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## Results of the US SAVE-IT project

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April 15, 2008

# SAVE-IT Program Summary

(SAfety VEhicles using adaptive Interface Technology)

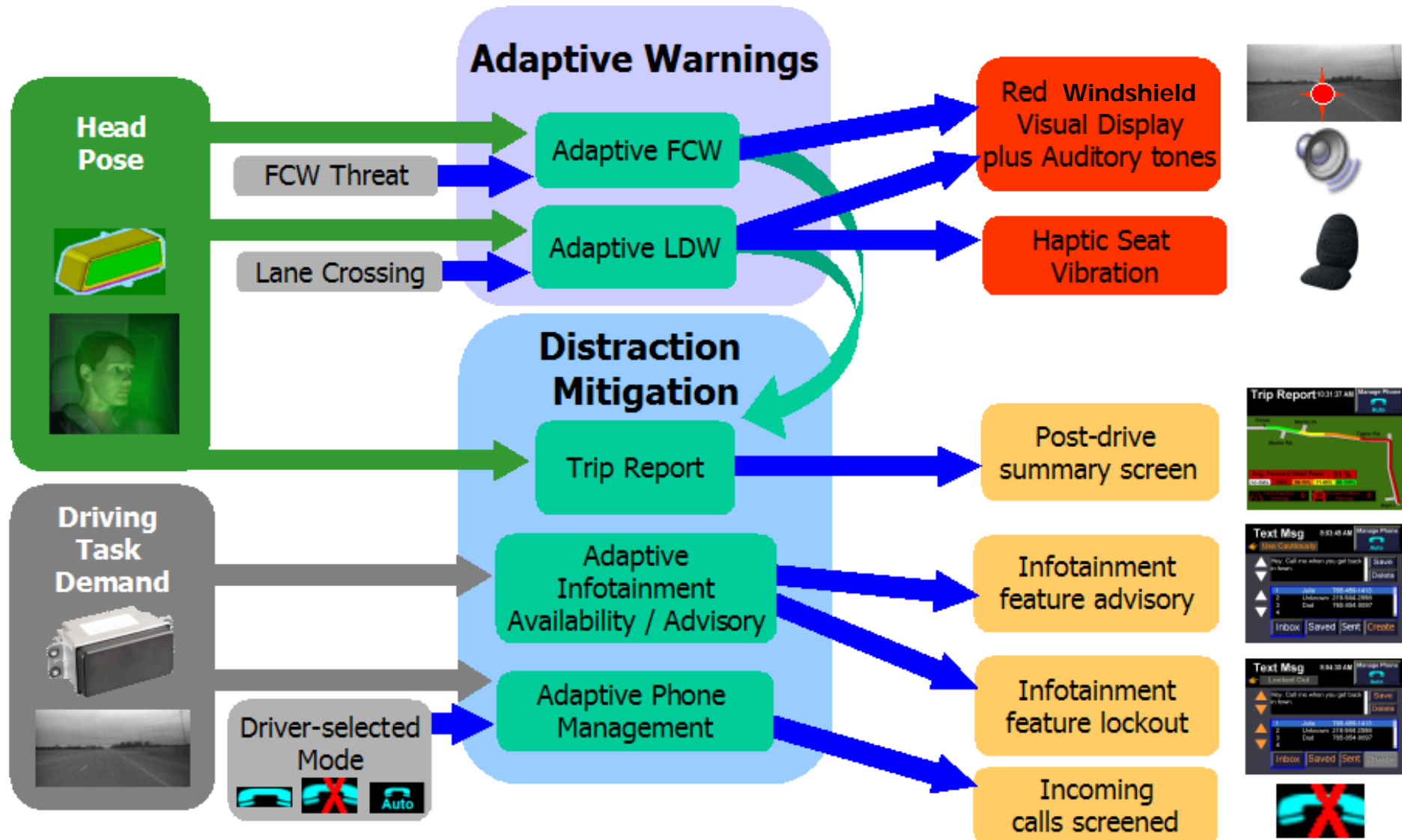
- Program start date: March 2003
- Program mission: To demonstrate a viable proof of concept that is capable of reducing distraction related crashes and enhancing safety warning effectiveness
- Method: Develop and test a comprehensive safety system which integrates select safety warning systems and the state of the driver
- 5 year research and development program sponsored by NHTSA, administered by Volpe



