Texas Transportation Institute
The Texas A&M University System
3135 TAMU
College Station, TX 77843-3135

979-845-1727
Fax: 979-845-6254
http://transops.tamu.edu

January 28, 2004

TO: Dr. Barry Kantowicz
Principal Investigator
University of Michigan Transportation Research Institute

Dr. Thomas Granda
Task Order Contractor Manager
Federal Highway Administration

FROM: Dr. Conrad L. Dudek
Task Order Leader
Texas Transportation Institute

RE: Task 2 Draft Letter Report
Impacts of Using Dynamic Features to Display Messages on Changeable Message Signs
Purchase Order 3000389616 (RF 475100) with the University of Michigan
US DOT Prime Contract No. DTFH61-01-C-00049 (RF 571000)

BACKGROUND

This letter report is in response to the requirements of Task 2 of the referenced report: Review and Summarize Literature. The objective of Task 2 was to provide a summary of the literature and a synthesis of the key findings and issues identified relative the effects of using dynamic features to display messages on changeable message signs (CMSs).

Several state departments of transportation (DOTs) currently operating CMSs are using dynamic features of the signs in the belief that the features attract the attention of drivers and emphasize the importance of the message. The dynamic features of interest in this Project are as follows:

- Flashing an entire one-phase message;
- Flashing one line of a one-phase message; and
- Alternating one line of text and keeping two lines constant on a three-line CMS.

It has been speculated by personnel from some state DOTs that continuously flashing certain one-phase messages (typically those that describe significant traffic disruptions downstream) or flashing one line of a one-phase message (typically the top problem statement line) emphasizes that the message is especially important to drivers and should be heeded. It is important to objectively determine whether these practices:

- Affects a driver's ability to properly comprehend the message;
- Affects the amount of time it takes a driver to read and comprehend the message; or
- Influences the importance drivers place on the message.

Another operating practice by some DOTs is to format a two-phase message in such a way that the top two lines of the message remain constant and a third (bottom) line is alternated between one unit of information and another. In essence, the CMS operates as if it were a two-phase message, but with one message line changing and some of the information constant between the two phases. A District in on state DOT is keeping the top line constant and switching the bottom two lines on some of their messages. There is a need to determine whether drivers actually notice that the line changes. Also, it is not totally clear what affect the redundancy of information has on driver comprehension and reading times of the entire message. For example, do the repeated lines cause drivers to read these lines more than once thus increasing reading times? Thus, there is a need to determine the following:

- Driver comprehension of redundancy in the form of repetition in a two-phase message when the bottom line changes while the other two lines remain the same versus a two-phase message without redundancy;
- Driver preferences for each of the two message styles; and
- Driver reading times for each of the two message styles.

The Texas Transportation researchers identified two key reported studies that were relevant to the issues in the current Project. One is a study conducted by TTI for the Texas Department of Transportation (TxDOT), and the other is a study conducted in Europe for the European Union DGVII through the TROPIC Project. Each study is summarized below.

1. TTI STUDY FOR TxDOT

Introduction

Dudek et al. in 2000[1] and Dudek and Ullman in 2002[2] reported on research that was conducted for the TxDOT as part of a study to improve CMS messages and operations in Texas. Several TxDOT districts were interested in knowing more about the effectiveness of using some of the dynamic features of CMSs. The following three issues were examined:

- Effect of flashing an entire one-phase message;
- Effect of flashing one line of a one-phase message; and
- Effect of alternating text on one line of a three-line CMS while keeping the other two lines of text the same.

Study Design

Single-task human factors studies were conducted in five cities (Dallas, El Paso, Fort Worth, Houston, and San Antonio) using laptop computers. The laboratory instrument was administrated to 260 individuals, 52 from each of the five study locations. Because most of the CMS messages evaluated would be used on freeways or highways, all subjects were required to have a current Texas driver license, drive at least 8000 miles per year, and travel on a freeway or highway at least 12 times per year. A demographic sampling method of the Texas driving population based on age, gender, and education level was used as a guide for subject selection. The same demographic sample was used in each of the five cities.

