WHAT WILL BE THE IMPACT OF INTELLIGENT COLLISION-MITIGATION SYSTEMS ON A STATEWIDE TRAFFIC LAW ENFORCEMENT AGENCY BY 2013?

A project presented to
California Commission on
Peace Officer Standards and Training

By

Assistant Chief Teresa Becher
California Highway Patrol

Command College Class XXXVI

Sacramento, California

September 2004

This Command College project is a FUTURES study of a particular emerging issue in law enforcement. Its purpose is NOT to predict the future, but rather to project a number of possible scenarios for strategic planning consideration.

Defining the future differs from analyzing the past because the future has not yet happened. In this project, useful alternatives have been formulated systematically so that the planner can respond to a range of possible future environments.

Managing the future means influencing the future: creating it, constraining it, adapting to it. A futures study points the way.

The view and conclusions expressed in this Command College project are those of the author and are not necessarily those of the Commission on Peace Officer Standards and Training (POST).

Copyright 2004
California Commission on Peace Officer Standards and Training

TABLE OF CONTENTS

LIST OF TABLES iii

LIST OF APPENDICES iv

Chapter 1
ISSUE IDENTIFICATION
Introduction 1
Statement of the Issue 2
Background 2
Current State 4
Existing Systems 4
Other Intelligent Vehicle Uses and Functions 7
Main Issues 8
Future 10
Intelligent Vehicle Initiative (IVI) 11
Systems in Development 12
Summary/Conclusions 14

Chapter 2
FUTURES STUDY
Introduction 16
Nominal Group Technique 16
Description of the Process 16
Trend Identification and Analysis 17
Event Identification and Analysis 20
Cross-Impact Analysis 25
Alternative Future Scenarios 27
Pessimistic 27
Optimistic 28
Surprise Free 30
Chapter Conclusions 31

Chapter 3
STRATEGIC PLANNING
Introduction 32
Vision and Goal 32
Organizational Description 33
Organizational Analysis 35
Strengths 35
Weaknesses 36

Opportunities....36
Threats....37
Stakeholder Analysis....38
Strategy Development....40
Chapter Conclusions....41

Chapter 4
TRANSITION MANAGEMENT
Introduction....42
Identification and Discussion of Critical Mass....42
Commitment Planning....44
Responsibility Charting....47
Evaluation Methodology....50

Chapter
CONCLUSIONS
Introduction and Project Review....51
Conclusions and Recommendations....57

REFERENCES....64

LIST OF TABLES

Tables

2-1 Trend Analysis.....18

2-1 Event Analysis.....22

2-3 Cross-Impact Analysis.....26

4-1 Commitment Chart.....45

4-2 Responsibility Chart.....49

LIST OF APPENDICES

Appendix

A List of Candidate Trends.....61

B List of Candidate Events.....62

C List of NGT Panel Members.....63

CHAPTER 1

ISSUE IDENTIFICATION

Nearly 43,000 people died last year in traffic collisions in the United States, and the traffic safety community is struggling to keep that number in check using traditional approaches in education, enforcement and roadway engineering (NHTSA, 2002). In contrast, technology advances in intelligent vehicles are moving forward rapidly worldwide (Bishop, 2004). Based on project research in this area, the basic technology already exists to mitigate traffic collisions through intelligent in-vehicle sensors, communication systems and electronic vehicle control technologies. The main reasons these technologies are not fully developed and mass-installed on all vehicles are cost, reliability, and a lack of consumer awareness (Poretto, 2003). The impact of these systems on law enforcement, and particularly traffic law enforcement, could be substantial depending on how the technology is implemented, used and received by the public and traffic safety stakeholders.

The focus of this paper is to determine what impact intelligent collision-mitigation systems (CMS) will have on a statewide traffic law enforcement agency by 2013. A 10-year timeframe is designated because it will take at least that long for CMS to take hold in the mass-vehicle market. Chapter 1 will outline the background, current state and future of CMS, and then draw conclusions as to where the issue will be in 2013.

Statement of the Issue

Background

The following terms will be used throughout the research project. First on the list is Intelligent Transportation Systems (ITS). According to the U.S. Department of Transportation, highway ITS can be generally defined as any technologies used primarily to enhance the movement and/or safety of vehicles on the nation's system of highways. The systems include everything from smart corridors that can send and receive traffic information in various forms, to completely autonomous highway systems that can drive a car with little input from the driver.

Next, is the Intelligent Vehicle Initiative (IVI) and references to Intelligent Vehicles (IV). The IVI is part of the Transportation Equity Act for the 21st Century (TEA-21), a federal law passed in 1998 directing and authorizing allocation of federal transportation dollars. The IVI funds research and development of intelligent vehicle (IV) systems, which include in-vehicle and vehicle-to-infrastructure (roadway) systems that assist in collision-mitigation and traffic management. These systems can provide navigational information, unlock doors, notify Emergency Medical Services (EMS) of a collision, hamper auto theft, and mitigate collisions in various ways. Intelligent vehicles are a vehicle-oriented subset of Intelligent Transportation Systems (ITS).

Finally, the project uses the term intelligent collision-mitigation system (CMS). As defined, this term is a subset of intelligent vehicles and refers mainly to those systems or portions of systems used or designed specifically for collision-mitigation. Collision mitigation is defined broadly here as reducing the occurrence of collisions, reducing the severity of an impending collision and/or lessening the injuries sustained. Intelligent

CMS ranges from *black box* technology that stores collision information for analysis to systems that actually intervene for the driver to avoid a collision. The focus of this paper is on intelligent CMS and its impact on collisions and traffic law enforcement.

According to the Department of Health Services, fatalities and injuries from traffic collisions are the nation's number one public health issue. Fatalities and injuries from collisions are also the primary concern for large traffic law enforcement agencies. In the United States, 42,815 people died from injuries sustained in traffic collisions in 2002 (NHTSA, 2002). In California alone, 4,089 persons died and 310,689 were injured in a total of 544,742 crashes (SWITRS, 2002). Traffic law enforcement agencies are involved in all aspects of traffic management, and their primary goal is generally to reduce death and injuries associated with collisions through education, enforcement and collision investigation.

Officers undergo hundreds of hours of training to develop traffic expertise. Furthermore, large departments establish specialized collision investigation teams to handle the more complex or high profile investigations. These teams specialize in collision reconstruction using physics and the dynamics of the roadway and vehicle structure to determine what happened. For example, the California Highway Patrol (CHP) has what is referred to as MAIT teams (Multidisciplinary Accident Investigation Teams). These teams are called out to multiple fatality or high-profile collisions that require comprehensive investigation and analysis. MAIT officers have the highest level of training for collision reconstruction provided and use advanced technology to literally recreate the collision.

Current State

Intelligent CMS systems can be segmented into systems that gather information about the vehicle environment (sensors and black box data); increase safety by enhancing vision or control (night vision); advise or warn the driver about collision potentiality (collision warning); or partially or fully control the vehicle (collision avoidance). Currently, all of the building blocks necessary to implement even the most futuristic CMS exist in basic form. Many of them, in fact, are in use in cars sitting on sales lots today. Global Positioning Systems (GPS) that track the vehicles movements, General Motors' OnStar emergency communications option, electric steering, power brakes and independent wheel control are all examples of CMS in demand by today's sophisticated buyer.

It is only a matter of time before highly refined sensor nets (laser, radar, video and impact control technologies) become commonplace on the car of tomorrow. The real work in CMS is in choosing the best mix of technologies and adapting them for the vehicle-highway environment. How best to optimize the human-machine interface, defining workable deployment paths and cultivating government-industry cooperation to accelerate deployment are questions yet to be answered (Bishop, 2001). The subsections that follow review existing CMS systems, other related applications and the main issues the industry is grappling with in the current state.

Existing Systems

A review of the literature reveals a large number of in-vehicle CMS systems already in use or just being introduced. The following is a listing of general types rather than specific brands of systems and their capabilities (compiled from multiple sources,

including Delphi Corporation, 2003; Fitzenberger, 2003; Ford Motor Company, 2003; General Motors, 2003; Toyota, 2003; Visteon, 2003, Austen, 2003 and USA Today, 2003):

- Black Box Systems – are currently installed in an estimated 25-40 million vehicles and were originally designed to monitor airbag deployment and capture basic information like vehicle speed, throttle position and seatbelt use in the five seconds immediately preceding a collision. Modern after-market versions record data such as speed, seatbelt use, hard braking, hard cornering, pedal-to-metal acceleration and throttle position for longer periods and in a format that can be easily uploaded to a business or home computer. Fleet managers (and parents of teenage drivers) are the prime market for the more comprehensive information available in these systems.
- Crash Notification Systems – use GPS technology to provide mapping/vehicle location functionality tied to impact sensors that can determine the severity of a crash and inform the EMS system when/where a collision has occurred.
- Collision Warning Systems for Passenger Vehicles and Heavy Trucks – use radar and video monitors to sense the environment 360 degrees around the vehicle and provide audible and visual warnings when collisions may occur.
- Lane Departure Warning Systems – visually track the lane lines and warn when a driver is crossing them if a turn signal has not been activated.

- Night/Fog Vision Systems – use near-infrared technology to enhance vision by projecting the road scene onto the windshield as an enhanced heads-up image. These systems also include advanced front-lighting that directs the headlight beams to match the vehicle direction of travel and adjusts the beam strength automatically for external environmental conditions.
- Backup Warning Systems – use video cameras mounted in the rear of the vehicle and/or radar sensors to warn when an obstruction is in the vehicle's path of travel while backing.
- Stability Control Systems –basic systems monitor tire pressure and notify the driver when it is too low. Another system compares input from sensors monitoring steering, traction and a vehicle's direction of travel. If the system finds the vehicle is not heading in the direction it is being steered, it can apply braking independently to each of the four wheels, as necessary, to get the vehicle back on track.
- Adaptive Cruise Control (ACC) – cruise control that senses when the vehicle is overtaking another and brakes automatically to compensate. ACC then accelerates again when clear.
- Pre-Crash Systems – multiple intervention systems that use radar and video based sensors to detect vehicles and obstacles ahead; provide warnings to the driver; and when a collision is imminent, tighten the seatbelts and assist in braking; only offered in models in Japan.

