FAST DASH: Program overview and key findings from initial technology evaluations

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ABSTRACT

One focus of the U.S. Federal Motor Carrier Safety Administration (FMCSA) is to provide leadership in the testing and evaluation of promising safety technologies developed for use in commercial motor vehicles (CMVs). To this end, a program was developed by FMCSA to conduct independent, short-turnaround evaluations of promising safety technologies. Vendors who had promising safety technologies, focused in the commercial vehicle domain, were solicited to participate and submit an application. One technology was selected by FMCSA for each evaluation cycle (lasting approximately 18 months). The technology was tested in both static and dynamic conditions, after which a trucking fleet, and its drivers, were brought in to test the technology in a field operational test (FOT) lasting approximately 6 weeks. During the FOT, 15–20 trucks were instrumented with the technology and other data collection equipment, including sensors and video cameras. A study was then conducted during which drivers used the technology in their revenue-producing operations. Initially, often for the first 2 months, the technology collected data but did but not actively present alerts to the driver. Following this baseline period, a four-month intervention period was conducted. Each evaluation has resulted in more than 1,000,000 km of driving data including continuous video data. Data analyses focused on understanding the efficacy of the technology in terms of (i) safety improvements, (ii) challenges to implementation (e.g., unintended consequences), and (iii) user acceptance (including driver, fleet manager, and other fleet personnel as appropriate). The technology vendors who applied for the first three evaluations can be classified into the following general categories: fatigue/drowsiness, fleet management, visibility safety systems, cell phone policy/enforcement, and other systems. Three technology evaluations were completed in the first 5 years of (i) a blind spot detection and warning system, (ii) an onboard monitoring system, and (iii) a novel mirror technology. High-level results of each of these three evaluations are highlighted in the paper.

1. Introduction

One focus of the U.S. Federal Motor Carrier Safety Administration (FMCSA) is to provide leadership in the testing and evaluation of promising safety technologies developed for use in commercial motor vehicles (CMVs) (FMCSA, 2016). According to FMCSA's *Large Truck and Bus Crash Facts 2015*, there were 4,311 large truck and bus fatal crashes in the U.S., up 8% from 2014 (FMCSA, 2017). Furthermore, though truck and bus fatal crashes decreased by 34% between 2005 and 2009, they subsequently increased by 20% from 2009 to 2015. One way to reverse these trends is through the implementation of vehicle safety technologies such as active collision mitigation, passive collision mitigation, and active driver behavior monitoring.

