Onboard Safety Technology Survey Synthesis

Final Report

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

December 2007

FOREWORD

This report documents and synthesizes several major qualitative survey efforts relating to stakeholder use and perspectives of onboard safety technologies for commercial motor vehicles. The Federal Motor Carrier Safety Administration (FMCSA) and the American Transportation Research Institute (ATRI) conducted this survey synthesis to identify and analyze gaps in existing survey research for onboard safety technologies.

The synthesis includes an analysis of 19 survey, interview, and focus group instruments. This synthesis provides an understanding of the relationships and factors involved in the use, selection, and impact of onboard safety technologies.

Throughout all the surveys, concerns arose about cost and the desire for information regarding demonstrated safety impacts of onboard safety systems. The survey synthesis findings indicated a need for increased information in reference to the financial implications of any safety technology including insurance costs and crash reduction savings, as well as cost of installation, maintenance, training, and upgrades to any safety system.

The information in this document can be used by motor carriers to learn more about onboard safety systems. Also, researchers used the findings to develop future research opportunities and reduce research redundancy.

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This program was administered through the Federal Motor Carrier Safety Administration (FMCSA). The FMCSA Program Manager is Ms. Amy Houser.

16. Abstract

The Federal Motor Carrier Safety Administration (FMCSA) funded this project to collect, merge, and conduct an assessment of onboard safety system surveys and resulting data sets that may benefit commercial vehicle operations safety and future research efforts. Until recently, many of these efforts have been conducted independently of each other with limited coordination of data aggregation. This synthesis provides an understanding of the relationships and factors involved in the use, selection, and impact of onboard safety technologies. Also, it may reveal future research opportunities and reduce research redundancy.

The synthesis includes an analysis of over 19 survey, interview, and focus group instruments. Throughout all the surveys, concerns arose about cost and the desire for information regarding demonstrated safety impacts of onboard safety systems. The survey synthesis findings indicated a need for increased information in reference to the financial implications of any safety technology including insurance costs and crash reduction savings, as well as cost of installation, maintenance, training, and upgrades to any safety system.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lbs)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m2	cd/m2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	Yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lbs)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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LIST OF ACRONYMS

ABS.....Antilock Brake System

ATA .....American Trucking Associations, Inc.

ATRI .....American Transportation Research Institute

CMV .....Commercial Motor Vehicle

CVO .....Commercial vehicle operations

CWS.....Collision Warning System

FMCSA.....Federal Motor Carrier Safety Administration

FOT.....Field Operational Tests

GPS .....Global Positioning System

IVBSS .....Integrated Vehicle-Based Safety System

IVI.....Intelligent Vehicle Initiative

LTL .....Less-Than-Truckload

LDWS .....Lane Departure Warning System

OEM.....Original Equipment Manufacturer

RA&C .....Rollover advisor and control

ROI.....Return on Investment

RPS .....Rollover prevention systems

RSA.....Roll stability advisor

RA&C .....Roll stability advisor and control

RSC.....Roll stability control

TL.....Truckload

TMC.....Technology and Maintenance Council

EXECUTIVE SUMMARY

There are a number of ongoing efforts and initiatives underway seeking to identify ways to reduce the number of crashes and fatalities on our nation's highways. The Federal Motor Carrier Safety Administration's (FMCSA) main objective is to reduce the number and severity of crashes involving large trucks. In recent years, FMCSA and the trucking industry have formed partnerships to test and evaluate onboard safety technologies, such as lane departure warning systems, forward collision warning systems, and stability control systems, all of which have the potential to significantly improve safety on the roadways.

The research efforts evaluating these types of technologies have produced a large amount of qualitative and quantitative safety data that may benefit commercial vehicle operations (CVO) safety and future research efforts. Until recently, many of these efforts have been conducted independent of each other with limited data aggregation. Synthesis of this data can provide insightful findings and recommendations as well as the identification of gaps for future research activities.

RESEARCH GOAL

This survey synthesis was developed to unify and consolidate the documentation and analysis of existing surveys, interviews, and focus groups. It provides an understanding of the relationships and factors involved in the use, selection, and impact of onboard safety technologies. It may also reveal future research opportunities and reduce research redundancy.

METHODOLOGY

The first phase of the synthesis was to identify all existing surveys, interviews, and focus group initiatives that addressed safety technologies in the trucking industry. Extensive research resulted in 19 studies/instruments. The instruments included those focusing on:

- Fleet managers, safety directors, and other carrier management
- Drivers
- Other stakeholders (i.e. insurance companies)

Next, a master database of questions was created from all of the collected surveys and interviews. Any duplicate questions were consolidated. Discussions amongst the research team members identified duplicative and unique questions for data consolidation and analysis. A master database of all data from each of the instruments was then created and analyzed. In addition to basic descriptive statistics, a trend analysis was conducted with all of the qualitative data responses.

SYNTHESIS FINDINGS

Throughout all the surveys, concerns arose about cost and the desire for information regarding demonstrated safety impacts of onboard safety systems. Findings indicated a need for increased information in reference to the financial implications of any safety technology including insurance costs and crash reduction savings, as well as cost of installation, maintenance, training, and upgrades to any safety system.

Most carriers indicated familiarity with a number of safety technologies including roll stability control, lane departure warning, and collision warning systems. However, the most recognized and research-focused technologies (lane departure warning, collision warning, and roll stability control systems) were not among the most widely installed onboard technologies. Nevertheless, the findings showed that onboard safety systems were among the fastest growing safety technologies.

Other key findings from the analysis include:

- There is an increasing acceptance and implementation of onboard safety technologies.
- Carriers want more documentation of safety impacts, reliability, and validity of the safety technologies.
- There are concerns regarding data privacy and security related to how the data is handled and potential future uses of the resulting data.
- Cost, return on investment (ROI), and ROI time periods are among the top priorities for companies when considering investing in safety technologies.
- Acceptance from all levels, from driver through upper management, is necessary for successful implementation and use of safety technologies.

Some of the key areas where additional research is needed include:

- Quantitative data on ROIs would be beneficial to gain a broader understanding of carrier considerations.
- More research on the training needs for drivers who will be using the technologies, maintenance staff who will be performing upkeep maintenance, and managers who will be analyzing the data would be beneficial.
- More information from technology vendors would be beneficial to understand the development and production of onboard safety systems.

1.0 BACKGROUND

The safety of our nation's highways is of paramount importance to transportation stakeholders at all levels. Increasingly, government agencies and highway users, particularly the United States Department of Transportation (USDOT) and the trucking industry, are seeking ways to improve highway safety. One avenue receiving considerable attention is the deployment of onboard safety technologies.

The Federal Motor Carrier Safety Administration's (FMCSA) main objective is to reduce the number and severity of crashes involving large trucks. FMCSA and the trucking industry have been working together to test and evaluate onboard safety technologies that can reduce crashes and increase safety, including lane departure warning systems (LDWS), forward collision warning systems (CWS), adaptive cruise control (ACC), and roll stability systems. Results from these research efforts may have broad applicability and benefit for commercial vehicle operations (CVO) safety and safety research efforts.

Over the last several years, USDOT, the American Trucking Associations (ATA), and the American Transportation Research Institute (ATRI) have undertaken a number of research initiatives to document and understand carrier use of onboard safety technologies. This research included surveys, interviews, and focus groups to gather input from carriers, drivers, manufacturers, vendors, and insurance companies, resulting in a large amount of qualitative and quantitative data. The majority of these research initiatives were conducted independently of each other with limited data aggregation and/or analysis across projects. By synthesizing the data and findings from these separate initiatives, results can provide a more in-depth understanding of specific issues and additional opportunities for the focus of future research activities.

The purpose of this survey synthesis project was to merge and consolidate the documentation and results of existing surveys, interviews, and focus groups; in particular, those related to industry design, use, and perspectives of onboard safety technologies. By consolidating the data for examination and analysis, the relationships and factors involved in the selection, use, and effect of onboard safety technologies were identified. The project results included the development of a master survey database, master survey template, and a survey gap analysis.

2.0 METHODOLOGY

In the effort to sort and select the survey instruments for the synthesis, inclusion requirements were established. The synthesis inclusion requirements involved using surveys conducted from the year 2000 and later relating to onboard safety technologies designed for data collection from large truck carriers, drivers, technology manufacturers/vendors, and/or industry insurers.[1] It should be noted that many of the surveys included questions about other in-vehicle technologies, which may not have major safety benefits; in addition to the onboard safety systems, which can reduce the number and severity of crashes.

SURVEY INSTRUMENT SELECTION AND IDENTIFICATION

First, current research studies related to large truck onboard safety technologies were identified, which addressed large truck onboard safety technology selection, use, perceptions, and acceptance. Seventeen studies were reviewed that focused on large truck onboard safety technologies and utilized multiple data collection methods and modes including interviews, focus groups, and surveys. The research tools (survey instruments and interview protocols) and raw data from the studies were used to create a master data set.

SURVEY INSTRUMENTS AND DATA SYNTHESIS

The research data was categorized by its target group in each study, which included:

- Fleet managers, safety directors, and other carrier management
- Commercial motor vehicle (CMV) drivers
- Other stakeholders, such as manufacturers, vendors, and insurance representatives

A database was created that included the questions and responses from each study. The initial process involved the development of the master question list which included every question from every instrument and notes regarding response formats (open or close-ended, and response options). The following section provides a discussion of the methodology for consolidating and analyzing ten fleet surveys, seven driver surveys, and two other stakeholder surveys.

FLEET SURVEY INSTRUMENTS

When the master database of questions was finalized for the fleet survey instruments, the questions were sorted by topic area into five primary categories:

[1] All USDOT information collections were covered by the OMB and Paperwork Reduction Act exemption for ITS-related surveys, questionnaires, and interviews defined in Section 5305, Title V, Subtitle C, paragraph (i) (2) of SAFETEA-LU (2005) and Section 5204, Title V, Subtitle C, paragraph (j) (2) of the Transportation Equity Act for the 21st Century (TEA-21) which state that "Any survey, questionnaire, or interview that the Secretary considers necessary to carry out the evaluation of any test or program assessment activity under this subchapter shall not be subject to chapter 35 of title 44."

General fleet information – industry segment, company size and productivity, commodities carried, and length of haul

- Technology and safety knowledge and experience – knowledge of different technologies and safety experiences and concerns
- Technology usage – technologies currently being used, benefits of installed technologies, and future plans for use of technologies
- Technology purchasing – return on investment (ROI) calculations and factors related to purchasing and evaluation criteria
- Research participation and follow-up – future research directions and possible participation in future research

Next, the questions were analyzed and organized into three discrete categories:

- Duplicate questions included any questions that were exactly the same and appeared on multiple survey instruments
- Unique questions were questions that did not have any duplicates or similar questions on other survey instruments
- Nuance questions were similar questions with slightly different wording on multiple survey instruments

All of the duplicate questions were automatically consolidated. The nuance questions and responses were analyzed to determine if these questions could be consolidated with other questions or kept separate. A Master Survey Template was developed that contained 55 questions and guided the development of the consolidated database of results for analysis. The questions were organized into a logical survey format and flow for the template, and question wording was kept in the original form from the original survey instruments.

Next, respondent data was gathered from the original survey sources and entered into the master response database. For quantitative and close-ended responses, data quality review and reorganization were required to ensure that each case was coded properly in the master database. For consolidated questions, recoding responses from the original coding sequence was needed to match the consolidation of multiple groups from different survey instruments. For these quantitative survey questions, appropriate descriptive analyses were conducted using the statistical software package from SPSS Inc. Some bi-variate analyses were also conducted to analyze responses by the year of the survey.

For the qualitative analysis, the responses to open-ended questions were analyzed by trend analysis using NVivo analysis software. Where possible, the responses were matched with the quantitative questions addressing similar issues so as to provide additional depth to the analyses of both sets of questions.

DRIVER SURVEY INSTRUMENTS

The same methodology described above was utilized with the driver surveys. First, the questions were segmented into topical areas. Next, questions were divided into duplicate, unique, and

nuance categorizations. Due to the limited number of driver surveys and unique nature of each study in this category, there were no duplicate or nuance questions. Once the data had been entered into the response database, SPSS and NVivo were used to analyze the closed and open-ended questions respectively. Due to the survey dissimilarities, a Master Survey Template was not constructed, and each survey instrument was analyzed independently.

OTHER STAKEHOLDER SURVEY INSTRUMENTS

The same methodology format was utilized in identifying and collecting survey instruments that were gathered for other stakeholders, such as manufacturers, vendors, and insurance companies. There were only two survey instruments in this category, which did not have duplicate or nuance questions. The data were analyzed to create a comprehensive summary of the responses from these stakeholders that correlated to the responses in the previous two categories.

3.0 SURVEY INSTRUMENTS

This section provides information about each of the survey instruments that were selected and included in this report. In several cases, only those sections of certain survey instruments were included based on the limited number of questions relating to onboard safety technologies.

FLEET SURVEY INSTRUMENTS

Intelligent Vehicle Initiative (IVI) Incentives Interviews

- Purpose: Guide the development of incentive-based policy options to enhance the deployment of onboard safety technologies
- Interviews were conducted by ATRI in 2004 with 16 companies (4 motor carriers or industry representatives) or other stakeholder groups (3 technology vendors; 3 truck manufacturers; 3 motor carrier insurance representatives; and 3 Federal Agencies).

Integrated Vehicle-Based Safety System (IVBSS) Initiatives Survey

- Purpose: Determine trucking industry opinions on certain onboard safety technologies, with a particular focus on forward CWS, LDWS, side object detection, automatic collision notification, and vehicle stability control systems
- Survey responses were gathered by ATRI in 2004 and 2005 from 15 carrier respondents.

Return on Investment (ROI) Survey

- Purpose: Understand how carriers identify value and ROI for onboard safety systems
- Interviews were conducted by ATRI in 2004 and 2005 with 14 carrier respondents.

Trucking In-Vehicle Technology Survey

- Purpose: Understand the current and planned future use of in-vehicle technology by motor carriers
- Survey responses were gathered by Gartner G2 and ATRI in 2002 from 88 carrier respondents.

Motor Carrier Technology Study

- Purpose: Understand member and non-member use of technologies and resources, and issues arising from the use of technologies
- Survey responses were gathered from 239 carrier respondents by the ATA Economics & Statistics Group in 2000.

Economic Analysis and Deployment Project Structured Interviews with Carriers

- Purpose: Determine which technologies fleets have knowledge of and are using, their expectations for investment and ROI, and the requirements for use and integration
- Interviews were conducted by ATRI and the Technology and Maintenance Council (TMC) in 2005 with 19 carrier respondents.

Trucking Industry Perspectives on Technology-Based Safety Systems

- Purpose: Identify carrier views on ways to accelerate the deployment of new onboard safety systems, particularly CWS, ACC, roll advisor and control (RA&C), and LDWS
- Interviews were conducted with 19 carriers in 2002 and 2003 by USDOT.

FMCSA IVI Workshop on Onboard Safety Technology Deployment in Commercial Motor Vehicles

- Purpose: Gain a wider range of understanding from stakeholders about the factors impacting the effectiveness of onboard safety systems, including driver and road characteristics, climate conditions, and carrier profiles
- An expert panel discussion with 18 participants was conducted by FMCSA in 2003.

Confidential Motor Carrier In-Vehicle Safety Systems Questionnaire

- Purpose: Understand the motivation for using onboard safety systems, perceptions of risks involved with using or not using the equipment, and ROI requirements
- Survey responses were gathered from 72 carrier respondents by FMCSA in 2004 and 2005.

Technical Requirements for Active Safety Systems Task Force/IVBSS Official Fleet Survey

- Purpose: Identify and understand issues related to the integration of onboard safety systems on CMV fleets
- Survey responses were gathered from 22 carrier respondents by the TMC in 2004 and 2005.

DRIVER SURVEY INSTRUMENTS

IVI Driver and Independent Owner/Operators Perspectives on Technology-Based Safety Systems

- Purpose: Determine driver familiarity with and opinions of onboard safety systems
- Interviews were conducted with 20 drivers by USDOT in 2002.

