Dwight David Eisenhower Transportation Fellowship Program

Integrating Graphics into Dynamic Message Signs to ease the slow down effect

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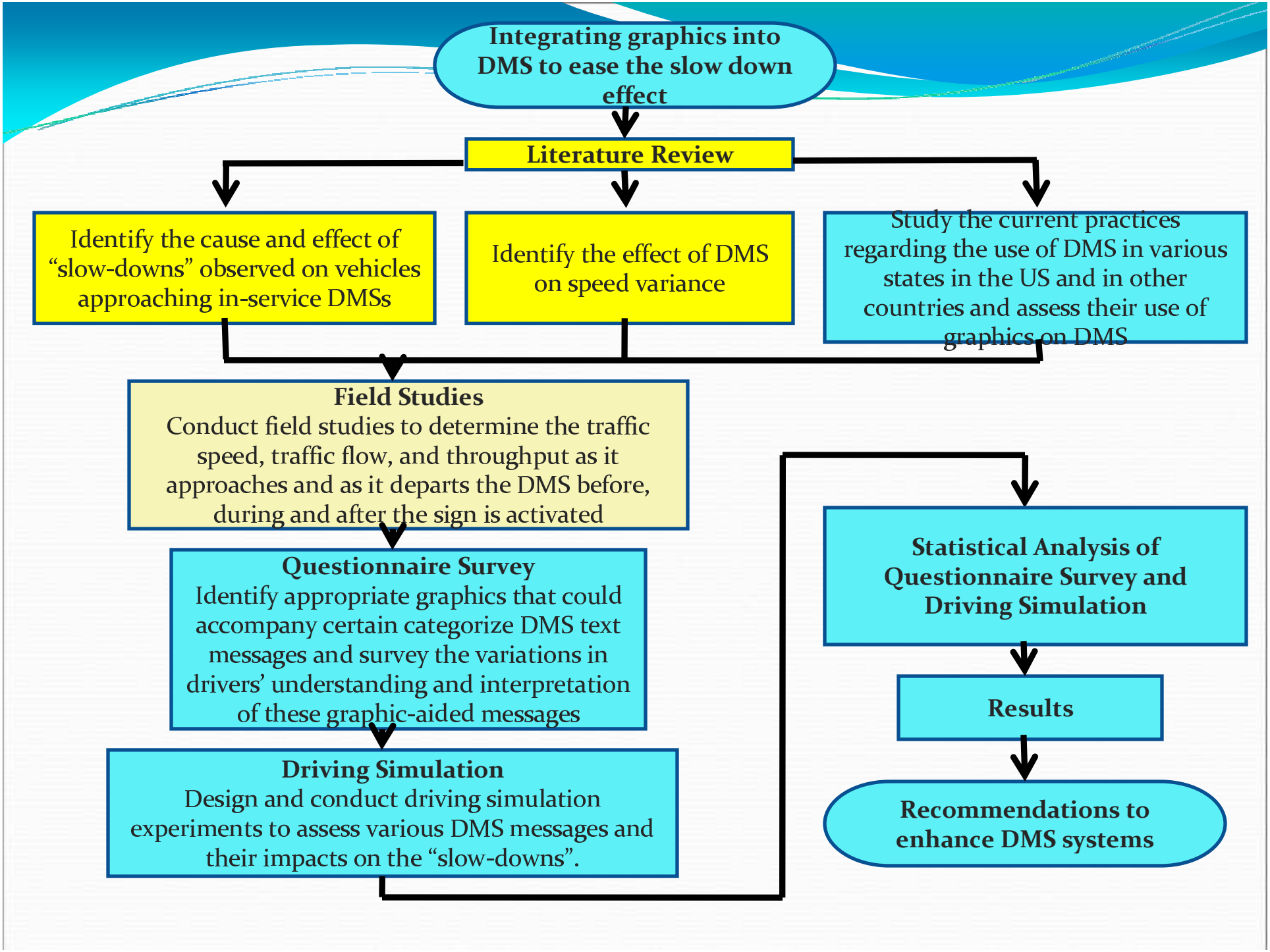
INTRODUCTION

- DMS have been used in Rhode Island since early 2004.
  - RI's DMS systems are capable of displaying 3 lines with 20 characters on each line.
- Long and complex messages demand attention from drivers who are occupied by the already tense highway driving task.
- In a driving situation the **amount of time** available to read a message on a sign is **limited**.

