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Evaluation of Signage Alternatives for Express Lane Facilities

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METRIC CONVERSION TABLE

U.S. CUSTOMARY UNITS TO SI* (MODERN METRIC) UNITS

LENGTH				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
in	inches	25.400	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.610	kilometers	km
mm	millimeters	0.039	inches	in
m	meters	3.280	feet	ft
m	meters	1.090	yards	yd
km	kilometers	0.621	miles	mi

AREA				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
in ²	square inches	645.200	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yards	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.590	square kilometers	km ²
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.470	acres	ac
km ²	square kilometers	0.386	square miles	mi ²

VOLUME				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
fl oz	fluid ounces	29.570	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³

NOTE: volumes greater than 1,000 L shall be shown in m³.

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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16. Abstract Express lanes are usually tolled freeway lanes that are separated from general-purpose lanes to provide a higher level of mobility. Guide signs upstream of express lanes are especially crucial as drivers have to read these signs and then comprehend and react to them accordingly while traveling at high speeds. This report presents a focus group study to obtain drivers' feedback on different express lane sign design alternatives, with a special focus on signs near the entrance of express lane facilities. It also includes a review of the current standards in the Manual on Uniform Traffic Control Devices (MUTCD) for express lane signs and the use of signs on existing express lane facilities from across the country. The provisions of regulatory signs, guide signs, and tolling agency's pictograph on express lanes are provided in Chapter 2E: Toll Road Signs and Chapter 2G: Preferential and Managed Lane Signs of the MUTCD. However, many existing express lane signs have not been updated to meet the current MUTCD standards for express lane signs. The existing express lane signs were found to vary not only in the types of information they display, but also in color, size, layout, and number of sign panels used. The signs were found to generally display information on toll amounts and accessibility status, and none were found to display comparative travel times on express lanes vs. general-purpose lanes. A focus group study involving 49 participants was conducted to assess drivers' understandings, preferences, and opinions toward the guide signs at the entrance of express lanes. Sign design alternatives as they relate to the following categories were evaluated: (1) sign legend preference for toll-exempt vehicles in Florida; (2) display of travel time; (3) display of average speed in lieu of travel time; (4) preference for travel time vs. average speed; (5) display of comparative travel times on express lanes vs. general-purpose lanes; (6) preference of comparative travel times vs. comparative average speeds; (7) display of comparative travel times and toll amounts on express lanes and general-purpose lanes; and (8) interpretation of high toll amount on express lanes signs. Additional real-time information on travel time and average speed on express lanes and general-purpose lanes were found to help drivers decide if they want to use express lanes. However, focus group participants found both travel time and speed information to be ambiguous. It is recommended to educate drivers about these measures so that drivers correctly interpret this information. Although this additional information is useful to drivers, care needs to be taken to not overload drivers with too much information. It is imperative to consider the other existing signs and the fact that drivers need to comprehend this information while driving at high speeds.					
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EXECUTIVE SUMMARY

Express lanes are usually tolled freeway lanes that are separated from general-purpose lanes to provide a higher level of mobility for vehicles using the facilities (Collier and Goodin, 2004). Depending on its pricing scheme, an express lane facility can require significantly more information to be communicated to drivers than other traditional lane management strategies, such as high-occupancy vehicle (HOV) lanes. Guide signs in advance of express lanes are crucial as drivers have to read these signs and then comprehend and react to them accordingly while traveling at high speeds. As such, the objective of this research was to determine the optimal amount and type of information to display and the manner in which the information is communicated to drivers.

A focus group study was conducted to assess drivers' understandings, preferences, and opinions toward the guide signs upstream of express lanes. A total of five focus groups involving 49 participants of different age, gender, and ethnic groups were conducted. The following eight potential sign designs and alternatives were evaluated:

1. Sign legend preference for toll-exempt vehicles in Florida
2. Display of travel time
3. Display of average speed in lieu of travel time
4. Preferences for travel time vs. average speed
5. Display of comparative travel times on express lanes vs. general-purpose lanes
6. Preference for comparative travel times vs. comparative average speeds
7. Display of comparative travel times and toll amounts on express lanes and general-purpose lanes
8. Interpretation of high toll amount on express lanes sign

The focus group participants were shown the sign alternatives using PowerPoint slides. The slides primarily included the proposed signs and their alternatives, typical layouts, and digitally edited photographs. For each scenario, a set of questions was asked to capture the participants' understanding of the signs. Some of the key observations are discussed below.