For promising technologies to ultimately pay off in terms of safety, they must evolve from the design stage to the implementation and deployment stages. To this end, the FMCSA developed a program called FAST DASH, an acronym for "FMCSA's Advanced System Testing Using a Data Acquisition System on the Highways." The purpose of the FAST DASH program was to perform independent evaluations of promising safety technologies aimed at commercial vehicle operations. In some ways, FAST DASH can be thought of as a "technology transfer" program, whereby the trucking industry was provided with new safety technologies for evaluation. Through a rigorous independent evaluation process, the efficacy of the technology was assessed in terms of crash reduction effectiveness (i.e., safety benefits), unintended consequences (i.e., safety disbenefits), and user acceptance (e.g., driver, safety manager subjective opinions). This assessment could then be utilized to promote the technology and further its engineering development. The purpose of this paper is to detail the program and, to this end, a few evaluation examples are presented. Other, more detailed, reports on the
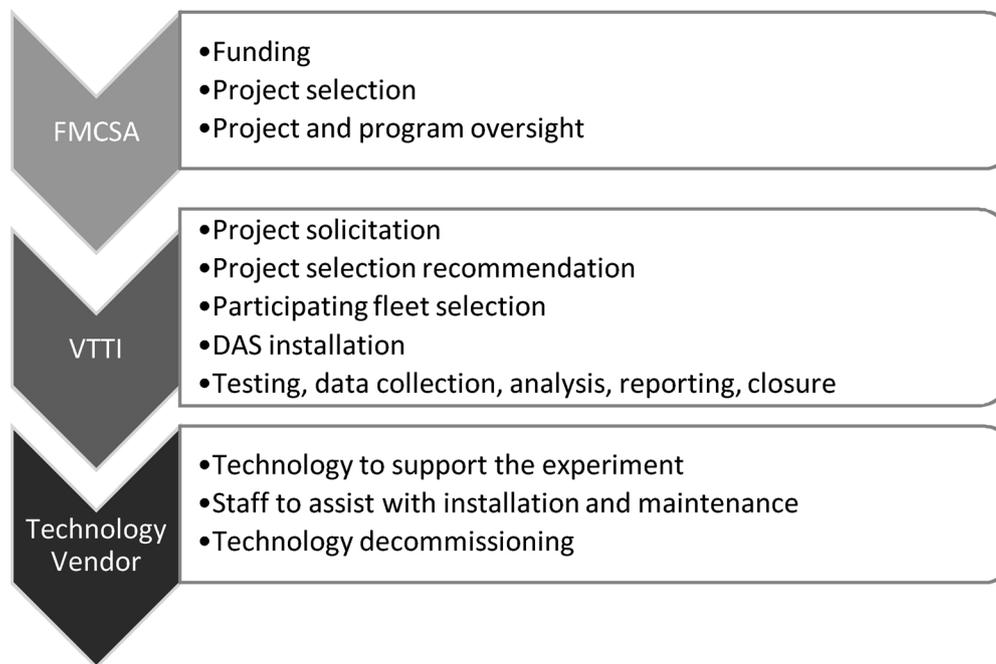

Fig. 1. FAST DASH program overview.

technology evaluations are referenced. However, the focus of this paper is on the program itself.

It should be noted that there are, and have been, many efforts to evaluate technologies in the field (e.g., Kuehn et al., 2011). Such programs have (are) occuring across the globe with some noteworthy programs include the European Field Operational Test on Active Systems (EuroFOT) and the USDOT's Connected Vehicle Test Bed. What is perhaps somewhat unique about FAST DASH is that it tests on a more modest scale, with a relatively quick turnaround, as compared to some of the larger programs.

2. FAST DASH program and method

As shown in Fig. 1, the FAST DASH program was a partnership between FMCSA, the Virginia Tech Transportation Institute (VTTI), the selected technology vendor, and the participating fleet. FMCSA funded the program, selected the project, and provided project and program oversight. VTTI advertised the initial project solicitation, advised FMCSA on project selection, selected the participating fleet, installed the data acquisition system (DAS), administered the testing, and performed data collection, analysis, and reporting. The technology vendor provided the technology and support staff for installation, maintenance, and decommissioning. Finally, the fleet provided access to vehicles and drivers as needed.

2.1. Technology and vendor selection

Each FAST DASH evaluation commenced with a solicitation for candidate technologies. The research team developed and posted a sources-sought notice via a dedicated FAST DASH Web page. A statement of work (SOW) providing details on the FAST DASH program and the requirements for proposal submission was made available on this Web page. In addition to posting the sources-sought notice, researchers created a list of potential technology vendors, who the research team had knowledge of through conferences and technical articles, and notified them of the solicitation.

Technology vendors submitted proposals for their safety systems and technologies. VTTI researchers conducted an initial review of these proposals and categorized the safety technologies by type, potential

safety benefits, and ease of implementation. A decision matrix was used to identify, analyze, and rate the technology applicants systematically. Each technology applicant was given a rating on a scale of 1–10 for meeting 14 relevant criteria, such as FMCSA's area of authority, FMCSA's mission, expected safety effectiveness, technology maturity, fitness for research, prior research, deployment potential costs (one time), deployment potential installation, and deployment potential maintenance and recurring costs. These criteria were assigned weights by the FAST DASH team (i.e., FMCSA and VTTI). A total score was computed for each technology applicant so that a comparison could be made across the applicant technologies. These scores were used in selection discussions and helped to differentiate the technologies, but were not the sole determinant for choosing a technology. Finally, all technology proposals were presented to FMCSA personnel for consideration. After a thorough review, a final candidate was selected by FMCSA.