OBJECTIVES

- To research about previous methodologies that have been used to identify drivers' slow downs due to in service DMS.
- To understand the slow down effect and its possible causes.
- To find a possible solution to reduce or even eliminate the slow down effect.

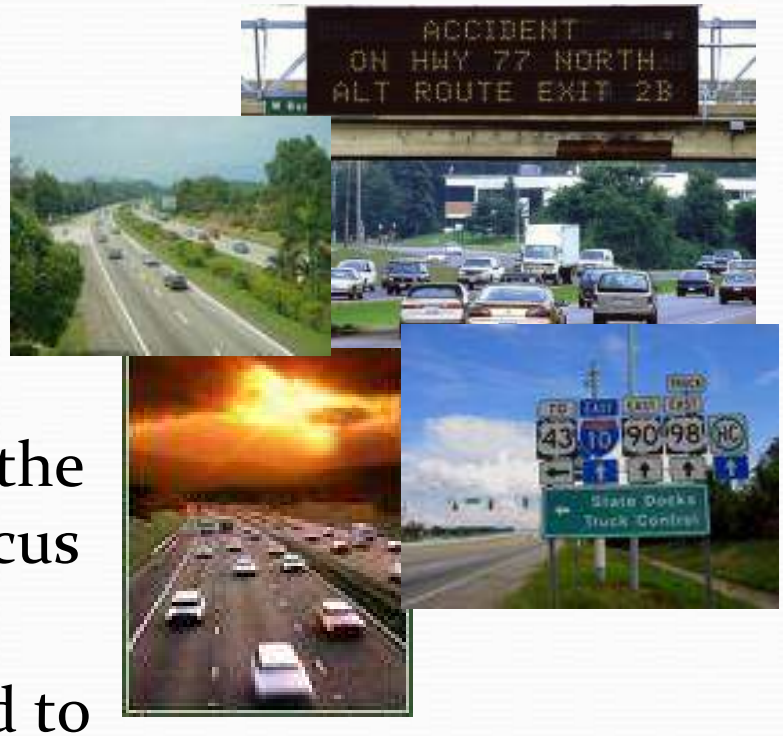

Integrating graphics into DMS to ease the slow down effect
Literature Review
Identify the cause and effect of "slow-downs" observed on vehicles approaching in-service DMSs
Identify the effect of DMS on speed variance
Study the current practices regarding the use of DMS in various states in the US and in other countries and assess their use of graphics on DMS
Field Studies
Conduct field studies to determine the traffic speed, traffic flow, and throughput as it approaches and as it departs the DMS before, during and after the sign is activated
Questionnaire Survey
Identify appropriate graphics that could accompany certain categorize DMS text messages and survey the variations in drivers' understanding and interpretation of these graphic-aided messages
Driving Simulation
Design and conduct driving simulation experiments to assess various DMS messages and their impacts on the "slow-downs".
Statistical Analysis of Questionnaire Survey and Driving Simulation
Results
Recommendations to enhance DMS systems

PROBLEM

- Research studies have identified that driver's slow down when approaching DMS.
  - (Ref. Alm and Nilsson (2000); Boyle and Mannering (2003)
- A non uniform reduction in speed causes an increase in the speed variance at the road section, though increasing the possibility of an accident.
  - "Larger speed variance is related to a higher crash rate" (Ref: Garber and Gadiraju et al., 1989)