The instructions to the subjects and the stimulus CMS messages were displayed on the computer screen. After reading the instructions and viewing a message, the subject wrote the answers to specific open-ended questions on the study form. Each time the subject pressed the space bar, the program would advance to the next message. The order of the alternative messages for each of the issues investigated was altered amongst the subjects in each city to counter recency bias. CMS messages that flashed, had one line flashing, and had one line alternating on two phases were compared with companion "static" CMS messages. When a flashing message (or line) was studied, the message (or line) was displayed alternately for 2 seconds on and a half-second off, which is identical to the flashing rate used by TxDOT.

In addition to accounting for the order of the message modes (flashing and static), the study was also counterbalanced with respect to whether the viewing time for the message was fixed at 8 seconds (the typical reading time available when prevailing speed is 55 mph), or self-paced where the subjects viewed the message and then turned the message off when they understood what the message said.

Flashing Messages

This part of the study was designed to evaluate the effects of continuously flashing one-phase messages.

Messages Tested

The subjects in each of the study cities viewed the following one-phase messages one at a time:

MAJOR ACCIDENT **AT** ***[location]*** **3 LANES CLOSED**

and

FREEWAY BLOCKED **AT** ***[location]*** **USE OTHER ROUTES**

Each message contained three units of information. (*Units of information* as used in the TTI study is consistent with the tenets advanced by Dudek and Huchingson[3] for CMS messages in the *Manual on Real-Time Motorist Information Displays*). The *[location]* term was changed to an actual physical location name on a freeway in each study city. The subjects in each city saw each message presented in a static mode and also in a flashing mode.

Study Protocol

After presentation of each message in either a static or flashing mode for either a fixed or a self-paced period of time, subjects were asked to answer specific questions. After the subjects responded to the questions for the second alternative viewed, they were shown both modes

(static and flashing) of presentation one at a time and were asked to select the message mode they preferred. The second alternative they viewed previously was shown first.

Study Results

Effect on Driver Comprehension

The results of the study upon driver comprehension are presented in Table 1. Generally speaking, the results indicated that flashing a one-phase message did not adversely affect driver comprehension to a significant degree. Nearly equal percentages of subjects overall correctly responded to the question "what is the traffic problem?" regardless of whether the message was presented in a static or in a flashing mode. There were some differences depending on whether or not the subjects viewed the message for a fixed period of time or saw the message for as long as they wanted, but these differences were identical for both the static and the flashing message presentation modes. The authors were not able to determine why the self-paced display time resulted in lower correct responses than the fixed display time.

Table 1. Responses to the Questions for Static and Flashing One-Phase Messages (3 Units of information) [2,3]

Responses	Fixed 8-Second Display Time (%)		Self-Paced Display Time (%)		Display Time Types Combined (%)	
	Static Message	Flashing Message	Static Message	Flashing Message	Static Message	Flashing Message
What is the traffic problem?						
√ Correct answer	86[a]	89[a]	78[a]	80[a]	82	84
Incorrect answer	9	5	15	11	12	8
Did not remember	4	5	5	8	5	7
Did not respond	1	1	2	1	1	1
Where is the traffic problem located?						
√ Correct answer	90	88	85	87	88	88
Incorrect answer	5	3	6	6	5	4
Did not remember	4	7	7	6	5	6
Did not respond	1	2	2	1	2	2
What are you to do?/What is told about the Lanes?						
√ Correct answer	84	82	87	80	85	81
Incorrect answer	10	13	8	11	9	12
Did not remember	5	4	4	8	5	6
Did not respond	1	1	2	2	1	1

n=260

[a] percent of correct responses differ significantly (α=0.05) between the fixed and the self-paced display times

The responses to the question about traffic problem location described in the message also resulted in no statistically significant differences between the static and the flashing message presentation modes. Responses were also consistent between the fixed and the self-paced display times.

The subjects' responses to the question "What are you to do?/What is told about the lanes?" resulted in no significant differences between the static versus flashing message presentation or between fixed and self-paced display times.

Effect on Message Reading Times

Basic descriptive statistics for the reading times of the subjects used during the self-paced portion of the study are shown in Table 2. The average reading time of the message when it was flashing was 1.5 seconds (17 percent) longer than when the message was not flashed (i.e., the message presentation was static). The implication of these results was that drivers can process more information in a one-phase CMS message if the message is presented in a static mode than if the message is flashed.

Table 2. Reading Times for Static and Flashing One-Phase Message (3 Units of information) [2,3]

Descriptive Statistics (n=260)	Static Message (sec)	Flashing Message (sec)	Difference (sec)
Median Reading Time	6.5	7.8	+1.3
Average Reading Time	8.6	10.1	+1.5*
Standard Deviation	8.5	8.9	+0.4

* Comparison of means test (Z=1.97) indicates difference is statistically significant ($\alpha = 0.05$)

Driver Preferences

Preference data are summarized in Tables 3 and 4. The researchers found the subjects to be fairly evenly split as to their preferences regarding static or flashing messages. The researchers also found that preference did appear to be related to order of presentation in the study, as illustrated in Table 3. In particular, if the subjects were initially presented a static message and then shown the flashing message, they tended to prefer the flashing mode. If the subject was first presented a flashing message and then shown the message in a static mode, they tended to prefer the static presentation mode.

Table 3. Preferences for Static or Flashing One-Phase Messages [2,3]

Preference	Static Message Presented Last (%)	Flashing Message Presented Last (%)	Both Presentation Orders Combined (%)
Static Message	53	40	47
Flashing Message	44	53	48
No Preference	3	5	4
Did not respond	0	2	1

A summary of common responses received from the subjects as to why they preferred a static or a flashing message is presented in Table 4. The authors found that those who preferred a flashing message did so because they felt it was better able to get their attention. Conversely, those who preferred a static message felt that it gave them more time to read and remember the information, and was less distracting than a flashing message.

Table 4. Common Reasons for Preferences of Static or Flashing One-Phase Messages [2,3]

Reasons for Preferring a Static Message	Reasons for Preferring a Flashing Message
• Gives more time to read and understand • One simple message displayed • Can see the entire message at the same time • Easier to understand • Flashing is distracting • Flashing is confusing – I have to start over reading each time	• Gets your attention • Alerts you • Makes the incident seem more recent • Easier to remember • Keeps you focused on the problem • Gives more information

Flashing One Line of a One-Phase Message

This part of the study dealt with the practice of flashing one line of a one-phase message (typically the top problem statement line).

Messages Tested

To evaluate these questions, the authors conducted an experiment where the subjects in each of the study cities viewed the following three-unit one-phase messages one at a time:

FREEWAY CLOSED
AT *[location]*
FOLLOW DETOUR

and

TRUCK ACCIDENT
AT *[location]*
USE SERVICE ROAD

The *[Location]* term was changed to an actual physical location name on a freeway in each study city. The subjects in each city saw each message presented in a static mode and also in a flashing mode.

Study Protocol

The study protocol was similar to that used for the case when the entire message was flashed.

Study Results

Effect on Driver Comprehension

The results of the study upon driver comprehension are presented in Table 5 in which the responses to each of the three questions that were asked after each message presentation are summarized. Nearly equal percentages of subjects overall correctly responded to the question "what is the traffic problem?" regardless of whether the message was presented in a static mode

or with the first line flashing. The responses were also consistent between the fixed presentation time (8 seconds) and the self-paced presentation.

Table 5. Responses to for Static and One Line Flashing Message (3 units of information) [2,3]

Responses	Fixed 8-Second Display Time (%)		Self-Paced Display Time (%)		Display Time Types Combined (%)	
	Static Message	One Line Flashing	Static Message	One Line Flashing	Static Message	One Line Flashing
What is the traffic problem?						
√ Correct answer	78	80	74	76	76	78
Incorrect answer	12	14	17	15	15	14
Did not remember	9	5	8	8	8	7
Did not respond	1	1	1	1	1	1
Where is the traffic problem located?						
√ Correct answer	92	89	91	94	91	92
Incorrect answer	6	6	3	3	5	4
Did not remember	2	5	5	2	3	3
Did not respond	0	0	1	1	1	1
What are you to do?						
√ Correct answer	74	61	71	60	72	60*
Incorrect answer	16	25	18	28	17	27
Did not remember	6	11	10	10	8	10
Did not respond	4	3	1	2	3	3

n=260

* Significantly different ($Z = 4.08$) than static message response ($\alpha = 0.05$)

The responses to the question about traffic problem location described in the message are also summarized. No statistically significant differences were found between a static message and a message with the first line flashing. The responses were once again also consistent between the fixed and the self-paced display times.

For the question "What are you to do?", the percentage of correct answers dropped significantly when the first line of the message was flashing (relative to the percentage of correct answers to that question obtained with a static message). The results indicated that flashing one portion of the message may have adverse effects on a driver's ability to remember other parts of the message.

Effect on Message Reading Times

Basic descriptive statistics for the reading times of subjects for the static message and the message with one line flashing used during the self-paced portion of the study are shown in Table 6. Average reading time of the message when one line was flashing was 1.8 seconds (20 percent) longer than when the one line was not flashed. The implication of these results was that drivers will not be able to process as much information on a CMS if one line of the message being presented is flashing as could be processed if none of the message is flashing.

Table 6. Reading Times for Static and One Line Flashing Message (3 units of information) [2,3]

Descriptive Statistics (n=260)	Static Message (sec)	One Line Flashing (sec)	Difference (sec)
Median Reading Time	6.9	8.8	+1.9
Average Reading Time	9.2	11.0	+1.8*
Standard Deviation	8.5	9.4	+0.9

* Comparison of means test (Z=2.29) indicates difference is statistically significant ($\alpha = 0.05$)

Driver Preferences

Preference data are summarized in Table 7. Overall, subjects were fairly evenly split as to their preferences regarding static or flashing messages.

Table 7. Preferences for Static or One Line Flashing Messages [2,3]

Preference	Static Message Presented Last (%)	Flashing Message Presented Last (%)	Both Presentation Orders Combined (%)
Static Message	55	34	45
One Line Flashing	44	63	53
No Preference	1	2	1
Did not respond	0	1	1

A summary of common responses received from the subjects as to why they preferred a static or a flashing message is presented in Table 8. The subjects who preferred a flashing message did so because they felt it was better able to get their attention. Conversely, those who preferred a static message felt that it gave them more time to read and remember the information, and was less distracting than a flashing message. A few of the subjects did comment specifically that the flashing portion of the message was the only part that they easily remembered (as was borne out in the lower percentage of correct answers to the last question in the previous section on driver comprehension).

Table 8. Common Reasons for Preferences of Static or Flashing One-Phase Messages [2,3]

Reasons for Preferring a Static Message	Reasons for Preferring a Flashing Message
• Easier to read and understand	• Gets your attention
• Message is clear and precise	• Easier to read
• I only remember the part that is flashing	• Highlights the important feature
• Easier to understand	• Alerts you
• Flashing is distracting and confusing	• Emphasizes what is important

Alternating One Line of Text and Keeping Two Lines Constant on a Three-Line CMS

The focus of this study was to study the effects of alternating the last line of a CMS message while keeping the top two lines the same.