2.2. Candidate technologies

Technologies that were proposed for evaluation covered the general areas of Fatigue/Drowsiness, Fleet Management, Visibility Safety, Cell Phone Policy Enforcement, and Other Systems. Table 1 provides a list of the technologies that were considered by category and calls attention to the breadth of vendors who applied.

2.3. Evaluation process

It is important to note that this program is focused on testing technologies that have either been recently deployed or are close to being deployed. As such, the primary focus is on the use of the technology in a real-world environment.

Each FAST DASH technology evaluation followed the same general process. Once a technology had been selected, and after a shakedown period, an on-road field study was conducted. A trucking fleet was identified and fleet drivers were recruited to test the selected technology. The goal of the program was to instrument approximately 15 to 20 fleet trucks for each evaluation with data collection equipment, including sensors and video cameras. An example data collection period might include a 2-month baseline with the test technology installed but

Table 1
Overview of types of technology vendors that applied to participate in FAST DASH.

Fatigue/Drowsiness	Fleet Management	Cell Phone Policy Enforcement	Visibility Safety Systems	Other Systems
• Fatigue management • Drowsiness detection technology • Real-time alertness and emergency monitoring • Fatigue risk management system – how-to/support/assessment • Evidence-based solutions for fit-for-duty risk associated with drugs, alcohol, and fatigue (small start-up company) • Fatigue risk management products: fatigue assessment tool • Wearable solution to shield drivers from fatigue and distraction	• Safety telematics fleet management • Driving state/enforcement technology application • Using a cloud-based platform to improve compliance, safety, and accountability for commercial vehicles by facilitating online inspection reports for annual Department of Transportation (DOT) inspections	• Hands-free wireless liquid-crystal display (LCD) connection (interface for phone) • Mobile policy enforcement technology	• Infrared laser blind-spot monitoring • Mirror contour optimization • Vehicle camera systems • Mirror-eye: removing side mirrors replaced with cameras	• Application of neuroscience, psychology, and computer science for optimal performance and safety in the workplace • Driver training system • Seat technology • Deceleration warning and brake light illumination • Tire inflator • Pneumatic trailer legs • Preview radar

not providing alerts, followed by a 4-month intervention period. Analyses were conducted that assessed both objective (e.g., driving performance) and subjective (e.g., driver opinion) measures. It must be noted that because the study was conducted in situ, it is possible that uncontrolled factors (e.g., weather) could have influenced the findings. However, the primary goal of FAST DASH, by design, was to understand how fleets might benefit from promising technologies in real-world operational settings. The study was then documented in a final report that included recommendations for potential system design improvements.

2.4. Basis for collection size

A power analysis was conducted prior to the first evaluation using two recent heavy-vehicle data sets from real-world studies to estimate the potential occurrence of vehicle safety-critical events (SCEs) for the field studies (Fitch et al., 2011; Hickman et al., 2011). Briefly, SCEs can include crashes, near-crashes, and crash relevant conflicts, and unintended lane deviations. The power analysis indicated that approximately 7 lane change/merge SCEs per 75,000 mi (120,700.8 km) could be expected in the current study. The mean lane change/merge SCE rate and standard deviation (SD) were computed for the purpose of performing a power analysis for a 2-month baseline period and a 2-month (at least) intervention period. The mean lane change/merge SCE rate in the baseline condition was 0.086 per 1,000 mi (SD = 0.120), while the mean lane change/merge SCE rate for the intervention period was estimated at 0.043 (SD = 0.072). Table 2 provides results for a paired-sample, one-sided *t*-test that compares a baseline distribution to an intervention distribution using a nominal power value of 0.8 and a significance level of 0.05 (Montgomery, 2009). The results are presented as the number of vehicles required for a 2-month baseline data collection period with a matched 2-month (at least) intervention condition. Also presented in the table are correlation values which indicate the level of positive correlation that is assumed for drivers' SCE rates in their baseline to treatment conditions.

