

# MEMORANDUM

**DATE:** December 15, 2017

**TO:** Electronic Display Traffic Control Task Force

**FROM:** R. S. McCourt, Joanne Conrad – Task Force Co-Chairs

**SUBJECT** Survey Findings and Draft Definitions for Discussion at January 3 NCUTCD Meeting

In the fall of 2017 we surveyed the industry (IMSA, ITS America, ATTSA, ITE) and the NCUTCD members regarding dynamic message signs. We had just less than 400 responses. Prior to this effort the Task Force discussed definitions that were related to electronic display traffic control. This memo summarizes both of these undertakings for discussion at our January 3<sup>rd</sup> meeting at the Crystal City Hilton near Reagan National Airport (399 Jefferson Davis Highway, Arlington, VA) in the Madison Room from 10:30 to noon. At that meeting we will review this memo and gather comments and assign tasks to each technical committee representative to advance MUTCD text modifications related to electronic display.

## DMS SURVEY

There were over 300 responses from the industry and less than 100 from the NCUTD committee on the DMS survey. The responses are highlighted below:

- Who are you:
  - Vendor Manufacturer – 12%
  - State DOT – 15%
  - Other Transportation Agency – 39%
  - Consultant – 22%
  - Academic – 2%
  - Other – 9%

Key Comments: most others were city (mis-entered) and contractors

- Knowledge of DMS standards and design (scale 0-10):
  - Industry survey – 6.5
  - NCUTCD survey – 6.2

Key Comments: the responders were rather knowledgeable – on the extremes for the industry survey, 0% gave themselves a 0, 3% gave themselves a 1, 9% gave themselves a 9 and 13% gave themselves a 10. For the NCUTCD survey 0% gave themselves a 0, 3% gave themselves a 1, 7% gave themselves a 9 and 14% gave themselves a 10.

- What do you use for guidance in building, designing or studying DMS (check those that apply):
  - MUTCD – 85%
  - NTCIP – 35%
  - ITE/ITSA – 29%

- NEMA TS-4 – 22%
- ASTM – 12%
- N/A – 10%
- Other – 11%

Key comments: the most common others were state standards (California, Florida, Ohio, Virginia, Ontario were noted), NEC, AASHTO Wind Loading for Trusses, IEEE, EN standards and UL 48/UL 60950-1

- When looking for information on electronic displays in the MUTCD, how easy is it to find the information you are looking for?
  - Both surveys scored this about a 3 out of 5 – where a 3 was defined as sort of typical, my work involves this
  - The second highest score was for “it’s a struggle, wish it were better”
  - Both combined were about 70% of the response and were nearly equal
- Understanding of DMS definition (score from 1(low) to 5 (high))
  - Both surveys averaged a 4
  - Over 70% of both survey responses were 4s or 5s

Key comments: include character and line matrix in definitions, part-time needs more definition, under DMS indicate that the four other items are “display formats”, “ONLY use the term DMS in the MUTCD” and use of examples would help

- Which design standards/criteria should be in the MUTCD or in NEMA TS-4?
  - Both surveys indicated MUTCD to the 95<sup>th</sup> percentile and NEMA TS-4 to roughly 25<sup>th</sup> percentile for all criteria except for:
    - Legibility 86% MUTCD; 33% NEMA
    - Character stroke 82% MUTCD; 33% NEMA
    - Message load 80% MUTCD; 35% NEMA
    - Pixel Pitch 53% MUTCD; 65% NEMA
    - Pixel Density 54% MUTCD; 64% NEMA

Key comments: reflection ratio, beam width, contrast, energy efficiency, flash spec, nighttime operation – brightness, message duration, number of panels, time between messages, blank time between end and start of message

“MUTCD should focus on physical sign characteristics, use, position & presentation, NEMA should define the product, wiring and circuit diagrams, performance, testing & construction details”

The NCUTCD responses included consideration for colors in various situations (fog, snow, low visibility), rules for changing messages, rate of change (flash, legend change), brightness, font relationship between MUTCD and NEMA TS-4

- What is your opinion of electronic display design criteria given current standards?

Criteria	OK	Clarification Needed	Out of Date/ Not reflective	Not Relevant
Color	38%	37%	19%	6%
Symbols	36%	38%	22%	4%
Lines of Text	50%	35%	13%	2%
Letter Height	50%	37%	10%	3%

Spacing of Letters/Words/Lines	40%	45%	11%	4%
Font	32%	47%	15%	6%
Use of Upper/Lower Case	38%	45%	11%	6%
Character Stroke	28%	46%	12%	14%
Number of Words	42%	41%	12%	5%
Abbreviations	37%	45%	14%	4%
Message Load	30%	51%	12%	7%
Visibility	48%	36%	14%	2%
Legibility	42%	41%	13%	4%
Sign Location/Position	48%	38%	10%	4%
Alignment	45%	41%	8%	6%
Clearance (vertical/horizontal)	53%	37%	6%	4%
Pixel Pitch	21%	45%	21%	13%
Pixel Size	23%	44%	21%	12%