Other Intelligent Vehicle Uses and Functions

To help determine what might impact the progress or design of intelligent collision-mitigation systems, it is important to understand the current and potential uses for intelligent vehicle systems outside of the collision environment. Many of these capabilities strengthen the likelihood that advanced IV systems and CMS will be natural successors to current capabilities such as:

- Traffic Congestion – on board vehicle navigation and information systems advise drivers what routes to take to avoid traffic delays.
- Vehicle Service Systems – provide roadside assistance for emergencies, remote door unlock, and remote vehicle diagnostics for breakdowns.
- Communications Interface – many IV system providers will integrate cellular and other communications technologies into their existing systems to create a centrally managed vehicle environment.
- Auto Theft – *Mayday* systems allow owners to call and report if a vehicle is being or has been stolen. GPS technologies can shut down and lock the vehicle while law enforcement is called and given its exact location.
- Pursuit Intervention – Using Mayday systems, law enforcement could end a pursuit immediately if they knew the vehicle was so equipped (capacity not yet established).
- Homeland Security/Amber Alert – with GPS technology, any known vehicle could be tracked and stopped instantly for criminal investigation (capacity not yet established).

Main Issues

The main issue is whether drivers will want CMS technology. Most drivers feel they are more in control of their vehicles than other drivers around them, which may result in a reluctance to relinquish control of their car to a computer. Consumer interest in the systems will depend on cost, reliability and user comfort with the products. Additionally, there must be user confidence that the systems will not be used to violate personal freedoms. The following list outlines some of the major issues that have been raised thus far relative to CMS technology (compiled from multiple sources including Bishop, 2003; Crouch, 2003; Pike, 1999; Paniati, 2004; Scladover 2004; and Seiler, Bongsob & Hedrick, 1998):

- Human Factors –technology that is too complicated to use or provides too many false alarms will be ineffective and may cause dangerous driver distraction or confusion. This issue is a primary concern for groups representing the older driver. They feel test procedures for CMS technology should be scaled to reflect the elderly population. Some opponents also suggest these technologies make drivers lazy or unduly passive in their normal driving habits.
- Commercial Vehicles – CMS functionality and the way large tractor trailer combinations react in an emergency set this user group apart from regular vehicle technology development for intelligent CMS. Development of commercial technology and standards must be kept separate and must include the commercial industry.

- Privacy Issues/*Big Brother* – while black box proponents say the devices can provide objective information about a crash, privacy advocates fear law enforcement will retrieve and abuse the information without safeguarding their freedom. Currently, the information cannot be retrieved without permission or a warrant. Similarly, GPS technology can locate any equipped vehicle. Law enforcement sees the technology as a way to prevent auto theft, safely manage pursuits and curtail certain criminal activities. Opponents see it as *Big Brother* watching and controlling them.
- Other Systems - as CMS advances toward vehicle-to-vehicle and vehicle-to-infrastructure capability, communications capabilities will partially drive technology development. Congress recently allotted 75 MHz of radio bandwidth dedicated to intelligent transportation uses. Known as dedicated short-range communication (DSRC), this frequency allotment is an important milestone in developing more advanced intelligent CMS systems.
- Liability – as CMS moves toward partial or full vehicle control capabilities, auto manufacturers and after-market vendors may incur liability if the system fails. As systems move to vehicle-to-vehicle and vehicle-to-infrastructure communication, the list of potentially liable entities increases dramatically to include road departments, monitoring centers and other ITS vendors. The litigious nature of American society is why some CMS technology is only offered in other countries so far.

- Development of Standards – CMS systems use a variety of complex algorithms to calculate when the vehicle should warn or intervene in an impending collision. Additionally, vendors approach human interaction with a CMS device in a variety of ways (e.g. warning light vs. buzzer, voice activated versus push button, et cetera). While standards will be critical to systematic development of CMS, federally mandated standards for these systems could slow advancement of the technologies as manufacturers and vendors have to adjust existing systems to comply.
- System Security/Susceptibility to Tampering – currently, CMS relies heavily on radar, video and GPS, all of which can be jammed or distorted. Additionally, future vehicle-to-vehicle and vehicle-to-infrastructure systems will rely on short-range radio communication to function (also susceptible to tampering). The success of CMS will hinge on the industry's ability to safeguard proprietary technology and law enforcement's ability to deter this new type of crime.

Future

In the United States, there are currently 292 million people (U.S. Census Bureau, 2004) traveling in 235 million vehicles (SWITRS, 2002). In California, those numbers are 34 million (U.S. Census Bureau, 2004) and 25 million respectively (DOF, 2000). By 2013, California projections indicate there will be 8-9 million more people traveling in 5 million more cars with no substantial increase in highway miles (CalTRANS, 2000). The future of vehicle safety and collision mitigation is in technology. As a result, the federal government authorized funding for the Intelligent Vehicle Initiative (IVI), which is

intended to be the driving force behind research and development of CMS technology. An important goal of the IVI is the development, testing and marketing of CMS technology by 2013.

Intelligent Vehicle Initiative (IVI)

Recognizing the benefits of intelligent vehicles in collision mitigation, Congress originally authorized funding for the IVI in the Transportation Equity Act for the 21st Century (TEA-21) in 1998. TEA-21 authorized $1.3 billion over six years. The most recent reauthorization for 2004 allotted $1.7 billion more.

The goal of IVI is to reduce motor vehicle crashes by accelerating development of driver assistance safety products (U.S. Department of Transportation, 2002). IVI focuses on the most common crash types including rear-end, intersection, road departure and lane change collisions. IVI also seeks to develop vision enhancement, vehicle stability and driver condition warning systems (e.g. drowsy driver). In partnership with states, research facilities, the auto industry and after-market vendors, IVI provides substantial funding for development of countermeasures for four vehicle platforms: light, commercial, transit and specialty (e.g. snowplows) vehicles.

Implementation of IVI by the U.S. Department of Transportation has enabled vehicle manufacturers and fleet owners to put new safety technologies on the road more quickly, where they can save lives that otherwise would have been lost (U.S. Department of Transportation 2002). IVI also ensures that human factors are taken into consideration, radio spectrum is made available for communications links and performance requirements are defined and standardized. The following section outlines CMS technologies under development either through IVI or through other research

mechanisms (compiled from multiple sources including Delphi Corporation, 2003; Ford Motor Company, 2003; General Motors, 2003; Toyota, 2003; Visteon, 2003; Bennett, 2003 and Whitfield, 2003).

Systems in Development

- Advanced Black Boxes – will provide more information in formats more easily downloaded. Future systems may also provide information about a vehicles movement directly to on-board emergency systems, other vehicles and the infrastructure, and possibly even to law enforcement in real time.
- Advanced On-Board GPS Systems – will be able to detect the number of occupants in the vehicle and whether they are wearing seatbelts. It will also advise drivers when they are exceeding speed limits and warn when vehicles are moving out of the designated traffic lane. Finally, it will put crash data on its website for the traffic safety community to use in analyzing collisions.
- Advanced Monitoring – cameras combined with GPS and radar systems mounted inside the vehicle and 360 degrees on the exterior will form a safety net for the vehicle. The interior systems will monitor the condition of the driver and passengers. Using inexpensive wireless technology and the navigation system, the exterior sensors will talk to each other, other vehicles and the roadway infrastructure to form a virtual floating safety network over distances as great as 500 meters.

- Advanced Front/Rear Crash Systems – in addition to expanded monitoring systems, crash systems will extend the front/rear bumper to absorb greater impact and intentionally dip the front end of the vehicle (on SUVs and trucks), if necessary, so unavoidable collisions will be bumper to bumper.
- Road Departure Avoidance Systems – using cameras that visually monitor lanes and/or GPS navigation systems, will warn drivers when they are about to drift off the road and crash or when they are approaching a curve too fast.
- Intersection Collision Avoidance – using vehicle-to-vehicle and vehicle-to-infrastructure communications, will warn drivers they are about to run a red light or crash into a vehicle crossing their path. These systems will also automatically brake to avoid or lessen the impact of the collision.
- Rollover Systems – warn drivers they are about to roll over, retracting seatbelts and/or implementing stability control intervention by the vehicle.
- Pedestrian-Protection Devices – a computer sensor embedded in a car's bumper will recognize when a human has been hit. Within milliseconds the sensor inflates two steel accordion-like devices under the hood, which now has room to collapse and absorb the impact. Other radar-based systems will recognize humans in the path of a vehicle and provide driver warnings. Most of this research is being done in Europe. In fact, the European Commission has mandated pedestrian protection devices in all new vehicles by 2005.

Summary/Conclusions

Intelligent CMS technology is rapidly advancing in the automotive industry with support from the federal government and the majority of the traffic safety community. Technology solutions could greatly assist law enforcement in fulfilling its mission relative to traffic safety by reducing the number of injuries sustained in collisions and saving lives. Intelligent CMS will definitely change the way law enforcement manages traffic, and responds to and investigates collisions. It will also impact the public's attitude about safe driving in the future. Allowing or depending on a vehicle to manage the driving environment is very different than practicing safe, defensive driving habits. In addition, intelligent CMS could positively impact other police responsibilities like pursuits, Amber alerts and auto theft by providing locator and tracking information coupled with the ability to shut down a vehicle.

One of the most promising benefits of CMS, internal to a large traffic law enforcement agency, is to reduce the number of officers killed or injured in the line of duty as a result of traffic collisions. According to the California Highway Patrol (CHP), Office of Public Affairs in 2004, 201 officers have been killed in the line of duty during CHP's 75 year history. Fully 70 percent of those deaths were the result of a traffic collision. Installation of intelligent CMS technology on all vehicles driven by that agency could greatly enhance employee and officer safety.

