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

NHTSA www.nhtsa.gov

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

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

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The University of Iowa College of Engineering

NADS UI

Ford

University of Michigan UMTRI Transportation Research Institute

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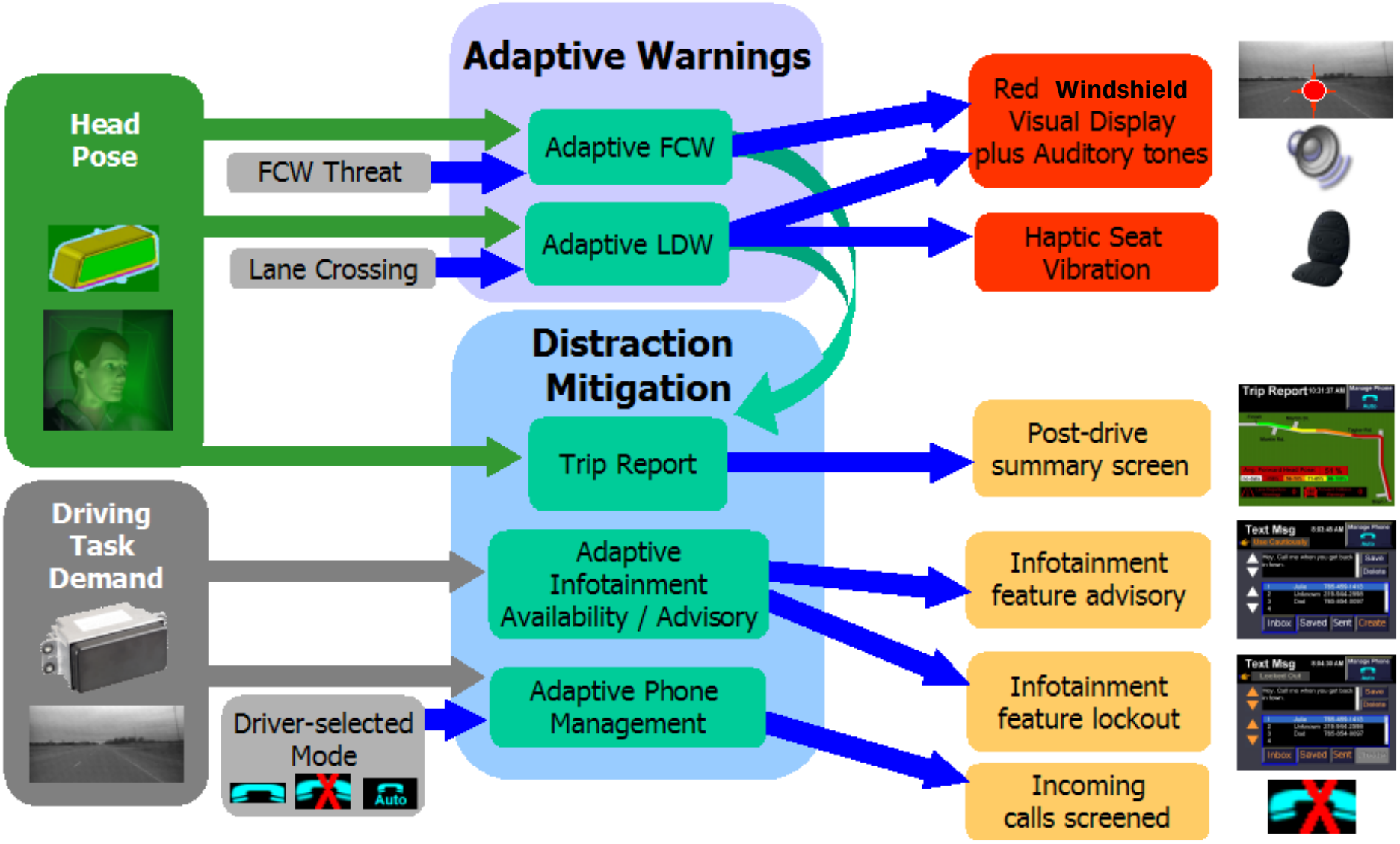
What is the SAVE-IT system?