- Do you consider the electronic display of lane use control on a freeway a:
  - Sign (industry 75%, NCUTD 62%)
  - Signal (industry 25%, NCUTD 38%)
- What pixel pitch would result in “no apparent loss of apparent recognition” when using a DMS?
  - Industry 22mm
  - NCUTCD 23mm

Key comments: In the NCUTCD survey responses 48% responded 20 mm

- Do you believe the current standards (MUTCD, NEMA TS-4) adequately address the issue of brightness, intensity, glare and dimming?
  - Yes – 21%
  - No – 32%
  - Don’t Know – 45%
  - Other – 2%
  - Key comments: brightness and intensity should be flexible to allow adjustment (dimming, glare reduction) to local conditions

## Comment Highlights

### Best practices not well addressed in the MUTCD:

Industry Survey:

- What counts as advertising (products, holidays, public messages – safety, service announcements, meetings,...)
- Message overloading
- Use for colors and text colors for line matrix
- Lines of text (in toll lanes for destination & pricing)
- Relation of display time (flash) related to speed
- A full matrix is not a full matrix if not 20 mm
- Cost data for signs
- Abbreviations
- Guidance on size of display relative to driver speeds
- Guidance on advisory speed and wrong way
- Pixel pitch for different roadway classifications
- Use of LED borders
- Variable width font styles and kerning
- Hybrid sign standards – use of character matrix or full matrix
- Battery power run times
- Define who develops message libraries (locals not MUTCD)
- When two panels are used – how many lines between panels (3x3, 3x2, 3x1,...) – when more than one panel what are the speed and context requirements (urban, rural) – right sizing of messages
- Acceptability of blank sign status
- 2L define freeway DMS AND arterial DMS
- Placement of DMS relative to highway decision points
- Contrast
- Line construction: line 1 = problem, 2 = where, 3 = distance ahead
- DMS has advanced since Table 2A-5 was created and limited DMS background colors to black, green and blue – out of date
- Portable CMS should not block ADA access, close bike lanes, shoulders or sidewalks
- Automatic dimming standards
- Phone numbers should not be posted
- EXTREME CAUTION should not be used – either tell motorist what to do or leave blank
- Use of static signs above DMS
- DMS allows symbols – should be considered over text (route shields), visual picture application
- Message load
- Pixel based sign legends (standards like the SHSM) vs vector-based signs
- Consistency in the MUTCD on definitions of technology – scattered today
- Hardware reliability
- Spacing between other existing signs (guide, warning and regulatory) and other DMS
- Lane use control for yellow arrows
- Pixel pitch to deliver “no apparent loss of recognition”

#### NCUTCD Survey:

- Electronic billboard proximity to roadways and drivers
- Define a pixel
- Imbedded transmission technology
- Use should more than shall
- Full matrix signs should match static MUTCD sign colors
- More information about full matrix and hybrid sign application

- DMS for TTC
- Arterial DMS in addition to freeway applications
- LRT/RR applications of part time signs
- Timing of sequential messages
- Sign pollution
- Use of colors and symbols for DMS
- Non-traffic control messaging
- Flashing of messages, flash rates
- Impact of direct sunlight
- Reference to NEMA TS-4
- Fonts
- Borders
- Arrows and arrow boards
- Legibility
- Pixel pitch

**What aspect of the MUTCD, if changed, would make DMS more uniform and consistent?**

Industry Survey:

- One DMS section in the MUTCD – 2L - not CMS
- Use of the term DMS and define dynamic
- Size of characters relative to speed
- Size of signs
- Font, font style, pixels, line spacing and 4x7 vs 5x7 consideration
- Color definitions
- Standard libraries – national or local
- A SHSM-like definition of full matrix sign compositions at 20 mm and for part-time signs at greater LED spacing
- Use of symbols over text with DMS
- More abbreviations to standards – things like MIN or M
- Legibility
- Visibility
- Message structure, load, size
- Toll/Express lanes use
- Pixel pitch & size...20 mm = DMS full matrix
- Intensity
- Frame rate and brightness
- Flashing standards
- More hybrid sign details
- Avoid going back and forth to other sections for information – for example speed for 10” characters – below 55 mph or below 45 mph
- Position of size – longitudinal placement along roadway, lateral placement above roadway
- Hybrid speed limit signs – static element is standard but the speed digits are not

- More common display messages – not enough illustrations in 2L.02
- Clarify the advertising, PSA, safety message use of DMS
- Address traffic impact of excessive/non-essential messages
- Angle of sign
- Use of manufacturers logo = advertising
- Powder coating – bump up to 2605
- Travel time applications – standardize layout
- Arterial and freeway standards
- Balance the need for DMS to address unpredictable travel conditions with uniformity – don't lock into a one size fits all mentality