International Driver Satisfaction Survey

- Purpose: Understand how the LDWS is used in commercial trucks and how drivers react to the system
- Survey responses were gathered from 205 drivers by Iteris in 2004.

In-Vehicle Safety Feedback: Driver Perspectives Suggest Technology has Promise for Improving Safe Driving Behaviors

- Purpose: Understand the driver perceptions and attitudes toward in-vehicle technology and feedback from the technology
- Focus groups were conducted with a total of 66 participants to develop the survey instrument; survey responses gathered from 198 drivers in 2003 by Liberty Mutual Research Institute for Safety.

Freightliner IVI Field Operational Test (FOT): Initial Stage Interview and Survey

- Purpose: Gather baseline information from drivers about experiences with the RA&C technology being evaluated
- Survey responses were gathered in early 2001 by USDOT from 23 drivers in the IVI FOT.

Freightliner IVI FOT: Short-Form Driver Survey

- Purpose: Gather information about drivers' perceptions on user-friendliness of rollover safety technology
- Survey responses were gathered in early 2001 by USDOT from 23 drivers in the IVI FOT.

Freightliner IVI FOT: Long-Form Driver Survey

- Purpose: Gather information about drivers' perceptions of the rollover safety technology was on four different dimensions
- Survey responses were gathered from 23 drivers in early 2001 by USDOT in the IVI FOT.

Freightliner IVI FOT: Debriefing Driver Interview

- Purpose: Gather final thoughts and information regarding driver acceptance and opinions of rollover safety technology
- Interviews were conducted in early 2001 by USDOT with 15 drivers who participated in the IVI FOT from beginning to end.

OTHER STAKEHOLDER SURVEY INSTRUMENTS

Original Equipment Manufacturer (OEM) and Vendor Perspectives on Technology-Based Safety Systems

- Purpose: Identify OEM and vendor perspectives on ways to accelerate deployment of onboard safety technologies
- Interviews were conducted with 8 respondents in 2002 and 2003 by USDOT.

MOTOR CARRIER INSURER PERSPECTIVES ON TECHNOLOGY-BASED SAFETY SYSTEMS

- Purpose: Identify industry insurer perspectives on ways to accelerate deployment of onboard safety systems
- Interviews were conducted with 5 respondents in 2002 and 2003 by USDOT.

4.0 SURVEY SYNTHESIS GAP ANALYSIS

After the surveys were analyzed and examined, a gap analysis was conducted to determine where information was lacking. This type of analysis can provide beneficial information when examining the directions for future research and the informational needs of federal agencies, trucking industry representatives, carriers, insurers, and other key stakeholders.

METHODS

The synthesized data for each category of survey instruments was analyzed and examined in depth – both the survey instruments themselves, and the responses to individual questions. The first step was to document any areas that were perceived as missing or lacking from the survey instruments consolidated in this synthesis. After these initial gaps were identified, a literature review and environmental scan was conducted of a wide array of related topics to determine if there were any other research recommendations or arenas that had thus far not been examined by a focused research project. At the completion of the database analysis and comparative research scans, the research team mapped the data against the issues and ascertained data components missing from the existing research used for this study.

GAP ANALYSIS RESULTS

Only seven of the nineteen research instruments included in this synthesis contained any recognition and analysis of the driver interaction with the safety technologies. One of these survey instruments was disseminated, collected, and analyzed by a vendor. This survey method, often viewed as market research, calls into question the reliability and validity of findings. Several of the other instruments had relatively small sample sizes, which also caused concern about the generalization of the data.

Several of these studies interviewed drivers about experiences with one particular type of safety technology (one focused on LDWS and four focused on RA&C). The studies that gathered information related to driver acceptance and experience across an array of technologies had a small sample size. Reviews of driver surveys from FOTs may provide additional information in this venue; one set of such surveys was included in this review.

Few of the questions on any survey instrument delved into the issues related to driver training. While many of the carriers and the drivers themselves mentioned the importance of driver training in open-ended expert panel and interview questions, few of the questions on the surveys or protocols probed this issue directly.

Another related issue was the lack of data on the training needs of companies implementing safety technologies. This was an issue that was volunteered in open-ended responses by many of the carriers when discussing factors related to evaluating technologies. However, none of the surveys directly asked about specific training features, training costs, or training needs. Issues such as driver training on the use of the technology, maintenance staff training on overall system upkeep and specific components, and training for the company safety managers related to

reasonable expectations are all very important to the acceptance and use of the technology. Similarly, none of the surveys identified existing training programs for carriers that use particular safety technologies, and the effectiveness of those programs.

Also there was a lack of questions specifically targeting manufacturers and after-market vendors on issues involved in the development and production of safety technology systems. A few interview and focus groups addressed these issues, but there was an inadequate effort to access technology manufacturers. Extremely small sample sizes and a shortage of questions focused specifically on this population are also indicative of a gap in this area.

Interviews and discussions with FMCSA stakeholders also indicated a need for more information about how carriers have implemented the technologies. This information should include not only the technologies that are being used and how the ROI is calculated, but also the minute details of the implementation, including training program design, problems encountered during installation and implementation, and technology purchase. While these issues were posed in open-ended responses, few of the questions directly related to this particular issue.

A few survey instruments, with relatively small response rates (often due to the type of survey instrument, such as an interview), asked questions about whether or not safety benefits had been realized. As more carriers install onboard safety technologies, it would be worthwhile to gather more information from a wider array of respondents about whether safety benefits were realized, how those safety benefits were enumerated, and timetables for realizing the benefits. This type of information could benefit federal agencies, other carriers, insurers and other stakeholders that are weighing ROI decisions, including decisions about how to increase technology implementation and acceptance. This type of information could also help in explaining the expectancy parameters regarding how quickly a technology will produce benefits.

More investigation into the acceptable cost of a particular safety system would also be beneficial. The surveys provided open-ended, qualitative responses, but very few questions were directly posed in a close-ended format to a large sample, which would be beneficial to determine what a viable cost would be for carriers.

To date, few surveys focused on the factors leading to the evaluation and selection of safety technologies by carriers who are using at least one safety technology. Additional investigation in this area would be beneficial. A repetition of some survey questions, with a larger sample, would help to provide more direction and insight into what motivates carriers to begin examining technologies, irrespective of what factors are responsible for individual technology selection.

5.0 PROJECT SUMMARY

The trucking industry is focusing more attention on the growing acceptance, knowledge and use of onboard safety technologies.[2,3,4,5] Technologies such as LDWS, CWS, and roll stability systems are receiving increased attention by government, industry, and the media.[4,5] By understanding industry perspectives, knowledge, and use of these technologies, FMCSA and other safety stakeholders can better focus efforts and resources to facilitate accelerated deployment of these systems.

Each of the studies included in this survey synthesis was conducted in conjunction with a particular initiative or hypothesis; therefore, not every study addressed the same issues, questions, or respondents. Nevertheless, the synthesis of data and findings can provide considerable insight into usage patterns, future research opportunities, and data gaps.

Given the increasing focus on safety by government and industry, many of the surveyed carriers indicated a familiarity with major safety technologies. The onboard safety technologies, LDWS, CWS, and RSC, were not among the most widely installed technologies by interviewees. However, these technologies were among the fastest growing categories for future installation. Additional analysis may provide more insight into this trend.

Key factors for most of the carriers in the investment decision-making process were the concern about cost, and the desire for information about the demonstrated safety impacts of the technologies. Cost management was also a key factor for carriers with regard to crash impacts. All of this information indicates the necessity for increased information regarding the financial implications of any safety technology, including insurance costs, crash reduction savings, and cost of installation, maintenance, training and upgrades to safety systems, along with any other incidental costs or savings.

Carriers also want systems that are acceptable and responsive to drivers. There is a general indication from carriers that if the system is not easy to use and driver-friendly, then installation is not worthwhile, as driver dissatisfaction can also impact driver retention. While carriers indicated a general knowledge of many different technologies, most carriers also acknowledged a limited amount of experience with the onboard safety technologies.

The lack of available research data from drivers and manufacturers for these surveys is important. These two groups are critical players in the design, distribution, and ultimate use of safety technologies. Understanding driver and manufacturer motivations and needs will lead to an increase in the marketplace acceptance of safety technologies. While carriers may purchase the technologies, without driver support and use, the technologies will likely not provide the maximum impact on highway safety. A broader range of information related to driver training

[2] Staff. Freightliner showcases safety, technology. *Fleet Owner*. August 1, 2003.

[3] Staff. Safety economics tied to driver behavior. *Fleet Owner*. May 2004.

[4] Cullen, D. Eyes on the road: Boosting safety by helping drivers better see what's outside the cab. *Fleet Owner*. February 2002.

[5] Kilcarr, S. Rollover Protection. *Fleet Owner* February 2004.

and driving experiences with the technologies may be useful.[6,7] If manufacturers do not identify the key features that are important to carriers, the production and purchase of safety technologies will likely fall short of desired goals.

This synthesis has resulted in a dataset which can be expanded and refined as more research is conducted in this area. By expanding this dataset, it is also possible to continue to track how safety technology investment trends change and adapt over time, and how stakeholders will need to adjust approaches and considerations as these trends change.

In summary, the key findings from the Safety Technology Survey Synthesis are:

- **There is an increasing acceptance and implementation of onboard safety technologies.** The surveys included in the analysis spanned a five-year time period (2000 to 2005). By examining the data by year, it was possible to examine reported safety technology use over time. In the more recent surveys and interviews, more carriers reported knowledge of and implementation of a wider range of onboard safety technologies.
- **Carriers and drivers want more documentation of safety impacts, reliability, and validity of the safety technologies.** Carriers and drivers both indicated concerns about the proven reliability and validity of safety technologies. Reports (from carriers currently using the systems) of false positives and problems with different warning technologies (such as the LDWS and CWS) caused concern among carriers. There is also interest in more objective (non-vendor sponsored) quantitative research regarding the safety impacts.
- **There are concerns regarding data privacy and security, related to how the data is handled, and potential future uses of the data.** Drivers and carriers both indicated concerns about how the data would be handled and used, both internally and during any potential legal issues arising from collisions. Data privacy and security were concerns for both groups.
- **Cost, ROI, and ROI time periods are among the top priorities for companies when considering investing in safety technologies.** Echoed by all three groups (fleet managers, drivers, and other stakeholders), the cost of a technology, ROI calculations, and the timetable for the ROI were all crucial components in the decision to purchase safety technologies.
- **Quantitative data on ROI timelines would be beneficial to gain a broader understanding of carrier considerations.** Connected to the previous statement, it is also necessary to gain a better, sharper understanding of carrier ROI timelines. Some information has been collected; however, more quantitative data would allow for stronger analysis and a clearer picture. This information would also help determine if carriers have realistic expectations for ROI timelines.

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[6] Roetting, M., Huang, Y.H., McDevitt, J. R., & Melton, D. Truck drivers' attitudes and opinions towards feedback by in-vehicle technology. *Liberty Mutual Research Institute for Safety*. 2005.

[7] ITERIS. (2004). Iteris Lane Departure Warning System Receives Praise from Commercial Truck Drivers in U.S. and Europe. Available online at: http://www.iteris.com/news/090204.html

- **Additional data would be beneficial on the perceived acceptable cost for purchasing and installing the equipment.** The surveys revealed little investigation of the perceived acceptable purchase and installation costs for carriers investing in safety technologies. More information in this area could be used to determine what carriers are currently spending and, among those who are not yet investing in the technologies, what an acceptable range would be. This information could be gathered in conjunction with an effort to gather similar data from technology vendors to determine the difference between the two.
- **Acceptance at all levels, from drivers through upper management, is necessary for successful implementation and use of safety technologies.** Carriers and drivers both indicated that support from each level was crucial to the successful implementation of any system. Without upper management support, the systems would not be installed; without driver buy-in, the systems may go unused.
- **More research would be beneficial on the training needs and supports in place for drivers who will be using the technologies, maintenance staff who will be performing upkeep maintenance, and managers who will be analyzing the data.** The surveys revealed little research to-date about the training needs for each of these groups, and many of the respondents indicated, in open-ended responses to other questions, that this was a crucial component of implementation. Research would be beneficial regarding the training that is currently available, training costs, time requirements, and preferred training modes.
- **More information from technology vendors would be beneficial to understanding the development and production of safety technology systems.** In the surveys analyzed for this study, almost no data was collected from technology vendors on related issues. More information from this population about perceptions of the industry and industry demands and costs of development and production would be useful when determining realistic delivery and installation timelines.

6.0 FLEET SURVEY INSTRUMENT QUESTIONS AND RESULTS

Fleet questions were categorized into five groups. The first section was general fleet characteristics, which included questions such as industry segment, fleet size, average length of haul, and commodities hauled. The second section was related to technology and safety knowledge and experiences and included questions about primary crash concerns, knowledge of current technologies, and perceptions of technology. The third group of questions focused on technology usage and included questions related to current and future technology installations, methods of installation, and expected safety benefits. The fourth group of questions addressed technology purchasing and focused on ROI calculations, factors associated with purchasing and evaluating technology, and other purchasing issues. The final category was future research participation, and included questions about willingness, as well as interest in participating in future FOTs and technology studies.

GENERAL FLEET QUESTIONS

This section includes questions related to fleet characteristics and descriptions including industry segment, fleet size, company size, and haul characteristics.

Q1. HOW WOULD YOU DESCRIBE YOUR COMPANY?

There were 6 surveys or interview protocols that asked about the industry segment. Not all of the categories shown below were asked in each survey. The responses showed substantial diversity among the fleets responding to the different surveys. Carriers were able to select multiple categories that applied to their own business. More than half of the carriers (54 percent) indicated truckload operations.

Category	Respondents	# selecting option	%
Truckload	314	170	54%
For-Hire	123	54	44%
Less-than-Truckload	149	50	34%
Regional	314	76	24%
Other	385	83	22%
Private	221	29	13%
Tank	127	17	13%
Owner-Operator	123	9	7%
Specialized	51	3	6%
Intermodal	73	3	4%
Lease-Rental	145	3	2%

Q2. WHAT IS YOUR ANNUAL REVENUE?

One survey asked carriers to indicate annual revenue for the previous year. This information contributes to an understanding of the company size. There were 64 responses to this question. The average annual revenue was $244 million, with a range of $10,000 to $4.5 billion.

Q3. WHAT IS THE SIZE OF YOUR FLEET?

Four of the surveys and interview protocols gathered information about fleet size, with the most common being over 200 power units (39 percent). Some of the surveys gathered open-ended responses to this question; in that case, the responses were coded to fit in the categories below.

Category	Respondents	# selecting option	%
1 to 10 power units	203	20	10%
11 to 50 power units	203	51	25%
51 to 100 power units	203	23	11%
101 to 199 power units	203	27	13%
200 or more power units	203	79	39%

Q4 – Q6. FLEET VEHICLE CHARACTERISTICS

One survey addressed several questions about fleet characteristics. Each of these questions was designed to determine general fleet features and to ascertain how often trailers and power units are replaced. On average, the responding fleets replaced a small percentage of their fleet each year (14 percent of power units, 7 percent of trailers). Two survey instruments asked respondents to indicate what percent of their trailers were tankers. On average, 5 percent of the responding fleets' trailers were tankers.

Category	Respondents	Mean %
What percent of your fleet's power units are replaced per year?	70	14.2%
What percent of your fleet's trailers are replaced per year?	69	7.4%
What percent of your fleet's trailers are tankers?	148	5.4%

Q7. WHICH BEST DESCRIBES YOUR COMPANY'S AVERAGE LENGTH OF HAUL?

Four surveys and interviews gathered information about the average length of the haul. There was a broad representation among the carriers in terms of length of haul. Almost half (48 percent) of the carriers generally had hauls of 500 miles or more.

Category	Respondents	# selecting option	%
1 to 50 miles	108	13	12%
51 to 100 miles	108	5	5%
101 to 200 miles	108	11	10%
201 to 499 miles	108	23	21%
500 miles or more	108	52	48%
Pick up & delivery	108	4	4%

Q8. WHAT PRIMARY COMMODITIES DOES YOUR COMPANY HAUL?