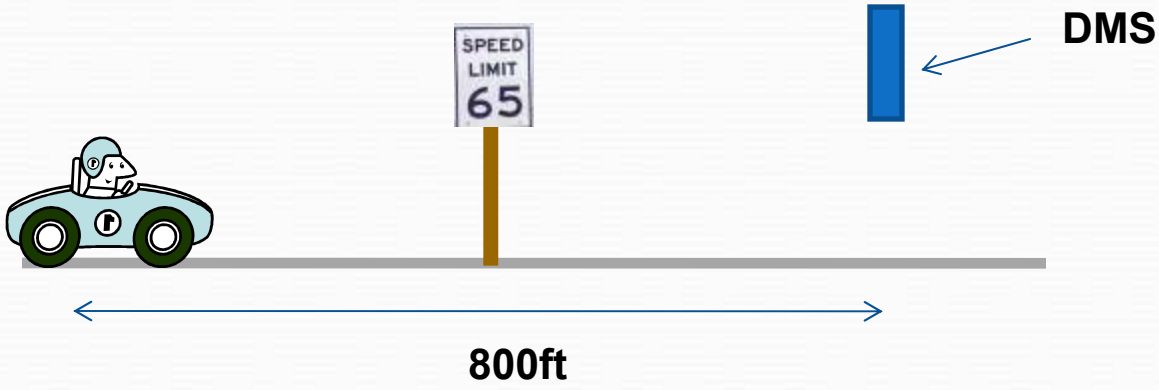
CAUSES FOR SLOW DOWNS: DRIVERS' MENTAL WORKLOAD

- Drivers must time-share their attention to:
  - **Roadway geometry**
  - **Traffic**
  - **Traffic Signs**
- It will take drivers longer to read the DMS message, since they can't focus 100% on this task.
- Drivers tend to reduce their speed to have more time to react to possible incidents. **(Ref. Alm and Nilsson et al.,2000)**



CAUSES FOR SLOW DOWNS: DMS's MESSAGE VISIBILITY

- 18" characters signs
  - Normal reading distance: **800ft** (Ideal conditions)
  - Reading distance at nighttime: **600ft**
- A driver in I-95 would have **8.4 sec** to read a DMS message, while driving at the posted speed.