The power analysis indicated that the number of trucks required ranged from 10 to 27 depending on the correlation value selected. Based on the power analysis performed, an A^2B^4 design was selected for the evaluations where "A" and "B" refer to the baseline and intervention phases, respectively. The superscript refers to the number of months in each phase (e.g., "2" refers to 2 months). It was recommended that the 20 CMVs originally scoped for the study would be satisfactory. According to the power analysis, 20 CMVs at a correlation value of just over 0.8 would provide sufficient power for statistical significance testing at the conclusion of data collection. The conclusions of the power analysis were also applied to the second evaluation in terms of number of trucks to be included.

3. FAST DASH evaluations

Three technology evaluations were performed during the first five years of the program and the evaluations were conducted sequentially and did not overlap. The technologies selected were (1) a blind spot object detection and warning system, (2) an onboard monitoring system, and (3) a novel mirror technology. The three studies are detailed in Schaudt et al. (2014); Krum et al. (2016); Miller et al. (2016),

Table 2
Power analysis results for an A^2B^4 design.

Correlation Value	Actual Power	N Pairs (# of Trucks)
0.7	0.806	27
0.8	0.804	21
0.9	0.800	15
1.0	0.831	10

Fig. 2. BSW technology evaluated by FAST DASH ("SideEyes" by Novita Technologies; ISO 17387, Type I).

respectively.

3.1. Evaluation #1: blind spot object detection and warning system (BSW)

Large trucks, because of their size and design, have extensive areas around them that are obscured from the driver's direct and indirect vision. These blind-spot areas have the potential to hide other road users from the driver's field of view, contributing to safety conflicts and crashes during maneuvers such as lane changes and merges. Blind spot object detection and warning system (BSW) technology provides drivers with object information that might not be available due to blind spots.

The BSW technology evaluated utilized an array of infrared laser beams to create a three-dimensional detection zone on both the driver and passenger sides of the CMV. A driver would be alerted to vehicles in the blind spot via the activation of amber light-emitting diodes (LEDs) mounted on the left and right side-view mirrors (Fig. 2).

The zones detected by the BSW system were carefully measured and compared to areas around the tractor-trailer than can be viewed by the driver directly through cab glass and indirectly with mirrors. The results of this mapping demonstrated that small vehicles, including motorcycles, could still remain hidden among the BSW zones and the direct and indirect visibility areas. Following controlled testing to assess the potential of the BSW, a 20-vehicle field study was conducted. The research team collected approximately 722,639 mi (1,162,975 km) of driver-ID-verified, on-road data.

Safety Benefits. One analysis investigated how the rate of involvement in lane change/merge SCEs changed from before the start of the intervention period to after. SCEs were filtered to only include lane change/merge conflicts, as this is the SCE type that is relevant for this particular technology (i.e., other SCE types, such as backing events, would not be relevant to this technology). The analysis compared the baseline period of data collection to the intervention period using a parametric paired t-test. In this test, overall SCE rate was reduced from 0.64 SCEs per 10,000 miles to 0.34 SCEs per 10,000 miles with a mean SCE rate difference of 0.37 SCEs per 10,000 miles between baseline and intervention periods ($p = 0.08$).

System Performance. The BSW system's object detection performance was evaluated for each driver in each week during intervention. Segments of video, kinematic, and BSW system data were selected, reduced, and scored from randomly sampled 5-minute daytime and nighttime periods from each week. Results from these analyses found a 90.30% correct detection rate for the driver side and a 92.03% correct detection rate for the passenger side. The basis for the correct detection sampling of video data is shown in Table 3. The large majority of the missed detections observed (24 of 32 total driver side; 32 of the 35 total passenger side) from the system performance measures were not of vehicles but rather objects labeled as "guardrails/barriers" positioned off the roadway. The performance evaluation also showed that a correct rejection rate of 94.13% was found for the driver side (5.87% false alarm rate), and a 94.89% correct rejection rate was found for the passenger side (5.11% false alarm rate). The basis for the correct

Table 3
Detection paradigm results for the driver-side & passenger-side BSW system.