Three of the surveys gathered information about primary commodities hauled; however, data at the individual level was only available for two of the surveys. Among those carriers, more than half hauled truckload-general freight (57 percent). Carriers were able to select more than one commodity, as appropriate. Because carriers were able to select multiple commodities, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
General Freight Truckload (TL)	148	84	57%
General Freight Less-than-truckload (LTL)	148	43	29%
Building materials	72	14	19%
Hazardous chemicals	72	13	18%
Processed foods	72	13	18%
Other	72	12	17%
Heavy machinery	72	10	14%
Refined petroleum products	72	10	14%
Automotive parts or vehicles	148	16	11%
Forest products	72	7	10%
Farm fresh products	148	12	8%
Household goods	72	6	8%
Retail store – grocery delivery	72	6	8%
Raw petroleum products	72	3	4%
Bulk – Dump truck	148	5	3%
Parcels	148	4	3%
Mine ores	72	1	1%

Q9. TOTAL NUMBER OF REGULAR, FULL-TIME EMPLOYEES

One of the surveys asked respondents to indicate the total number of regular, full-time employees (drivers, office workers, mechanics/technicians, etc.) excluding independent contractors. There were 69 respondents, with an average of 1,461 employees.

Q10. AVERAGE DRIVING EXPERIENCE OF DRIVERS (IN YEARS)

While one of the surveys asked about the average years of driving experience, only a portion of the respondents provided a response to that question (61 of 72 carriers). The average number of years of driving experience was 8.6, although responses ranged from less than one year to 25 years.

TECHNOLOGY AND SAFETY KNOWLEDGE AND EXPERIENCES

Q11. WHICH OF THE FOLLOWING DO YOU HAVE GENERAL KNOWLEDGE OF?

Two surveys asked carriers about their general knowledge of specific safety technologies. A majority of the respondents had general knowledge of all three technologies listed (forward CWS, roll stability control [RSC], and LDWS). The most widely known technology was the CWS (84 percent). Because carriers were asked to indicate each technology that they had general knowledge of, the percentages total more than 100 percent.

Category	Respondents	Mean %
Forward CWS	38	84%
RSC	38	66%
LDWS	38	63%

Q12. WHAT SPECIFIC CRASH SCENARIOS OR SAFETY ISSUES ARE YOUR BIGGEST CHALLENGES?

Two surveys asked carriers to identify what type of crash scenario represented the biggest safety challenges. The following scenarios were identified by approximately half of the carriers. Road departure collisions were the most commonly selected scenario (51 percent). Because carriers were asked to indicate all crash scenarios that represented their biggest challenges, the percentages total more than 100 percent.

Category	Respondents	Mean %
Road departure collisions	35	51%
Lane change/merge collisions	35	46%
Rear-end collisions	35	43%

Q13. BASED ON YOUR FLEET'S EXPERIENCE, PLEASE INDICATE YOUR PERCEPTION OF YOUR FLEET'S OVERALL RISK OR EXPOSURE TO THE FOLLOWING CRASH TYPES.

One survey asked carriers to identify their perception of their fleet's overall risk to certain crash types. Carriers were asked to rate each crash type on a scale of 1 to 5, with 1 being the least risk and 5 being the greatest risk. The table below displays the number of responses to each crash type, the average score for each, and the percent of respondents who ranked it in each category. Not every respondent ranked each crash type. The crash types with the highest perceived overall risk were "another vehicle striking a truck in motion" (Mean = 3.07), and "other," which included lane changes/sideswipes, intersections, and backing crashes (Mean = 3.22).

Category	N	Mean	1	2	3	4	5
Other	9	3.22	11%	11%	22%	0%	44%
Another vehicle striking truck in motion	70	3.07	17%	16%	26%	26%	16%
Truck rear-ending another vehicle in motion	71	2.97	24%	20%	17%	14%	25%
Truck striking a fixed object	72	2.99	14%	25%	25%	25%	13%
Another vehicle striking truck while parked	72	2.50	33%	18%	22%	18%	8%
Truck running off a road	69	2.41	30%	25%	28%	9%	9%
Truck overturning on a curve	70	2.29	39%	23%	17%	14%	7%
Truck jackknifing	71	2.25	34%	28%	23%	10%	6%
Truck rear-ending a parked vehicle	71	1.75	55%	25%	14%	1%	4%
Truck striking a pedestrian	70	1.66	61%	20%	13%	3%	3%

Q12 & Q13. FOLLOW-UP ANALYSIS

In a follow-up analysis, the responses to these two questions above relating to crash-risk were consolidated into one set of responses. The response options from the first question (rear-end collisions, road departure collisions, and lane change/merge collisions) were used as the primary categories. When the responses were consolidated in this manner, they were found to be very similar to the initial analysis. Since carriers could select multiple categories, the percentages total more than 100 percent.

Category	Respondents	Mean %
Lane change/merge collisions	105	60%
Rear-end collisions	106	53%
Road departure collisions	106	50%
Other	72	71%

Q14. RELATIVE TO OVERALL CRASH COSTS/IMPACTS, PLEASE INDICATE THE IMPORTANCE OF THE FOLLOWING CRASH IMPACT CATEGORIES TO YOUR COMPANY (1 = NOT SIGNIFICANT, 5 = VERY SIGNIFICANT).

One survey asked carriers to rate how important crash impact categories were to their company relative to the overall crash costs and impacts. Carriers were asked to rate each impact from 1 (not significant) to 5 (very significant). The table below indicates the number of respondents, the average score for each impact, and the percentage ranking of each impact in each category. The two crash impacts with the highest average ratings were the "impact on liability insurance rates" (Mean = 4.61) and "equipment and property damage" (Mean = 4.47). The two lowest average ratings were for "Crash-related administrative costs" (Mean = 3.43) and "shipping penalties" (Mean = 3.13).

Category	N	Mean	1	2	3	4	5
Impact on liability insurance rates	69	4.61	1%	1%	6%	17%	74%
Equipment and property damage	68	4.47	0%	0%	7%	38%	54%
Impact on Federal safety rating	68	4.37	4%	3%	10%	18%	63%
Cost of replacing driver	67	4.36	0%	3%	12%	31%	54%
Impact on worker's compensation rates	68	4.31	1%	3%	21%	13%	62%
Impact on medical insurance rates	68	4.28	3%	4%	15%	18%	60%
Crash-related legal expenses	68	4.19	1%	1%	22%	28%	46%
Loss of customer good will and/or business	68	4.16	7%	4%	9%	24%	56%
Impact on public image	69	4.13	3%	4%	19%	25%	49%
Cargo damage/loss	69	4.03	4%	12%	10%	25%	49%
Impact on employee morale	68	4.01	4%	1%	24%	29%	41%
Environmental clean-up	69	4.01	4%	4%	25%	20%	45%
Liability from automated data collection via technology	67	3.76	3%	15%	22%	22%	37%
Reimbursement of emergency response cost	69	3.75	4%	9%	29%	25%	32%
Cost of towing/recovering damaged vehicle	69	3.64	7%	7%	30%	25%	30%
Cost of management time spent on crash settlement	69	3.67	4%	10%	28%	30%	28%
Cost of off-loading cargo and transport by relief vehicle	68	3.66	7%	6%	29%	28%	29%
Crash-related fines	68	3.62	7%	19%	16%	19%	38%
Cost of crash investigation	69	3.61	4%	6%	39%	26%	25%
Crash-related administrative costs	69	3.43	7%	10%	35%	38%	20%
Shipping penalties	67	3.13	13%	25%	18%	21%	22%

Q15. WHAT CONDITIONS/CHARACTERISTICS/FACTORS DO YOU THINK IMPACT THE EFFECTIVENESS OF THE ROLL STABILITY ADVISOR AND CONTROL TO EITHER MITIGATE OR REDUCE CRASH SEVERITY?

One expert panel asked carriers what conditions or factors would impact the effectiveness of RA&C in mitigating or reducing crash severity. This group specifically focused on RA&C systems, which is why the question is not broader. Conditions that participants felt would impact the effectiveness of this type of system included:

- **Driver Experience** – Participating carriers thought that this type of system could be a benefit to any driver, as long as they were provided with training prior to use. Factors such as risk-taking characteristics, personality, attitudes, and performance history could impact driver use and system effectiveness.
- **Type of road** – It was thought that an RA&C would be more helpful in mountainous areas and on ramps, while it would be less of a factor on freeways. There was a mixed discussion about the degree of helpfulness of the system in urban and rural areas. In urban areas, participants indicated that it may increase safety when a driver had to make sudden moves to avoid other vehicles or pedestrians. On rural freeways, there was a discussion about environmental factors, such as soft shoulders, which the system may not be designed to compensate for.
- **Weather** – Participants indicated that weather could overshadow other factors influencing the effectiveness of the RA&C, as drivers are more cautious in adverse conditions. Also, conditions such as snow, ice, rain, and wind cause the vehicle to move differently and reduce friction with the road. Fog was the weather condition in which participants felt that the system would be most helpful, because it may assist drivers in avoiding incidents during reduced visibility.
- **Type of vehicle** – The overriding view was that the RA&C could be beneficial for any type of vehicle combination. Generally, it was expected that the system would benefit tractor-tank combinations the most, followed by tractor-trailers and straight trucks.

Q16 – Q18. REALISTIC PREVENTION OF CRASH TYPES

One survey asked carriers to indicate what percentage of different types of crashes could realistically be prevented. The objective of these questions was to determine whether carriers thought that particular safety technologies or practices could have a substantial impact on particular types of crashes. The responses were aggregated and an average of the percentage of crashes that could be prevented was calculated. Respondents indicated that, on average, about 75 percent of crashes could be prevented. Responses for each category ranged from 0 to 100 percent.

Category	Respondents	Mean %
Rollover crashes	65	79%
Run-off-the-road crashes	64	73%
Rear-ending other vehicle crashes	65	71%

A follow-up question regarding the way that these crashes could be prevented had responses that covered a wide range of approaches and topics. Generally, across all crash types, respondents indicated that education was the key.

Rollover crashes

- Driver education and training
- Driver screening and drug testing
- Reducing speed and increasing alertness to surroundings
- Proper load securement
- Safe routing and trip planning

Run-off-road crashes

- Driver training
- Driver alertness and awareness of surroundings
- Fatigue recognition training and proper rest
- Speed management

Rear-ending other vehicle crashes

- Driver training
- Increase following distance
- Driver alertness
- Onboard warning systems
- Speed management

TECHNOLOGY USAGE QUESTIONS

Q19. FOR EACH IN-VEHICLE TECHNOLOGY, PLEASE INDICATE IF YOU ALREADY HAVE IT INSTALLED IN SOME OR ALL FLEET VEHICLES.

Seven surveys and interviews asked carriers to identify which in-vehicle technologies they had already installed in all or some of their fleet vehicles. Not every survey/interview gathered information about each category. The most common in-vehicle technologies in use by the carriers were satellite or cellular-based communications between terminal and vehicle (37 percent) and Global Positioning System (GPS) (25 percent). Satellite radio and mayday systems were not indicated by any carriers. Because carriers were able to select multiple technologies, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
Satellite or cellular-based communications between terminal and vehicle	315	117	37%
Automated in-vehicle route guidance via satellite navigation (GPS)	490	124	25%
Ability to connect employee's cellular phone to the vehicle so it can be used in a hands-free, voice activated manner while parked	490	90	18%
Real-time vehicle position tracking	249	34	14%
Stolen vehicle tracking	249	30	12%
Ability to access client/order information from vehicle electronically	490	57	12%
Remote diagnostic system that senses malfunction and notifies driver, company and/or repair station	325	37	11%
Load stability sensors/Rollover stability	125	13	10%
Forward CWS/Forward radar	518	52	10%
In-vehicle internet access	249	15	6%
ACC	108	6	6%
Cameras/video imaging systems for heavy trucks	108	6	6%
LDWS/Lane change aid	366	18	5%
Side object detection	108	5	5%
Drowsy driver warning	108	4	4%
Night vision enhancement	108	2	2%
Real-time, on demand traffic information	97	1	1%
In-cabin hazardous location safety advisory	97	1	1%
Automatic collision notification/mayday systems	97	0	0%
Subscription to digital satellite radio for entertainment	97	0	0%

Q20. WHAT IN-VEHICLE SAFETY TECHNOLOGIES OR SYSTEMS ARE BEING USED BY THE TRUCKING INDUSTRY THAT YOU ARE AWARE OF?

One of the surveys asked participants to indicate what onboard safety technologies or systems they were aware of being used in the trucking industry. Fourteen carriers responded to this question. The responses varied from none to several different technologies:

- Fatigue 8 – a video on fatigue management (1 carrier)
- Backup detectors/video cameras (5 carriers)
- EATON VORAD CWS/forward radar (11 carriers)
- LDWS/lane change system (4 carriers)
- Blind-spot side object detection system (2 carriers)
- Electronic onboard recorders (3 carriers)
- Anti-rollover technology (2 carriers)
- Perclos driver alertness system (2 carriers)
- GPS (1 carrier)
- ACC (1 carrier)
- Highway notification systems (1 carrier)
- Tire pressure chip to signal low tire pressure (1 carrier)

Q20A. WHO IS USING THEM AND CAN YOU DESCRIBE HOW THEY ARE BEING USED?

Most of the respondents indicated that the carriers who were using these systems were larger carriers or those currently involved in testing the systems. Several carriers indicated an interest in using the technologies, but they were concerned about the cost and proven effectiveness of the systems.

Q21. IF YOU HAVE ALREADY INSTALLED THE SAFETY SYSTEMS, HAVE THE BENEFITS BEEN REALIZED?

One survey asked carriers if they had realized the benefits of the safety systems installed in their fleet. A majority of the respondents indicated that they had realized the benefits (75 percent).

Q22A. How are in-vehicle safety systems installed in your fleet?

Q22B. Do you see this as being representative of future installations?

Three surveys asked carriers how technologies are typically installed on their fleet. Most of the carriers (60 percent) indicated that the technologies were installed on new vehicles. One of the three surveys asked carriers if this was seen as representative of future installations; slightly more than three-quarters agreed (76 percent). Since carriers were able to indicate information about new vehicle and retro-fitted installations, the percentages for the latter question total more than 100 percent.

Category	Respondents	# selecting option (or answered "Yes")	%
If you have already installed a safety system, have the benefits been realized?			
	4	3	75%
How are technologies installed on your fleet?			
New vehicles	*45*	*27*	*60%*
Retro-fitted	*45*	*17*	*38%*
Have not installed any	*45*	*9*	*20%*
Do you see this is being representative of future installations?			
	17	13	76%

Q23. Overall, what impact has each factor had on preventing in-vehicle safety systems from being more widely installed on your fleet?

One survey asked carriers to indicate what impact each factor from a pre-determined list had in preventing installation of onboard safety system on their fleet. Each carrier was asked to rate each impact on a scale from little impact (1) to significant impact (3). The table below shows the number of carriers responding to each impact, the average rating for each, and the percent of respondents who ranked it in each category. Cost (Mean = 2.56) and lack of data on crash reduction (Mean = 2.53) were the impacts that carriers ranked as the most significant. The least significant, on average, was a lack of clear ROI (Mean = 1.46).

Category	N	Mean (X)	Little	Some	Significant
Cost	18	2.56	0%	44%	56%
Lack of data on crash reduction	15	2.53	0%	47%	53%
Lack of operator experience	16	2.44	0%	56%	44%
Limited availability of technology	16	2.19	13%	56%	31%
Lack of clear ROI	13	1.46	54%	46%	0%

Q24 – Q27. WHAT ARE YOUR PERCEPTIONS, LIKES, AND DISLIKES OF SAFETY TECHNOLOGY DEVICES?

One of the interview protocols asked carriers to discuss general perceptions of safety technology and specific likes and dislikes about particular technologies. Generally, the overall perception responses were positive. Some respondents indicated concerns about driver acceptance and usefulness. One carrier mentioned that this type of technology was a necessity when hauling hazardous materials. While interested and generally supportive, some respondents indicated concern about the lack of evidence regarding effectiveness of the technologies.