The remainder of this project will explore the impact of intelligent collision-mitigation on a large traffic law enforcement agency by 2013. As a way to help foster implementation of these systems on all vehicles over time, the project will propose to develop and install intelligent CMS for all vehicles in a large traffic law enforcement

agency to enhance employee and officer safety, and improve effectiveness. The next chapter will identify trends and events that may impact this issue over the next ten to fifteen years.

CHAPTER 2

FUTURES STUDY

Futures study is essential to determine the impact of intelligent collision systems on a statewide traffic law enforcement agency by 2013. However, futures forecasting can seem like speculation unless a structured model is employed to lend credibility to the outcome. Using a Nominal Group Technique (NGT), this chapter will identify and analyze the trends and events that could possibly impact the project issue in the future, as identified by a group of subject matter experts in the field. A cross impact analysis will then be presented to assist in determining the level of impact potential events will have on important trends. Finally, using this information and related research, optimistic, pessimistic and surprise-free alternative possible future scenarios will be presented.

Nominal Group Technique

Description of the Process

The NGT process is a structured facilitation process designed to provide informed input on a specific issue (Esensten, 2003). In this case, an NGT panel convened in April 2004, was asked to identify and forecast trends and events that could possibly impact development of intelligent collision-mitigation systems. There were eleven panel members representing some of the most important stakeholders in the traffic safety/CMS community. Members included representatives from the Program for Advanced Transit and Highways (PATH) at the University of California at Berkeley, Federal Highway Administration (FHWA), the California State Automobile Association (insurance industry and motorist representation), the American Association of Retired Persons

(AARP), the California Trucking Association (CTA), the California Department of Transportation (Caltrans), the Office of Traffic Safety and the IVI Brake and Steer by Wire Committee, the average driver (layperson) the CHP (See Appendix C for detailed panel makeup).

Trend Identification and Analysis

The panel was first asked to brainstorm trends that could impact the development of intelligent CMS. Trends were defined as something that may have happened in the past, was happening now and/or will continue to happen in the future. The trends could be quantitative or qualitative but had to be measurable in some form (see Appendix A for the complete list of candidate trends developed). After this list was developed, the panel was asked to vote on the most important trends. In this case, nine trends were identified as most likely to impact collision systems. The panel members were then asked to estimate the level (growth or reduction) of the trends 5 years ago, 10 years from now and 15 years from now, using 100 as a standard value for the present. Information from panel members was then summarized onto one table using the median value computed for each category. Table 2-1 summarizes the trends identified and the data developed from this exercise. The information following the table defines what the panel meant by each trend and provides an assessment of the most critical trends and/or the trends with the largest variation over time.

Trend Analysis (Table 2-1)

TRENDS	-5 Years	Today	+10 Years	+15 Years	Concern
1. Level of public funds for transportation projects.	125	**100**	90	90	10
2. Level of driver training in CMS technologies	100	**100**	90	90	7
3. Level of focus on liability for CMS	90	**100**	110	120	7
4. Level of reliability of CMS technology	80	**100**	125	135	8
5. Level of public acceptance of CMS technology	80	**100**	120	130	6
6. Rate of development of smart roadway infrastructure	80	**100**	120	130	6
7. Level of Population	90	**100**	110	120	7
8. Level of development of efficient mass transportation.	80	**100**	120	125	8
9. Level of societal sensitivity to privacy issues.	90	**100**	115	125	7

T1: The level of public funds for transportation projects

Much of the research into CMS technologies has been funded by federal transportation dollars. The NGT panel believed that allocation would be reduced over the next 10-15 years and the concern level was very high (10) that any loss of funding would negatively impact CMS development.

T2: The level of driver training including CMS technologies

The panel felt driver training that included how to use new technologies would positively impact public acceptance of these systems and reduce the number of collisions caused by distraction of the systems. However, they were concerned that driver training would actually decrease over the next 10-15 years because of budget impacts in the state.

T3: The level of focus on liability for CMS

In this litigious society, the panel felt focus on liability issues relative to CMS technology would increase somewhat in the next 10 years and continue to increase in the next 15 years as new, untried technologies were introduced. The concern level is 7 because lawsuits can significantly hamper introduction of CMS to the mass market.

T4: Level of reliability of collision mitigation technology

The NGT panel felt that as technology in this field becomes more advanced, reliability will automatically and substantially increase. The concern level was eight because the panel felt reliability would directly impact acceptance of the technology.

T5: Level of public acceptance of collision mitigation technologies

The NGT panel believed that acceptance of vehicle technologies in general will increase sharply over the next 15 years as new devices are tested, proven and mass-produced. Most of the sophisticated vehicle technologies currently in use are considered "toys" to the public at large. The concern level for this trend was six because the panel felt if reliability was proven, acceptance would automatically follow.

T6: Rate of development of smart infrastructure

The panel defined this category as installation of existing intelligent roadway technologies plus the short wave radio systems and sensors necessary for vehicle-to-infrastructure communication for CMS. Rapid evolution of these and other technologies is expected by the group. However, the numbers indicated by the panel tended to reflect how quickly they felt the technology would be installed. The concern level was six because vehicle-to-infrastructure communication is important but not critical to mass-producing basic CMS technologies.

T7: Level of population

The NGT group defined the level of population as important because it will dictate both the number of cars on the road and commute distances. Fairly steady growth is expected. The level of concern is seven because the number of vehicles in California directly impacts the issues faced in traffic safety and the funding received from the federal government to mitigate collisions.

T8: Level of development of efficient mass transit

The group defined this category as specific to government providing efficient mass transit to encourage its use among the public. Increased development and use of mass transit as an alternative to driving has a positive influence on traffic safety but could also have a negative impact on development of CMS. The group thought there would be improvements in this important trend but that they would not be significant enough to impact CMS. The concern level for the category, however, is high because the group felt efficient mass transit solutions could have a huge impact on traffic issues in California.

T9: Level of societal sensitivity to privacy issues

The NGT panel felt society would become increasingly sensitive to privacy issues over the next 15 years, particularly if constitutional rights to privacy were eroded considerably because of terrorism. Also, society would react strongly to the misuse of CMS technology like “black boxes” to invade their privacy. The group felt this issue was as much a concern to CMS as the reliability of the technology.

Event Identification and Analysis

The NGT panel was then asked to create a list of possible events that could impact the development of intelligent CMS. Events were defined as a single occurrence

(e.g. earthquake, terrorist event, legislation passed, new technology, et cetera.) that has the ability to significantly impact the development of CMS technology. The events had to have some probability of occurring in the next 15 years (see Appendix B for the detailed list of candidate events developed). After this list was developed, the panel was again asked to vote to decide which were most important. This time, eight events were recognized as most likely to impact development of collision systems. The panel members were then asked individually to decide in what year the event would likely first occur (>0) and then what percentage probability it would occur within 10 and 15 years. Then they were asked to determine what level of impact its occurrence would have on a large traffic law enforcement agency's ability to manage the issue. The information from the panel members was then summarized onto one table using the median rating for each category. Table 2-2 summarizes the events identified and the data developed from this exercise. The information following the table clarifies what the panel meant by each event and provides key information from the panel's discussion.

Event Analysis (Table 2-2)

Events	Year >0	+10	+15	Impact -10 to +10
1. FMVSS standards are implemented to require CMS in vehicles.	10	50	75	+10
2. Legislation is passed limiting liability on CMS systems to $1 million	10	25	50	+5
3. Auto manufacturers decide to equip all new vehicles with wireless DSRC.	8	75	100	+8
4. Major technological breakthrough creating sensors that equal human capacity.	15	0	1	+9
5. Auto industry decides to heavily market in-vehicle safety systems.	5	75	100	+8
6. Massive failure of in-vehicle safety system forces recall of three million vehicles	6	25	50	-8
7. Hacker hacks into ITS/CMS infrastructure system causing multiple, major crashes	8	30	75	-8
8. Congress transfers 25% of transportation funds to the federal General Fund	5	50	50	-6

E1: FMVSS standards are implemented to require CMS in vehicles

Federal Motor Vehicle Safety Standards (FMVSS) are regulatory and define for the automotive industry what safety equipment is required to be installed and maintained on vehicles sold in the United States. The panel felt this event would have the most positive impact on the issue because passage of standards relative to CMS technology would help make the technology more consistent from vehicle to vehicle. Also, requiring CMS technology in all new cars would hasten introduction of CMS in the mass market. The panel felt it was marginally possible regulations would pass within five years and 50 percent possible in 10 years. Within 15 years, the group felt it was fairly likely these regulations would be passed (75 percent).

E2: Legislation is passed limiting liability on CMS systems to $1 million

Since liability issues are a major concern in the implementation of new, untried technology, the panel felt a reasonable limitation on liability for CMS failures would positively impact development but there was only a 50-50 chance of this legislation passing within 15 years.

E3: Auto manufacturers decide to equip all new vehicles with wireless DSRC

The NGT panel felt that automobile manufacturers' decision (all or one or two major manufacturers) to install wireless Dedicated Short-range Radio Communications systems (DSRC) in all vehicles would push the installation of roadway infrastructure communications systems. This very important event would significantly speed up implementation of vehicle-to-infrastructure CMS technology. The panel felt it is virtually certain to occur within the next 15 years.

E4: Major technological breakthrough creating sensors that equal human capacity to perceive, think and react.

The NGT panel felt the major barrier to CMS reliability and acceptance was the fact that in-vehicle and roadway sensors could not compete with the human capacity to perceive, think and react. As a group, they felt this event would greatly impact the issue in a positive way because it would greatly enhance the capacity and reliability of the technology. However, after individually assessing the event, the group decided there was only about a one percent chance this event would occur in the next 15 years, even with technology advances moving forward exponentially.