Light Activation	Driver Side		Passenger Side	
	In Zone	Not in Zone	In Zone	Not in Zone
Yes	298	188	404	158
No	32	3,012	35	2,933

Table 4
Counts of vehicles and objects attributed to false alarms on driver side.

Description Driver Side	Count	Description Passenger Side	Count
Other Stationary Object	3	Pickup truck	1
Van	6	Van	1
Heavy Truck	7	Parked Vehicle	3
Sign	7	SUV	3
Pickup Truck	8	Heavy Truck	6
SUV	8	Car	8
Fence	11	Hill/Embankment/Cliff	12
Car	25	Sign	13
Guardrail/Barrier	29	Other Stationary Object	17
None	85	Guardrail/Barrier	39
		None	52

rejection sampling of video data is shown in Table 3.

Driver Acceptance. User trust is an important element in the long-term acceptance of any technology. The most frequent comments from drivers referred to the number of false alarms triggered by the system. These comments are reinforced by findings from the system performance analysis. Table 4 presents a list of the nearest vehicles or objects attributed to the false alarms and their corresponding counts for both driver and passenger sides. If no objects or vehicles were visible in the BSW detection zone, then "none" was specified. Some evidence from system performance testing demonstrated that rain could lead to false alarms, but the status of weather was not considered in the field data. Design options such as modifications to the installation or the addition of other sensors for redundancy could lead to a reduction in false alarms and an increase in the saliency of information for drivers. Analyses of drivers' subjective responses, as collected using a 7-point Likert-type scale, indicated that the BSW was easy to use, met performance expectations, and helped to improve driving performance and eliminate blind spots.

3.2. Evaluation #2: onboard monitoring system (OBMS)

Many studies on crash causation have found driver error to be the predominant factor. In FMCSA's Large Truck Crash Causation Study, 87% of the critical reasons in large truck crashes were assigned to driver error (FMCSA, 2006). Onboard monitoring systems (OBMSs) aim to improve driving performance by measuring and reporting errors, which managers can then use for coaching. The second FAST DASH evaluation selected a non-video-based OBMS for study (Fig. 3).

The tested OBMS included seatbelt usage monitoring and

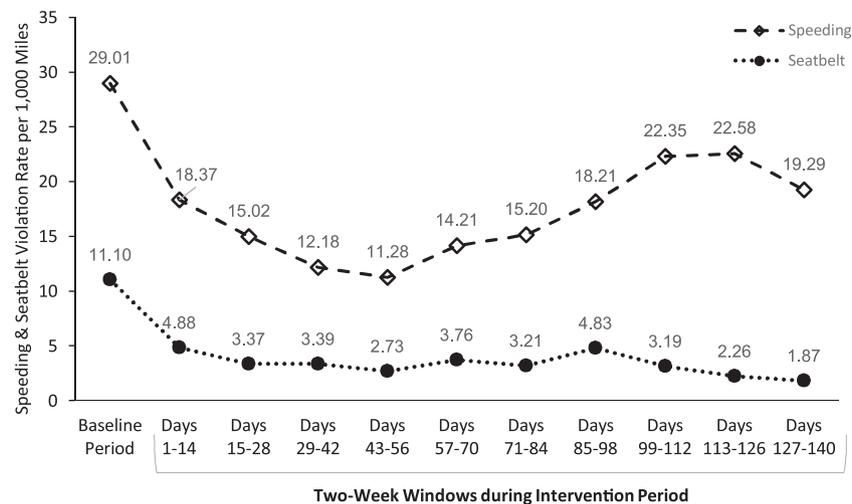**Fig. 3.** OBMS technology used in second FAST DASH evaluation (waySmart™ by inthinc®).