When specifically asked about rollover stability technologies, the responses were extremely diverse. While there was the perception that this type of technology provided some protection, there was concern about how well the system actually worked, the impact of a wide variety of variables, and the high cost. Some of the respondents had a generally favorable opinion, but were unable to identify specific factors or features that were mentioned as "likes" about the technology. The high cost was the most common concern.

Responses regarding CWS and LDWS were more positive with fewer concerns. Again, a few carriers indicated concern about the high cost and one carrier indicated that the signal could be annoying to drivers. The carriers typically had the same concerns for both technologies. CWS were discussed being very useful in bad weather; however, there were also concerns about the annoyance level of the auditory alerts. The "likes" that were discussed relative to LDWS were more general comments related to fatigue crash avoidance.

Q28. FOR EACH TECHNOLOGY, PLEASE INDICATE IF YOU PLAN TO INSTALL IT IN ALL OR PART OF YOUR FLEET IN THE FUTURE.

Three of the surveys asked carriers about future planned technology installations. Not every category was included in each survey, so the respondent numbers vary. The most commonly selected technologies were automatic collision notification/mayday systems (26 percent), remote diagnostic systems (23 percent), and rollover stability systems (23 percent). None of the respondents indicated a plan to install drowsy driver warning systems, night vision enhancement, or side object detection systems. Carriers were asked to indicate all of the technologies they plan to install; therefore, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
Automatic collision notification/mayday systems	239	61	26%
Remote diagnostic system that senses malfunction and notifies driver, company, and/or repair station	239	56	23%
Load stability sensors/Rollover stability systems	225	52	23%
LDWS/Lane change aid	239	51	21%
Forward CWS/forward radar	239	49	21%
Real-time vehicle position tracking	239	48	20%
Ability to connect employee's cellular phone to the vehicle so it can be used in a hands-free, voice activated manner while parked	239	47	20%
Stolen vehicle tracking	225	44	20%
Ability to access client/order information from vehicle electronically	239	42	18%
In-vehicle internet access	239	41	17%
Satellite or cellular-based communications between terminal and vehicle	239	40	17%
Real-time, on demand traffic information	225	38	17%
Subscription to digital satellite radio for entertainment	239	36	15%
In-cabin hazardous location safety advisory	87	4	5%
Automated in-vehicle route guidance via satellite navigation (GPS)	239	7	3%
ACC	87	3	3%
Cameras/video imaging systems for heavy trucks	87	3	3%
Night vision enhancement	87	0	0%
Drowsy driver warning	87	0	0%
Side object detection	87	0	0%

Q29. ARE THERE OTHER TECHNOLOGIES THAT SHOULD BE CONSIDERED IN AN INTEGRATED VEHICLE-BASED SAFETY SYSTEM (IVBSS) BESIDES THE THREE DRIVER ASSISTANCE SYSTEMS MENTIONED?

One survey asked carriers if there were specific technologies that they would like to have considered in an IVBSS beyond rollover stability, CWS, and LDWS. There were many different suggestions:

- Smart cruise control
- Trailer tracking/GPS
- Low speed rollover protection; rollover protection for twin and triple trailers
- Technology to address backing crashes
- Black box recorders
- Road surface temperature monitoring
- Drowsy driver systems

Q30 – Q31. WHAT ARE YOUR GENERAL REQUIREMENTS FOR AN INTEGRATED SYSTEM? ARE THERE ANY KEY FEATURES?

When carriers were asked about general requirements and key features of an integrated system, there was a myriad of responses. While many carriers indicated that there were not any specific requirements that they would like to have in place, other carriers had very specific needs. One of the key features mentioned by several respondents was that the new system had to integrate with the existing technology, including the use of existing equipment rather than the addition of new equipment. Other key requirements were that the system must be and include:

- Tamper-proof so that drivers cannot intervene with the system
- Self-operating and require minimal driver interaction
- Unobtrusive, driver-friendly and not distracting
- Company support and training on the proper use of the equipment

Q32. ON A SCALE OF 1 TO 5, HOW IMPORTANT IS IT TO YOU THAT AN IVBSS WOULD ADDRESS ALL THREE CRASH TYPES?

One survey asked carriers the importance of an IVBSS addressing all three collision types – rollover, lane change, and rear-end. Carriers were asked to rank the importance on a scale from not very important (1) to very important (5). The average rating was 4.05, indicating that it is important for an integrated system to address all three crash types.

Q33. WHAT BENEFITS WOULD YOU WANT IN AN IVBSS?

The same survey asked carriers what benefits they would like in an IVBSS. The benefit selected by almost all of the respondents was greater driver acceptance (91 percent). Easier driver use (77 percent) and reduction of more types of crashes (68 percent) were also selected by a majority of the carriers. Carriers were able to select multiple categories; therefore, the percentages total more than 100 percent.

Category	Respondents	%	Mean
On a scale of 1 to 5, how important is it to you that an Integrated Vehicle-based Safety System (IVBSS) address all three crash types?			
	22		4.05
What benefits would you want in an IVBSS?			
Greater driver acceptance	*22*	*91%*	
Easier driver use	*22*	*77%*	
Reduces more types of crashes	*22*	*68%*	
Lower costs compared to buying individual systems	*22*	*64%*	
Lower maintenance costs	*22*	*59%*	
Other	*22*	*0%*	

Q34. IF YOU HAVE SAFETY SYSTEMS INSTALLED, WHAT WAS THE PRIMARY MOTIVATION FOR INSTALLATION?

Two surveys asked carriers to indicate the primary motivation (from a pre-determined list) for installation of onboard safety technologies. Only carriers who had safety systems installed responded to this question. A majority (68 percent) installed the safety systems to reduce crashes. Lowering insurance rates was the second most commonly selected option (52 percent). Other responses included helping veteran drivers, avoiding construction and traffic congestion, and increasing driver retention. Carriers were able to select multiple motivations; therefore, the percentages total more than 100 percent.

Category	Respondents	# selecting option)	%
Reduce crashes	25	17	68%
Lower insurance rates	25	13	52%
Assist new drivers	25	10	40%
Lower maintenance costs	25	10	40%
Other	25	8	32%

TECHNOLOGY PURCHASING QUESTIONS

Q35 TO 40 – WHAT THINGS DO YOU THINK WOULD MOTIVATE GROUPS TO DEVELOP, MANUFACTURE, PURCHASE AND USE AN IVI ONBOARD SAFETY SYSTEM?

One expert panel discussion included questions about the motivations to develop and manufacture onboard safety systems, to purchase the technologies, and to use the technologies. Each section was followed by investigation of features that could accelerate the development, purchase and use of these technologies. Below is a brief description of the responses.

Development and Manufacture of Onboard Safety Systems

Motivations for the development and manufacture of the technologies included:

- Market opportunity and major customer requests – carriers indicated that FOTs could help accelerate this process by providing an opportunity for testing and increasing industry knowledge of the tested technologies. The increased exposure and publicity help to create demand for the product.
- Competition – FOTs were suggested as a method to accelerate the competition by expanding tests to include more vehicle types and more fleets.
- Regulation – vendors indicated that regulations motivate them to develop and market technology.
- Creating a pull market and developing a competitive advantage – market demand was noted as a key factor and necessary prerequisite for deployment of the technology.
- Safety – the need for safety included the establishment of a safety conscious image and the political correctness of the issue. Connected to these motivations to improve safety was the concept of a move to reduce liability or risk factors.

Purchase of Onboard Safety Systems by Owner-Operators and Carriers

Motivations for owner-operators and carriers to purchase the technologies included:

- Contractual requirements – this could be addressed with an independent evaluation of the technologies which validates the benefits or results of system use.
- Recognition and focus on individual carrier needs – these may include a need to correct a problem, improve the bottom line, or reduce company risk. Methods to accelerate investment based on these motivations include providing real-life examples of success, word of mouth from other carriers, and focusing on near-term pay-offs.
- Driver morale and training – suggestions for accelerating investment based on these motivations include publishing the results from field operational tests and lowering insurance premiums.
- Insurance impact – if onboard safety technologies can reduce crashes, insurance companies will be better able to maintain fair and equitable insurance rates.
- Industry image – some carriers believe that investing in safety is the “right thing to do.”

Use of Onboard Systems by Drivers

Motivations for drivers to use the technologies included:

- Recognition or financial reward for safe driving – outreach programs designed to raise awareness of the existing technologies may accelerate the use of safety systems for drivers who are motivated by rewards for safe driving. Drivers also need to be confident that the data will be used to educate and improve behavior, rather than in a punitive manner.
- Recognition of the value of the systems – this recognition can be accomplished through education, training, and awareness. One suggestion for accelerating use of the systems was to allow drivers to test the technology during trial runs.
- Inclusion – drivers want to be included in the decision about which technologies to purchase and use.
- Reliability and product durability over time – this is another area where the trial test runs may help accelerate technology acceptance and use by drivers.

Another interview protocol that asked carriers about the information needed to encourage the purchase and use of safety systems by fleets and drivers yielded similar results. Generally, fleets are concerned with ROI and increased safety. Respondents indicated that drivers were primarily concerned with the distraction and nuisance factor of the equipment.

Q41. How do you go about determining the ROI for onboard safety systems?

Two surveys asked carriers how they determine the ROI for onboard safety technologies. The responses were diverse. All carriers indicated they do have a system in place to determine ROI. The level of sophistication and detail varied from an in-depth analysis to an informal evaluation.

Carriers have a wide variety of ways to consider ROI, including savings related to labor, timetables costs, and all potential options and investments. Some carriers indicated that they did not have a set ROI equation due to the vast differences between technologies and systems and the benefits available from each. The challenges of enumerating the precise benefits and costs of some systems and the inherent risk in these decisions were recognized by the carriers. Carriers who had experienced problems with specific types of crashes mentioned the role that this played in the decisions to begin investigating safety technologies, as well as the selection of the technology.

ROI assessments were conducted in various ways, including informal approaches involving discussions with vendors and drivers, to more formalized assessments involving the modeling of costs and savings over time, testing of products, in-house product reviews, and recommendations from colleagues. Almost all of the respondents indicated a need for documentation and data support of benefits and costs when conducting ROI analyses. Timetables were also a crucial component of the calculations in these analyses. Often, long-term returns were discounted due to more immediate company needs. Informal communications and testimonials were important to several carriers when conducting initial examinations of technologies.

Carriers also discussed an interest in improving operations and savings by increasing productivity and safety through technology. Practicality was important to many carriers in that systems must improve operations and be functional for regular driver use. Systems must also be integrated with existing technologies. This was very important to carriers when selecting new technologies. Systems that cannot be integrated with existing technologies often involve higher costs due to the tangential adaptations that must be made.

Q42. WHAT WOULD INFLUENCE YOUR DECISION TO PURCHASE SUCH TECHNOLOGIES?

Two interview protocols asked carriers to identify factors that would influence the decision to purchase. Carriers indicated that factors such as fleet safety issues, evidence of successful testing, and insurance reductions were the greatest influence on decisions to purchase technologies.

Other factors included:

- Determination of ROI
- Need for increased safety
- Reduction in the cost of the products
- Government mandates
- Tax rebates for use of the products
- Need determined based upon the cost of crashes and driver injuries

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Q43. PLEASE INDICATE WHAT FACTORS ARE MOST IMPORTANT WHEN ASSESSING TECHNOLOGIES.

Two surveys asked carriers what factors are most important when assessing technologies. Carriers had a wide range of responses; however, they were most interested in demonstrated safety improvements. Specific factors included:

- Demonstrated safety benefits and minimized risk factors
- Time for ROI
- Public and driver reactions
- Field testing statistics
- Overall cost and impact on internal resources
- Results of pilot programs
- Ease of use

Q44. How important are the following for you to know in order to decide whether or not to install an IVBSS system (1 = Not very important; 5 = Very important)?

One survey asked carriers to indicate how important certain factors were in deciding whether or not to install an IVBSS. Carriers were asked to rate each feature on a scale from 1 (not important) to 5 (very important). Crash reduction (Mean = 4.64) and time for ROI (Mean = 4.45) were the most important factors in deciding to install a system. The number of responses, the average response for each category, and the percent response by rank are shown in the table below.

Category	N	Mean	1	2	3	4	5
Crash reduction	22	4.64	0%	0%	5%	27%	68%
Time for ROI	20	4.45	0%	0%	15%	25%	60%
Crash problems targeted	21	4.33	0%	0%	10%	48%	43%
Maintenance costs	21	4.33	0%	0%	10%	48%	43%
Suitable for vehicles	22	4.27	5%	0%	14%	27%	55%
Install costs	21	4.24	0%	0%	24%	29%	48%
Standards for development	20	4.10	0%	0%	20%	50%	30%
Driver acceptance	21	4.10	0%	10%	19%	24%	48%
Experience on other vehicles	21	3.86	5%	5%	19%	43%	29%
Experience on light vehicles	20	2.25	45%	20%	10%	15%	10%
Experience on transit	20	2.20	50%	10%	15%	20%	5%

Q45. PLEASE INDICATE HOW YOU FEEL THE FOLLOWING FACTORS INFLUENCE YOUR COMPANY'S DECISION TO BUY AND USE IN-VEHICLE SAFETY TECHNOLOGIES (1 = NOT IMPORTANT; 5 = VERY IMPORTANT).

Two surveys asked carriers to rank particular features from not important (1) to very important (5) regarding company decisions to buy and use onboard safety technologies. On average, the most important features were proving the accuracy and reliability of the system (Mean = 4.64), reduction of crash-related costs (Mean = 4.69), and proving the effectiveness of the system (Mean = 4.64). The following table displays the number of responses in each category, the average rank, and the percent of responses in each rank.

Category	N	Mean	1	2	3	4	5
Reduced crash-related costs	16	4.69	0%	0%	6%	19%	75%
Proving accuracy and reliability of a system	86	4.64	0%	1%	8%	16%	74%
Proving effectiveness of a system	85	4.64	0%	0%	9%	18%	73%
Cost to install and maintain	88	4.42	0%	7%	10%	17%	66%
Customer satisfaction	66	4.41	3%	3%	12%	14%	68%
Reduced insurance premiums	16	4.25	0%	0%	19%	38%	44%
Availability of vendor or OEM technical support	66	4.20	3%	6%	15%	20%	56%
Protection of recorded vehicle data	67	3.97	3%	6%	25%	22%	43%
Overall driver satisfaction/reduced turnover	19	3.95	0%	%	26%	53%	21%
Ability to monitor driver behavior via onboard data	67	3.93	1%	12%	15%	36%	36%
Potential liability risk of improperly using system	66	3.86	3%	5%	32%	24%	36%
Availability of system for OEMs in new equipment	66	3.83	5%	11%	23%	21%	41%
Potential liability risk of using system	68	3.79	6%	6%	29%	21%	38%
Insurance company endorsement or requirement	85	3.73	4%	11%	31%	20%	35%
Driver acceptance of a system	86	3.70	3%	12%	26%	30%	29%
Other	18	3.78	0%	17%	22%	28%	33%
Cost to train drivers in use of a system	87	3.69	3%	13%	29%	22%	33%
Availability of system for after-market installation	66	3.65	2%	12%	35%	23%	29%
Potential liability risk of not using system	67	3.60	10%	4%	31%	22%	31%
Overall business climate	66	3.59	3%	14%	23%	42%	18%

Q46. When deciding whether to buy in-vehicle technologies, how important are the following benefits to your company?

One survey asked carriers how important ten different factors were when deciding whether or not to purchase in-vehicle technologies. Not surprisingly, based upon the responses discussed above, improving safety and performance was ranked at the top of the list, followed by a reduction in maintenance costs. The items, ranked from most to least important, are shown below:

- Increase safety
- Improve on-time performance
- Reduce vehicle maintenance costs
- Optimize fleet utilization
- Reduce fuel consumption
- Offer better comfort for drivers
- Managing driver efficiency
- Identify stolen vehicles quickly
- Reduce vehicle emissions
- Automate vehicle location tracking

Q47. Please indicate the pros and cons associated with your primary factors/ROI approach.

