Management
- Instrumented Vehicle Studies of Truck Crashes and Other Safety Incidents

* Report pdfs will be e-mailed to attendees.

Virginia Tech TRANSPORTATION INSTITUTE

Slide 4

Behavior-Based Safety (BBS)

- Method for reducing industrial accidents, incidents, and injuries
- Combines:
  - -Behavior modification
  - -Quality management
  - -Organization development

- Key elements:
  - -Continuous improvement process
  - -Focuses on changing *behavior*, not "attitudes" or outcomes

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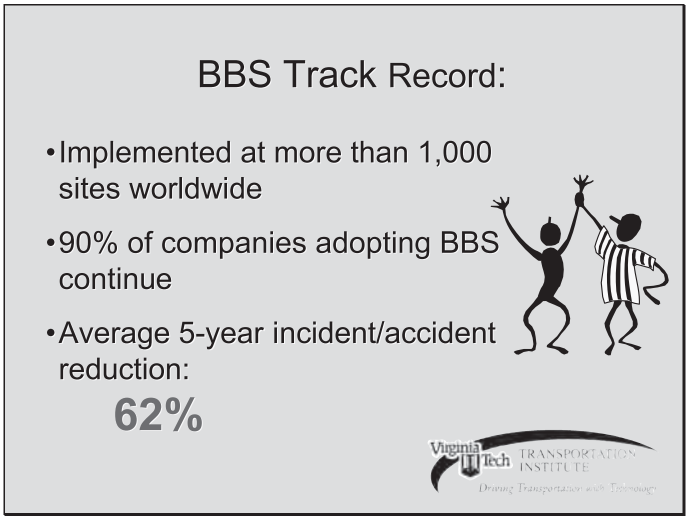
Slide 5



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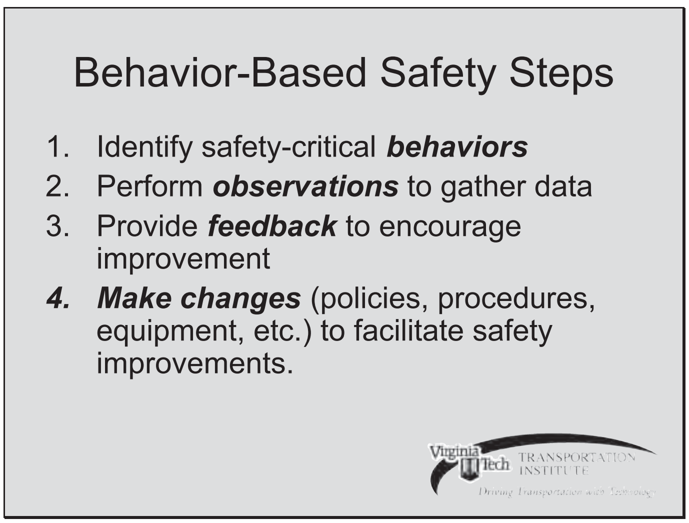

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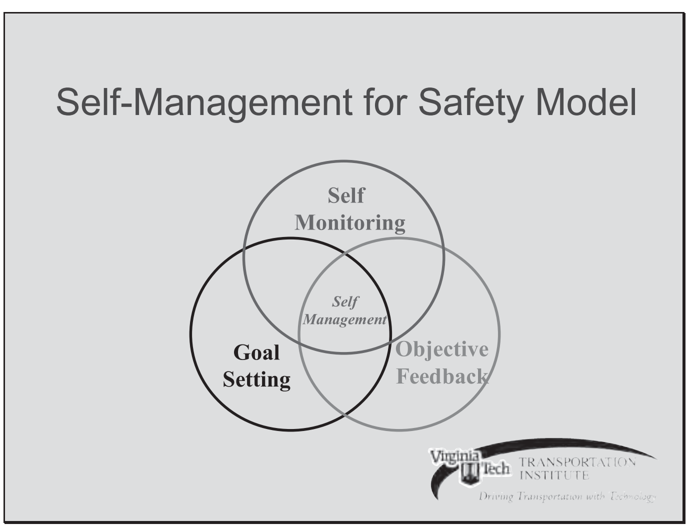

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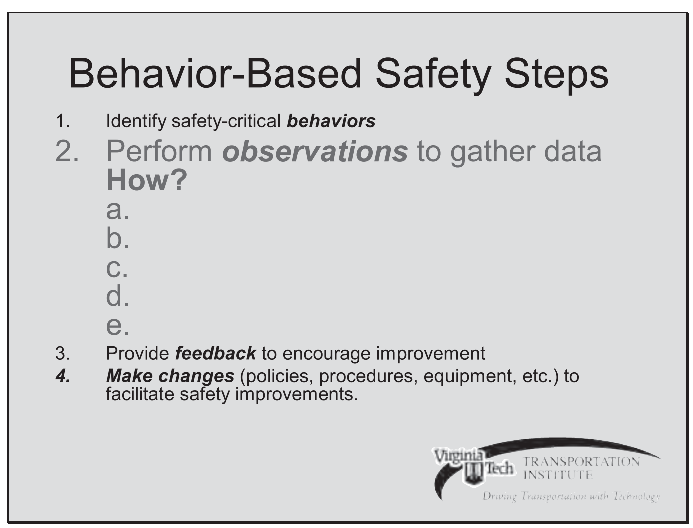
Slide 9

Slide 10



Slide 11

Behavior-Based Safety Steps

1. Identify safety-critical ***behaviors***
2. Perform ***observations*** to gather data
3. Provide ***feedback*** to encourage improvement. **How?**
   a.
   b.
   c.
   d.
   e.
4. ***Make changes*** (policies, procedures, equipment, etc.) to facilitate safety improvements.

Slide 12

Behavior-Based Safety Steps

1. Identify safety-critical ***behaviors***
2. Perform ***observations*** to gather data
3. Provide ***feedback*** to encourage improvement
4. ***Make changes*** (policies, procedures, equipment, etc.) to facilitate safety improvements. **What?**
   a.
   b.
   c.
   d.
   e.

Slide 13

Barriers to BBS Implementation?

a.
b.
c.
d.
e.

Slide 14

BBS Project Survey

- To be e-mailed to attendees
- ~15 minutes to complete
- Anonymous & confidential
- Will address:
  - Safety-critical behaviors
  - Observation methods
  - Feedback methods
  - Fleet safety policies & procedures
  - Barriers to BBS implementation
- *Respondents will be mailed a bound copy of project report*
- *Thank you in advance for participating!*

Slide 15

Virginia Tech Seeks Trucking Industry Partners

- Various CMV safety studies
- Pilot tests of safety technologies
- Behavioral safety management studies (Current study: fleet case studies wanted!)
- Crash causation/driver risk studies
- Many studies provide free safety consultation and/or pay for participation.
- Contact: Dr. Jeff Hickman
  (540) 231-1542
  jhickman@vtti.vt.edu

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation