

**CHANGEABLE MESSAGE SIGN MESSAGES FOR WORK ZONES:
TIME OF DAY, DAYS OF WEEK, AND MONTH DATES**

by

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ABSTRACT

The New Jersey Department of Transportation initiated a research study which in part is designed to further the state of knowledge of changeable message sign message design with specific application to the needs in New Jersey. This paper reports on human factors laboratory studies conducted in New Jersey to evaluate shorter alternative messages than those currently used regarding the display of time of day, days of week, and calendar dates. These type of messages are oftentimes displayed on portable changeable message signs used in highway work zones.

Among the findings were that the "dash" can be used in place of *THRU* when giving road work for a range of successive days; the term *WEEKEND* was not a good descriptor for work that begins on Friday evening and ends on Monday morning; the term *DAYS* did not connote specific daytime, off-peak times for road work, but may be satisfactory for certain time periods; likewise, the term *NIGHTS* did not connote specific nighttime, off-peak times for road work, but may be satisfactory for certain time periods; *NITE* is an acceptable substitute for *NIGHT*; and calendar dates were not easily translated by drivers to specific days of the week.

KEY WORDS: Changeable Message Signs, Sign Messages, Highway Work Zones, Traffic Operations, Intelligent Transportation Systems

INTRODUCTION

Changeable message signs* (CMSs), sometimes referred to as variable message signs, perform a critical role on highways by furnishing drivers with real-time information. However, to be effective the messages must be fully understood by the drivers. The challenge of CMS message designers is to develop well-understood messages that communicate the intended information and can be read by drivers within a short time frame. Studies have shown that given the measured legibility distances of current CMSs, drivers traveling at 88 km/hr (55 mph) have only about eight seconds to read a CMS message.(1) Thus brevity in conjunction with proper format, wording, and load are essential to good message design.(2) Message design is even more difficult when messages must be displayed on portable CMSs which generally have only eight characters per line.

Several previous studies were conducted by the Texas Transportation Institute and others to assess principles of CMS message design.(3-8) The findings were incorporated into the *Manual on Real-Time Information Displays*.(2) In more recent years, Brien studied the attitudes regarding the content of messages on CMSs.(9) Studies by Knoblauch, et al. resulted in guidelines for uniform traffic control and warning messages for portable message signs.(10)

The Texas Transportation Institute is conducting a research study for the New Jersey Department of Transportation (NJDOT) which in part is designed to further the state of knowledge of CMS message design with specific application to the needs in New Jersey. As part of this study, a series of human factors laboratory studies were conducted in New Jersey to evaluate message design issues that have specific application in the State and that were not addressed in previous research.

One area of concern by NJDOT were specific messages for display on portable CMS in work zones which have not been previously evaluated. Although CMSs are used to inform drivers of current situations in work zones, in current practice agencies oftentimes use CMSs to inform drivers of impending work and lane closures. When this occurs, times of day, days of week, and/or month dates are displayed.

The research discussed in this paper involves evaluations of shorter alternative CMS messages to those currently used by NJDOT for displaying times of day, week days, and/or month dates, particularly portable signs. The studies reported in this paper were part of a larger series of human factors laboratory studies conducted for NJDOT.

STUDY METHOD

The studies were conducted using laptop computers. The instructions to subjects and the stimulus (messages) were displayed on the computer screen. After reading the instructions and viewing a message, the subject wrote open-ended answers to specific questions on a form. Each time the subject pressed the space bar, the program would advance to the next study.

* The National Committee on Uniform Traffic Control Devices and the Federal Highway Administration have adopted the term "changeable message signs." Some transportation agencies refer to the devices as "variable message signs" or dynamic signs."

Studies were conducted in both the northern part of New Jersey (Morristown) and the southern part of the State (Cherry Hill) to determine any differences in message understanding. One hundred and four subjects participated in the study: 52 from north New Jersey and 52 from south New Jersey. The subject pool matched the New Jersey licensed driver population as close as possible relative to age and education. The subjects were evenly divided by gender. Because the messages are for CMSs that would be used on freeways, toll roads, and/or turnpikes, all subjects had a valid New Jersey driver's license, drove more than 8,000 miles per year, and traveled frequently on the freeways, toll roads, and/or turnpikes in New Jersey. The subject demographics are shown in Tables 1 and 2.