- Team participants: Delphi (lead), Ford (VIRTTEX), University of Iowa & NADS, University of Michigan Transportation Research Institute (UMTRI)

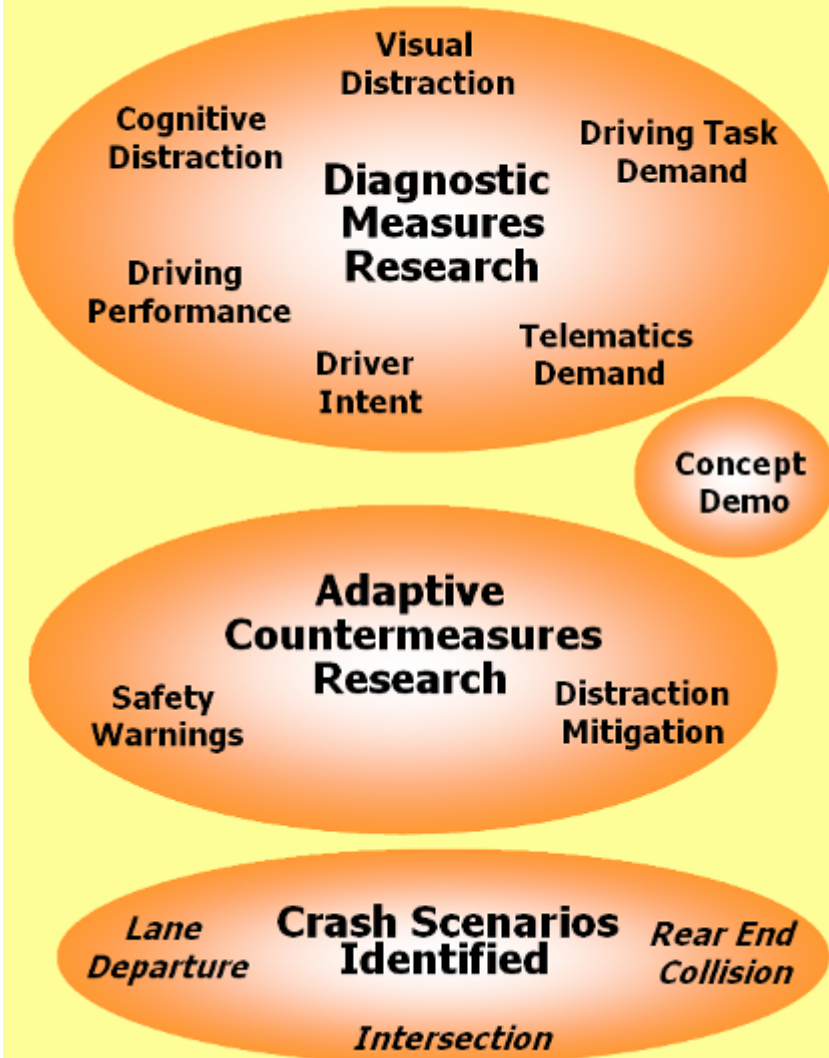


# What is the SAVE-IT system?



# SAVE-IT Research Structure

## Phase 1 (1.5 years)



## Phase 2A (2 years)

Test Vehicles and Simulator Integration



Data fusion & Algorithm Development