Fig. 4. Speeding and seatbelt violation rate per 1,000 miles over time (baseline period and 2-week intervention period windows).

proprietary "Speed-by-Street™" monitoring, which compares real-time vehicle speed to pre-existing speed maps. A key feature of the tested OBMS was its driver-vehicle interface, which would sound an audible verbal alert (e.g., "check your speed") when speeding, seatbelt, or aggressive driving criteria had been exceeded. For the speed and seatbelt alerts, the OBMS would allow drivers a brief grace period to correct performance in either of those categories before recording a violation. The participating fleet's application of the OBMS delivered weekly report cards to fleet managers but not to drivers.

Following controlled testing to assess the potential of the OBMS, a 20-vehicle field study was conducted with the same fleet that supported the BSW system evaluation. The research team collected approximately 1,274,452 mi (2,051,033 km) of driver-ID-verified, on-road data over a calendar period of approximately 11 months.

Safety Benefits. The rate of speeding violations per 1000 miles averaged across all drivers was significantly reduced (37%) from baseline to the first 2-week intervention period (see Fig. 4), when the OBMS started providing in-cab feedback. The rate of seatbelt violations was significantly reduced (56%) from baseline to the first 2-week intervention period and remained at significantly improved levels throughout the entire intervention phase (see Fig. 4).

As measured by SCEs, the field testing demonstrated neutral results. The mean rate of driver-at-fault SCEs (excluding curb strikes) per 10,000 miles during the intervention phase was not significantly lower than the mean rate during the baseline phase. However, the rate of driver-at-fault SCEs (excluding curb strikes) decreased for two-thirds of drivers.

System Performance. The OBMS's performance was evaluated by randomly sampling driving periods based on speeding and seatbelt violations and non-violations for each driver during the intervention period. A relative number of violation syncs were selected from each driver's set of collected intervention violations using a random number generator (no time syncs were repeated). At each identified time sync, researchers evaluated a 16-s section of the video and the OBMS audible alert data. In order to evaluate the speeding alerts, audio was played to listen for in-cab alerts and a posted speed sign was identified from the over-the-hood camera view. To evaluate the seatbelt alerts, audio was played to listen for in-cab alerts and the seatbelt worn status was identified from the driver-face camera.

The OBMS reliably detected speeding and seatbelt violations. The OBMS speed monitoring sensor correctly identified when commercial vehicle drivers were speeding (according to fleet-selected criteria; 5 mph over the posted limit) 86% of the time. The OBMS seatbelt monitoring sensor correctly identified when the driver's seatbelt was unfastened 100% of the time. The majority (85%) of seatbelt violations

occurred in parking lots and at low speeds (less than 15 mi/h [24.1 km/h]; 93%). Video data were used to verify that seatbelts were being worn properly since drivers could circumvent the system by latching the seatbelt buckle and sitting on the shoulder belt or the lap belt or both. Across the 449 non-violation periods sampled, 33 (7.3%) were observed to have some deficiency in proper seatbelt wear across the lap and left shoulder (clavicle). All of those cases were categorized as "loose shoulder belt."

Driver Acceptance. The results of surveys, collected from seven participating drivers, regarding the OBMS's safety benefits align with the analyses on the continuous data performed by the research team. Drivers' ratings of the OBMS's usefulness, effectiveness, and level of annoyance did not change significantly from the pre-test to post-test period. General positive comments included the following: "reminds you to wear your seatbelt," "made me a better driver," and "kept you from speeding a lot." General negative comments included the following: "would not have correct speed limits" and "seatbelt warning set at too low of a speed, should be at least 20 mi/h, verbal warning while moving in yard, 5 mi/h = too slow." The fleet manager and the dispatcher indicated that drivers did not initially like having the current OBMS (or previous OBMSs) in their trucks, but over time they tended to recognize that an OBMS can help them do their job better. In general, the fleet manager and the dispatcher thought the OBMS improved drivers' seatbelt usage and reduced speeding. However, they did have some concerns about the system's inability to distinguish between CMV and light vehicle split highway speeds, as some portions of highways throughout the United States post different speed limits for light vehicles and CMVs. This challenge to the OBMS's accuracy was noted in the system performance evaluation as one important source of error in the speed maps.