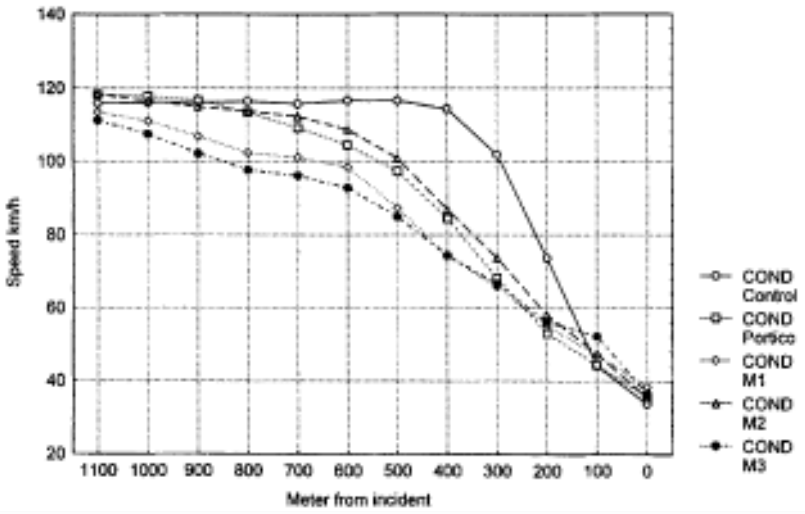


Ref: FHWA CMS Operation and Messaging Handbook

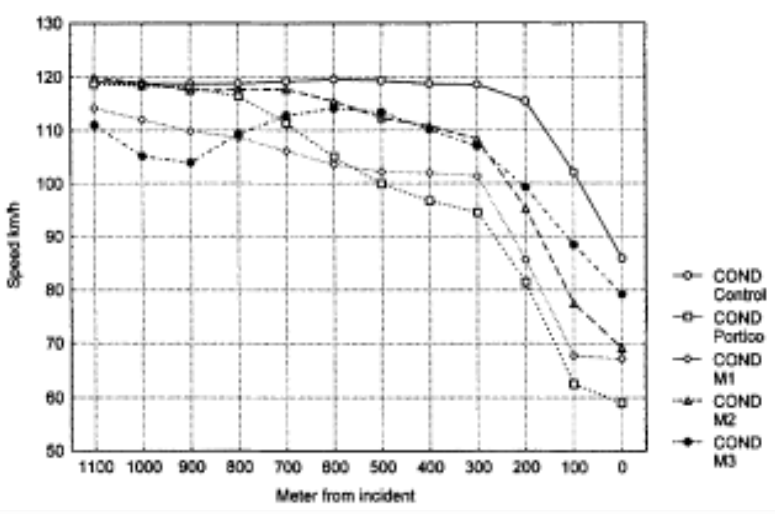
ALM'S AND NILSSON'S STUDY (2000)

- Purpose:
  - Increase understanding of the effects of different Incident Warning Systems (IWS) messages on drivers' behavior.
- Methodology used: Driving Simulation
  1. Control group: No Incident Warning Systems
  2. PORTICO site group:
     - White poles located on the left and right sides of the road with a red light on top.
  3. MELYSSA site group:
     - Incident message presented using a DMS.
     - The messages displayed had 3 levels of detail
       - M1: Warning and incident type
       - M2: (M1 + Distance to incident)
       - M3: (M2 + Recommended action)

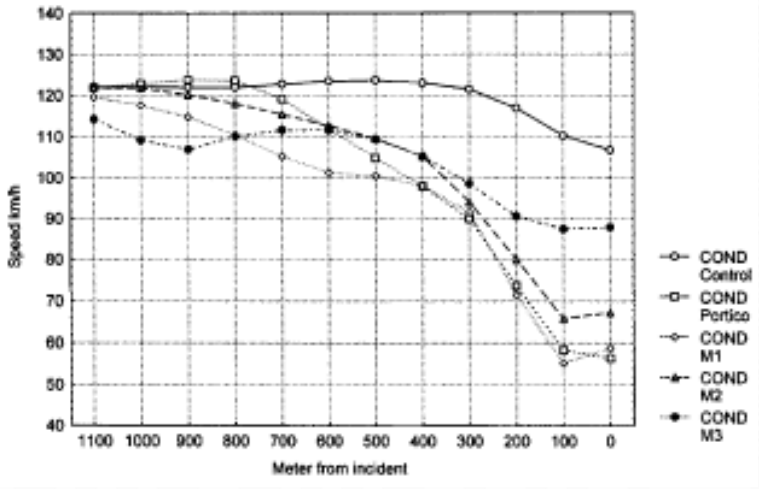
ALM'S AND NILSSON'S RESULTS



CONGESTION



ROADWORK



ACCIDENT

Ref: Incident Warning Systems and Traffic Safety: A comparison between the PORTICO and MELYSSA test site systems

DRIVERS COMPENSATING BEHAVIOR

- Drivers' tend to speed up downstream once passed the DMS message. **(Ref. Alm and Nilsson, 2000; Ulfarsson and Shankar, 2002)**
- This behavior might be due to:
  - Desire to compensate for time lost reading the message
  - Feeling overconfident that the information will allow them to react in a timely manner

HOW CAN DMS MESSAGE DISPLAY BE ENHANCED TO EASE SLOW DOWN EFFECT?