Sensor, Architecture, Central Interaction Manager Development

## Phase 2B (1.5 years)

On road & Simulator Testing

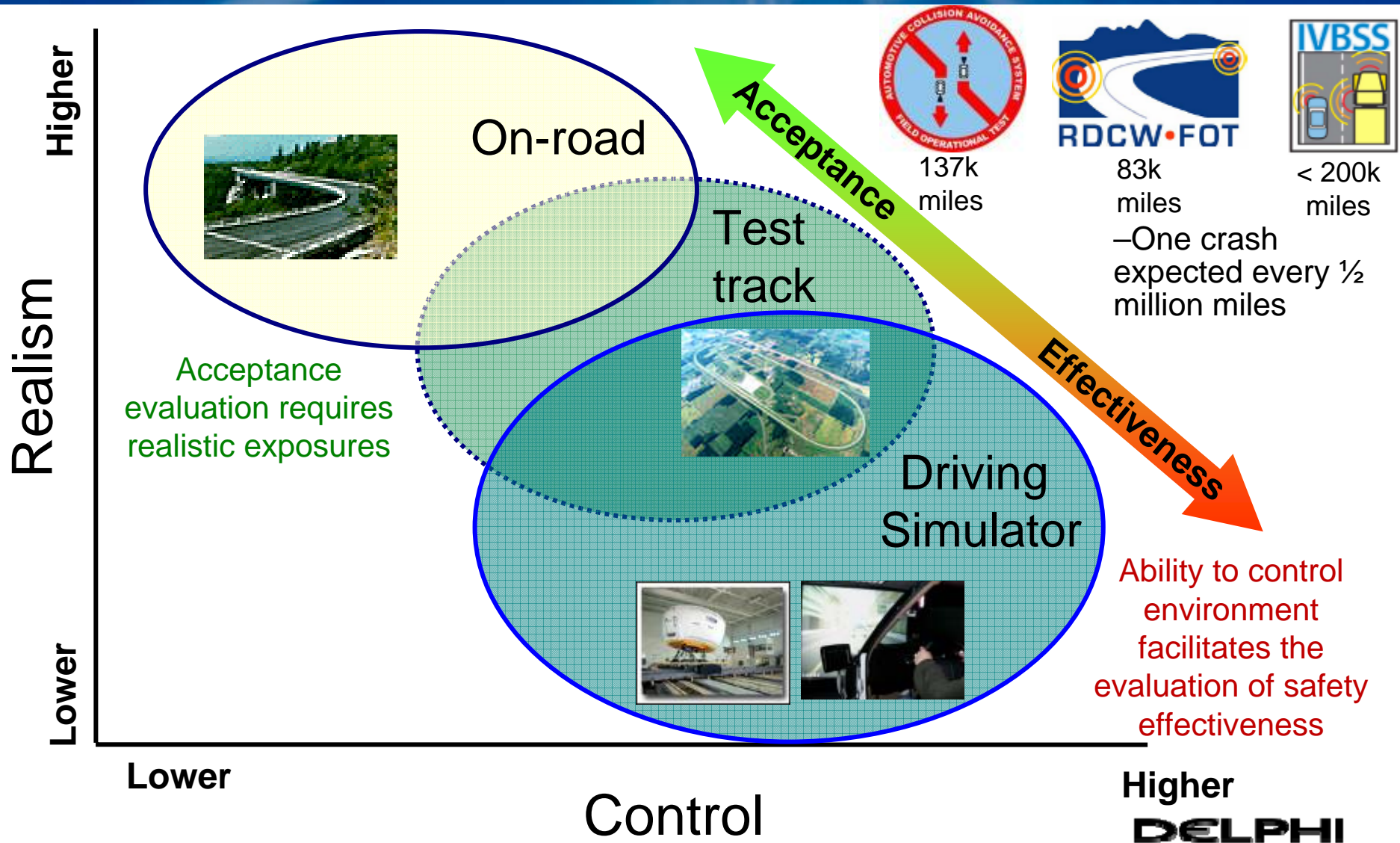


Benefits Analysis

Establish Guidelines & Standards

# Crash Reduction Effectiveness vs. Acceptance

## Research Venue



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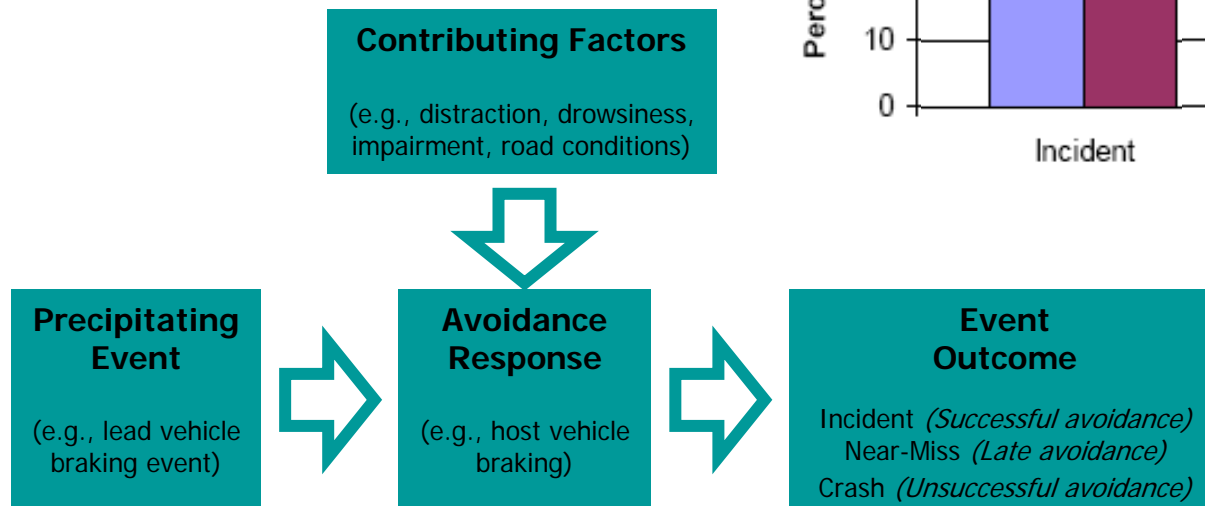