Table 1. Subject Age

Age Group	Number (Percent)
17-24	12 (12%)
25-39	27 (26%)
40-54	25 (24%)
55-64	18 (17%)
65+	22 (21%)
TOTAL	104 (100%)

Table 2. Subject Education

Educational Attainment	Number (Percent)
No High School Diploma	22 (21%)
High School Diploma	31 (30%)
Some College	27 (26%)
College Degree	24 (23%)
TOTAL	104 (100%)

MESSAGES WITH TIME OF DAY, DAYS OF WEEK, AND MONTH DATES

Study 1: Use of a Dash to Indicate “THRU” in Displaying a Range of Week Days

Background and Objective

The constraint of eight-characters per line on portable CMSs has led to use of a dash for inclusive days on one line of a sign when signing for impending road work. However, there is a risk that some drivers may interpret the dash as “to” rather than “thru” thus deleting the final day.

The objective of this study was to determine whether a dash can be used in place of “THRU” in displaying a range of week days.

Method

The following information and message appeared on the computer screen:

If you saw this message on the next sign, during which days of the week do you think the lane is closed?

*LEFT LANE
CLOSED
MON-WED*

Results

The results summarized in Table 3 show that the dash is an acceptable substitute for the word *THRU* for inclusive week days. Ninety-six of the 104 drivers surveyed (92 percent) stated that the days included Monday, Tuesday and Wednesday. An additional two subjects repeated the use of the dash by indicating “Monday-Wednesday.” There were no apparent response differences between drivers in north New Jersey and drivers in south New Jersey.

Table 3. Response to Question : During which days of the week do you think the lane is closed?

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
Monday, Tuesday, Wednesday	47	90	49	94	96	92
Monday-Wednesday	2	4			2	2
Monday & Wednesday	1	2	2	4	3	3
Other Responses (<i>2 different groups of responses</i>)	2	4			3	3
TOTAL	52	100	52	100	104	100

Study 2: Descriptor “FOR 1 WEEK”

Background and Objective

If the transportation agency intends to perform road work from Wednesday through Tuesday, the question is whether drivers would interpret *FOR 1 WEEK* as the same including Saturday and Sunday. If the term has a specific meaning, then it would take less CMS space to display than using the days of the week. (The term *1 WEEK* by itself is ambiguous because it is not clear if it means work begins in one week from now. The prepositions *IN* and *FOR* are necessary to provide this distinction.)

The objective of this study was to determine driver interpretation of the term *FOR 1 WEEK*.

Method

The following information and message appeared on the computer screen:

You are driving on Interstate 95 on a Wednesday morning. You will be shown a message on a sign and will be asked when you think there will be road work.

*ROADWORK
FOR 1 WEEK*

Results

Results of the study revealed that the term *FOR 1 WEEK* is ambiguous as to whether this begins the date of view, the next day, or from the beginning of the current or next work week. The results in Table 4 that lists the responses having the highest percentages of subjects shows that there was a wide variety of interpretations of the inclusive days for the term *FOR 1 WEEK* when the message was displayed on a Wednesday. Only 31 percent of the drivers surveyed interpreted the message to mean Wednesday through Tuesday including Saturday and Sunday. An additional 11 percent included the following Wednesday. Eleven percent indicated that the work will begin on the next Monday and continue through Friday.

Table 4. Response to Instruction: List the days you think there will be road work

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
Wed., Thurs., Fri., Sat., Sun., Mon., Tues.	20	38	12	23	32	31
Wed., Thurs., Fri., Sat., Sun., Mon., Tues., Wed.	5	9	7	13	12	11
Mon., Tues., Wed., Thurs., Fri.	3	6	8	15	11	11
Mon., Tues., Wed., Thurs., Fri., Sat., Sun.	3	6	5	9	8	7
Thurs., Fri, Sat., Sun., Mon., Tues., Wed.	4	8	4	8	8	7
Sun., Mon., Tues., Wed., Thurs., Fri., Sat	3	6	4	8	7	7
Other Responses (<i>9 different groups of responses</i>)*	13	25	12	24	25	25
Not sure	1	2			1	1
TOTAL	52	100	52	100	104	100

* None of the individual groups exceeded 5 percent.

Study 3: Alternative Way to Display the Time That Road Work Begins on Friday Evening and Lasts Until Monday Morning

Background and Objective

Although it is desirable to present the inclusive hours of road work, the portable CMS is limited to eight characters per line. The question is: would drivers assume that *ROAD WORK NEXT WEEKEND* means Friday evening to Monday morning rather than Saturday and Sunday? The approximate beginning and end hours are also important in knowing whether this descriptor has specific time connotations.

The objective of this study was to determine if *WEEKEND* may be used instead of the lengthy *7PM FRI/ TO 5 AM MON.*

Method

The following information and message appeared on the computer screen:

As you continue on the Interstate, you see a message on another sign. You will be asked what information does the sign give you about the hours the road work will take place.

- 1. Do you think "Weekend" means work begins Friday evening or Saturday morning?*
- 2. At approximately what hour does it begin?*
- 3. Do you think "Weekend" means work ends Sunday evening or early Monday?*

*ROADWORK
NEXT
WEEKEND*

Results

The drivers were divided in opinion as to whether road work for a weekend began on Friday evening or Saturday morning. A summary of the drivers' response to the day that a weekend begins is shown in Table 5. Friday evening was selected by 40 percent of the drivers surveyed; Saturday morning was selected by 60 percent.

Opinions as to the hour that a weekend began varied widely. Specific starting times for a weekend which were given by the highest percentages of the subjects are summarized in Table 6. Thirty-four percent of the drivers gave either 6, 7 or 8 AM on Saturday as the starting time for a weekend. Thirty-one percent gave 5, 6, 7, 8, 9, or 10 PM Friday as the starting time. An additional 18 percent indicated that a weekend begins at midnight on Friday.

The majority of the drivers understood that road work during a weekend would end on Sunday evening rather than Monday morning. The ending times for a weekend are shown in Table 7. Sunday evening was given by 79 percent of the drivers to indicate the end of road work during a weekend; whereas, 21 percent gave Monday morning as the ending time.

Table 5. Response to Question: Do you think "Weekend" means work begins Friday evening or Saturday morning?

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
Friday Evening	18	35	24	46	42	40
Saturday Morning	34	65	28	54	62	60
TOTAL	52	100	52	100	104	100

Table 6. Response to Question: At approximately what hour does it begin?

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
FRIDAY: 5 PM	4	8	3	6	7	7
FRIDAY: 6 PM	3	6	7	13	10	9
FRIDAY 7 PM	5	10	2	4	7	7
SATURDAY: 12 AM (Midnight)	9	17	10	19	19	18
SATURDAY: 6 AM	7	13	9	17	16	15
SATURDAY: 7 AM	6	11	6	11	12	11
SATURDAY: 8 AM	4	8	4	8	8	8
Other Responses (<i>7 different groups of responses</i>)*	7	14	6	12	13	13
Do not know	7	13	5	10	12	12
TOTAL	52	100	52	100	104	100

* None of the individual groups exceeded 4 percent.

Table 7. Response to Question: Do you think "Weekend" means work ends Sunday evening or early Monday?

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
Sunday Evening	41	79	41	79	82	79
Monday Morning	11	21	11	21	22	21
TOTAL	52	100	52	100	104	100

Study 4: "DAYS" in Context with Time of Day

Background and Objective

When time of day of the road work is presented on CMSs, the inclusive times with *AM* or *PM* are lengthy at a glance and may be misinterpreted when both an *AM* and *PM* designation are displayed. The intent was to evaluate a descriptor for daytime off-peak road work (e.g., 9 AM to 4 PM). If the time of day could be omitted by use of *DAYS* then the possible confusion can be reduced. In addition, the message will be much shorter.

The objective of this study was to determine whether *DAYS* is interpreted to mean daytime, off-peak hours (e.g., 9 AM to 4 PM).

Method

The following information and message appeared on the computer screen:

*As you continue on the Interstate and saw the next sign, what hours do you think
"DAYS" means?*

*ROADWORK
MON-FRI
DAYS*

Results

The results showed that the term *DAYS* does not connote specific times for the work, although 6/7 AM and 5/6 PM were the modal choices for the beginning and end of day work. This implies that *DAYS* may be satisfactory to display provided that work does not begin before 6 AM and does not last beyond 6 PM.

The hour that "DAYS" begins and ends given by the highest percentages of the subjects are summarized in Table 8. When asked when "DAYS" begins, 55 percent of the drivers selected 6 or 7 AM; 26 percent selected 8 or 9 AM. The hours of 5 or 6 PM were selected by 67 percent of the drivers for the time when "DAYS" ends.

Table 8. Response to Question: If you saw this message, what hours do you think “DAYS” means? GIVE BEGINNING AND END HOURS.