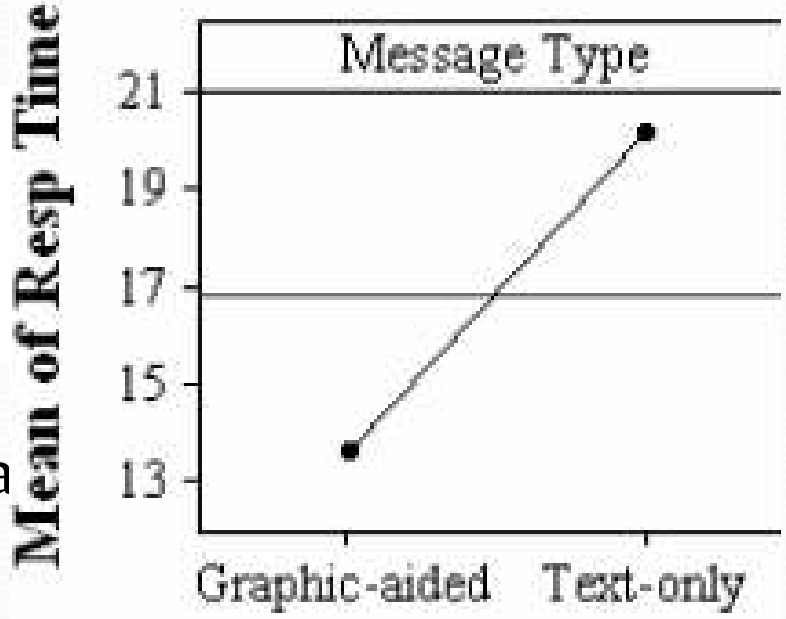
- Adding graphics to DMS messages
  - The **legibility distance** of symbol signs is **twice** as that of text traffic signs (Kline and Fuchs, 1993)
  - Graphically presented information produced faster responses than words. (Wang and Hesar et al. 2005)
- Advantages of graphic-aided messages:
  - Identified easier,
  - Identified quicker,
  - Larger visibility distance,
  - Could be seen better under adverse viewing conditions,
  - Can be understood by people who can't understand the language in words

WANG AND HESAR'S RESULTS

Accident Message

Road Work Message

- Overall there was approximately a 6sec reduction in the mean response time between the text message and the graphic –aided message.



Ref. Employing Graphics to aid Dynamic Message Signs, Hesar 2005

FIELD STUDY

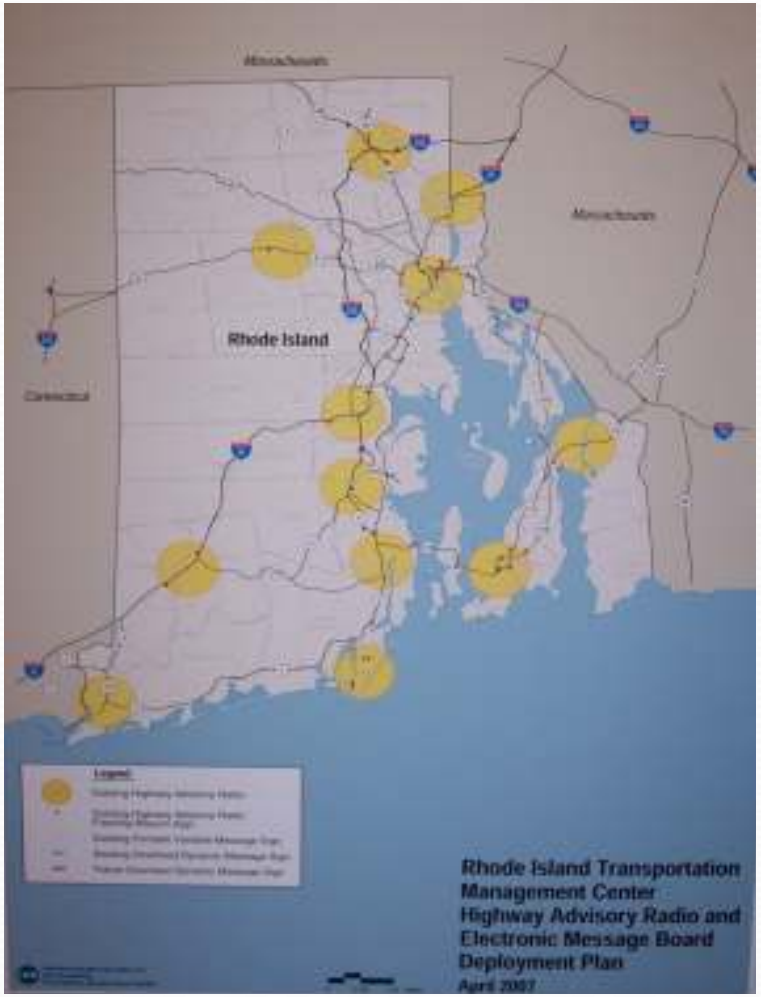
- METHODOLOGY: **Full scale study**
  - Measure drivers' speed as they approach DMS
    - In service / Out of service
  - Locations of measurement
    - DMS in visual range of driver
    - After driver has passed the DMS location
- INFORMATION TO BE GATHERED
  - Quantify driver's slow down effect
  - Observe driver's compensating behavior