SAVE-IT Research Structure

Phase 1 (1.5 years)

Visual Distraction

Cognitive Distraction

Driving Task Demand

Diagnostic Measures Research

Driving Performance

Telematics Demand

Driver Intent

Concept Demo

Adaptive Countermeasures Research

Safety Warnings

Distraction Mitigation

Crash Scenarios Identified

Lane Departure

Rear End Collision

Intersection

Phase 2A (2 years)

Test Vehicles and Simulator Integration

Data fusion & Algorithm Development

Sensor, Architecture, Central Interaction Manager Development

Phase 2B (1.5 years)

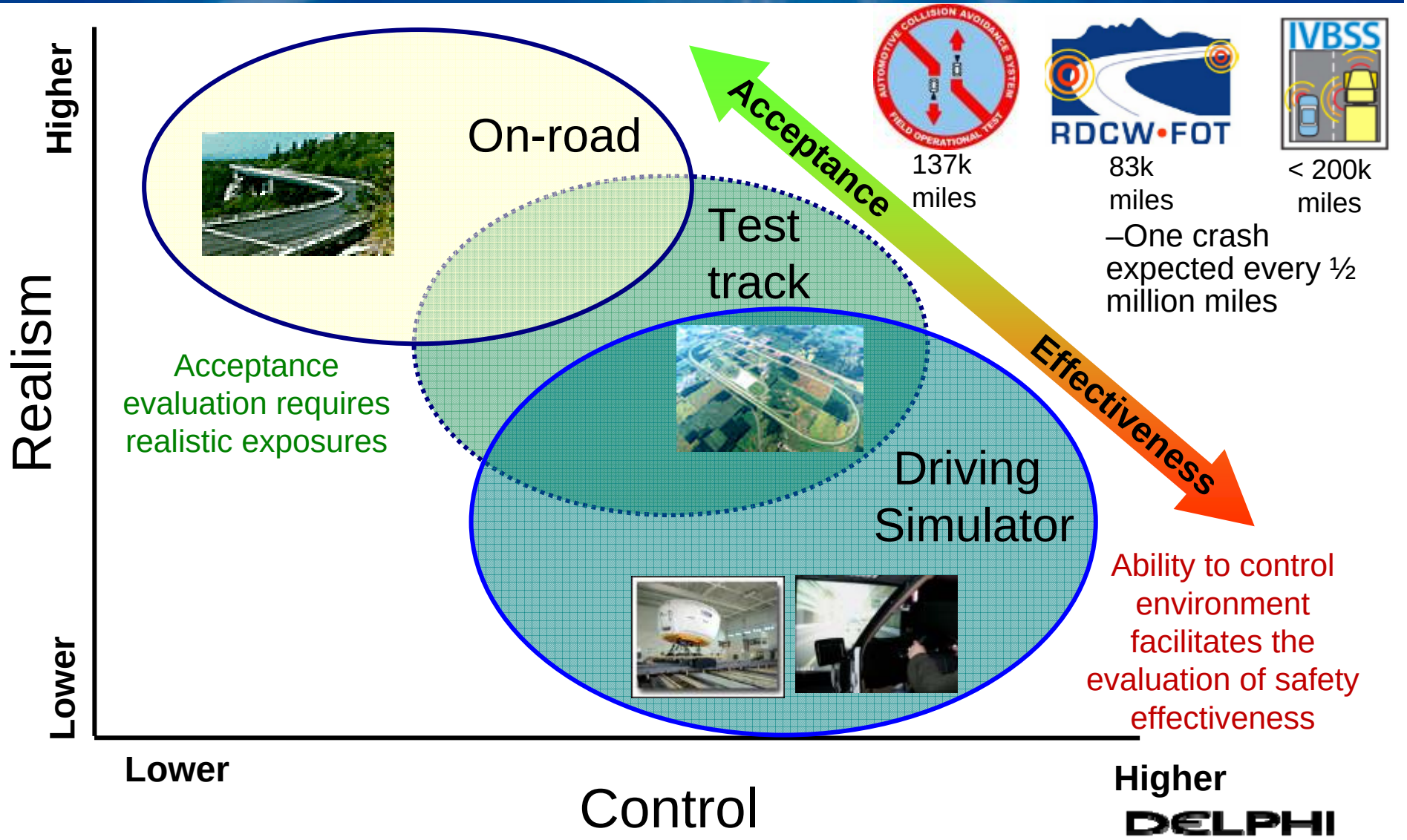
On road & Simulator Testing

Benefits Analysis

Establish Guidelines & Standards

Crash Reduction Effectiveness vs. Acceptance

Research Venue

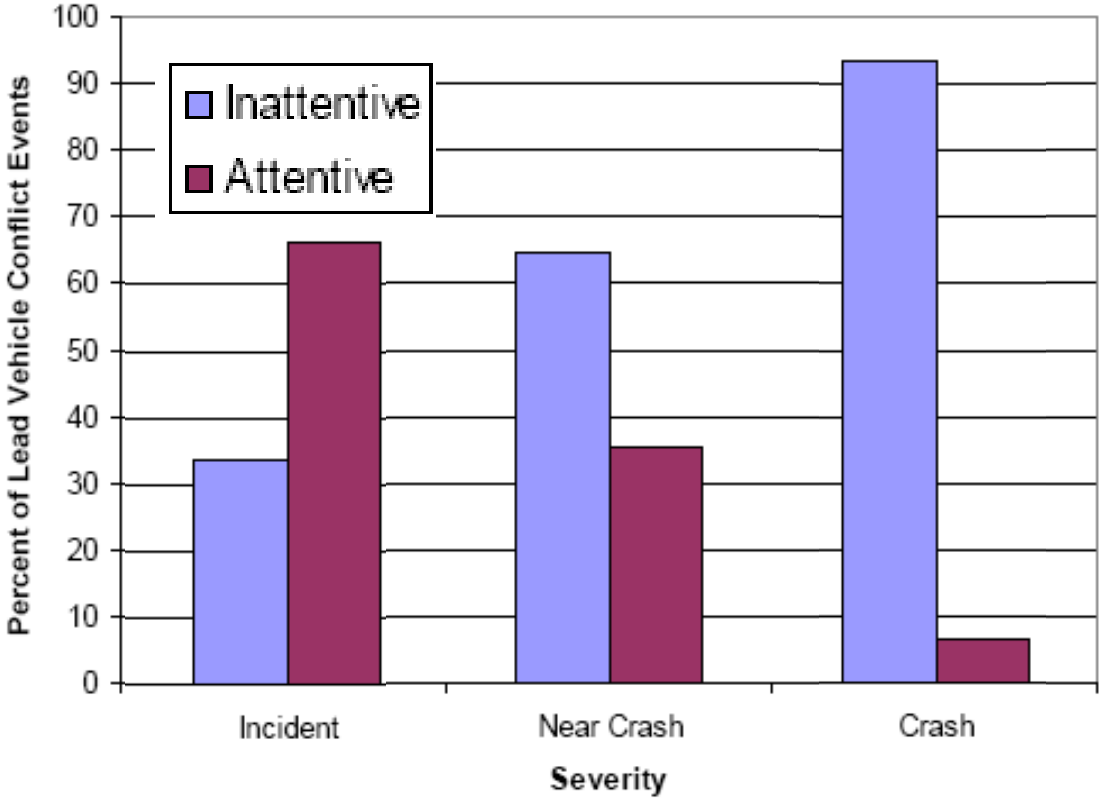


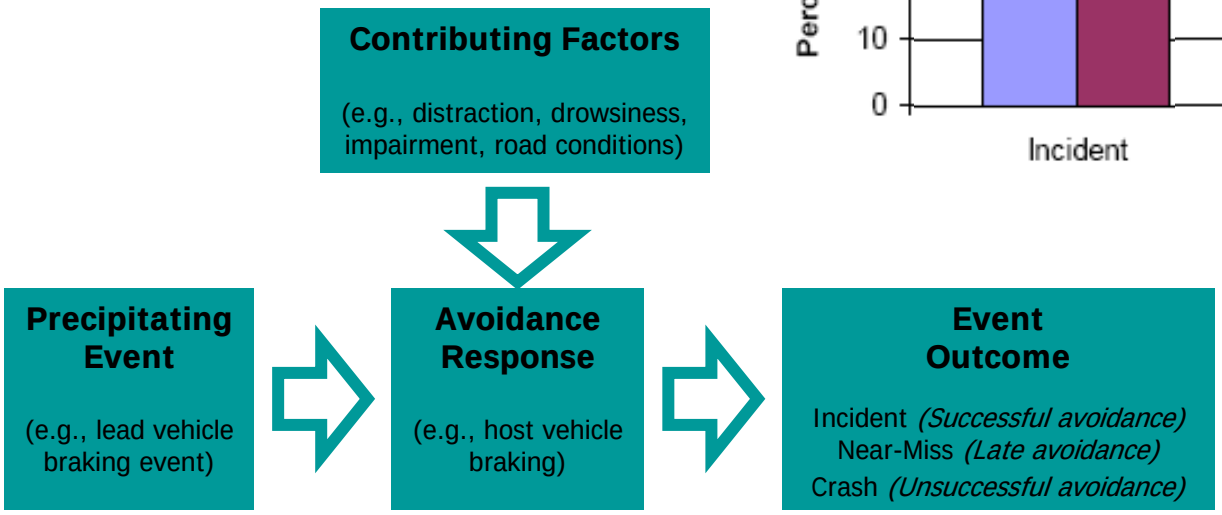
Adaptive Warnings

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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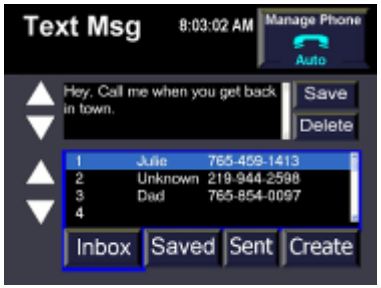
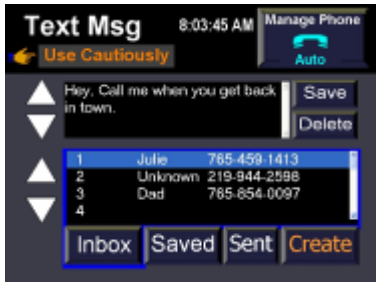
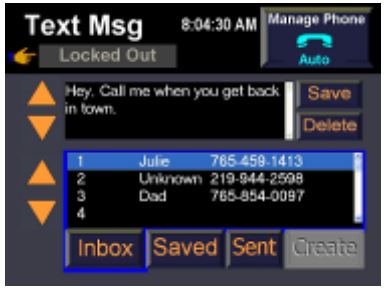
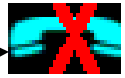
Distraction Mitigation

Demand-Based IVIS Distraction Mitigation and call screening

	Park	Low	Medium	High
Driving Demand *(from Radar, Yaw, Path, Wipers, etc.)*				
IVIS Function	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

Driver selects "call screening" mode

No Screen (lets all calls through)


Do not disturb (let no calls through)

Auto Screen (screening based on demand)