Response: Days Begins at	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
6 AM	17	33	17	33	34	33
7 AM	12	23	11	21	23	22
8 AM	4	8	10	19	14	13
9 AM	7	13	7	13	14	13
Other Responses (<i>7 different groups of responses</i>)*	12	23	5	10	17	17
Don't know; Did not respond			2	4	2	2
TOTAL	52	100	52	100	104	100

Response: Days End at	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
4 PM	8	15	8	15	16	15
5 PM	13	25	19	36	32	31
6 PM	20	38	18	35	38	36
7 PM	5	10	1	2	6	6
Other Responses (<i>6 different groups of responses</i>)*	6	12	4	8	10	10
Don't know; Did not respond			2	4	2	2
TOTAL	52	100	52	100	104	100

* None of the individual groups exceeded 5 percent.

Study 5: "NIGHTS" In Context with Time of Day

Background and Objective

As with the previous study, the inclusive times with *PM* are lengthy at a glance and may be misinterpreted when both an *AM* and *PM* designation are displayed. The intent is to have a shorter descriptor for the times of nighttime, off-peak road work rather than displaying specific times (e.g., 7 *PM* - 6 *AM*). If the time of work at night could be omitted by use of *NIGHTS* then the possible confusion can be reduced. In addition, the message will be much shorter.

The objective of this study was to determine whether *NIGHTS* means night work (e.g., 7 *PM* to 6 *AM*).

Method

The following information and message appeared on the computer screen:

*As you continue on the Interstate and saw the next sign, what hours do you think
"NIGHTS" means?*

*ROADWORK
MON-FRI
NIGHTS*

Results

The term *NIGHTS* did not connote specific work times to the drivers, although 6/7 *PM* and 5/6 *AM* were the modal choices. The results imply that *NIGHTS* may be used provided the work does not begin before 5 *PM* and does not last beyond 6 *AM*.

A summary of responses to the meaning of *NIGHTS* given by the highest percentages of the subjects is shown in Table 9. When asked what hours the drivers thought *NIGHTS* begin, 70 percent gave 5, 6, 7, or 8 *PM*. Fifty percent gave 5 or 6 *AM* as the time that *NIGHTS* ends.

Table 9. Response to Question: If you saw this message, what hours do you think “NIGHTS” means? GIVE BEGINNING AND END HOURS.

Response: Nights Begins at	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
5 PM	5	9	6	11	11	10
6 PM	13	25	16	31	29	28
7 PM	9	17	12	23	21	20
8 PM	8	15	5	9	13	12
9 PM	5	9	1	2	6	6
Other Responses (6 different groups of responses)*	12	25	10	20	22	22
Don't know; Did not respond			2	4	2	2
TOTAL	52	100	52	100	104	100

Response: Nights End at	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
12 Midnight	3	6	13	25	16	15
5 AM	16	30	3	6	19	18
6 AM	15	29	19	36	34	32
Other Responses (9 different groups of responses)*	16	31	15	29	31	31
Don't know; Did not respond	2	4	2	4	4	4
TOTAL	52	100	52	100	104	100

* None of the individual groups exceeded 5 percent.

Study 6: The Use of “NITES” Instead of “NIGHTS” in a Message

Background and Objectives

CMS line capacity constraints often limit the use of certain words. The homonym *NITE* has been widely used in other contexts and is one character shorter in length in comparison to *NIGHT*.

The objective of this study was to determine whether *NITES* is an acceptable substitute for *NIGHTS*.

Method

The following information and message appeared on the computer screen:

As you continue on the Interstate, you see a message on another sign. If you saw this message on the next sign, what do you think “NITES” means?

*LANE CLOSED
MON-FRI
NITES*

Results

The results are summarized in Table 10. *NITES* was correctly interpreted as *NIGHTS* by 82 percent of the drivers surveyed. Although only 65 percent of the drivers gave *NITES* for *NIGHTS*, a review of the other answers indicates that the drivers understood the message to imply a time after sunset. Some of the driver participants misinterpreted the instructions and attempted to give inclusive hours of nighttime work which were acceptable interpretations. A few gave “evening” and “after sundown” which does not support they understood the work could be all night, but of this we cannot be sure. Six percent of the subjects did not know the meaning of *NITES*.

Table 10. Response to Question: What do you think “Nites” means?

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
Nights	36	68	33	62	69	65
Nites	1	2	3	6	4	4
Evenings	3	6	3	6	6	6
After sundown	2	4	5	10	7	7
Other Responses (9 different groups of responses)*	6	12	6	12	12	12
Don't know	4	8	2	4	6	6
TOTAL	52	100	52	100	104	100

* None of the individual groups exceeded 2 percent.