One survey asked carriers to identify the positives and negatives associated with company ROI formulas.

Strengths

- Method allows for balance and prioritization of technology spending with other capital requirements. Do not have to use resources from other areas to cover these expenses.
- Voluntary incentives are more supportive of employee morale than mandates.
- Training and employee acceptance strategies are important.

Weaknesses/Negatives

- Process of identifying and selecting technology to install is vague and challenging.
- Long-term investment and projects receive less attention and financial support than quick fixes.
- Evaluating second order impacts, such as the impact that a technology has on driver turnover, is difficult.
- Often there is not enough quality data to form a complete evaluation.
- More third-party evaluation data is needed rather than relying solely on vendor data.
- A more detailed cost/benefit ratio is necessary.

Q48. GENERALLY, WHAT IS THE MAXIMUM ACCEPTABLE PAYBACK TIME WHEN YOUR COMPANY CONSIDERS INVESTING IN IN-VEHICLE TECHNOLOGIES?

Three surveys asked carriers to indicate the maximum acceptable payback when examining in-vehicle technologies. A shorter time period was preferred over a longer time frame; however, there was a range of responses, from less than 12 months to more than 36 months. The most frequently selected category was a payback time of less than 12 months (39 percent).

Category	Respondents	# selecting option	%
Less than 12 months	234	91	39%
13 to 24 months	234	69	29%
25 to 36 months	234	49	21%
More than 36 months	234	20	9%

Q49. WHAT IS A REASONABLE PER-UNIT PRICE LEVEL THAT WILL MAKE THESE SYSTEMS ATTRACTIVE TO YOUR ORGANIZATION?

One survey asked carriers to indicate what reasonable per-unit price would make the safety systems attractive. Over half of the carriers (53 percent) indicated that the per-unit price would need to be less than $500.

Category	Respondents	# selecting option	%
Less than $500	15	8	53%
$500 to $1,000	15	3	20%
$1,000 to $2,000	15	3	20%
$2,000 to $3,000	15	0	0%
$3,000 to $4,000	15	0	0%
$4,000 to $5,000	15	0	0%
More than $5,000	15	0	0%
Based on time to recoup investment	15	1	7%

Q50. WHAT ARE THE MAJOR OBSTACLES, BARRIERS, OR CONCERNS TO INVESTING AND INCORPORATING NEW SAFETY TECHNOLOGIES/SYSTEMS INTO THE TRUCKING INDUSTRY?

One survey asked carriers about the obstacles or barriers to investing in and incorporating new safety technologies into the trucking industry. Consistent with previous responses to similar questions, most carriers mentioned cost as one of the major obstacles for technology implementation. Costs consisted of purchasing, installation, and maintenance. Other concerns included:

- Data ownership issues
- Owner and driver acceptance
- Questions of technology durability and reliability
- Increased complexity of truck systems
- Established standards of performance
- Proof of ROI potential
- Integration with existing systems (engine, transmission, antilock brake system (ABS), etc.)

Q51. HOW CAN WE BEST EVALUATE THE USER ACCEPTANCE BY CARRIERS AND DRIVERS OF AN ONBOARD SAFETY TECHNOLOGY?

Q52. HOW CAN WE GATHER DATA ON A LARGE POPULATION OF CARRIERS AND DRIVERS IN A COST EFFECTIVE WAY?

These two questions were on the end of an expert panel meeting, and due to the expansive responses to the preliminary questions during that process, little time was spent on these topics. General recommendations included focusing outreach at all levels (companies, industry representatives, other stakeholder representatives, etc.) to provide information about FOTs and their findings. Recommendations also included outreach through a wide variety of sources, including FMCSA State Directors, American Trucking Associations (ATA), State trucking associations, the National Truck Driving Championship, magazines, and other media outlets. There was extensive discussion about the importance of conducting this type of evaluation, but little discussion about exactly how it could be done. One suggestion involved providing samples to carriers and drivers to evaluate technologies and provide feedback.

Q53. WOULD YOUR COMPANY CONSIDER BEING PART OF A LARGER INDUSTRY TEAM TO EVALUATE THE BENEFITS OF AN IN-VEHICLE SAFETY SYSTEM?

Q54. MAY WE CONTACT YOU AS A FOLLOW UP TO THIS QUESTIONNAIRE?

One survey asked carriers about their willingness to participate in a larger industry team evaluating the benefits of in-vehicle safety systems. Of the 20 respondents, 14 (70 percent) said they would be willing to participate. These carriers indicated having an average of 76 trucks per carrier to participate in the evaluation, ranging from 2 to 350 trucks. Some of the conditions that carriers mentioned as prerequisites for participation included help with installation, no cost involvement or at least assistance with the cost of equipment, minimal down time, and minimal additional labor on the part of the company staff.

Q55. WHAT WOULD YOU LIKE TO SEE FMCSA DO TO ENCOURAGE THE DEVELOPMENT AND DEPLOYMENT OF ADVANCED SAFETY TECHNOLOGIES?

One survey asked carriers what FMCSA could do to encourage the development and deployment of these technologies. Participants had a number of suggestions:

- Provide tax incentives for the expense of the equipment
- Make the technology more affordable
- Avoid mandates
- Encourage public-private partnerships

CONCLUSION AND FOLLOW-UP ANALYSES

As shown by these surveys, there is a growing acceptance of onboard safety systems and other in-vehicle technologies; however, cost remains a concern. In recent surveys, more carriers indicated that there is wider use of a variety of technologies and a greater knowledge of safety technologies. As these systems and related benefits receive more industry and media attention, and become more widely used by a range of carriers, greater acceptance will likely be achieved.

A substantial number of concerns involved the need to show the proven reliability and stability of these systems. These concerns have existed over the last five years, and they are still being discussed in the more recent surveys. This indicates that there is either not enough objective research produced and disseminated about these systems, or that the information distributed is not reaching the majority of carriers.

Also, carriers had concerns about how the data recorded by some of these systems is handled, and the privacy and security of this information. These concerns were echoed by the driver surveys.

7.0 DRIVER SURVEY INSTRUMENT RESULTS

Seven driver survey instruments were included in this synthesis. None of the studies had duplicative questions. One of the seven addressed general driver interactions with all safety technologies, one focused on LDWS, and the third was focused on reactions to feedback from the technologies. The other four surveys were focused on driver experiences with RA&C during an FOT. These survey results are summarized below.

SURVEY 1

Q1. WHICH OF THE FOLLOWING SAFETY SYSTEMS HAVE YOU EVER USED?

The survey asked 20 drivers which safety systems they had used. Nineteen drivers responded and indicated experiences on a range of safety technologies. The most frequently used system was ABS (89 percent) and none of the drivers indicated experience with LDWS, RSA, RSC, or ACC systems. Because drivers were asked to indicate all of the technologies ever used, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
ABS	19	17	89%
Pre-Pass	19	8	42%
Electronic disc brakes	19	2	11%
In-vehicle navigation	19	1	5%
Forward CWS	19	1	5%
Blind-spot side object detection system	19	1	5%
Lane tracking/LDWS	19	0	0%
RSA	19	0	0%
RSC	19	9	0%
ACC	19	0	0%

Q2. ARE YOU CURRENTLY USING THE FOLLOWING TECHNOLOGIES?

Nineteen of the 20 participants responded when asked about technologies currently being used. ABS was again the most commonly cited system (79 percent), with even fewer systems currently in use by the drivers. Because drivers were asked to indicate all of the technologies ever used, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
ABS	19	15	79%
Pre-Pass	19	5	26%
Electronic disc brakes	19	1	5%
In-vehicle navigation	19	1	5%
Forward CWS	19	0	0%
Side-looking radar	19	0	0%
Lane tracking/LDWS	19	0	0%
RSA	19	0	0%
RSC	19	9	0%
ACC	19	0	0%

Q3. HOW MANY YEARS OF EXPERIENCE DO YOU HAVE WITH EACH OF THE FOLLOWING?

Although the survey asked drivers to indicate how many years of experience each had with the technologies, there were very few responses. The few respondents who provided feedback to this question indicated 5 years of experience with ABS, 1 trip with electronic disc brakes, 6 weeks with in-vehicle navigation, and three months each with the CWS and blind-spot side object detection system.

Q4. ARE YOU WILLING TO TRY ANY OF THE FOLLOWING SYSTEMS?

When asked what systems they would be willing to try, respondents were receptive to most of the systems. The one exception was ABS brakes, since two drivers were not willing to try them. For each of the other categories, a majority of the drivers were willing to try each system. Drivers were asked to respond to each category separately; therefore, the percentages total more than 100 percent.

Category	Respondents	# selecting option	%
Side-looking radar	19	19	100%
Lane tracking/LDWS	19	18	95%
RSA	19	18	95%
Forward CWS	19	18	95%
In-vehicle navigation	19	17	89%
Electronic disc brakes	19	16	84%
ACC	19	14	74%
Pre-Pass	15	11	73%
RSC	19	12	63%
ABS	2	0	0%

Q5. RANK THE USEFULNESS FROM 1ST TO 3RD.

Drivers were asked to rank each technology in terms of usefulness. None of the drivers ranked ABS brakes. Most of the respondents ranked lane tracking, in-vehicle navigation, and blind-spot side object detection systems as the most useful systems. Electronic disc brakes, rollover control, and adaptive cruise control received the lowest rankings.

Category	Total	Mean Score	Rank 1st n	Rank 1st %	Rank 2nd n	Rank 2nd %	Rank 3rd n	Rank 3rd %
Side-looking radar	13	1.6	6	46%	6	46%	1	8%
In-vehicle navigation	8	1.6	5	63%	1	13%	2	25%
Lane tracking/LDWS	12	1.8	6	50%	2	17%	4	33%
Forward CWS	3	2.0	1	33%	1	33%	1	33%
Electronic disc brakes	6	2.0	2	33%	3	50%	0	0%
Pre-Pass	7	2.1	2	29%	2	29%	3	43%
ACC	6	2.3	1	17%	2	33%	3	50%
RSA	10	2.4	2	20%	2	20%	6	60%
RSC	4	3.0	0	0%	0	0%	4	100%

Q6. HAVE YOU EVER RECEIVED TRAINING IN THESE SYSTEMS? IF SO, PLEASE RANK THE TRAINING FROM 1 (VERY EFFECTIVE) TO 5 (INEFFECTIVE).

When asked about training on the systems, only three respondents indicated receiving training on ABS systems, ACC, CWS, and blind-spot side object detection systems. Each of the respondents ranked the effectiveness of the training as either a 1 or 2, indicating it was very effective.

Q7. RANK THE TOP THREE WAYS THAT YOU WANT TO HEAR ABOUT THE SYSTEM.

Drivers were not interested in hearing about systems from the internet or email, onsite orientations or ride-along, or on simulators. Drivers indicated that the worst way to hear about a system would be through a government mandate or over the CB radio. The top ranked ways to hear about systems included hands-on experience, talking with other drivers, or formal classroom orientation training.

Category	Total	Mean Score	Worst	Worst %	Rank 1st	Rank 1st: %	Rank 2nd	Rank 2nd: %	Rank 3rd	Rank 3rd: %
Trial and error/Hands on	8	1.9	1	13%	4	50%	2	25%	1	13%
Message from company system	4	2.0	0	0%	1	25%	2	50%	1	25%
Formal classroom	10	2.1	1	10%	4	40%	2	20%	3	30%
Magazines	15	2.1	0	0%	4	27%	6	40%	5	33%
Talk with other drivers	5	2.2	1	20%	2	40%	1	20%	1	20%
CB	3	3.3	2	66%	0	0%	1	33%	0	0%
Government mandate	8	4.0	8	100%	0	0%	0	0%	0	0%
Read manuals	1	4.0	1	100%	0	0%	0	0%	0	0%

Q8. How would you like to learn to use the system?

Drivers indicated that the worst ways to learn to use a system would be through government mandates or over the CB radio. However, drivers ranked fewer methods as the worst way to learn how to use systems than when selecting the worst methods to hear about systems. The top ranked methods for learning how to use a system include: formal training, actual road experience training, and hands-on training. No drivers ranked talking with other drivers, message over the company system, or the internet as either the worst or one of the top three ways to receive training.

Category	Total	Mean Score	Worst	Worst %	Rank 1st	Rank 1st: %	Rank 2nd	Rank 2nd: %	Rank 3rd	Rank 3rd: %
Formal classroom	14	1.6	0	0%	9	64%	2	14%	3	21%
Trial and error/Hands on	15	1.8	0	0%	6	40%	6	40%	3	20%
Actual road experience	12	2.0	0	0%	5	42%	2	17%	5	42%
On-site orientation/ ride-along	1	2.0	0	0%	0	0%	1	100%	0	0%
Read manuals	5	2.6	0	0%	0	0%	2	40%	3	60%
Magazines	4	2.8	0	0%	0	0%	1	25%	3	75%
Simulator	3	3.0	0	0%	0	0%	0	0%	3	100%
Truck shows	1	3.0	0	0%	0	0%	0	0%	3	100%
CB	1	4.0	1	100%	0	0%	0	0%	0	0%
Government mandate	3	4.0	3	100%	0	0%	0	0%	0	0%

Q9. How much do you agree with each statement on a scale of 1 to 5 from strongly agree to strongly disagree?

Drivers were asked to indicate how much they agree with a variety of statements related to the effectiveness and efficiency of the safety systems, perceptions of usefulness of the safety systems, and opinions about general driver reactions to these types of systems. All 19 drivers ranked each statement. In general, drivers agreed that there could be benefits to these systems. There was some concern about how reliable the systems were, but there were few concerns about safety systems causing distraction and decreased alertness. It is important to note that, on average, the drivers agreed that they would like to find ways to encourage their company to use these types of technologies.

	Statement	Mean Score	1: n	1: %	2: n	2: %	3: n	3: %	4: n	4: %	5: n	1: %
1.	These systems could help save time on my trips.	2.0	3	16%	15	79%	0	0%	0	0%	1	5%
2.	These systems could help me respond faster in emergency situations.	1.9	5	26%	12	63%	0	0%	2	11%	0	0%
3.	These systems are more helpful under some conditions than others.	2.1	2	11%	15	79%	0	0%	2	11%	0	0%
4.	I feel safer driving with these systems than without them.	2.0	4	21%	12	63%	2	11%	1	5%	0	0%
5.	These systems could increase my driving workload; that is, they could increase the amount of effort and concentration it takes to drive.	3.4	0	0%	5	26%	2	11%	12	63%	0	0%
6.	A skilled driver really does not need systems like these.	3.7	1	5%	1	5%	1	5%	16	84%	0	0%
7.	These safety systems help reduce the stress and fatigue of truck driving.	2.3	2	11%	13	68%	0	0%	4	21%	0	0%
8.	I find I have become dependent on these safety systems such that I feel less safe in a truck without them.	2.4	5	26%	7	37%	2	11%	4	21%	1	5%
9.	Most of the drivers I know would rather have these systems than not have them in their trucks.	2.8	0	0%	10	53%	3	16%	6	32%	0	0%
10.	I would sometimes keep some of these systems turned off in my truck while I am driving.	3.1	1	5%	7	37%	0	0%	11	58%	0	0%

	Statement	Mean Score	1: n	1: %	2: n	2: %	3: n	3: %	4: n	4: %	5: n	1: %
11.	To really make a safety improvement, every truck on the road should have these kinds of systems.	2.4	2	11%	12	63%	0	0%	5	26%	0	0%
12.	I find that some of these systems can be distracting while I am driving.	2.8	2	11%	7	37%	2	11%	8	42%	0	0%
13.	I think these systems can actually cause me to be less alert in my driving.	3.1	0	0%	10	53%	0	0%	6	32%	3	16%
14.	I trust the reliability of these safety systems.	3.7	0	0%	4	21%	3	16%	7	37%	5	26%
15.	These systems may interfere with my driving tasks.	3.3	0	0%	6	32%	1	5%	12	63%	0	0%
16.	Having these systems has not really changed the way I drive.	2.8	1	5%	10	53%	0	0%	8	42%	0	0%
17.	Overall I would really like to have these systems on my truck.	2.5	1	5%	13	68%	1	5%	3	16%	1	5%
18.	My company/customer feels it is important to install these kinds of safety systems in their fleet.	3.1	0	0%	8	42%	4	21%	5	26%	2	11%
19.	I would like to encourage my company to outfit trucks with more systems like these.	2.0	6	32%	8	42%	4	21%	1	5%	0	0%

Q10. DO YOU HAVE ANY SUGGESTIONS FOR MAKING FURTHER SAFETY IMPROVEMENTS?