Messages Tested

The subjects in each of the study cities viewed the following two-phase messages one at a time:

CONSTRUCTION AT *[location]* ALL LANES CLOSED	**CONSTRUCTION AT *[location]* USE OTHER ROUTES**
1st Phase	*2nd Phase (with redundancy)*

Versus

CONSTRUCTION AT *[location]* ALL LANES CLOSED	**USE OTHER ROUTES**
1st Phase	*2nd Phase (no redundancy)*

Or

MAJOR ACCIDENT AT *[location]* ALL LANES CLOSED	**MAJOR ACCIDENT AT *[location]* USE OTHER ROUTES**
1st Phase	*2nd Phase (with redundancy)*

Versus

MAJOR ACCIDENT AT *[location]* ALL LANES CLOSED	**USE OTHER ROUTES**
1st Phase	*2nd Phase (no redundancy)*

The *[location]* term was changed to an actual physical location name on a freeway in each study city.

Study Protocol

After presentation of each message, the subjects were asked specific questions. After the subjects responded to the questions for the second alternative viewed, they were shown both modes (with redundancy or without redundancy in each phase) of presentation one at a time and were asked to select the message mode they preferred. The second alternative they viewed previously was shown first.

Study Results

Effect on Driver Comprehension

The results of the study upon driver comprehension are presented in Table 9. Nearly equal percentages of subjects overall correctly responded to the question "how many lanes are blocked?" regardless of whether the message was presented without redundancy or with redundancy on the top two lines while the bottom line changed for each phase. The responses

were also consistent (statistically speaking) between the fixed presentation time and the self-paced presentation.

Also, in response to the second question, no statistically significant differences were found between a message without redundancy and one with redundancy on the top two lines while the bottom line changed for each phase. The responses were once again also consistent between the fixed and the self-paced display times. Similar consistency was also observed in the responses to the question "What are you told to do?" Finally, no statistically significant differences in responses were identified between the two test conditions (no redundancy versus with redundancy) in response to the question "Where is the traffic problem?"

Table 9. Responses to the Questions for Two-Phase Message With One Line Changing and Alternating While the Other Two Lines Remained the Same (4 units of information) [2,3]

Responses	Fixed 8-Second Display Time, 4 Seconds per Phase (%)		Self-Paced Display Time (%)		Display Time Types Combined (%)	
	No Redundancy	With Redundancy	No Redundancy	With Redundancy	No Redundancy	With Redundancy
How many lanes are blocked?						
√ Correct answer	89	82	91	90	90	86
Incorrect answer	6	9	6	7	6	8
Did not remember	4	7	2	3	3	5
Did not respond	1	2	1	0	1	1
What is the traffic problem?						
√ Correct answer	77	81	81	81	79	81
Incorrect answer	17	14	14	12	16	13
Did not remember	5	4	4	6	4	5
Did not respond	1	1	1	1	1	1
What are you told to do?						
√ Correct answer	77	81	81	81	79	81
Incorrect answer	17	14	14	12	16	13
Did not remember	5	4	4	6	4	5
Did not respond	1	1	1	1	1	1
Where is the traffic problem located?						
√ Correct answer	82	72	73	82	78	77
Incorrect answer	5	13	15	7	10	10
Did not remember	10	12	10	10	10	11
Did not respond	3	3	2	1	2	2

n=260

Effect on Message Reading Times

Basic descriptive statistics for the reading times of subjects for the information redundancy versus no redundancy messages used during the self-paced portion of the study are shown in Table 10. The average reading time of the message that had redundant information in both phases was 2.8 seconds (21 percent) longer than the message that did not include redundant information in both phases. The implication of these results was that drivers will not be able to process as much information overall on a CMS if redundant information is included.

Table 10. Reading Times for Two-Phase Message With and Without One Line Alternating [2,3]

Descriptive Statistics (n=260)	No Redundancy (sec)	With Redundancy (sec)	Difference (sec)
Median Reading Time	10.1	12.8	+2.7
Average Reading Time	13.4	16.2	+2.8*
Standard Deviation	12.4	14.5	+2.1

* Comparison of means test (Z=2.37) indicates difference is statistically significant ($\alpha = 0.05$)

Driver Preferences

Preference data are summarized in Table 11. Overall, the subjects were fairly evenly split as to their preferences for having redundant information in the message (i.e., changing only one line between the two phases).