3.3. Evaluation #3: novel mirror technology

The third FAST DASH evaluation was aimed at determining whether mirror technology could be adapted to reduce blind spots on heavy trucks. A novel set of multi-radii convex mirrors (developed by Dr. R. Andrew Hicks of Drexel University under patent #US20100033854 A1) was selected for evaluation. The mirrors are designed to increase field of view (FOV) for drivers and provide a reflection similar to that found on flat mirrors (i.e., 1:1 unit magnification of images). Four prototype mirrors—door-mounted and hood-mounted for driver and passenger sides—were created through simulations and fabricated for testing purposes (Fig. 5).

As this was the initial development of a single prototype, the evaluation was limited to three testing activities. The first was a detailed
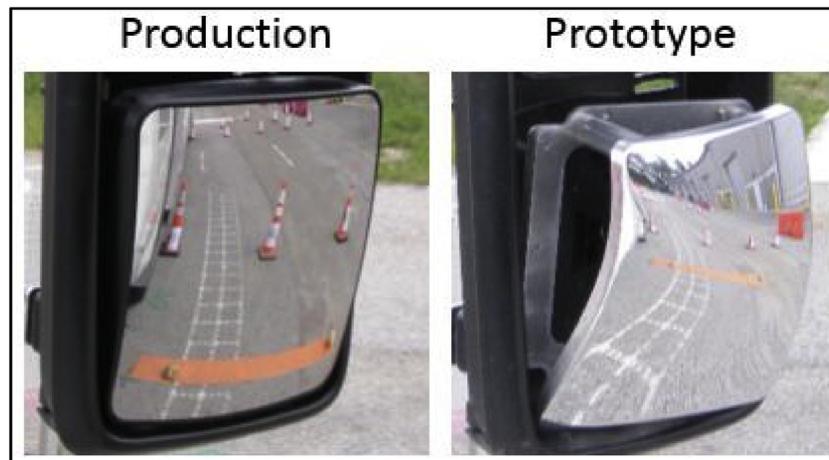
Fig. 5. View of the passenger-side production (left) and prototype (right) convex door mirrors.

mapping of both production and prototype mirrors by two VTTI research staff who served as driver models across an extreme eye-point range because they matched representative 5th percentile female and 95th percentile male sitting eye heights. The second activity was a formal study involving nine participating commercial vehicle drivers at the Virginia Smart Road's static test area. The third was a pilot test drive on public roads by a VTTI research staff member featuring real-world scenarios and tasks designed to compare the production and prototype mirrors.

Safety Benefits. Safety benefits were measured through gap estimation and the pilot drive. Participant drivers were asked to estimate distances to a cone placed on alternating sides of the truck at one of two positions rearward from the door mirrors. Their estimates provide some insight into the effect of the prototype mirrors on judging objects in nearby lanes of traffic on the road. The average gap estimated by the drivers was smaller for the prototype mirrors than the production mirrors on both the driver- and passenger-side mirrors; however, the distance was not significantly lower.

The focus of the pilot drive evaluation was on the driver's ability to change lanes, merge, and conduct parking lot maneuvers, as well as the driver's perception of the mirrors' available FOV on the road. For merging and overtaking actions using the prototype mirrors, gap acceptance was very similar to the production mirrors for both driver side and passenger side. However, the driver noted that in the passenger-side prototype mirror, visual cues, such as shadows, were used to decipher the location of an experimenter-driven remote vehicle and its relation to the combination unit truck. The driver also noted that the remote vehicle was very difficult to see readily by glancing at the mirror, as were other vehicles on the road. This may have been a result of the location of distortion on the mirror; high distortion areas were often where vehicles in lanes alongside the combination unit truck would appear in the mirror.