#### NCUTCD Survey:

- Clarify standards and message content for DMS between permanent installations and portable TTC applications
- Just like for static signs provide size, shape, color, message, visibility, alignment, letter height, borders, font, abbreviations, sign spacing and symbol standards for DMS plus number of words, brightness and time sequence switching between messages/panels
- DMS should focus on recurring travel conditions and emergencies not PSA and advertising – be clear with the intent
- Visibility and legibility should be clearly defined
- Show graphics of the number of lines and messages criteria
- Signs communicating with CV/AV
- Provide standard and flexibility for local applications
- Flash rates
- Reference NEMA TS-4 where appropriate
- Address polycarbonate front faces – avoid

#### **Please share your top three research need:**

##### Industry Survey:

1. Messages (28) – lines of text, duration, relation to decision point, words/length, pricing, relationship to speed, standard messages, appropriateness, content, consistency, comprehension, changing between travel time-text-symbol-blank
2. Colors and symbols (24) – use of symbols vs words, use of colors, human factors with color blind and elderly, size of symbols
3. Font (14) – size relative to vehicle speed, standard fonts
4. Glare/Brightness/Intensity/Dimming (12)
5. DMS use for PSA/Advertising (10)
6. Pixel pitch (7) – level for which DMS produces no apparent loss of recognition
7. Consumers Report data (7) -DMS reliability, cost, maintenance, operational costs, performance, life cycle
8. Lane Use control signs (6) – impact of AV/CV, comparison to ISO 19190, arrow types (up, down, sideways, V2I aspects
9. Visibility (4) – fog, rain, snow
10. Full Freeway Width DMS (3) – addressing shoulder running operation, HOV
11. DMS in TTC (3), Arterial DMS (3)
12. Spacing of DMS (2), Abbreviations (2), Position/view angle/sight distance (2), DMS Access (front,
13. Security (1), Height Clearance (1), Reflection impact of DMS Face covers (1), Message only when vehicle approaches (1)

NCUTCD Survey:

1. Effectiveness, comprehension, cost, cost effectiveness and impact (driver distraction with DMS (11)
2. Brightness/intensity (6)
3. Location, spacing in relation to static signs (2); Moving images – for example for lane closures (2); When can flashing lights and flashing words be used (2); AV role in future of DMS (2); Border need or not (2); Full color (2); Best travel time displays (2); Sun glare/glare issues (2)
4. Durability of DMS; TTC application of DMS; Standard messaging; LRT/RR applications for second train approaching; Visibility given various ambient conditions; Legibility; Contrast; Information load; Need/lack of need for polycarbonate sheeting in front of sign; Abbreviations; RFID and nano tracking

**Would you like to share anything else with the Task Force?**

Industry Survey:

- Training?
- Sign certification
- Wig-wag flashing if more than one color
- Edge lit LED signs
- Use a table for criteria – reduce text explanations
- Address CV/AV impact to DMS for the future
- Best uses are special events, construction and emergency closures
- Reduce cost and make solar powered
- Are people using DMS for parking availability
- Pictographs and more graphics – where might those be effective (congestion map)
- Let's settle on DMS
- Abandon dot-matrix signs in a timely manner
- DMS should display standard MUTCD images
- Consider lane use control BOTH a sign and signal
- Security
- Resist PSA/advertising
- Fix brightness, poor viewing angle, length of message, irrelevant message – degrades DMS
- Parallel wiring
- Drop "EXPECT DELAYS" – should be able to provide better information to drivers
- Consider arterials
- Use DMS to warn drivers of their speed in construction zones
- Real time information is key to DMS
- Do away with 3x8 signs
- Band 40 mm signs
- Guidance on private DMS signs visible to drivers
- Be careful that the standard are being implemented by non-professionals

NCUTCD Survey:

- Guidelines with flexibility (flexibility was mentioned 5 times)
- Cost and reliability issues
- How to coordinate permanent DMS application with TTC
- Large letter heights
- Lane uses controls should not be less than 3'x3'

- Clarity in color applications
- No advertising on signs

#### **Standard and Criteria Area Cross Reference to Existing MUTCD/NEMA TS-4**

<b>Criteria</b>	<b>MUTCD</b>	<b>NEMA TS-4</b>
Color	2L.04	5.5 Chromaticity
Symbols	Part 2A.12	
Lines of Text	2L.04	
Letter Height	2L.04	5.6.2.3.1 Character Height
Spacing of Letters/Words/Lines	2L.04	5.6.2.3.2 Character Ratios 5.6.2.3.4.3 Interline Spacing
Font	SHSM	5.6.1 Fonts
Use of Upper/Lower Case	Part 2	
Character Stroke	2L.04	5.6.2.3.4.4 Stroke
Number of Words	2L.05	
Abbreviations	2L.05	
Message Load	2L.05	
Visibility	2L.03	5.2 Contrast Ratio
Legibility	2L.03	
Sign Location/Position	2A.20	
Alignment		5.3 Cone of Vision
Clearance (vertical)	Part 2A.18	
Clearance (horizontal)	Part 2A.16, 2A.19	
Pixel Pitch	Part 2 (20m)	
Pixel Size		
Intensity		5.4 Luminance
Display Update Speed		5.7 Display Change Time