Table 11. Preferences for With and Without One Line Alternating [2,3]

Preference	Message with No Redundant Information Presented Last (%)	Message with Redundant Information Presented Last (%)	Both Presentation Orders Combined (%)
With Redundancy	38	55	47
No Redundancy	57	41	49
No Preference	4	3	3
Did not respond	1	1	1

A summary of common responses received from the subjects as to why they preferred to have or not to have redundancy in the message is presented in Table 12. A few of the subjects noted that they might not notice the change in the bottom line if the top two lines of the message do not change between phases. On the other hand, those subjects who preferred messages with redundant information felt that the important information was reinforced with the redundancy and so was easier to remember.

Table 12. Common Reasons for Preferences of Messages With and Without One Line Alternating [2,3]

Reasons for Preferring Messages Without Redundancy	Reasons for Preferring Messages With Redundancy
• Clear and precise • Easier to read • Provides more information with less words • Saves time • Simple and direct • When top line says same thing, may not notice that bottom line changes • When bottom line changes, it makes that information seem less important	• It's more complete • Clear and precise • Easier to read • Easier to remember • Maintains [information] where problem is located • Reinforces the problem and where it is located • Able to see all relevant information at one time

Summary of Findings

Flashing Messages

The results of the part of the study that addressed flashing messages were as follows:

- Flashing a one-phase three-unit message on a CMS had no significant effect upon driver comprehension of the information being presented.
- Driver preferences were fairly evenly split between flashing the message or not (i.e., a static message).
- Flashing the message increased the amount of time required to read and comprehend the message.

Flashing One Line of a One-Phase Message

The results of the part of the study that addressed flashing one line of a message were as follows:

- Flashing one line of a one-phase CMS message containing three units of information reduced the ability of drivers to remember parts of the message that were not flashing.
- Reading times were significantly increased when a line was flashed.
- Driver preferences were fairly evenly split between flashing the message line or not (i.e., a static message).

Alternating One Line of Text and Keeping Two Lines Constant on a Three-Line CMS

- Three-line CMSs including redundant information by repeating the top two lines on both phases of a two-phase message while changing the bottom line did not reduce the ability of drivers to remember parts of the message.
- Total message reading times were significantly increased when redundant information was included.
- Driver preferences were fairly evenly split between having and not having redundant information in both phases.

Author's Critique

Although the results of the study relative to the longer reading times for flashing messages, flashing one line of a one-phase message, and alternating one line of a two-phase message are valid, the study was single-tasked. That is, the subjects were not placed under heavy work load conditions that may impact the results.

2. STUDY FOR THE EUROPEAN UNION DGVII AND NATIONAL SPONSORS INCLUDED IN TRAFFIC OPTIMISATION BY THE INTEGRATION OF INFORMATION AND CONTROL (TROPIC)

Introduction

The objective of a study reported by Luoma et al. in 2001[4] was to investigate the comprehension of control strategies and technical features of CMSs. Three problems were investigated: (1) how many drivers understand factors that influence the control of CMSs, (2) how they interpret flashing displays and flashing amber lanterns (beacons) on the displays compared with a steady display, and (3) how they interpret different speed displays. The relevant part of this study relative to the objectives of the current FHWA study is item 2. Thus, only issues and findings of driver interpretation of flashing messages are included in this letter report.

Study Design

Colored signs depicting pictograms of warning for slippery road, warning for fog, warning for queue, and a word message KEEP YOUR DISTANCE were placed on sheets of paper and shown to drivers. The pictograms and lettering were white, the triangle of warning signs was red, and background of each display was black. The signs were 75 mm x 75 mm, except for the text message (85 mm x 40 mm). Each sign was shown on a schematic background of a two lane road seen from the vantage point of the driver.