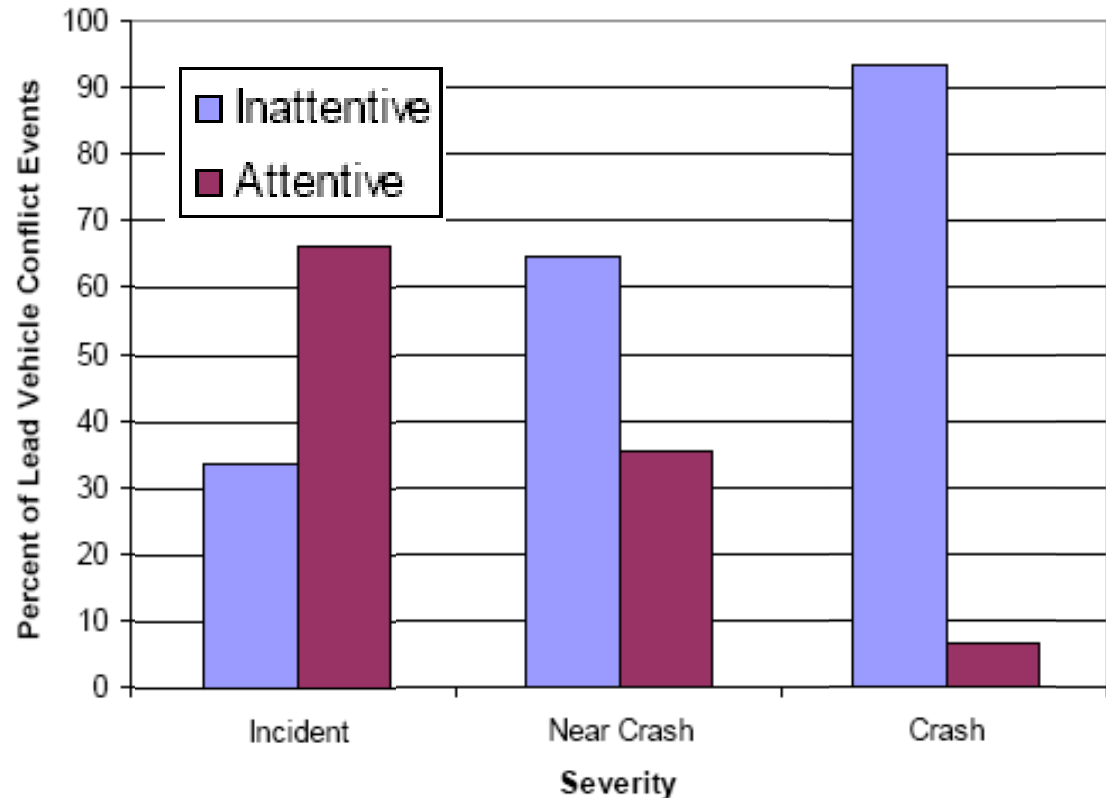
# Adaptive Warnings

# Support from the 100-Car Study: Distraction as the catalyst for Crashes

## From the 100-Car Study:

Forward inattention more frequent for crashes than incidents and near misses

Suggests that distraction converts incidents into crashes by undermining an avoidance maneuver that might otherwise have been successful.