System Performance. The performance of the mirrors was measured based on FOV and image distortion. During the FOV evaluation, the viewable area was set first by having the VTTI staff eye-point models adjust their mirrors to view specific target areas and to minimize overlap of the mirrors' views. Following that, researchers created an FOV map by maneuvering a pole of a set height to determine the boundaries of indirect visibility. FOV mapping revealed a larger area of indirect visibility for the prototype mirrors than for the production mirrors. First, the prototype door-mounted mirrors provided an increased view over corresponding production mirrors with regard to the two lanes outward from the vehicle, which was the maximum distance mapped. Second, horizon was visible on both driver- and passenger-side, door-mounted prototype mirrors; however, measurements extended only to a 100-ft mark from the front of the cab. Although

horizon was visible, the staff models noted increased distortion toward the top of the mirror, increasing the difficulty of mapping the FOV. Third, the curvature in the prototype mirrors increased forward indirect visibility further forward than the production mirrors.

Drivers classified the image distortion of each mirror type and position by viewing a flat grid situated to cover the majority of the mirror (Fig. 6). Drivers classified the outside and lower regions as most distorted on both door mirrors. Drivers also classified the outside and lower regions of both hood mirrors as most distorted. Drivers identified all four of the prototype mirrors as creating more image distortion than the production mirrors; however, the passenger-side hood mirror was not rated as having significantly more distortion.

Driver Acceptance. Drivers provided mixed feedback on the prototype mirrors, suggested other ways to improve them, and proposed follow-up tests that they would like to see. General positive comments included the following: "field of view is larger," "actual image presentation is clearer," "more definitive," "I like the design better, no sun glare." General negative comments included the following: "harder to place things in the mirror," "too distorted," and "still a bit of work to do on the mirror." Some drivers expressed interest in seeing future mirror developments and applying mirrors in a real driving scenario. The nine drivers in the study expressed acceptance of certain facets of the prototype mirrors; however, most drivers noted their preference for the production mirrors.

Results were mixed, and the system was deemed not far enough along to instrument in a 20-truck fleet. The recommended next step was to refine the mirror design, manufacture, and re-evaluate.

4. Discussion

The FAST DASH program and research teams applied a scientific

Fig. 6. Location of checkerboard used during the image distortion task for driver-side, door-mounted convex mirror. The numbers were mirrored to provide a properly oriented number sequence for driver identification while looking at mirrors.

methodology to collect, organize, and analyze large-scale data sets from revenue-producing transportation businesses who wanted assistance finding effective and reliable safety advancements. This research also provided innovators the opportunity to incubate their products to identify benefits and sharpen ineffective components. As part of that process, key outputs of the program include a publically available report that documents the study and findings, and engineering/design guidance to the vendor that they can use to revisit specific aspects of their design.

The first five years of the FAST DASH program supported evaluations of a BSW system, an OBMS, and a concept mirror. The evaluations considered important aspects of the implementation and provided guidance for improvements of the hardware, software, and services. The FAST DASH program provided a mechanism to perform quick-turnaround, independent evaluations of promising safety technologies aimed at commercial vehicle operations.

The FAST DASH program can serve as a model for the global implementation of applied research through private-public partnerships that recognize the advantages of cooperation in accelerating industrial growth while balancing achievements in safety, efficiency, and sustainability. However, this approach should be considered a starting point by providing initial data on a technology of interest. Though a fast, quick-turnaround evaluation can be informative, there are obvious limitations with this approach including: (i) only involving a single fleet and a relatively small number of drivers and (ii) conducting the evaluation of a period of several weeks vs several months or years. To this end, programs like FAST DASH should be considered a preliminary step in the more extensive evaluations that are required for the successful development and implementation of a transportation safety technology.

Acknowledgements

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