Drivers indicated that there were several things that could be done to increase safety. One of the most common recommendations was related to educating automobile drivers about the experience of driving a truck and an understanding of the issues truckers must address. Other recommendations included:

- Automatic transmissions in all trucks
- More comprehensive training programs
- Better CDL license screening
- Reduction of bugs in safety systems before distribution

Q11. ARE THERE ANY OTHER TECHNOLOGIES YOU WOULD LIKE TO HAVE ON YOUR TRUCK THAT YOU CURRENTLY DO NOT?

Drivers indicated an interest in several technologies that were specifically mentioned previously, as well as GPS, blind-spot detection systems, CWS, route guidance, lane tracking, and rollover prevention systems (RPS).

Q12. HOW WOULD YOU LIKE A NEW SAFETY TECHNOLOGY TO BE INTRODUCED?

Drivers indicated that before a new safety technology is introduced, it should receive upper management support within the corporation, go through trial runs, and be demonstrated at truck shows, as well as publicized, so that drivers and management are familiar with the equipment before it is distributed.

SURVEY 2

The second survey gathered driver responses from 205 drivers at six different fleets utilizing LDWS. This survey was conducted by a vendor related to the particular product.

Q1. About how long have you been driving with the Lane Guidance System?

Most of the drivers had been using the system for about six months.

Category	Total Respondents	# of Respondents	%
Less than 1 month	194	29	15%
1 to 6 months	194	100	52%
More than 6 months	194	65	34%

Q2. Do you normally drive with the system enabled (on) or disabled (off)?

The majority (80 percent) of the drivers normally keep the system enabled when driving.

Category	Total Respondents	# of Respondents	%
Enabled	205	163	80%
Disabled	205	42	20%

Q3. In what types of situations would you tend to turn the system off?

Drivers were asked an open-ended question about when they typically turned the system off. There were a wide range of responses, with the most common being construction zones (28 percent), heavy traffic/cities (16 percent), or narrow or curvy roads (13 percent). Another 23 percent indicated never turning the system off. Other responses included:

- Daytime
- Most of the time
- Foggy conditions
- Training a new driver
- Bad weather
- Heavily faded or no lanes
- Small towns
- Co-driver is trying to sleep

Q4. DO YOU FEEL THAT THE LANE DEPARTURE WARNINGS THAT YOU GET FROM THE LANE GUIDANCE SYSTEM COME AT ABOUT THE RIGHT TIME?

Drivers indicated that the warnings were valid most of the time (75 percent), and only 3 percent indicated that rarely receiving good warnings.

Category	Total Respondents	# of Respondents	%
Good warnings most of the time	193	144	75%
Good warnings some of the time	193	43	22%
Good warnings rarely	193	6	3%

Q5. HOW MANY "FALSE ALARMS" DO YOU GET FROM THE LANE GUIDANCE SYSTEM?

The drivers provided diverse responses as to how often false alarms from the system were received. Most of the drivers indicated that it was once a week or more.

Category	Total Respondents	# of Respondents	%
More than once a day	188	42	22%
About once a day	188	28	15%
Few times a week	188	50	27%
Once a week	188	13	7%
Less than once a week	188	55	29%

Q5A. IS THE SYSTEM VALUABLE EVEN WITH THE FALSE ALARMS?

Almost all (92 percent) of the respondents indicated that the system was valuable even with the false alarms.

Q6. PLEASE DESCRIBE THE TYPES OF CONDITIONS IN WHICH FALSE ALARMS OCCUR.

The drivers were asked an open-ended question regarding when false alarms typically occur. There was a wide range of responses. The most common response was road construction (38 percent), followed by curvy/narrow roads (17 percent) and weather conditions (such as fog) (14 percent). Nine percent of respondents indicated no experience with false alarms. Other responses included:

- Two lanes merging into one
- Pot holes
- Trailer off tracking
- Exit ramps
- Urban areas
- Overhead bridge

Q7. HAS THE SYSTEM HELPED YOU TO BE A BETTER/SAFER DRIVER? IF SO, HOW?

A majority (70 percent) of the drivers indicated that the system had helped them become a better driver. The system had been helpful with a variety of situations and issues, including weather (15 percent), increased alertness (57 percent), and driver awareness of location on the road (28 percent).

Q8. WHAT DO YOU LIKE ABOUT THE LANE GUIDANCE SYSTEM?

When drivers were asked an open-ended question about what they liked about the lane guidance system, the responses were consistent with the issues that the system had helped them improve on. The general responses were categorized into six general topics for analysis. The most common response was that the system helps keep the driver more alert.

Category	Total Respondents	# of Respondents	%
Increases alertness	139	64	46%
Helps driver keep the truck straight	139	35	25%
Weather-related assistance	139	24	17%
Nothing	139	8	6%
Everything	139	6	4%
You can turn it off	139	2	1%

Q9. WHAT IS YOUR OVERALL DEGREE OF SATISFACTION WITH THE LANE GUIDANCE SYSTEM?

Drivers were asked to indicate satisfaction with the system on a scale from very satisfied to very dissatisfied. Most of the drivers were somewhat (28 percent) or very satisfied (40 percent).

Category	Total Respondents	# of Respondents	%
Very satisfied	194	77	40%
Somewhat satisfied	194	55	28%
Neutral	194	50	26%
Somewhat dissatisfied	194	1	1%
Very dissatisfied	194	11	6%

Q10. WHAT WOULD YOU LIKE TO CHANGE ABOUT THE LANE GUIDANCE SYSTEM?

When asked an open-ended question about changes to the LDWS, there was a wide range of responses. Most of the drivers indicated that they would not change anything about the system (57 drivers, 53 percent). Other suggestions included:

- A different type of auditory alert or different volume (both louder and softer were recommended)
- Reduction in the brightness of the indicator lights
- Faster response times
- Reduction of false alarms
- Better functionality in weather such as heavy fog and snow

Q11. DO YOU BELIEVE THE SYSTEM CAN PREVENT CRASHES?

Almost all of the drivers (96 percent) believed that the system can help prevent crashes.

Q12. DO YOU HAVE ANY ADDITIONAL COMMENTS?

When asked if there were any additional comments or incidents that the driver would like to share, drivers provided a great deal of feedback. Almost all of the respondents indicated that it worked well and it improved safety, as well as several respondents described circumstances where it prevented a crash.

Q13. HAS THE SYSTEM EVER CAUSED YOU TO REALIZE THAT YOU WERE GETTING TIRED AND CAUSED YOU TO STOP AND REST?

Only 27 drivers responded to this particular question. Of those drivers, 59 percent indicated that the system had not caused them to realize they were getting tired and to stop and rest, while 41 percent indicated that it had.

SURVEY 3

This survey and focus group effort was conducted by the Liberty Mutual Research Institute for Safety. The focus group included a total of 66 participants in 9 different focus group sessions. The focus group data was used to develop the survey instrument. The survey was conducted and responses were obtained from 198 long-haul truck drivers. Several attempts were made to obtain the original survey instruments and data from this research; however, it was only possible to obtain the summary reports and articles that were written based on the findings. A summary of the information is presented below.

Q1. WOULD TRUCK DRIVERS LIKE TO RECEIVE MORE FEEDBACK ABOUT THEIR DRIVING PERFORMANCE?

Drivers were fairly evenly spread across the continuum from agree to disagree in response to this question. Most of the drivers indicated that they generally received positive feedback and it was more helpful than negative feedback.

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
I receive enough feedback about how I drive.	24%	34%	42%
I would like to receive more feedback about how I drive.	20%	36%	45%
When I receive feedback about how I drive, it is mostly positive feedback.	15%	31%	55%
When I receive feedback about how I drive it is mostly negative feedback.	48%	19%	33%
Positive feedback about how I drive is more helpful to me than negative feedback.	12%	29%	59%

Q2. WHAT ARE THE PERCEIVED BENEFITS OF RECEIVING FEEDBACK ON SAFE DRIVING PERFORMANCE BY TECHNOLOGY?

Drivers generally agreed that feedback from safety technologies could be used in defending driver behavior in the event of a driving incident. The drivers also indicated a belief that the technology could create a safer driving environment. However, drivers disagreed that feedback from in-vehicle technology reduces the stress of truck driving.

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
Data from technology will likely be used to defend me if I am involved in an incident.	28%	16%	56%
In-vehicle technology giving feedback about how I drive will make me a safer driver.	32%	22%	46%
In-vehicle technology giving feedback about how I drive will reduce the stress of driving a truck.	46%	22%	32%

Q3. WHAT ARE THE PERCEIVED DRAWBACKS AND CONCERNS OF RECEIVING FEEDBACK ON SAFE DRIVING PERFORMANCE BY TECHNOLOGY?

Again, the responses were very diverse when drivers were asked about concerns related to safety technologies. Drivers were very concerned about data privacy and data accessibility. Drivers were not concerned about the potential labor pool impacts from the technologies.

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
I want technology to create a record of how I drive.	35%	30%	35%
I am concerned that the data collected by in-vehicle technology will get into the wrong hands.	18%	16%	65%
I am concerned that the technology will be too complex for me to use.	47%	33%	19%
Too many people will be able to drive trucks because these technologies will make the job too easy.	62%	15%	23%
Drivers who depend too much on technology will lose the skills they need to be a safe driver.	36%	12%	52%
Receiving feedback from technology may be a distraction.	28%	24%	49%
I am concerned that technology may not be very reliable.	25%	33%	42%

Q4. WHAT IS THE PREFERRED FORM OF FEEDBACK ON SAFE DRIVING PERFORMANCE BY TECHNOLOGY?

Drivers were asked about a wide variety of display and feedback forms. There was a variety in the responses regarding the most preferred method, indicating that a range of options is the best method of meeting all driver needs and preferences. Over half of the drivers indicated that they would like to receive feedback when requested, rather than automatically, and immediately after an event. Drivers indicated that they do not want to receive the feedback from a computerized voice.

"I would like to receive feedback from technology about how I drive…"

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
…by a display on the dashboard.	34%	19%	47%
…by a computer printout at the end of a shift.	43%	20%	37%
…by a computerized voice.	57%	24%	20%
…when I request it rather than technology delivering feedback automatically.	16%	34%	51%
…at regularly scheduled intervals.	22%	35%	43%
…immediately after the event.	21%	23%	57%
…once a day.	34%	31%	34%
…once a week.	25%	31%	44%
…once a month.	26%	28%	47%
…once every three months.	32%	30%	38%
…once a year.	35%	28%	37%

Q5. FROM WHOM WOULD TRUCK DRIVERS LIKE TO RECEIVE FEEDBACK ON SAFE DRIVING PERFORMANCE?

When drivers were asked to indicate who they would like to receive feedback from, the respondents were split across the continuum relative to receiving feedback from technology rather than a person. When specifying a particular person, most drivers indicated a preference for feedback from the safety director, direct supervisor, a senior manager at the company, or their team driving partner.

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
Receiving feedback about how I drive from technology is as helpful as feedback from a real person.	37%	26%	37%

"I would like to receive feedback about how I drive from …"

Statement	Strongly or somewhat disagree	Neither agree nor disagree	Strongly or somewhat agree
…the safety director of my company.	17%	15%	68%
…my direct supervisor, dispatcher, or driver manager.	21%	18%	61%
…a senior manager in my company.	21%	23%	57%
…a team driving partner.	23%	24%	54%
…other truck drivers.	28%	22%	50%
…a customer.	30%	25%	44%
…a 1-800 "How's my driving" service.	46%	25%	29%
…"four-wheelers."	59%	19%	22%

Q6. WHAT ARE THE MOST IMPORTANT SAFE DRIVING BEHAVIORS?

Drivers were asked to indicate what driving behaviors were considered the most important safe driving behaviors. Responses are listed below from the behaviors selected the most to the least.

- Looking well ahead of my vehicle to adjust to what is happening in front of me (74 percent)
- Expecting other drivers to make driving mistakes and being ready to avoid them – expect the unexpected (55 percent)
- Using turn signals to give other drivers plenty of warning when changing lanes or making turns (49 percent)
- Adjusting my mirrors to prevent blind spots (29 percent)
- Not driving drowsy (28 percent)
- Not driving faster than the posted speed limit (17 percent)
- Wearing my seat and shoulder belt (16 percent)
- Keeping at least two seconds following distance between my rig and vehicles in front (13 percent)
- Not driving distracted (9 percent)
- Being courteous to other drivers (9 percent)

SURVEYS 4 THROUGH 7

These surveys were part of the same FOT for RA&C. For that reason, the results of the instruments are presented together to allow for greater interpretation and understanding of the results. Fifteen drivers completed each instrument. The other eight drivers left the employment of the company where the FOT was being conducted during the study time period. The drivers left employment for a variety of reasons and were not replaced in the study. The drivers who participated were 35 years old or older and most of the drivers had at least 22 years of truck driving experience and 8 years of experience driving a tanker.

SURVEY 4: INITIAL CONTACTS

The 4th survey addressed driver decision-making characteristics. This is the only driver survey to address this particular perspective. Generally, the results indicated that participants invested a substantial thought and examination into their decision-making, and did not have many risk-taking characteristics.

Q1. WHAT AFFECTS YOU WHEN MAKING DECISIONS?

Drivers indicated that they frequently consult others, rely on gut feelings and stick to decisions once made, remain calm when making quick decisions, feel in control of things, take the safe option, plan well ahead, and weigh the pros and cons when making decisions. They indicated that they rarely made decisions without considering all the ramifications. Most of the participants enjoyed making decisions. All of these factors may influence how the drivers may interact with the technology as they make decisions in various driving situations.

	Question	Never	In-frequently	Somewhat infrequently	Somewhat Frequently	Frequently	Always
1.	Do you enjoy making decisions?	0%	0%	0%	13%	39%	48%
2.	Do you rely on your “gut feeling” when making decisions?	4%	4%	22%	30%	30%	9%
3.	Do you like to consult with others?	0%	0%	0%	9%	65%	26%
4.	Do you stick by your decisions come what may?	0%	9%	4%	17%	44%	26%
5.	When you find one option that will just about do, do you leave it at that?	17%	35%	9%	22%	17%	0%
6.	Do you remain calm when you have to make decisions very quickly?	0%	0%	9%	22%	39%	30%
7.	Do you feel in control of things?	0%	4%	9%	13%	35%	39%
8.	How often are your decisions governed by your ideals regardless of practical difficulties?	4%	17%	13%	35%	30%	0%

	Question	Never	In-frequently	Somewhat infrequently	Somewhat Frequently	Frequently	Always
9.	Do you make decisions without considering all of the implications?	39%	35%	22%	0%	4%	0%
10.	Do you change your mind about things?	0%	17%	44%	22%	17%	0%
11.	Do you take the safe option if there is one?	0%	0%	0%	0%	26%	74%
12.	Do you prefer to avoid making decisions if you can?	22%	30%	17%	22%	4%	4%
13.	Do you plan well ahead?	0%	0%	0%	9%	44%	48%
14.	When making decisions, do you find yourself favoring first one option, then another?	9%	30%	13%	9%	30%	9%
15.	Do you carry on looking for something better even if you have found a course of action that is just about OK?	4%	4%	4%	22%	35%	30%
16.	Do you find it difficult to think clearly when you have to decide something in a hurry?	9%	22%	9%	26%	30%	4%
17.	Do you make up your own mind about things regardless of what others think?	4%	0%	13%	9%	52%	22%
18.	Do you avoid taking advice over decisions?	26%	30%	26%	4%	4%	9%
19.	Do you work out all the pros and cons before making a decision?	0%	0%	9%	13%	52%	26%
20.	In your decision-making, how often are practicalities more important than principles?	9%	17%	13%	35%	22%	4%
21.	Is your decision making a deliberate logical process?	4%	0%	0%	22%	44%	30%

Q2 – Q3. WHAT ARE YOUR EXPECTATIONS RELATED TO ONBOARD TECHNOLOGIES?