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# Adaptive Warnings Development

- Adaptive warning goals:
  - reduce annoyance
  - improve or minimally degrade crash reduction potential.
  - technology must be affordable
- Due to affordability requirement and need for simplicity, head-pose became the only adaptation variable (cognitive distraction, eye-gaze, and intent not used)

## **Forward Collision Warning**

- Adaptive timing was selected for the evaluation phase
  - When head pose was away, alert timing was proportional to the duration of the away head pose, and when head pose was forward, only late alerts were provided.
  - Earlier warnings were shown to improve effectiveness during distracted episodes
  - During attentive episodes, conflicts were usually resolved prior to a delayed warning.
- Although not implemented for the evaluation, suppressing the auditory component of the alerts during attentive episodes appeared to be promising too

## **Lane Departure Warning**

- Total suppression was selected for the evaluation phase
  - When the driver's head pose was forward, alerts were completely suppressed
  - Testing revealed that alerts provided little to no benefit during attentive episodes
- Although beyond the scope of this program, drowsiness would also need to be monitored in a production system.

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# Benefits and Acceptance of Adaptive Warnings: Test Track Results

- Test track used to accelerate driver understanding of the SAVE-IT systems
  - Experience nuisance
  - Experience suppression
  - Experience earlier alerts
- Two surprise FCW braking events (using surrogate target) provided while drivers engaged in IVIS task
- Alerts were delivered earlier during the distraction episodes as designed
- Earlier alerts resulted in significantly faster reaction times
- Adaptive FCW rated as significantly more useful than non-adaptive
- Drivers agreed significantly more with “...I would want a \_\_\_ on my next car” for adaptive than non-adaptive FCW
- LDW showed a similar trend but was not-statistically significant



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# Benefits and Acceptance of Adaptive Warnings: On-road Results

- A subset of the test-track drivers later drove the SAVE-IT vehicle around Michigan
  - Two circuits with 2 hours of adaptive/distraction mitigation, and 2 hours of nominal warning systems and no mitigation
- Results revealed substantial alert suppression for both FCW and LDW
  - LDW alerts were reduced by 88 percent
  - FCW alerts were reduced by 60 percent and proportionally more false alerts (80%) and lane-change alerts (77%) were reduced than same lane alerts (65%).
  - The earlier timing during non-forward episodes also added extra alerts.
- Adaptation significantly reduced annoyance associated with LDW
- In some instances, head pose was forward but eyes were away, suggesting that total alert suppression could reduce system effectiveness
- Analyzed data from past field operational tests ACAS FOT (FCW) and RDCW FOT (LDW) to examine potential impact of using adaptive timing and suppression.
  - Estimated suppression rate for FCW was 72 percent.
  - Perfect head pose tracking would have eliminated almost all of the LDW alerts
  - No LDW alerts that were subjectively judged as being “potentially useful” were suppressed