Study 7: Use of Week Days vs Month Dates in Communicating Future Road/Lane Closures

Background and Objective

Oftentimes transportation agencies inform drivers of specific days that road work will take place by displaying month dates. The concern with displaying month dates is that it requires drivers to recall the specific days of the week for the dates or may require them to consult a calendar. Days of the week may be easier for drivers to understand. This study compared typical messages employing month dates frequently used by New Jersey transportation agencies with messages using days of the week.

The objective of this study was to determine whether the use of week days is better understood than month dates in communicating future road work.

Method

Below are the two separate messages that were given to the subjects one at a time. The order of the messages was counterbalance among the subjects.

1. *ROAD CLOSED/ SEP 25 - SEP 28* (current message used by NJDOT); and
2. *ROAD CLOSED/ TUES - FRI* (alternative message).

The following information appeared on the computer screen with each message:

After viewing the next sign, you will be asked for information about the days of the week.

1. *On what days of the week will the road be closed?*

Note that each of the message terms was shown at different points in a larger study in which a total of 25 signs were shown one at a time. Also, the calendar dates given in the message were for days during the week following the study.

Results

Driver had extreme difficulty in relating calendar dates to specific days of the week. In contrast a large majority of the drivers were able to recall the days that road work would take place when the specific days were displayed.

The results of the study for first message (calendar dates) and the second message (week days) are shown in Tables 11 and 12. For the message with calendar dates, only 11 percent of the subjects were able to give the correct days of the week. Whereas, for the alternative message with days of the week, 93 percent of the drivers responded correctly.

Table 11. Response to Question: During which days of the week do you think the lane is closed? (calendar dates)

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
✓ Gave correct days of the week	8	15	4	8	12	11
Gave incorrect days of the week	13	25	10	19	23	22
Sep. 25, Sep. 26, Sep. 27, Sep. 28	14	27	20	38	34	33
I must check a calendar	1	2	2	4	3	3
Don't know	16	31	16	31	32	31
TOTAL	52	100	52	100	104	100

Table 12. Response to Question: During which days of the week do you think the lane is closed? (days of the week)

Response	NJ North		NJ South		TOTAL	
	Freq	%	Freq	%	Freq	%
✓ Gave correct days of the week	48	92	49	94	97	93
Tues. to Fri.			2	4	2	2
Tues., Wed., Thurs.	2	4			2	2
Tues. & Fri.	2	4			2	2
Don't know			1	2	1	1
TOTAL	52	100	52	100	104	100

Summary and Recommendations

This study addressed CMS message issues relative to displaying times of day, days of week, and month dates when signing for future road work in New Jersey. The intent was to find alternative message terms that were well-understood but were shorter in length than those currently used by the New Jersey transportation agencies. Human factors laboratory studies were conducted in New Jersey with 104 drivers participating: 52 from northern New Jersey and 52 from southern New Jersey. Consequently, the findings and recommendations apply to CMS messages in New Jersey. The following recommendations are made based on the findings in this research:

1. When displaying messages giving road work or lane closures for a range of successive days (e.g., Monday through Wednesday), a dash may be substituted for the word *THRU*. Thus *MON-WED* is preferred to *MON THRU WED* because it is shorter and well-understood by drivers.
2. The shorter term *FOR 1 WEEK* in place of giving the days of the week (e.g., *WED THRU TUES*) is not recommended. The message *FOR 1 WEEK* was found to be ambiguous as to whether the work or lane closure begins the date of view, the next day, or from the beginning of the following week.
3. The term *WEEKEND* was not a good descriptor for road work that begins on Friday evening or ends on Monday (e.g., *FRI 5 PM - MON 6 AM*). However, the term *WEEKEND* may be satisfactory to describe road work that begins on Saturday morning about 6 AM and ends on Sunday at about 6 PM.
4. The term *DAYS* did not connote specific daytime, off-peak times for road work. The modal choices by the subjects for the beginning and end of the work were 6/7 AM and 5/6 PM. The results imply that the term *DAYS* may be satisfactory to indicate road work provided the work does not begin before 6 AM and does not last beyond 6 PM.
5. The term *NIGHTS* did not connote specific nighttime, off-peak times for road work, although the modal choices for the beginning and end of the work were 6/7 PM and 5/6 AM. The results imply that the term *NIGHTS* may be used provided the work does not begin before 6 PM and does not last beyond 6 AM.
6. The term *NITES* is an acceptable substitute for *NIGHTS*.
7. Drivers have difficulties in relating calendar dates (e.g., *SEP 25- SEP 28*) with specific days of the week. Consequently, calendar dates should not be displayed. Days of the week should be displayed instead (e.g., *TUES - FRI*).

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