Drivers were also asked some preliminary questions about expectations related to the RSA and other technologies. Some of these questions are similar, but not completely compatible with questions from other surveys about other technologies. The majority of the participants (79 percent) indicated an expectation that the RSA would somewhat reduce the chances of a rollover. This indicates that, while drivers saw a value in the RSA, they did not expect it to make a dramatic difference in rollover occurrence. Drivers were also asked questions to determine how well they understood this particular technology and the messages it provided.

Q2. I EXPECT THE ROLLOVER ADVISORY SYSTEM TO _____ MY CHANCES OF A ROLLOVER.

Greatly Reduce	Somewhat Reduce	Make no difference
21%	79%	0%

Q3. A ROLLOVER ADVISORY SYSTEM MESSAGE SAYING THAT A CURVE YOU ARE TAKING REQUIRES A SPEED SLOWER BY 3 MPH MEANS THAT…

You should slow down immediately when the message appears	Next time you take this turn or one like it, you should go slower by 3 mph
21%	79%

Q4 – Q6. WHAT IS YOUR TECHNOLOGY EXPERIENCE?

Unlike the other surveys discussed in this section, this particular survey asked drivers about their technology experience both at home and in their truck. Most of the drivers indicated that they did have a computer at home (71 percent) and that they used it occasionally (50 percent) or frequently (30 percent). However, over half (57 percent) also indicated that they know less about computers than most of the people they work with. This is an important distinction regarding how comfortable the drivers may be with technology in general. The drivers who participated in this particular FOT had a generally high interaction level with technology such as computers.

Q4. DO YOU HAVE A HOME COMPUTER?

Yes	No
71%	29%

Q5. HOW OFTEN DO YOU USE IT YOURSELF?

Frequently	Occasionally	Rarely	Never
30%	50%	10%	10%

Q6. WHAT IS YOUR LEVEL OF EXPERTISE ON THE COMPUTER?

I know more about computers than most people I work with.	I know less about computers than most people I work with.
43%	57%

Q7. HAVE YOU USED ANY OTHER "HIGH TECH" TRUCK CONTROL OR INFORMATION SYSTEMS WHEN WORKING WITH OTHER EMPLOYERS IN THE PAST FEW YEARS?

Most drivers (93 percent) indicated that they had used other "high tech" truck control or information systems. A small number of drivers used trucks with the CADEC Mobile Logistics Management System that interfaces with multiple communication systems with GPS, electronic DOT logs, automated state fuel tax reporting, electronic tachograph capability, and route management. Most of these drivers had used trucks with the EATON VORAD CWS installed. Half of the drivers (50 percent) indicated that these systems could useful when driving. Previous experience with in-vehicle technology may impact how receptive drivers are to other new technologies.

Yes	No
93%	7%

Q7A. IF YES, PLEASE NAME THEM.

CADEC and EATON VORAD	CADEC only	EATON VORAD only
15%	8%	77%

Q7B. IN GENERAL, DID YOU SEE THESE SYSTEMS AS …

Useful to you in driving your truck	Creates a problem for you when driving your truck	Not useful to you in driving your truck but not a problem either
50%	29%	21%

Q8. How useful and user-friendly do you anticipate the "rollover advisor and control" to be?

Drivers were asked in this preliminary survey how useful and user-friendly they anticipated the RA&C would be. These questions were posed to the drivers prior to any experiences with this particular technology. Most of the drivers indicated that they were not sure how beneficial this safety system would be to an experienced driver. Almost half of the participants (43 percent) neither agreed nor disagreed that "*high tech systems like these really do not help the experienced driver*". A majority of the participants indicated that there was a good understanding about how to use the RSA (71 percent). This is consistent with the responses to the statements about comfort with the RSA and RSC on the truck. A majority of drivers were comfortable with the RSA (79 percent) and the RSC (64 percent) on the truck.

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
High tech systems like these really do not help the experienced driver.	7%	21%	43%	21%	7%
I have a good understanding about how to use the RSA.	7%	71%	21%	0%	0%
I am comfortable having the RSA on my truck.	0%	79%	14%	7%	0%
I am comfortable having the RSC on my truck.	7%	64%	14%	14%	0%

Q9. How do you feel about having these new technologies installed?

Drivers were also asked a series of questions about their perceptions of risk and vigilance prior to the installation of the RA&C. The participants indicated that they may be better off with these types of technologies; however, the responses were more diverse when drivers were asked about whether the technologies would reduce the chance of rolling the truck (36 percent agreed; 36 percent disagreed) and whether the drivers expected to drive differently with the technology (36 percent agreed; 36 percent disagreed).

Question	Strongly agree	Agree	Neither	Disagree	Strongly disagree
I would be better off driving without these types of high tech advice and control systems.	8%	8%	39%	39%	15%
I don't need the RSA to keep from rolling my truck.	0%	36%	21%	36%	0%
I don't expect to drive any differently as a result of having the RSA in my truck than I would drive without it.	0%	36%	21%	36%	0%

SURVEY 5: SHORT SURVEYS

These surveys were given to the drivers at two points during the study. The first short survey was given after 1 month of RSA use, and the second after 2 months. Generally, responses were similar between the two measurement periods.

Q1. THE RSA IS GIVING ME USEFUL FEEDBACK ABOUT MY DRIVING IN CURVES AND CORNERS.

There was a slight difference in the responses regarding the usefulness of feedback from the RSA regarding driving in curves and corners.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	11%	32%	11%	21%	5%	21%
2	0%	40%	7%	0%	20%	33%

Q2. THE RSC OPERATES SAFELY WHEN IT SLOWS MY TRUCK.

Drivers were also asked to indicate how safely the RSC operates when it is slowing the truck. While there was a great deal of diversity in these responses, most of the participants agreed that the RSC did operate safely when slowing the truck. It is important to note that more drivers experienced RSC systems that were not activated during the second measurement period.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	0%	26%	16%	11%	0%	47%
2	0%	13%	20%	0%	0%	67%

Q3. I AM LEARNING THINGS ABOUT MY DRIVING HABITS FROM THE RSA I HAD NOT KNOWN.

In the short surveys, drivers were asked to indicate whether anything was learned about driving habits from the RSA. In both survey distributions, over forty percent of the drivers agreed or strongly agreed that they had learned things about their driving habits from the RSA. Also, approximately a quarter of the participants in both survey distributions experienced systems that were not activated.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	5%	37%	21%	11%	5%	21%
2	13%	20%	27%	0%	13%	27%

SURVEY 6: LONG SURVEYS

The long form surveys investigated the drivers' experiences and the user-friendliness of the RA&C technology in a more in-depth and thorough manner. The long surveys were given at three different times (3, 4 and 5 months after technology activation).

Q1. HOW DO YOU EXPECT THE RSA TO AFFECT YOUR CHANCES OF HAVING A ROLLOVER?

In the more extensive survey, most drivers indicated that the RA&C would have little or no impact on the chances of a rollover event. It is important to note, however, that approximately a third of the drivers at each survey point indicated the RSA could somewhat or greatly reduce the chances of a rollover. The respondents provided very diverse responses to this question.

Survey	Greatly reduce	Somewhat reduce	Reduce – a little	No difference
1	15%	23%	23%	39%
2	25%	17%	0%	58%
3	22%	11%	33%	33%

Q2. IN GENERAL, DO YOU SEE THESE SYSTEMS AS:

When asked whether the systems were useful in driving or created a problem when driving, almost all of the drivers indicated the system was useful in driving in the third survey distribution. In the first two interview periods, most of the participants indicated that the system was neither useful nor a problem.

Survey	Useful in driving	Creates a problem when driving	Neither useful nor a problem
1	27%	9%	64%
2	36%	9%	55%
3	67%	0%	33%

Q3 – Q12. ARE THE ADVISORY MESSAGES FROM THE RSA USER-FRIENDLY?

At each of the survey points, drivers were asked a series of questions concerning how user-friendly the RSA was and the experiences with particular features of the technology. Most of the respondents indicated that the system was easy to understand, there were occasional false positives, they had a good understanding about how to use the technology, and there were no difficulties in learning how to use the systems.

Q3. THE ADVISORY MESSAGES FROM THE RSA ARE EASY TO UNDERSTAND.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	60%	13%	0%	0%	13%
2	13%	67%	7%	7%	0%	7%
3	13%	47%	20%	7%	0%	13%

Q4. WHEN AN ADVISORY MESSAGE APPEARS, IT IS EASY TO DETERMINE WHICH MANEUVER CAUSED IT.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	20%	47%	13%	0%	0%	20%
2	13%	53%	20%	7%	0%	7%
3	7%	53%	27%	0%	0%	13%

Q5. WHEN I GET AN ADVISORY MESSAGE, IT IS CLEAR WHAT I COULD HAVE DONE DIFFERENTLY TO AVOID GETTING A MESSAGE.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	33%	20%	7%	0%	27%
2	7%	60%	13%	13%	0%	7%
3	7%	53%	27%	0%	0%	13%

Q6. ROLL ADVISORIES ARE SOMETIMES DISPLAYED WHEN THERE IS NO REAL ROLLOVER RISK.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	60%	0%	13%	0%	7%	20%
2	47%	13%	13%	13%	0%	13%
3	33%	20%	20%	7%	0%	20%

Q7. I HAVE ENOUGH TIME TO SAFELY READ THE ROLL ADVISORIES.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	20%	27%	20%	7%	7%	20%
2	20%	13%	20%	27%	7%	13%
3	7%	53%	20%	7%	0%	13%

Q8. THE MESSAGES FROM THE RSA ARE EASY TO READ.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	60%	13%	0%	0%	20%
2	20%	40%	13%	13%	0%	13%
3	13%	47%	20%	13%	0%	7%

Q9. I HAVE A GOOD UNDERSTANDING ABOUT HOW TO USE THE RSA.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	29%	64%	0%	0%	0%	7%
2	27%	60%	0%	7%	0%	7%
3	13%	60%	27%	0%	0%	0%

Q10. I HAVEN'T HAD ANY DIFFICULTY LEARNING HOW TO USE THESE SYSTEMS.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	29%	36%	21%	0%	0%	14%
2	27%	47%	13%	7%	0%	7%
3	15%	46%	39%	0%	0%	0%

Q11. HIGH TECH SYSTEMS LIKE THESE REALLY DO NOT HELP THE EXPERIENCED DRIVER.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	0%	33%	27%	20%	13%	7%
2	20%	13%	33%	27%	0%	7%
3	20%	7%	47%	20%	7%	0%

Q12. THE INFORMATION I GET FROM THE RSA ABOUT ROLLOVER DANGER IS HELPFUL.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	13%	33%	13%	0%	27%
2	13%	40%	33%	7%	0%	7%
3	13%	20%	47%	0%	7%	13%

Q13. CAN THE RSC SLOW YOUR TRUCK SAFELY?

As in the short survey, drivers were asked whether the RSC can safely slow the truck. In the long survey, most of the drivers indicated that the system had not activated. Among those drivers who indicated that the system had activated, most neither agreed nor disagreed with how safely the RSC can slow the truck. The other responses were split.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	0%	0%	36%	7%	7%	50%
2	7%	7%	29%	0%	7%	50%
3	0%	7%	36%	7%	7%	43%

Q14 – Q19. DO THE SAFETY SYSTEMS INCREASE THE STRESS AND FATIGUE OF DRIVING?

Another component of the long survey included questions regarding workload and stress. These questions were designed to gather information about whether the technologies reduced or increased driver workload and stress. The participants were relatively neutral about whether the advisory messages about hard braking were useful and whether the messages and alarms interfered with driving. The drivers were more neutral about the usefulness and interference in the second and third surveys. Across all questions, drivers demonstrated a very diverse range of experiences and opinions about the technology, and the distraction and usefulness of each component. Generally, drivers disagreed with the idea that the messages interfered with driving due to distraction. Drivers were neutral about whether the systems interfered with driving responsibilities. Overall, drivers did not think that the safety systems increased the stress and fatigue of driving.

Q14. ADVISORY MESSAGES ABOUT HARD BRAKING ARE HELPFUL TO ME.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	13%	27%	13%	7%	33%
2	0%	20%	33%	27%	0%	20%
3	7%	20%	33%	13%	7%	20%

Q15. THE ADVISORY MESSAGES AND ALARMS DO NOT INTERFERE WITH MY DRIVING.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	33%	20%	7%	20%	7%	13%
2	13%	0%	53%	13%	7%	13%
3	13%	27%	27%	13%	13%	7%

Q16. THE RSA MESSAGES INTERFERE WITH MY ABILITY TO DRIVE SAFELY BECAUSE THEY DISTRACT ME.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	13%	27%	20%	20%	13%
2	13%	0%	33%	27%	13%	13%
3	7%	7%	47%	20%	20%	0%

Q17. I WOULD BE BETTER OFF DRIVING WITHOUT THESE TYPES OF HIGH TECH ADVICE AND CONTROL SYSTEMS.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	0%	7%	67%	13%	7%	7%
2	0%	13%	53%	13%	13%	7%
3	13%	0%	67%	13%	7%	0%

Q18. THESE SYSTEMS SOMETIMES INTERFERE WITH MY DRIVING RESPONSIBILITIES.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	7%	57%	0%	14%	14%
2	7%	13%	47%	20%	7%	7%
3	7%	7%	57%	7%	21%	0%

Q19. I FIND THAT HAVING THIS SAFETY SYSTEM IN MY TRUCK REDUCES THE STRESS AND FATIGUE OF DRIVING.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	14%	7%	21%	29%	21%	7%
2	13%	0%	27%	27%	27%	7%
3	0%	14%	50%	14%	21%	0%

Q20 – Q24. In what ways, if any, has the RA&C changed your driving?

At each of the long survey distributions, drivers were asked a series of questions about risk and vigilance impacts of the RA&C. Most of the responses were neutral about the impact of the system. However, the drivers agreed with the statements regarding driving more safely with regard to hard breaking. Over the course of the three data collection periods, participants agreed to a lesser extent that the systems impacted driving practices. The drivers generally disagreed that the system reduced the number of crashes or near-crash situations.

Q20. Since the new safety system was activated, I drive my vehicle more safely with regard to rollover risk.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	13%	40%	27%	0%	7%
2	7%	20%	53%	7%	13%	0%
3	7%	27%	47%	7%	7%	7%

Q21. Since the new safety system was activated, I drive my vehicle more safely with regard to hard braking.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	27%	27%	7%	13%	13%
2	7%	33%	27%	7%	13%	13%
3	7%	33%	47%	13%	0%	0%

Q22. With the RSA, I don't drive any differently than I would drive without it.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	40%	27%	20%	7%	0%	7%
2	33%	47%	20%	0%	0%	0%
3	20%	20%	53%	0%	0%	7%

Q23. I DON'T NEED THE RSA TO KEEP FROM ROLLING MY TRUCK.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	13%	60%	0%	7%	7%
2	7%	33%	53%	0%	0%	7%
3	20%	0%	73%	0%	7%	0%

Q24. HAVING THIS SYSTEM IN MY TRUCK HAS REDUCED THE NUMBER OF CRASHES OR NEAR-CRASH SITUATIONS COMPARED TO WHAT I WOULD HAVE HAD WITHOUT IT.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	0%	36%	36%	14%	7%
2	7%	7%	29%	36%	21%	7%
3	0%	7%	21%	50%	21%	0%

Q25. ARE YOU LEARNING NEW THINGS ABOUT YOUR DRIVING HABITS FROM THE RA&C?