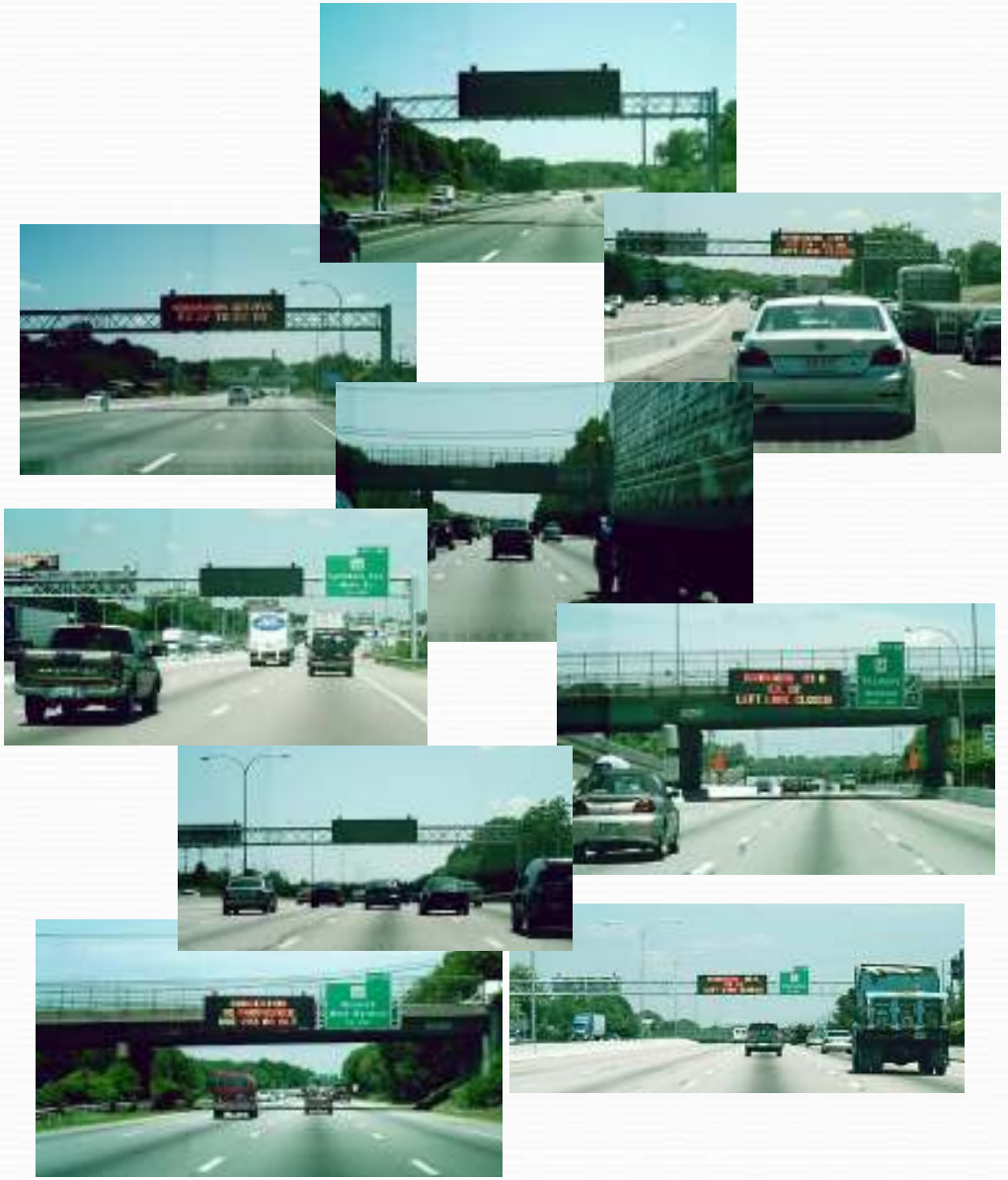
Area of study

- I-95
  - The only Interstate highway in the State of RI
  - Urban / Rural Segment
  - Speed Limit: 65mph
  - There are 8 DMS located in I-95 RI
    - 4 Northbound
    - 4 Southbound

Ref. www.mapathon.com/ri.html

FIELD WORK


Rhode Island
Rhode Island Transportation Management Center
Highway Advisory Radio and Electronic Message Board Deployment Plan
April 2007



MOBILITY TECHNOLOGY SENSORS

- A Network of **64 Radar Vehicle Detectors** (RVD) was installed in Rhode Island early in 2004
- Locations
  - **I-95**, **I-295**, **Route 6**, **Route 10**, **Route 4**, and **Route 146** (primarily in the Providence Metropolitan Area)
- The network collects key traffic information, including:
  - Vehicle speeds per lane
  - Vehicle counts
  - Roadway density

This system is not capable of measuring the per vehicle speed

LOCATION OF MOBILITY TECHNOLOGY SENSORS

- DMS located near MTS
  - DMS 2-2
  - DMS 2-3
  - DMS 2-6
  - DMS 2-12
  - DMS 2-4

MTS SPEED INFORMATION

- Vehicle's Speed Information
  - Average speed in each lane
    - 5 min time intervals
- Study Period
  - START: 30 min before the DMS is activated
  - END: 30 min after the DMS is deactivated

FUTURE WORK

- Field studies (two approaches)
  - Analyze the speed data obtained from the MTS
  - Test subjects will drive through the test route several times to record the traffic speed as they approach and depart the DMS before and after the sign is activated
    - In-vehicle digital image recorder
    - GPS
    - Portable computer

TO CAPTURE THE DRIVING SCENE AND TEST THE VEHICLE'S SPEED

FUTURE WORK

- Questionnaire Survey
  - Obtain information about drivers' understanding and interpretation of graphics-aided messages and their preferences on the use of graphics in DMSs.
- Driving Simulation Experiment
  - Test DMS messages which appeared in the field study and were surveyed in the questionnaire
  - Test critical factors affecting the design and display of DMS messages

REFERENCES

- Hesar, S., Collyer C. E., Wang J.H., 2005, " Adding Graphics to Dynamic Message Sign Messages".
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- Ulfarsson, G.F., V.N. Shankar, and P. Vu., 2002, "The Effect of Variable Message Signs on the Relationship Between Mean Speeds and Speed Deviations", Proceedings of the 81st Annual Meeting of Transportation Research Board, CD-ROM, 29.
- Alm, H., Nilsson, L., 2000, " Incident Warning Systems and Traffic Safety: A Comparison between the PORTICO and MELYSSA Test Site Systems".

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Questions?