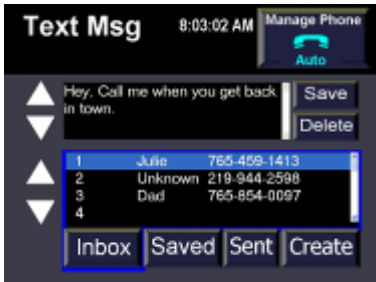
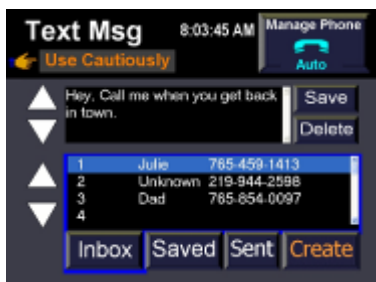
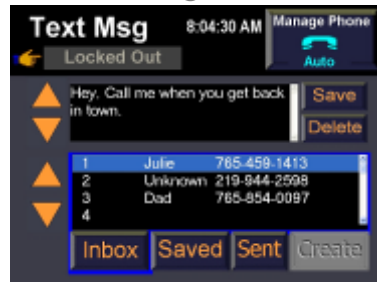
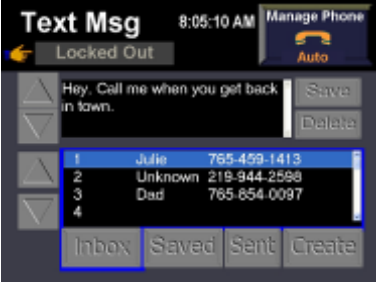
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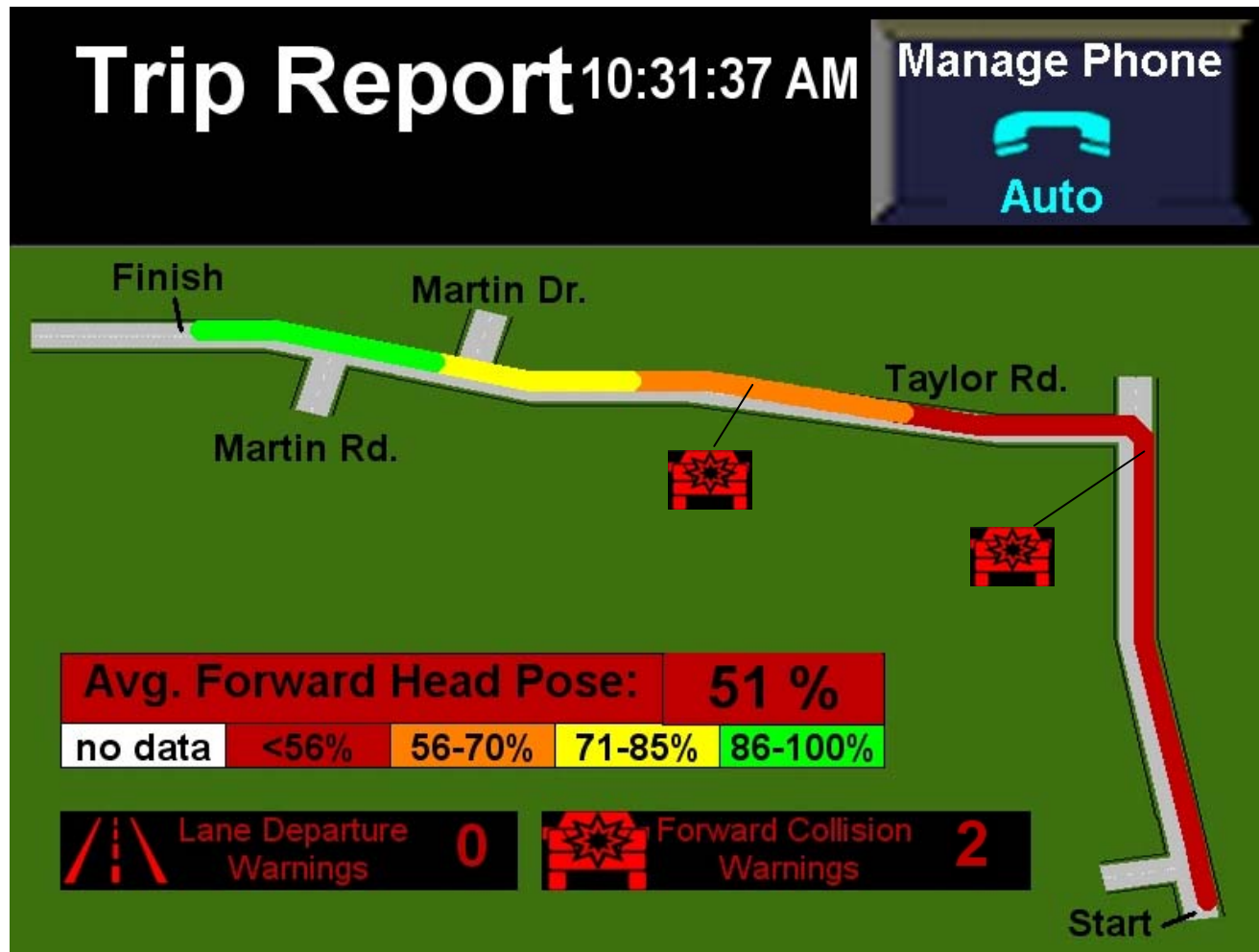
# Distraction Mitigation

