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

- 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](http://www.mapathon.com/ri.html)
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

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Questions?