E5: Auto industry decides to heavily market in-vehicle safety systems

This event could include either a decision by all or one or two major manufacturers. The panel felt this decision would be heavily tied to both the reliability

and liability trends. Still, they felt this event would happen (100 percent likely) in the next 15 years and would have a very substantial positive impact on the issue because it would ensure public acceptance and introduction into the mass market.

E6: Massive failure of in-vehicle safety system forces recall of three million vehicles

Thinking in terms of the Firestone tire scandal and the ongoing controversy about the safety benefits of air bag systems, the NGT panel believed that a major failure or defect with a CMS could jeopardize general acceptance and mass production of such systems. The panel felt such a scandal was 25 percent likely to occur in 10 years and 50 percent likely to occur in the next 15 years.

E7: Hacker hacks into ITS/CMS infrastructure system causing multiple, major crashes

The panel defined this event as somebody actually hacking into a computer that controls an ITS system (like intersection signaling) or somebody jamming the DSRC system in an intersection. The group felt it was 30 percent likely to occur in 10 years and 75 percent likely this would happen within a 15-year time span. They also thought this type of event could become the new crime or terrorism issue for law enforcement. The panel felt this event could have a big negative impact (-8) on the issue because it would directly impact public acceptance and reliability of CMS.

E8: Congress transfers 25% of federal transportation funds to the general fund

The state of the economy has a significant impact on development of new technologies, particularly roadway infrastructure CMS. A 25 percent transfer of federal transportation funding to the federal general fund would have a detrimental impact on the issue. The group felt there was a 50-50 chance of the event occurring within 5-10 years and that the probability of occurrence would not increase after 10 years.

Cross-Impact Analysis

The cross-impact analysis was completed by a three-member subset group of the main research group including the lieutenant from Commercial Vehicle Section, a senior transportation planner from CHP's Special Projects Section and the author. The subset group evaluated the impact of each event on each trend on a scale of –5 to +5 as they relate to the overall impact on the project issue.

Cross Impact Analysis (Table 2-3)

Event/ Trend	**T1: Level trans funds**	**T2: Level driver training**	**T3: Focus on liability issues**	**T4: Level CMS reliability**	**T5: Level public accept**	**T6: Rate develop smart roads**	**T:7 Pop-ulation**	**T:8 Mass trans**	**T:9 Privacy issues**
E1: FMVSS STDS	+3	+1	-1	+2	+1	+4	0	-1	-3
E2: Liability limited $1 mil	0	0	+3	-1	0	+1	0	0	-2
E3: Wireless DSRC all Vehicles	+2	0	-1	0	0	+5	0	-1	-2
E4: Sensors equal human	+2	-1	-4	+5	+5	+3	0	-4	-4
E5: Auto Mfgs Market Safety	+2	+2	-3	+1	+3	+1	0	-1	-1
E6: CMS failure =recall	-1	0	-5	+2	-4	+2	0	+2	-3
E7: Hacker causes crashes	+2	0	-2	+2	-3	-2	0	+1	-3
E8: 25% trans fund loss	-5	0	0	-1	-1	-4	-2	-4	0

Development of CMS sensors that equal human capacity would have the greatest positive impact on the overall issue (E4). However, this event had the least probability of occurrence. Passage of FMVSS standards (E1) is one of the likely events to occur with

the highest positive impact on the issue. Passage of these standards would slow down trends that would hamper development and implementation of CMS (T3, T8, T9) and would positively impact trends that would speed up the technology (T1, T4, T5). A safety defect scandal involving a collision system (E6) would have the largest negative impact on the general acceptance of this type of technology and would ultimately hurt law enforcement's ability to manage and investigate collisions. Similarly, loss of transportation funding (E8) is very likely to occur and would have a fairly detrimental impact across all trends.

Alternative Future Scenarios

In the following sections, several alternative future scenarios are presented using the information compiled from the NGT, the panel discussions and the background research. These scenarios will assist in determining the future course of a large traffic law enforcement agency seeking to manage the impact of intelligent CMS. The following futures represent a pessimistic, optimistic and surprise-free view of possible futures.

Pessimistic

In 2013, acts of terrorism have become as commonplace in California as they currently are in the Middle East. All law enforcement can do is respond call to call to try and stop the destruction of life and property. Terrorists have targeted mass transit for attacks and have hacked into existing ITS to cause traffic backups and collisions in major metropolitan areas (E7). The public is afraid of anything driven by technology (T5). The economy is extremely weak and agencies are working with fewer rather than more officers. Congress has cut transportation funding by 50 percent and the highway system

is characterized by potholes, faded lane markings and missing signs (E8). Special traffic programs are almost non-existent at the local level and the CHP is barely able to keep up with demand for services to provide protection for vulnerable bridges and structures. More people are driving than ever before because they are afraid to take buses, trains or airplanes. Consequently, traffic collisions are skyrocketing (T8). Collision-mitigation systems have not moved forward because of public apathy (T5), and the weak economy is hampering further development of low cost technology. Earlier attempts to use black box information in all collision investigations was fought off by the American Civil Liberties Union as violating an individual's right against illegal search and seizure (T9). Finally, development of more efficient collision avoidance technology has been severely hampered by a recent incident where defective equipment caused the death of a family of four because it caused a vehicle to speed up and hit another vehicle rather than braking (E6). Lawsuits have caused all American automobile manufacturers to withdraw this technology on all but a few vehicle models.

Optimistic

In the year 2013, a new, low cost alternative fuel has been introduced in California, giving a huge boost to the automotive industry. Cars are proliferating as a means of travel. Collision warning systems and "black box" data collection systems are mandated equipment on all new vehicles through FMVSS standards (E1). NHTSA is also considering requiring a retrofit on older model vehicles for safety reasons. CMS technology is considered highly reliable because it's known to react faster than humans during an incident (E4). Traffic enforcement units and agencies can quickly compile information at the scene of a collision then routinely back up initial findings with

information from in-vehicle data devices. Law enforcement, in general, has a much greater understanding of collision causes through the data collected and constantly adjusts its outreach strategies to focus on the appropriate factors. Collision rates have decreased by half and fatal collisions are almost non-existent because of safety enhancements and collision warning systems.

DSRC was implemented early (E-3) and Congress has allocated major funding to transportation infrastructure; “smart highways” are being constructed routinely. The backlog of deferred maintenance has been eliminated (E-8). Public acceptance of technology (T5) and a strong economy have made collision-mitigation technology easily affordable and mass-produced (T2). Information from in-vehicle collision notification systems is fed from vendor systems directly to dispatch centers, and EMS services are activated almost instantaneously and at the appropriate levels.

Overall, congestion has been reduced despite moderate population growth because vehicles are moving more efficiently on the highway system. Traffic law enforcement is now free to be more focused on traffic management, community outreach and other law enforcement duties. Staffing is less of an issue because it takes fewer officers to handle traffic collisions and incidents. CMS systems installed on police vehicles have greatly enhanced officer safety in driving and on roadside stops. A new, quick warrant procedure was established through the courts to allow law enforcement access to GPS-location information and in-vehicle engine control systems under strictly specified circumstances. Law enforcement agencies can tell if vehicles have these GPS systems through registration information and are able to safely manage hazardous pursuits and stolen vehicles.

Surprise-Free

In the year 2013, traffic safety and management has not changed much. Technologies for safety enhancements and collision-mitigation systems have improved greatly (T4), but the economy has not yet recovered enough to allow them to be mass-produced. A variety of Japanese and European as well as high-end American vehicles utilize these systems and they make up only about five percent of the vehicles on the road. Additionally, infrastructure development was hampered by the poor economy and transportation agencies are struggling just to maintain the highway system (T1). Collisions were increasing annually until fuel prices began to negatively impact vehicular travel. Law enforcement still needs a search warrant to get black box data in collisions and, because they are not universally available, has never pushed to mandate access. Technology advancements are still moving forward exponentially but are considered very "pie in the sky" by the general public (T4&5). Law enforcement personnel strength and allocation to traffic safety issues has not changed much either. Although officers are using more automated devices to complete their tasks, they are still being stretched thin trying to cover all responsibilities. Department staffing levels remain the same while agencies are dedicating a great deal of resources to terrorism and homeland security. The public is interested in traffic safety generally but believes most issues were addressed in California some time ago. They believe there is no longer a problem, particularly since total collisions have stabilized due to a reduction in average daily traffic volume.

Chapter Conclusion

This chapter utilized a Nominal Group Technique to identify and analyze trends and events that would impact the project issue. Using this information, three future scenarios were developed forecasting the development and distribution of intelligent CMS in 2013. In the next chapter, this information will be used to develop a strategic plan for a large traffic law enforcement agency to manage these impacts in the most positive manner.

CHAPTER 3

STRATEGIC PLANNING

Chapter 1 of this research project was focused on reviewing the background and current research on intelligent collision-mitigation systems. In Chapter 2, alternative possible futures were developed based on trends and events that might impact the project issue in this time frame. This chapter will focus on developing a model strategic plan for a statewide traffic law enforcement agency. This plan will be designed to help move development of intelligent CMS in a positive direction and to manage the impact on the agency. Specifically, the plan will provide the framework to develop and install CMS on all vehicles assigned to a statewide traffic law enforcement agency.

Strategic planning is a structured process that helps move an organization toward a desired future by defining a vision and goals; assessing the organization, analyzing stakeholders; and developing strategies (Estensen 2003). Strategic planning is critical to any organization wanting to look ahead and prepare for emerging issues.

Vision and Goal

The ultimate plan for intelligent CMS is development and installation of the technology on all vehicles on the roadway. However, this worthy goal is outside the reach of most statewide law enforcement agencies. The overall vision or goal for this project is the development and installation of intelligent CMS in all vehicles owned by a statewide traffic law enforcement agency by the year 2013. Intelligent CMS will reduce overall crashes of state vehicles as well as assist in substantiating investigation findings.