The data were collected in three European countries (England, Finland, and Italy). A total of 96 subjects participated in the study—32 from each country. All subjects were licensed drivers between the ages of 25 and 35. Sixteen of the subjects were inexperienced drivers (annual driving less than 10,000 km), and 16 subjects were experienced drivers (annual driving of more than 20,000 km). There were eight females and eight males in each experience group

Subjects were presented with CMSs with and without amber lanterns (beacons). When shown the sign with amber lanterns, subjects were asked: "This picture shows a variable message sign equipped with flashing amber lanterns. Please describe whether the sign has any different or additional meaning compared to the steady sign without flashing amber lanterns." When shown the sign with no amber lanterns, subjects were asked: "This picture shows a VMS involving a steady display. However, the display may also flash. Please describe whether the sign has any different or additional meaning should the display be flashing."

Results

The overall responses are given for each sign type subject matter in Table 13. Regarding the sign and for slippery road conditions, there was no real difference between the main overall response percentages for the two sign types, with roughly half the subjects interpreting the two sign types as giving a stronger warning than a steady sign with no amber lanterns. About 25 percent of subjects thought the signs had no additional meaning. There was little difference between countries, although 23 percent of the English subjects indicated that both types of signs were more attention-grabbing.

Table 13. Interpretations of Different Technical Features for CMSs [4]

Message	Flashing Display No Amber Lanterns (%)			Steady Display Amber Flashing Lanterns (%)		
	No Added Meaning	Stronger Warning	Attention	No Added Meaning	Stronger Warning	Attention
Slippery Road Conditions	25.3	51.6	--	24.0	52.6	--
Fog	29.5	27.4	13.7	33.7	36.8	11.6
Queue	29.5	23.2	13.7	23.2	29.5	10.5
KEEP YOUR DISTANCE	38.0	13.7	14.7	33.7	12.6	12.6

n=96

Interpretations for the fog message were similar between the two sign types, although there was a slight difference in percentage of subjects giving various responses. Although the overall response percentages were similar between the two sign types for the queue message, the flashing sign was more often thought to have no added meaning while the sign with amber lanterns was more often thought to indicate a stronger warning. These two interpretations were commonest overall. Overall, there was very little difference in responses between the two signs for KEEP YOUR DISTANCE. In each of the above cases, the researchers found significant differences among the countries studied. They suggested that further research is needed, including more countries, in order to harmonize European CMSs use effectively.

Author's Critique

This was essentially a paper study and does not shed any light on the objectives of the current FHWA study. The study only attempted to measure relative importance that the dynamic feature of a CMS would imply to a driver, and did not objectively assess whether the dynamic features would impact driver interpretation of the information being presented. Furthermore, the experimental approach did not allow for the opportunity to measure relative reading times between a steady and flashing message, which is another key evaluation criteria. In addition, the message used in the study KEEP YOUR DISTANCE is not typical of the type of message that would be displayed during incident or roadwork situations.

REFERENCES

1. Dudek, C.L. and R.D. Huchingson. *Manual on Real-Time Motorist Information Displays.* Report No. FHWA-IP-86-16. FHWA, U.S. Department of Transportation, August 1986.

2. Dudek, C.L., N. Trout, B. Durkop, S. Booth, G.L. Ullman. *Improving Dynamic Message Sign Operations.* Research Report FHWA/TX-01/1882-2. Texas Transportation Institute, College Station, TX, October 2000.

3. Dudek, C.L. and G.L. Ullman. Flashing Messages, Flashing Lines, and Alternating One Line on Changeable Message Signs. In *Highway Research Record 1803*, TRB, National Research Council, Washington, 2002, pp. 94-101.

4. Luoma, J., P. Rama, and K. MacLaverty. Understanding Control Strategies and Technical Features of VM Signs. In *Traffic Engineering and Control,* Vol. 42, No. 5, May 2001, pp. 168-171.

XC: Sharon Thigpin, Texas A&M Research Foundation