As a follow-up to the questions asked during the short surveys, drivers were asked to indicate whether the RA&C provided feedback about driving habits that the driver did not currently know. Most of the participants were neutral about whether they had learned anything from the systems. This was consistent with the short survey responses.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	14%	36%	21%	7%	14%
2	20%	20%	40%	7%	7%	7%
3	14%	14%	50%	7%	14%	0%

Q26 – 30. DOES THE RA&C PROVIDE YOU WITH ACCURATE, USEFUL ADVISORY MESSAGES?

The participants were asked during each long survey distribution to provide information on the product quality and maturity. Most of the participants indicated that the system provides useful advice, and information not normally available. There is some concern with the percentage of respondents who agreed or strongly agreed that some of the maneuvers should have produced advisory messages but did not. Also, more participants agreed or strongly agreed that some advisory messages occurred during perceived safe maneuvers. As with many of the previous questions, there was a great deal of diversity among the responses.

Q26. THE RSA PROVIDES ME WITH INFORMATION ABOUT MY VEHICLE THAT I WOULD NOT NORMALLY HAVE.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	27%	27%	27%	7%	0%	13%
2	33%	20%	20%	20%	0%	7%
3	13%	27%	33%	13%	0%	13%

Q27. THE ADVISORY MESSAGES FROM THE RSA PROVIDE USEFUL ADVICE.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	33%	27%	7%	7%	20%
2	20%	33%	20%	13%	0%	13%
3	13%	33%	33%	7%	0%	13%

Q28. I THINK SOME OF MY MANEUVERS SHOULD HAVE PRODUCED ADVISORY MESSAGES, BUT NONE WERE DISPLAYED AFTER THE MANEUVER.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	27%	7%	27%	13%	13%
2	20%	20%	13%	20%	13%	13%
3	27%	20%	20%	13%	0%	20%

Q29. I AM SURPRISED BY SOME ADVISORY MESSAGES THAT OCCUR DURING WHAT I THINK IS A SAFE MANEUVER.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	27%	33%	7%	7%	0%	27%
2	36%	36%	0%	7%	7%	14%
3	33%	20%	20%	7%	0%	20%

Q30. THE SPEED REDUCTION RECOMMENDATIONS ARE ACCURATE.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	27%	13%	20%	7%	27%
2	20%	13%	40%	7%	7%	13%
3	13%	13%	53%	7%	7%	7%

Q31. THE RSC HAS COME ON AND SLOWED ME AT TIMES I DO NOT THINK IT SHOULD HAVE COME ON.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	13%	0%	13%	7%	0%	67%
2	7%	13%	13%	13%	0%	53%
3	0%	27%	27%	7%	0%	40%

Q32. THE RSC CAN SLOW MY TRUCK SAFELY.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	0%	0%	36%	7%	7%	50%
2	7%	7%	29%	0%	7%	50%
3	0%	7%	36%	7%	7%	43%

Q33. THESE SYSTEMS OFTEN FAIL TO GIVE ME AN ALERT WHEN I THINK THEY SHOULD.

Survey	Strongly agree	Agree	Neither	Disagree	Strongly disagree	System did not activate
1	7%	21%	36%	7%	14%	14%
2	0%	47%	13%	27%	7%	7%
3	0%	21%	43%	7%	21%	7%

SURVEY 7: DEBRIEFING INTERVIEW

Drivers were asked about a wide variety of issues in the debriefing interview.

Q1 – Q5. HOW DID THE RA&C WORK FOR YOU?

Almost all of the drivers (93 percent) indicated that they had seen an RSA message. None of the participating drivers indicated seeing an RSC event. All of the participating drivers indicated that they were able to distinguish between safety-related messages and other messages. Almost all of the participants (93 percent) indicated that it was possible to hear warning sounds when the messages came on, and that the sound was not distracting (85 percent).

	Question	Yes	No
Q1.	While you were driving, do you recall seeing any RSA messages?	93%	7%
Q2.	While you were driving do you recall any RSC events?	0%	100%
Q3.	Could you distinguish the safety-related messages from other informational messages on the message center?	100%	0%
Q4.	Did you hear the warning sound when the messages came on?	93%	7%
Q5.	Did you find the sound distracting?	15%	85%

Q6. HOW MANY RSAS DID YOU HEAR AND HOW EFFECTIVE WAS THE MESSAGE CENTER?

Most of the respondents indicated hearing between 1 and 6 advisories. Over half of the participants rated the effectiveness of the message center as very good (57 percent) or good (36 percent).

Q7. ARE YOU BETTER OFF WITHOUT THESE TYPES OF TECHNOLOGIES?

Less than a third of the participants agreed (13 percent) or strongly agreed (13 percent) that they were better off without these types of technologies. A majority (87 percent) of the drivers indicated that they could describe nothing that was undesirable about the RSA.

Q8. WHAT IS THE DEGREE OF BENEFIT OR HARM THAT THE RSA MIGHT PROVIDE FOR EACH POTENTIAL USER?

A majority of the participating drivers indicated that the RSA would be of great (60 percent) or some (33 percent) benefit to inexperienced drivers. There was more diversity among the perceived benefit to the responding driver, but still over half indicated that the technology would have some benefit (57 percent). Almost three-quarters (73 percent) indicated that the technology provided at least some benefit to experienced drivers.

User	Great Benefit	Some Benefit	No Benefit	Harmful
You	7%	57%	36%	0%
Experienced	7%	73%	20%	0%
Inexperienced	60%	33%	0%	7%

Q9. WHAT IMPACT DID THE RSA AND RSC HAVE ON YOUR LEVEL OF FATIGUE AND STRESS?

As in the previous surveys, drivers were asked about the impacts on fatigue and stress. In the debriefing interview, almost all of the participants indicated that the RSA and RSC had no impact on their level of fatigue and stress. Seven percent of the respondents indicated that the system actually reduced their fatigue; none of the participants indicated that the systems increased fatigue.

Q10 – 14. DID YOUR WORKLOAD CHANGE AT ALL AFTER THE INSERTION OF THE RA&C TECHNOLOGY?

In the debriefing interview, participants were also asked a series of questions about their overall workload. A tested instrument, the Overall Workload Scale[8], was used in this assessment. In the table below, numbers ranging from 20 to 100 are indicative of a range from a very low workload to a high workload. (Blank cells represent unanswered questions.) In almost all cases, the workload stayed the same or decreased after the installation of the RA&C technology. Only nine drivers participated in this part of the data collection due to scheduling conflicts.

		Q10. What was your workload going around a curve on a two-lane road?	Q11. What was your workload taking an off-ramp?	Q12. What was your workload making a fast lane change?	Q13. What was your workload taking an on ramp and merging?	Q14. What was your workload in the worst conditions your ordinarily face?
Driver 1	1	75	80	90	60	95
Driver 1	2	70	80	90	60	95
Driver 2	1	25	50	50	50	80
Driver 2	2	25	40	50	50	80
Driver 3	1			90	90	100
Driver 3	2			90	90	100
Driver 4	1	70	70	30		90
Driver 4	2	40	30	30		50
Driver 5	1	80	20	90	90	95
Driver 5	2	80	20	90	90	95
Driver 6	1	75	100	75	100	
Driver 6	2	75	100	75	100	
Driver 7	1	50	70	95	70	100
Driver 7	2	50	50	95	70	100
Driver 8	1	30	50	70	50	70
Driver 8	2	30	50	70	50	70
Driver 9	1	30	40	100	60	100
Driver 9	2	30	42	100	60	100

1 – Before Activation; 2 – Past 5 months

[8] Vidulich, M. A., & Tsang, P.S. (1987). Absolute magnitude estimation and relative judgment approaches to subjective workload assessment. *In Proceedings of the Human Factors Society 31st Annual Meeting* (pp. 1057 - 1061). Santa Monica, CA: Human Factors Society.

Q15 – Q17. WHAT WAS THE EFFECTIVENESS OF THE RA&C?

When participants were asked to provide information about the effectiveness of the RA&C, most of the participants indicated that they received some incorrect messages (64 percent). All of the drivers indicated that the training received was adequate and that driving occurred the same way on an RA&C equipped truck as in any other truck.

	Question	Yes	No
Q15.	Did you ever get some messages you thought were wrong?	64%	36%
Q16.	Do you drive differently in an RA&C equipped truck than you do in other trucks?	0%	100%
Q17.	After 5 months of use, do you think the training you received was adequate?	100%	0%

Q16. HOW WOULD YOUR RATE THESE SIX SAFETY TECHNOLOGY SYSTEMS?

In the debriefing interview, drivers were asked to rank a series of safety technology systems. Drivers were asked to rank the options from 1 to 6 with regard to which options should be installed on fleets. The technologies are shown below with the average rank for each.

Technology	Rating	Range
Forward CWS	2.63	1 to 6
LDWS	2.81	1 to 6
RSA	3.06	1 to 5
Interior upgrade	3.31	1 to 6
RSC	3.94	2 to 6
Hard braking event detector	3.94	2 to 6

CONCLUSION

According to the driver surveys, drivers were generally positive about onboard safety systems. The surveys represented a limited number of respondents who were surveyed or interviewed on a limited number of topics. The surveys for this study indicated that, while drivers were generally positive about the technologies, there was diversity among their acceptance of the systems, preferences regarding implementation and actual technology use, and impacts on driving practices. Additional research and reviews of existing driver surveys can provide further insight into what key components impact the driver reactions to these types of safety technologies.

The current survey findings indicated that there is a period of adjustment for drivers in acclimating to a new technology in the truck. Generally, drivers perceived some technologies (such as CWS and LDWS) as more useful than other technologies (RSA). In addition, often these technologies were perceived as more beneficial for inexperienced drivers than experienced drivers.

There are a myriad of factors that impact how drivers will react to technologies in the cab, including decision-making processes and behaviors, attitudes and experiences with technology in general, and previous experience with new technologies in trucks. All of these factors may change as these technologies become more prevalent and technology in general becomes a larger part of day-to-day life for drivers.

The findings from the various driver surveys were relatively consistent with the findings from the fleet surveys and interviews. Driver acceptance of the systems is critical to the actual use and success of any in-vehicle technology. Only by gathering information about driver experiences, preferences, and challenges will it be possible to alter, if necessary, the distribution and implementation of the systems.

The existing research provides insight into driver acceptance of onboard safety systems; however, there are still many areas related to driver acceptance and use that can be explored. These areas include more in-depth exploration of training experiences, examination of usage patterns and practices, and analysis of a wider range of technologies rather than focusing on one or two in particular. Furthermore, anecdotal industry information indicates that the “right” safety technologies could also be promoted as driver retention and fleet management tools.

8.0 OTHER STAKEHOLDER SURVEY INSTRUMENTS RESULTS

As part of the larger report, *Factors in Decisions to Make, Purchase, and Use Onboard Safety Technologies*, FMCSA conducted interviews with original equipment manufacturers (OEMs) and vendors, as well as insurance companies. A synopsis of the findings is provided below.

OEM AND VENDOR INTERVIEWS

The interviews followed a semi-structured format, with the respondents guiding the exact topics and issues that were covered. Most of the interviews echoed information from the fleet interviews and surveys that ROI was key to the purchase and implementation of onboard safety technology.

Familiarity with the systems and appropriate marketing is important.

Among the OEMs, there was some familiarity with a few of the major safety technologies that have been discussed earlier in this report, including CWS and ACC. There was less familiarity with RSC. The OEMs estimated that approximately 10 to 20 percent of new vehicle orders would include safety technologies as options. Several respondents discussed the importance of targeting the safety technologies appropriately to fleets; particular industry segments would benefit from specific features and not from others.

The bottom line and ROI are crucial.

According to these interviews, OEMs were motivated to incorporate what customers will purchase; therefore, the bottom line is critical. Consistent with the fleet findings, when a financial benefit can be shown, the acceptance rate increases. However, due to the newness of the technology, the respondents felt that there was not enough real-world data and information about its financial benefits. Carriers and owner-operators were willing to purchase trucks with the safety technologies if there was evidence of reduced costs through crash or insurance premium reductions. Several of the respondents indicated that the safety technologies were currently not affordable for most carriers.

Working toward providing data regarding technology validity and reliability is important.

The surveys showed that there is skepticism among carriers and drivers about the technologies. The respondent felt that as both groups become more confident in the reliability and value of the systems, there will be greater acceptance. They indicated that systems must require little maintenance and upkeep beyond the traditional maintenance schedules, and function under all conditions to receive support and become more widely used. A few respondents indicated that public awareness may help facilitate the recognition and awareness of the benefits of safety technologies.

Driver opinion and acceptance is crucial.

Consistent with both the fleet and driver surveys, driver opinions of this type of equipment are receiving more and more attention. According to the respondents, driver dissatisfaction will often lead to the driver disabling or sabotaging the system. When technologies are user-friendly, it is often easier to gain driver acceptance and use.

The respondents felt that drivers are also concerned about how the data will be used if these systems record information.

Support from insurance industry and government is important.

OEMs indicated that there had not been support insurance rate reductions or other incentives when safety technologies are used.

INSURANCE INTERVIEWS

The insurance interviews followed a more structured outline. Five respondents were interviewed on a number of topics, including system benefits, familiarity with technologies, and factors impacting decisions to purchase and use technologies.

Q1. WHAT IN-VEHICLE SAFETY TECHNOLOGIES OR SYSTEMS ARE YOU AWARE OF?

Only one respondent indicated not being aware of any safety technology system. The other respondents indicated an awareness of a range of systems, including the following:

- CWS with ACC (4 respondents)
- LDWS (3 respondents)
- GPS (1 respondent)
- Fatigue technologies to track eye movement (1 respondent).

Q2. ARE YOU FAMILIAR WITH CWS WITH ACC, LDWS, OR RA&C?

Respondents were asked to indicate familiarity with each of the three technologies from the field operational tests. Again, one respondent indicated he was unfamiliar with all three. Four of the respondents indicated familiarity with CWS and LDWS. Only one respondent indicated familiarity with the RA&C.

Q3. WHAT FACTORS IMPACT THE DECISIONS OF CARRIERS TO BUY AND USE ONBOARD SAFETY TECHNOLOGIES (EITHER RETROFIT OR AS ORIGINAL TRUCK EQUIPMENT)?

Respondents were asked to rank on a scale of 1 to 5 from not important to very important a range of factors related to purchasing and implementation decisions. Consistent with the fleet surveys and interviews, cost to install and maintain was considered very important by all but one of the respondents. Three respondents thought that the effectiveness of the system for improving safety and reducing crash-related costs was very important.

Category	1	2	3	4	5
Cost to install and maintain	0%	0%	20%	0%	80%
Cost to train drivers in use	20%	20%	0%	0%	0%
Overall driver satisfaction/ reduced turnover	0%	20%	20%	0%	0%
Driver acceptance of a system	0%	0%	0%	0%	40%
Accuracy and reliability of a system	0%	0%	0%	40%	40%
Effectiveness of a system in improving safety	0%	0%	0%	20%	60%
Insurance company requirement	40%	20%	0%	20%	0%
Reduced insurance premiums	20%	0%	0%	20%	40%
Reduced crash-related costs	0%	0%	0%	20%	60%
Tax incentives	0%	20%	0%	40%	0%

CONCLUSION

The interviews for this section provided insight into the perspectives of other industry stakeholders, as well as information about how these stakeholders view drivers and carriers and the efforts to increase safety technology implementation and acceptance. The responses confirmed the findings of the fleet and driver interviews and surveys that ROI, driver acceptance, and data about safety and reliability impacts are crucial to carrier acceptance and implementation of these systems. Also, similar to the previous findings, CWS, ACC, and LDWS were more widely recognized by both groups than RSC.

A larger sample of survey responses could provide more insight into what could be done to facilitate wider implementation of safety technology systems and increase the recognition by insurance companies of the achieved safety benefits. This type of information could inform and guide other research studies related directly to the safety benefits of the different technologies. Additional survey research should also gather information about how vendors and OEMs currently share information with customers about safety technologies. Understanding these different means of information sharing would be very useful to increase the implementation and acceptance of these types of systems.