# Demand-Based IVIS Distraction Mitigation and call screening

	<u>Park</u>	<u>Low</u>	<u>Medium</u>	<u>High</u>
<b>Driving Demand</b> <i>(from Radar, Yaw, Path, Wipers, etc.)</i>				
<b>IVIS Function</b>	All IVIS Features Are Available 	Almost all IVIS Features are available and few are advised against 	Many IVIS Features are available and many are advised against 	Few IVIS features are available and almost all are advised against 



# Distraction Mitigation: Trip Report



- Examined real-time feedback and post-hoc feedback (trip report)
- By saving feedback to the end of the drive, we avoided providing additional distraction
- Provided to the driver for a brief review after each drive but it can be ignored if they are not interested
- Report may trigger enough curiosity to briefly capture the driver's attention
- Acceptance data on trip report was positive and response times to lead vehicle braking were significantly reduced

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# SAVE-IT Conclusions

- Adaptive warnings help alleviate the tradeoff between providing sufficient warning during distracted episodes and annoying drivers when they do not need the warnings
- The challenge of adaptive systems is to function differently across driver states while preserving the perception of consistent system behavior
  - Phase I on-road testing suggested that we must be careful not to violate the perception of system consistency or stability
  - Providing earlier alerts during distracted episodes appears to best match the driver's expectations for FCW systems and can help negate the effect of distraction
- Adaptive HMI (e.g., suppressing the more annoying components of the alert) Or adaptive timing may be more effective than total alert suppression
- Trip report demonstrated high acceptance and revealed the potential to encourage safer driving
- There were many positive results, however, more work would be beneficial
  - The lessons learned during evaluation could be applied to improve the system
  - In many cases, statistical power was insufficient or exposures were too short for detecting statistically significant results.
  - Ford VIRTTEX results are still being analyzed...

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# For more information

- Many SAVE-IT documents are available at:

<http://www.volpe.dot.gov/hf/roadway/saveit/index.html>



The screenshot shows the RITA (Research and Innovative Technology Administration) website. The header includes the RITA logo and the text 'U.S. Department of Transportation | Research and Innovative Technology Administration | Volpe National Transportation Systems Center'. A search bar and navigation links are present. The main content area features a sidebar with various navigation options and a central article titled 'Safety Vehicle Using Adaptive Interface Technology (SAVE-IT)'. The article includes a description of the project, project details, and two images: one of a car with 'SAVE-IT' on the hood and another of a car's interior dashboard.

**RITA** U.S. Department of Transportation | Research and Innovative Technology Administration  
Volpe National Transportation Systems Center

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### Safety Vehicle Using Adaptive Interface Technology (SAVE-IT)

NHTSA seeks to develop a test vehicle incorporating adaptive interface technology to help it understand the safety benefits such a system might achieve and the requirements necessary to achieve such benefits. The development of such a vehicle will also spur ongoing industry efforts and create a basis for possible industry standards needed to achieve widespread application of a common adaptive interface.

#### Project Details

The number of in-vehicle technologies and their potential for distracting drivers is expected to increase as more electronic devices, both stand-alone systems mounted in vehicles and portable hand-held devices, appear in cars. The National Highway Traffic Safety Administration (NHTSA) estimates that driver distraction and inattention contribute to 20 to 30 percent of police reported crashes - about 1.5 million crashes a year.



SAVE-IT Phase I Demonstration Vehicle, Washington, DC, May 2004.



Phase II Preliminary Vehicle, Driver State Monitor interface.

Vehicles, in which these systems and devices are embedded or operated, need to be designed so that the demands they impose on drivers match drivers' capabilities to process and respond to the information presented. A central monitoring system is a promising approach to achieving, and increasing, the benefits of advanced vehicle technologies, without creating adverse safety consequences due to driver distraction and information overload. Such a system would integrate the data being obtained by sensors to control the information flow to the driver through an adaptive driver-vehicle interface.

- More information on NHTSA activities and papers in this area are available at: <http://www.nhtsa.gov/portal/site/nhtsa/menuitem.8f0a414414e99092b477cb30343c44cc/>

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