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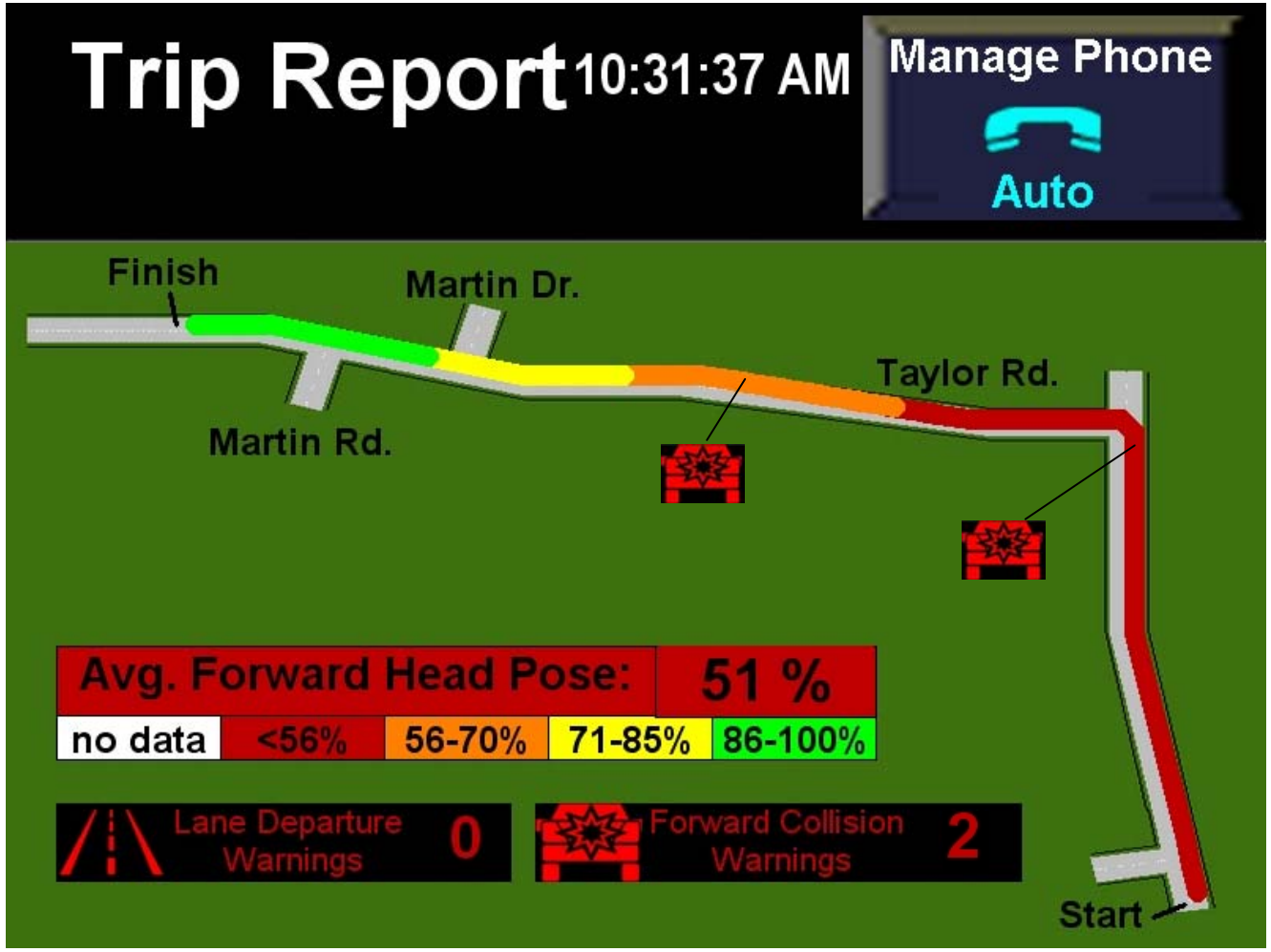
Distraction Mitigation: Trip Report



- 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

- 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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