The technology also has the ability to increase officer safety on roadside stops. Many officers injured and killed in the line of duty are struck by vehicles during enforcement stops where the officer is outside his or her own car. Pedestrian CMS systems combined with lane departure and roadway departure systems could greatly enhance officer safety.

Both of these impacts will save lives and reduce injuries for officers and other employees as a result of traffic collisions. The desired future for intelligent CMS in law enforcement is one where:

- The technology is reliable, fairly standard, affordable and in use on all vehicles owned by a statewide law enforcement organization.
- Black box technology and collision warning systems are mandated equipment for all vehicles owned by the statewide law enforcement agency.
- Dedicated funding for CMS roadway sensors and infrastructure-to-vehicle communication systems are a priority at the federal, state and local levels.
- Retrofits for major collision intersections have been completed.

Organizational Description

The California Highway Patrol (CHP) is the largest traffic law enforcement agency in the nation and is used as a model organization in this project. The CHP is a department in state government within the California Business, Transportation, and Housing Agency. Its primary responsibility is providing traffic safety and service to the motoring public as they use the state's highway transportation system. As a statewide criminal justice agency, the CHP also provides law enforcement assistance to local

governments and allied agencies when situations exceed the limits of local resources. The CHP serves as the leader for statewide vehicle theft prevention and recovery efforts, and is the primary authority for enforcing laws and regulations relating to commercial vehicle safety and the commercial vehicle industry. In addition, the CHP is responsible for providing security and protective services to elected state officials, state government employees, and state facilities.

The CHP currently has more than 10,000 authorized positions: 7,186 uniformed (or sworn), and 2,951 nonuniformed (or civilian) positions. Leading the organization is the Commissioner, assisted by a Deputy Commissioner. The organization is divided into two major operational areas: field operations and staff operations. Each operational area is led at the headquarters level by an Assistant Commissioner. The four commissioners and two executive assistants make up the department's executive management team.

Field operations are divided into eight field divisions located throughout the state. Each field division has under its command a number of area offices. Currently, there are a total of 101 area offices, 16 commercial vehicle inspection facilities, and 6 communications centers—enough to maintain a CHP presence in every county in the state. Staff operations are divided into eight headquarters divisions based in Sacramento. These divisions are designed to provide support for, and information and direction to, the field commands.

The CHP performs its primary traffic management function on all state highways constructed as freeways in both incorporated and unincorporated areas of the state. These freeways include interstate routes, United States highways, and state routes. The CHP also has responsibilities for all streets and highways in unincorporated areas of the state.

This jurisdiction encompasses highways under the control of both state and county government maintenance authorities. In total, the CHP currently patrols over 103,000 miles of roadway throughout California (CHP 2001-2003).

Organizational Analysis

The SWOT (strengths, weaknesses, opportunities and threats) framework was used to analyze the CHP as an organization for purposes of the strategic planning model. Strengths and weaknesses identified are organizational or internal, and opportunities and threats are environmental or external. The SWOT model is designed to assess the organization in terms of its readiness to adapt to the proposed change. In this case, it means to assess CHP's readiness to develop and install intelligent CMS on all vehicles owned by that agency. The following is an assessment of the CHP in these four categories relative to the project issue:

Strengths

- The CHP focuses on traffic safety issues as its primary mission and is already writing procedures to handle some CMS technologies like black boxes.
- The CHP has a nationwide reputation for expertise in traffic safety issues and is already included as a major stakeholder in planning for CMS at the federal level.
- The CHP is the lead agency for collision investigation in the state and the central point of data collection for all fatal and injury collisions. The CHP already analyzes statewide collision information and decides what information should be collected and tracked.
- The CHP is already participating on national committees looking at intelligent CMS including GPS locator technology and steer and brake by wire technology.

- The CHP has a Transportation Planning Unit which works closely with the California and United States Departments of Transportation (DOT) on issues relative to transportation management.
- The CHP has an existing focus on strategic planning and understands the importance of looking forward to define and plan for emerging issues.

Weaknesses

- Like most law enforcement agencies, the CHP has limited personnel resources to dedicate to futures issues.
- The CHP is a large bureaucratic organization, which by nature can slow down change.
- As a statewide law enforcement agency, the diversified mission of the CHP can be a challenge to its traffic safety priority when other issues, like homeland security, become an elevated concern.

Opportunities

- The CHP has strong legislative, administration and public support and close ties to other traffic safety stakeholders. These relationships provide a solid basis for helping to influence the direction of intelligent CMS.
- The CHP is the lead agency in California for buying police vehicles. Many other agencies purchase their police vehicles through the CHP contract to save money.
- Car purchasers have generally been more interested in safety features during the last decade and auto manufacturers have responded with systems exceeding the minimum federal standards. There is an opportunity to build on this foundation.

- GM continues to publicize and fund OnStar, a telematics service that is sold on the basis that it will reduce the emergency response time to an incident (Mateja, 2002). This commitment of corporate resources is helping motorists to accept advanced technology in vehicles, and to accept related tradeoffs (e.g. more safety but less privacy). There is an opportunity to work with GM and others to leverage this public acceptance.
- U.S. and state DOTs are transitioning from a focus on construction to a focus on operations. As more operational activities are made eligible for gas tax funding, an opportunity exists to make more law enforcement activities eligible for this major source of funding. It is likely that gas taxes will be increased in the future and a small portion could be reserved for law enforcement without directly competing with DOTs for this funding.
- There has been more overall public safety focus on transportation and traffic safety issues. Increased focus by all law enforcement will make it much easier to collectively move intelligent CMS in a positive direction.
- Existing CMS technology results in fewer overall crashes occurring.

Threats

- The state of California is suffering a fiscal crisis at present and all state agencies are working under substantial budgetary constraints. Fiscal issues play an important role in deciding which issues are given the most focus.
- It is not necessarily cost-effective to develop CMS technology just for statewide law enforcement vehicles.

- The threat of terrorism is spreading resulting in diversion of law enforcement and other societal resources, fear that inhibits travel patterns, a greater desire for control and less acceptance of technology that could be susceptible.
- High fuel prices or shortages are impacting people's driving behavior.

Stakeholder Analysis

Analysis of the stakeholders for the project issue is critical to developing strategies to affect the overall goal and objectives for this project. A stakeholder is someone impacted by or who can impact the proposed change, someone who has a vested interest in the issue. The following lists key stakeholders for intelligent CMS and noteworthy expectations and concerns they might have relative to this issue

- Auto manufacturers – This group is key to the research, development and installation of in-vehicle intelligent CMS. Major concerns they might have are research funding, cost of the systems, liability issues, privacy issues and public acceptance of CMS.
- Vendors – This group, working with the auto manufacturers or developing after-market systems, would have the same overall concerns as the manufacturers
- U. S. Department of Transportation – This group is leading the effort through the Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA) focus on the Intelligent Vehicle Initiative (IVI). IVI provides federal money and direction on research and development of intelligent CMS. Their main concern will be interoperability and compatibility with existing and future ITS standards.

They will also focus on the safety of the systems as well as their overall impact on collision reduction.

- International Association of Chiefs of Police (IACP) – Law enforcement nationwide stands to benefit from this technology and the IACP is in the best position to represent the interests of all agencies for this technology.
- State Department of Transportation – A significant portion of the money for transportation projects comes from federal transportation funding. The main concern for these entities may be to have a say in the distribution of project money. Their focus will likely be on funding for infrastructure systems.
- Office of Traffic Safety – California's counterpart to NHTSA is the Office of Traffic Safety which provides grant funding to state and local agencies for traffic safety programs.
- Employee Unions – This group is focused on employee rights and protections as they relate to the work environment. Officer's unions may oppose use of some CMS technology (e.g. black boxes) if it may impact the results of an employee investigation.
- The Media – This group will mainly be concerned with reporting the issues as the technology advances. They will focus on privacy, reliability and liability issues. The media will expect strong proof of any beneficial outcomes worth reporting.
- Environmental Groups – These groups will be mainly concerned about the effect of any new technology on the environment and could easily be the

snail darter[1] for this issue. In project terms, a snail darter is something or someone that can completely stop advancement of goals and the planner may not even be aware they exist. For example, an environmental group may find or allege some detrimental effect on humans or an endangered animal species from short range radio waves (vehicle-to-infrastructure communications systems for CMS or DSRC).

Strategy Development

The following are strategies a large traffic law enforcement agency can employ to develop and install intelligent CMS in all vehicles owned by a statewide law enforcement agency:

1. Work with the automobile manufacturers to develop intelligent CMS specific to law enforcement vehicles.
2. Seek grants or other fund sources to cover the cost of implementation.
3. Wait until the technology is developed through existing methods.
4. Combine strategies 1 & 2.

It may be difficult to evoke interest in strategy #1 with the automobile manufacturers because the demand for law enforcement vehicles is small compared to the rest of the vehicle market. However, this strategy offers the best opportunity to provide input and expertise into the development of intelligent CMS. Automobile manufacturers already look to law enforcement to try out new safety ideas in vehicles, in particular the

[1] A snail darter is a fish listed on the threatened and endangered species list in 1975 of the subgenus Imostoma. The snail darter's critical habitat was identified initially as the Little Tennessee River. This simple designation stopped the filling of the Tellico Reservoir until a federal law was passed exempting it in 1979.

CHP. Seeking grants, as outlined in strategy # 2, is the best way to fund the implementation of this project but may be difficult to acquire. Other fund sources may be available to help defray the costs of the project, possibly through the auto manufacturers themselves.

Strategy # 3 is the method requiring the least effort to install intelligent CMS in all vehicles owned by a statewide law enforcement agency. Then again, this strategy assumes the law enforcement agency would want no input into the process and is willing to wait until the technology is already in mass-production. Strategy # 4 will take a lot of work and a commitment from the law enforcement agency involved. Nevertheless, this strategy offers the best opportunity for success in the implementation of the overall goal because it provides both the input and the funding to implement the project.

Chapter Conclusions

This chapter outlines a basic strategic plan to help promote development and use of intelligent CMS in all vehicles owned by a statewide law enforcement agency. Strategy # 4, to work with the automobile manufacturers and seek funding for the project, was chosen as the best strategy to implement the overall goal. The next chapter will provide information on how to manage the transition using strategy # 4.

CHAPTER 4

TRANSITION MANAGEMENT

In order to fully prepare for the impact of intelligent CMS by 2013, all or some of the strategies outlined in the previous chapter must be implemented. A transition management plan is one method to affect the necessary changes with the least negative impact on the agency. This chapter outlines a transition management plan that includes the identification and discussion of critical mass for the project goal, commitment planning, responsibility charting and an evaluation methodology. In the case of responsibility charting and the evaluation methodology, only one strategy was used to show how the methodology works.

Identification and Discussion of Critical Mass

Critical mass refers to individuals or groups whose active commitment is necessary for change to occur (Simon 2003). Critical mass can include internal and external stakeholders. In this case, critical mass can be defined several ways. The overall vision for this project is development and use of reliable, affordable, standardized intelligent collision-mitigation systems in all vehicles owned by a statewide law enforcement agency. The model agency for this project is the California Highway Patrol. Critical mass for this vision includes the following key individuals and groups:

- Auto manufacturers – This group must be involved at all levels. A group of smaller auto manufacturers working together could be the critical mass. Conversely, a single major manufacturer focused on the issue could also single handedly sway the industry. As an example, GM's support and

commitment to the *OnStar* technology swayed the industry with respect to GPS tracking and onboard navigational computers.

- National Highway Traffic Safety Administration (NHTSA) – As part of the federal administration, the support of this department is critical to research, development and funding for the Intelligent Vehicle Initiative (IVI) and ultimately for infrastructure-to-vehicle communications technology.
- Office of the Governor and/or the California Business, Transportation and Housing Agency – Support of the CHP's oversight agency and the Governor's office will be critical to authorize the project and funding for installation of CMS technology.
- Office of the Commissioner/Top Management (CHP) – Within a large traffic law enforcement agency like the CHP, critical mass for a broad goal or policy is important as well. Support of the Commissioner is vital, but support from Executive and Top Management is important as well to ensure downward flow of information and direction on the issue.
- Employee Unions – Buy-in from employee unions will be critical to successful implementation of these systems and use by the officers. Without their support, change is much more difficult to sell to employees.
- Employees – The support of employees working in the field is critical to the implementation and use of CMS systems. Key employees in area commands can sway the entire group. These go-to employees are usually tenured, well thought of and have great communication skills. Smart

commanders know who these go-to employees are and work with them to affect change.

Commitment Planning

The next phase of the transition plan is commitment planning. Commitment planning is a strategy, a series of action steps, developed to secure the support of those subsystems vital to the change effort. The four steps to the plan include identifying the individuals or groups whose commitment is needed; defining the critical mass; developing a plan to get the commitment; and creating a monitoring system to assess the progress (Simon 2003). For purposes of this project, the goal to develop and install intelligent CMS on all vehicles owned by a statewide law enforcement agency is used. Critical mass was identified in the previous section for this goal, so the remainder of this section will focus on getting the commitment of these groups and creating a monitoring system to measure success.

One technique used to help get commitment is called Commitment Charting. A commitment chart is a simple rating system. It assumes all groups listed are resisting change in some form and fall into one of four categories in terms of their attitude toward the change issue. These categories include no commitment, let it happen, help it happen and make it happen. A commitment chart lists all members or groups who are part of critical mass. Then, for each member of the group an X is placed in the box where their present level of commitment is located and an O is placed in the box where their minimum commitment needs to be. From there, strategies are developed to move people or groups toward O as necessary. The following is a commitment chart for the goal to

development and install intelligent CMS on all vehicles owned by a statewide law enforcement agency.

Commitment Chart (Table 4-1)

Key Players	No Commitment	Let it Happen	Help it Happen	Make it Happen
1. Auto Manufacturers			X	O
2. NHTSA			X	O
3. Governor's Office	X		O	
4. Business, Transportation and Housing Agency.	X		O	
5. CHP Executive and Top Manangement		X		O
6. Employee Unions	X	O		
7. Employees		X	O	

As shown in the chart, the automobile manufacturers NHTSA and IACP need to move from helping it happen to making it happen. Similarly, the Office of the Governor and the California Business, Transportation and Housing Agency need to change from no commitment to helping it happen. CHP's Executive and Top Management need to move from letting it happen to making it happen. Finally, Employee Unions need to move from no commitment to letting it happen, and employees need to move from letting it happen to helping it happen.

Possible intervention strategies to move specific groups in a positive direction on this issue include the following:

1. Auto manufacturers – This group will move toward making the goal happen when they can see the larger benefit to the ultimate goal of

installing these systems on all vehicles. One way a statewide traffic law enforcement agency can assist is by working with the auto manufacturers in the research, development and testing of these systems to prove their reliability in preventing crashes.

2. NHTSA – This group will move toward making the goal happen when the collision reduction benefits are proven and there is funding available to support the research, development and installation of these systems. A large traffic law enforcement agency can help with this generally by supporting development of the technology and dedicated transportation funding for intelligent CMS.
3. & 4 Office of the Governor and BTH – These two offices will move from no commitment to helping it happen when the benefits are proven, funding is available and public acceptance and support is shown.
5. CHP Executive and Top Management – The concern of traffic law enforcement management is saving lives and reducing injuries from collisions and officer safety. When the technology is proven affordable and reliable, management in traffic law enforcement will work toward helping it happen.
6. Employee Unions – When privacy concerns and the rights of employees are addressed either by memorandum of understanding or by policy, unions will move from no commitment to letting it happen.
7. Employees - Within the organization, participation in testing the devices and working with the industry to educate the public will bring support

from the officers. Also, providing clear policies and procedures for how to handle collisions and other incidents involving intelligent CMS will prevent officers from becoming discouraged with the technology.

The final step to commitment planning is to create a monitoring system to assess progress toward support for the changes being implemented as part of the project goal. In this case, the monitoring system can be simple. The CHP's Transportation Planning Unit (TPU) already works closely with the key stakeholders for the project issue and is in the best position to monitor commitment levels. On an annual basis, this unit should conduct an analysis to determine the status of research and development for intelligent CMS as it relates to law enforcement vehicles. From there, the TPU can poll the critical mass groups to see what level of commitment they are willing to afford the issue.

Responsibility Charting

Responsibility charting is a method to determine who should be involved in implementing one of the strategies associated with the project goal and at what level. The process begins by identifying actions, decisions or activities necessary to accomplish the change strategy. Then, the people involved in each action are identified. Finally, the required behavior of each person is charted using the following classifications:

R – Means the person has responsibility for a particular action but not necessarily the authority.

A – Means the person must approve the action and/or has the power to veto the action.

S – Means the person or group must support the action by providing resources even if they don't necessarily agree with it.

I – The person must be informed or consulted before the action, but cannot veto.

N/A – means the person or group is irrelevant to this particular action (Simon 2003).

For purposes of this project, strategy # 4, which includes working with the automobile manufacturers and seeking funding for the project, will be charted. The following is a list of actions, decisions or activities identified for this strategy:

1. Research &Development (R&D) of agency needs for intelligent CMS in state vehicles specifically designed for law enforcement.
2. Contact the various auto manufacturers and ascertain interest.
3. Work with NHTSA to develop standards and funding for development.
4. Set up initial and ongoing meetings.
5. Develop budget.
6. Monitor development/testing.
7. Present outcomes/findings.

The following chart (Table 4-2) outlines the results of the responsibility charting exercise. The key players are listed across the top and the action steps are listed vertically. Key players for this strategy included the auto manufacturers, NHTSA, Officer of the Governor, BTH, the Office of the Commissioner/top management, the CHP project manager and employee unions.

Responsibility Chart (Table 4-2)

Actors→ / Actions ↓	Auto manufacturers	NHTSA	Office of the Governor	California BTH	Commissioner/ Top Management	CHP Project Manager	Employee Unions	Employees
1. R&D Intelligent CMS for Law Enforcement		S	I	I	A	R	I	S
2. Contact Auto Mfgs	A	I	I	I	A	R	I	I
3. Work with NHTSA on Stds and Funding	S	A	S	S	A	R	S	I
4. Initial and Ongoing Meeetings	S	S	I	I	A	R	I	I
5. Develop Budget	I	I	I	I	A	R	I	I
6. Monitor Development and Testing	S	S	S	S	A	R	S	S
7. Present Outcomes & findings	S	S	S	S	A	R	I	I

R= Responsibility; A = Approval; S = Support; I = Informed; N/A = not applicable

With this strategy, the CHP commissioner would retain approval for most actions and the CHP project manager would be responsible for most of the steps. The outside stakeholders would be consulted before any final actions were taken and the rest of the CHP employees would likely be in support roles. This type of responsibility charting helps to ensure each participant in a strategy knows and understands their roles. A responsibility chart for each of the strategies outlined in the strategic plan in Chapter 3 would need to be developed at a later time.

Evaluation Methodology

Any strategy must ultimately be evaluated in terms of impact and effectiveness. Using the strategy outlined in the responsibility chart in the previous section, an evaluation methodology will be developed to assess the level of accomplishment. The evaluation methodology for this strategy will include:

1. Requiring reports back from the project manager on the support and feedback from the auto manufacturers and NHTSA.
2. Providing updates to the Commissioner, the Office of the Governor and BTH on the status of the strategy.
3. Presentation and demonstration of CMS technologies developed specifically for law enforcement

Understanding how to manage change is important to the success of any organization. This chapter provided a transition management plan that will help a statewide traffic law enforcement agency implement intelligent CMS. This plan included a discussion of critical mass, commitment planning and charting, responsibility charting and an evaluation methodology. One strategy developed in the strategic plan was charted and evaluated to illustrate the importance of using an appropriate methodology to achieve success. The next and final chapter will review the project in its entirety, highlighting key findings and recommendations.

CHAPTER 5

CONCLUSIONS

Chapter 1 provided comprehensive information and background about intelligent collision-mitigation systems (CMS) and the issues surrounding them. The most important points from the literature review included identification of existing systems, the main issues impacting the issue in the present and the discussion of systems now in development. Initial impressions about the impact of intelligent CMS were also developed. Existing systems identified include:

- Black Box Technology – used to record relevant vehicle information in the five seconds preceding a collision (used to support airbag deployment).
- Crash Notification Systems –provides mapping/vehicle location information to emergency medical services when a collision has occurred.
- Collision Warning Systems for Passenger Vehicles and Heavy Trucks – provides audible and visual warnings when potential collisions may be impending.
- Lane Departure Warning Systems – warns when a driver is crossing a lane line if a turn signal has not been activated.
- Night/Fog Vision Systems – enhances vision by projecting the road scene onto the windshield as a heads-up image.
- Backup Warning Systems – warns when an obstruction is in the vehicle's path of travel while backing.

- Stability Control Systems – notifies the driver when tire pressure is too low and/or applies brakes when steering does not match vehicle path of travel.
- Adaptive Cruise Control (ACC) –senses when the vehicle is overtaking another and brakes automatically to compensate.
- Pre-Crash Systems – provides warnings to the driver; and, when a collision is imminent, tightens the seatbelts and assists in braking.

The literature review and assessment of systems currently in use identified issues most likely to affect or impact development of intelligent CMS and law enforcement's ability to manage the overall impact of the systems. The primary issues for the project are:

- Human Factors – an individual's ability to multi-task using complex vehicle technology and/or over reliance on the technology will influence public acceptance.
- Commercial Vehicles – commercial technology and standards must be developed separately and must include commercial industry participation.
- Privacy Issues – privacy advocates fear law enforcement will retrieve and abuse the information without safeguarding their freedom (e.g. Big Brother intrusions).
- Other Systems - communications development and capabilities will partially drive CMS technology development

- Liability – liability issues may hamper or slow development of CMS technology (although litigation may speed new safety systems if the liability is greater for not using them).
- Development of Standards – development of standards will be critical to consistency in the technology.
- System Security/Susceptibility to Tampering – CMS technology must be safeguarded against tampering that could imperil the integrity of any deployed system.

Intelligent collision-mitigation systems in development provide a vision for the future of the issue. Research and development of systems currently underway includes:

- Advanced Black Boxes – will provide more information in formats more easily downloaded.
- Advanced On-Board GPS Systems – will act as a total communications system for the driver, detecting collision scenarios and providing information about speed limits and vehicle function to the driver.
- Advanced Monitoring – cameras, GPS and radar systems will form a safety net for the vehicle, monitoring the interior and exterior environment. The vehicle will then use wireless technology to transmit the information either to the infrastructure or back to a vendor/monitor.
- Advanced Front/Rear Crash Systems – will extend the front/rear bumper to absorb greater impact and intentionally dip the front end of the vehicle to align the bumpers of involved vehicles, minimizing damage.

- Road Departure Avoidance Systems – will warn drivers when they are about to drift off the road and crash or when they are approaching a curve too fast.
- Intersection Collision Avoidance – will warn drivers they are about to crash into a vehicle crossing their path. These systems will also automatically brake to avoid or lessen the impact of the collision.
- Rollover Systems – will warn drivers they are about to roll over, retracting seatbelts and/or implementing stability control intervention by the vehicle.
- Pedestrian-Protection Devices – will recognize humans in the path of a vehicle and provide driver warnings and vehicle impact control.

The first chapter concluded that intelligent CMS has the ability to positively impact law enforcement in several important ways. It will help with the public service mission to reduce fatalities and injuries associated with traffic collisions if overall collisions are reduced and severity of collisions is lessened. CMS can also potentially be used advantageously by law enforcement to assist with other law enforcement issues including pursuits, auto theft and child kidnapping. The review ultimately concluded that law enforcement could either help or hinder development of the technology depending on how the issue was supported in its early stages of development. Chapter 1 also first proposed that a statewide law enforcement agency should work to help develop and install this technology on all vehicles owned by that agency by 2013.

Chapter 2 provided details of the futures study portion of the project. A Nominal Group Technique was used to identify trends and events that could impact the project issue. Key stakeholders in the area of intelligent collision-mitigation systems were

brought together to brainstorm and develop this information. These trends and events were then analyzed and used to develop three possible future scenarios for the project.

The three scenarios developed outlined a pessimistic, optimistic and surprise-free view of the future of intelligent collision-mitigation technology. These scenarios were developed to demonstrate how the occurrence or non-occurrence of events and direction of trends would impact the future. The pessimistic future assumed almost no progress had been made in the development of intelligent collision-mitigation systems and that the transportation system itself was in crisis because of budget issues. Collisions and congestion increased and the public was distrustful of technology solutions because of homeland security and defective equipment issues. The optimistic future saw major advances in collision-mitigation technology as well as widespread acceptance and use of the systems. The technology had a positive impact on collision reduction and other law enforcement concerns. The surprise-free future showed very little change in development and use of collision-mitigation technology. Collisions and congestion did not increase but rather were being influenced by other external trends and events.

The focus of Chapter 3 was to develop a strategic plan based on the optimistic future presented in Chapter 2. This scenario was chosen as the vision for the strategic plan because it offered the most opportunity to design and implement strategies which would positively impact development of collision-mitigation systems. The vision or goal for intelligent CMS was to promote the development and installation of intelligent CMS in all vehicles owned by a statewide traffic law enforcement agency by the year 2013. The desired future for intelligent CMS in law enforcement was identified as one where:

1. The technology is reliable, fairly standard, affordable and in use on all vehicles owned by a statewide law enforcement organization.
2. Black box technology and collision warning systems are mandated equipment for all vehicles owned by the statewide law enforcement agency.
3. Dedicated funding for CMS roadway sensors and infrastructure-to-vehicle communication systems are a priority at the federal, state and local levels.
4. Retrofits for major collision intersections have been completed.

The next phase of the strategic plan was to develop strategies and establish implementation and feedback systems. First, the California Highway Patrol was described as the model agency through which the impact of intelligent collision-mitigation systems would be analyzed. The SWOT (strengths, weaknesses, opportunities and threats) method was used to identify key issues in terms of the agency and the project. Next, key stakeholders were analyzed including auto manufacturers, the U.S. Department of Transportation, the state department of transportation, the Office of Traffic Safety, employee unions, the media, and environmental entities.

Through this analysis, four strategies were developed for a large traffic law enforcement agency to employ in order to achieve the chosen objective. These strategies are:

1. Work with the automobile manufacturers to develop intelligent CMS specific to law enforcement vehicles.
2. Seek grants or other fund sources to cover the cost of implementation.
3. Wait until the technology is developed through existing methods.

4. Combine strategies 1 & 2.

Chapter 4 created a transition management plan including identification of critical mass and commitment planning for the overall vision and goal of the project. Responsibility charting and an evaluation methodology were developed for one strategy to act as a basis of future development of a more comprehensive plan.

Critical mass for the project vision included the auto manufacturers, NHTSA, the IACP, the Office of the Governor and the California Business, Transportation and Housing Agency, the CHP Commissioner and top management, the employee unions and the employees of the statewide traffic law enforcement agency used as a model. The responsibility charting and evaluation methodology exercises focused on the strategy designed to work with automobile manufacturers and seek funding for implementation of the goal. The chart (Table 4-2) listed action steps to implement the strategy then identified key actors and their required behavior in the process. The evaluation methodology included requiring reports back from the project manager on the support and feedback from the auto manufacturers and NHTSA, providing updates to the Commissioner, the Office of the Governor and BTH on the status of the strategy; and, presentation and demonstration of CMS technologies designed specifically for law enforcement.

Conclusions and Recommendations

So, what will be the overall impact of intelligent collision-mitigation systems on a statewide traffic law enforcement agency by 2013? Overall, the project concluded the impacts would be beneficial to law enforcement if the issue is carefully planned in the present. Impacts could include the following:

- A significant reduction in collisions and injuries and fatalities associated with collisions.
- Specific reductions in officers killed and injured in the line of duty as a result of collisions.
- Enhanced officer safety.
- Enhancements in the way traffic collisions are investigated and documented to include CMS information.
- A reduction in overall traffic congestion and congestion-related incidents.
- Changes in public perception and attitudes about driving.
- Development of new driver training and testing standards.
- Police personnel reductions or redirection from traffic issues.
- Ability to use the technology to address other law enforcement issues.
- Increased ability to provide other types of service to the public.
- Development of new high-tech units to focus on crimes related to intelligent CMS.
- Stakeholder agencies working more closely together on related issues.
- More community/public support for law enforcement.

For law enforcement, an important strategy is to use caution in exploiting this technology for enforcement purposes. Provoking concerns about the unreasonable violation of a person's privacy is a significant means by which law enforcement can hamper future development of important CMS systems. Relinquishing an immediate tool for the promise of a longer term solution (for reduction of traffic collisions) is often the wiser practice.

The project issue could be further developed by enhancing focus on CMS applications for commercial vehicles and addressing the impact of CMS on the elderly driving population. Intelligent CMS includes these groups generally; however, each has different needs and a far different perspective of the issue than the average driving population.

Intelligent collision-mitigation systems are here in basic form already and are moving forward rapidly. Technological advances in the systems will exponentially enhance their capabilities. The only reason they have not yet had a greater impact on traffic law enforcement is because they are not in mass-production – yet. Given that a blend of safety and profit motive will induce vehicle manufacturers to introduce more CMS measures in subsequent model years, it is imperative that law enforcement take the lead to ensure those advancements enhance driving safety for all, not just those who can afford it. Many police agencies are already looking at some of the initial technology like black boxes and may be trying to develop procedures or protocols to handle the information. By the time they get that strategy in place, the technology and public perceptions will have changed. A piecemeal approach to this issue will not work, and would only serve to place law enforcement in a position of catch-up for years to come.

Traffic law enforcement stands to gain a great deal from the technology in terms of achieving its mission and goals to reduce fatalities and injuries associated with collisions; particularly officer-involved collisions. Law enforcement in general stands to gain from the technology relative to its other associated uses (e.g. pursuit termination and curtailing auto theft). In addition, law enforcement as a stakeholder has a lot to add to research, development and implementation of this technology. The best way to get

involved now is through strategic planning and participation in the process of creating the future. Using the steps and strategies outlined herein, any large law enforcement agency with a major traffic unit concerned with managing futures issues can become involved. Working toward development and installation of intelligent CMS on all vehicles owned by an agency is a good first step.

Unless it can be imagined, the desired future will not happen. Unless the value of making cars smarter is recognized, law enforcement will fail to capitalize on a future where drivers are safer, and where the police can do their jobs better, with the implementation of intelligent CMS. The choice is there to make.

Appendix A

List of Candidate Trends

1. Number of collisions occurring annually in California
2. Changes in travel patterns
3. Age of driving population
4. Rate of communications advancements
5. Availability of public funds for capacity and safety issues
6. Level of public interest/concern for traffic safety issues
7. Level of reliability of CMS technology
8. Level of public acceptance for CMS technology
9. Cost of advanced transportation technology
10. Level of focus on homeland security
11. Level of focus on legal liability
12. Level of focus on privacy issues
13. Lifestyle trends (pace of life)
14. Level of development of efficient mass transit
15. Price of oil/fuel
16. Available roadway capacity
17. Driver demographics (age, culture, gender)
18. Development of alternative fuels/sources of energy
19. Ability to integrate in-vehicle technology with infrastructure
20. Public attitudes toward DUI
21. Ratio of cost to performance in CMS technology
22. Public attitude toward CMS technology
23. Driver attitude toward tracking devices
24. Trucking volume associated with international traffic
25. Age of on-road vehicles
26. Level of driver training
27. Trends in workweek/times
28. Level of standards developed
29. Level of interstate versus intrastate commercial traffic
30. Level of support from government entities
31. Number of people commuting longer distances
32. Level of media focus on traffic safety technology
33. Level of concern for distracted driving
34. Level of frustration with congestion

Appendix B

List of Candidate Events

1. Major scandal involving safety defect of Intelligent CMS
2. Major transfer of transportation funds to general fund
3. Auto manufacturers decide to equip all vehicles with wireless DSRC
4. New interstate transportation initiative overlays existing system
5. Law passed requiring pre-license training in CMS equipped vehicles
6. Hydrogen fueled vehicles introduced in mass market without standards or regulation
7. California initiative funding major mass transit development
8. Legislation passes limiting liability on CMS technology to $200,000
9. Legislation passes outlawing use of data from in-vehicle systems by government
10. CMS legislation found to be based on fraudulent/defective data
11. Grass roots initiative eliminates black box technology
12. CMS system saves the life of a major celebrity
13. Massive failure of CMS system forces auto manufacturer to recall three million vehicles
14. Terrorist attack on mass transit system
15. Major state data center hacked into. New security requirements impact CMS
16. Gasoline reaches $5 gallon
17. Major technological breakthrough makes CMS sensors equal to human capacity
18. Radio interference causes CMS technology to malfunction at intersection resulting in a major collision with multiple fatals
19. Natural disaster destroys major CMS system
20. Hacker hacks into CMS causing collisions
21. AARP files class-action suit against manufacturers to ban CMS because older people have trouble multi-tasking
22. Government CPR task force does away with control agency for technology projects in California
23. CMS system foils major terrorist attack
24. Auto industry decides to heavily market safety systems including CMS
25. FMVSS standards implemented to require CMS technology for collision warnings in vehicles
26. Significant change in public viewpoint of societal vs. individual rights
27. Development of super fuel economy vehicles
28. NHTSA mandates data collection devices on collisions in vehicles

Appendix C

List of NGT Panel Members

1. Ms. Michelle Tobias, Transportation Policy Analyst, California State Automobile Association (CSAA)
2. Dr. Steven Shladover, Research Engineer, University of California at Berkeley, Partners for Advanced Transit and Highways (PATH)
3. Mr. Frank Cechini, Intelligent Transportation Systems Engineer, Federal Highway Administration
4. Mr. Kent Milton, representing the American Association of Retired Persons (AARP)
5. Mr. Michael Ellis, Motor Carrier Safety Supervisor, California Highway Patrol, and Committee member with NHTSA and the Society of Automotive Engineers, Steering and Braking by Wire Technology Committee for IVI.
6. Lieutenant Bruce Kynaston, Commercial Vehicle Section, California Highway Patrol
7. Mr. Matt Hanson, Transportation Engineer, Caltrans
8. Mr. Greg Larson, Transportation Engineer, Caltrans
9. Ms. Michele Meadows, Operations Specialist, California Office of Traffic Safety
10. Mr. Richard Leimann, Director of Safety, California Trucking Association
11. Ms. Meriko Hoshida, a CHP employee representing the average driver

REFERENCES

Austen, I. (2003, December 11). An electronic assist for perilous driving. *The New York Times*. No page number.

Bennett, J. (2003, April 26). High-tech cars soften blow to pedestrians. *Free Press.* Available on website, http://www.freepress.com.

Bishop, R. (2004). Intelligent vehicle applications worldwide. *IEEE Computer Society*. Available on website, http://www.computer.org/intelligent/articles.

Bishop, R. (2003, September). Review of work addressing non-technical barriers to intelligent vehicle deployment in the U.S. and Europe. Special Report. *IVsource*. Available on website, http://ivsource.net/.

California Department of Transportation [CalTrans]. (2000, November). *California motor vehicle stock, travel and fuel forecast.* Available on website: http://www.dot.ca.gov.

California Highway Patrol. (1999, July). *Strategic plan 2001-2003*. Sacramento, CA: Author.

Crouch, E. (2003, December 12). High-tech policing. *STLtoday News*, Saint Charles SC. Available on website, http://www.stltoday.com.

Delphi Corporation (2003). *Driving tomorrow's technology*. Available on website, http://www.delphi.com.

Department of Finance [DOF]. (2000). Interim county population estimates projected to 2005, 2010, 2015, and 2020. Available on website http://www.dof.ca.gov.

Esensten, T. (2003, August). *The nominal group technique*. Organizational Effectiveness Consulting. Information presented at POST Command College class session in Oxnard, CA in December 2003.

Esensten, T. (2003, December). *The strategic organization*. Organizational Effectiveness Consulting. Information presented at Post Command College class session in Oxnard, CA.

Fitzenberger, J. (2003, January 5). A way through the fog. *The Fresno Bee*. No page number.

Ford Motor Company. (2003). *2003 Research and advanced engineering report*. Available on website, http://www.fordbetterideas.com.

Ford Motor Company. (2003). *Telematics for safety*. Available on website, http:// www.ford.com/en/innovation/vehiclefeatures/telematicsforsafety.htm.

General Motors (2003). *Looking forward to crushing rear-end crashes*. Research and development [Data file]. Available from website, http://www.gm.com

General Motors (2003). *Safety car showcases team innovation*. Research and development [Data file]. Available from website, http://www.gm.com.

Honda, Toyota offer systems to help drivers avoid a crash. (2003, June 18). *USA Today*. Available from website, http://www.usatoday.com

Mateja, J. (2002, October 21). GM expects to add cars to OnStar galaxy. *Chicago Tribune*. no page number.

National Highway Traffic Safety Administration [NHTSA]. (2002). *Fatal analysis reporting system annual report. Available on website, http://www.nhtsa.gov*.

Paniati, J. (2004). *USDOT outlines the new VII initiative at the 2004 TRB annual meeting*. Newsletter of the ITS Cooperative Deployment Network. Available on website, http://www.nawgits.com.

Pike, J. (1999, November 7-9). *Protecting the older driver –vehicle components. Research and vehicle technology*. Ford Motor Company. Paper presented at TRB meeting, Bethesda, MD.

Poretto, J. (2003, July 26). Emerging crash-avoidance systems: Will drivers want them? *The Detroit News, Auto Insider*. Available on website, http://www.detnews.com.

Seiler, P., Bongsob S., Hedrick, J. (1998). *Development of a collision avoidance system*. Society of Automotive Engineers. University of California at Berkeley, 98PC-417.

Simon, C. (2003, December). *Transition management in a strategic organization*. Commission on Peace Officer Standards and Training. Information presented at Post Command College class session in Oxnard, CA.

Statewide Integrated Traffic Reporting System [SWITRS]. (2002). Annual report of fatal and injury motor vehicle traffic collisions. California Highway Patrol, Sacramento, CA.

Toyota. (2003). Annual report – *Taking the initiative*. Available from website, http://www.toyota.com/about/shareholder/findata/2003/2003annualreport.pdf.

U.S. Department of Transportation. (2002). *Intelligent vehicle initiative 2001 annual report.* Federal Highway Administration. Washington, D.C.:Author.

Visteon. (2003). *Driver awareness systems.* Home/Technology/Automotive [Data file]. Available from website, http://www.visteon.com/technology/ automotive/smart_radar.shtml

Whitfield, K. (2003, December 22). Danger ahead. *Automotive Design and Production.* Available on website, http://www.automfg.com/articles.