Sign Legend Preference

Express lanes are usually open to all drivers who choose to pay a toll to use the facility. However, a few vehicles qualify to ride for free on almost all express lane facilities. For example, motorcycles and registered buses and car pools can use express lanes for free on 95 Express in Miami-Dade County, Florida. Since toll-exempt vehicles vary by jurisdiction, displaying this information is helpful for drivers. Two sign alternatives, one displaying toll-exempt vehicles using words alone, and the other displaying the same information using words and symbols, were provided to the participants. A slight majority (51%) of the participants preferred to have the information on toll-exempt vehicles in both symbols and words. However, these results could be biased toward the alternative that uses only words to display toll-exempt vehicles since this sign is currently used on 95 Express in Miami-Dade County and participants are familiar with it.

Measures of Traffic Conditions on Express Lane Facility

Travel time and average speed are good measures of traffic conditions on a facility. However, since these are rarely displayed on the signs, several participants misinterpreted this information. It is therefore recommended to educate drivers about these measures so that confusion and misinterpretation are minimized.

Since providing both travel time and average speed information on a sign results in information overload, it is recommended to provide either one of the two performance measures. Participants who preferred average speed argued that average speed has a fixed range that is independent of distance. It should be clear to all drivers that a low average speed on an express lane facility implies that the facility is congested, while a high average speed implies otherwise. On the other hand, participants who preferred travel time information argued that this information will explicitly tell them how much time it takes to reach the destination. However, travel time information might not be useful for tourists and unfamiliar drivers as they might not know the actual travel time/distance to the destination, and hence, cannot predict congestion.

Measures of Traffic Conditions on Express Lanes and General-purpose Lanes

The existing signs on express lanes provide the toll amount for using express lanes. However, in addition to the toll amount, drivers may need information such as travel times along express lanes and adjacent general-purpose lanes to better assess the benefit of paying extra to use the express lanes. When the traffic conditions (i.e., travel time or average speed) on both express lanes and general-purpose lanes are provided on a single sign, a majority of the participants stated that comparative travel time information (and not comparative average speed information) helped them decide whether or not to use the express lanes.

Almost all the participants considered the sign displaying comparative travel times on express lanes and general-purpose lanes and the toll amount on the express lanes to be useful. However, over half of the participants noted that the sign has too much information and preferred to display this information (i.e., comparative travel times and toll amount) on two separate signs. Nonetheless, a few participants preferred to see the same sign with all the information multiple times, instead of two separate signs.

Interpretation of High Toll Amount on Express Lanes

Express lanes provide a higher level of mobility and reliability by maintaining a certain level of traffic flow. Traffic volumes on express lanes are usually maintained by adjusting the toll amount. When the facility is congested, drivers are charged a high toll amount to discourage more drivers from entering the facility. Over 75% (38) of the focus group participants misinterpreted the high toll amount on the express lanes, and thought that it indicated the local (i.e., general-purpose) lanes are congested, and hence, there is a high demand for the express lanes.

Congestion on express lanes could be better assessed if information such as comparative travel times on the express lanes and the general-purpose lanes are provided in addition to the toll amount. However, 26.5% (13) of the participants misinterpreted the high toll amount on express lanes even when comparative travel times were provided. Drivers, therefore, need to be educated to minimize confusion and misinterpretation.

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LIST OF ABBREVIATIONS/ACRONYMS

AFV	Alternative Fuel Vehicle
DMS	Dynamic Message Sign
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
FIU	Florida International University
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
IRB	Institutional Review Board
MINS	Minutes
MPH	Miles per hour
MUTCD	Manual on Uniform Traffic Control Devices
SR	State Route
U.S.	United States

CHAPTER 1 INTRODUCTION

1.1 Background

Express lanes are usually tolled freeway lanes that are separated from general-purpose lanes to provide a higher level of mobility for vehicles using the facilities (Collier and Goodin, 2004). These facilities are becoming increasingly popular in the United States. Since the opening of the first express lane facility in Orange County, California, in 1995, more than a dozen similar facilities have been in operation across the nation, and many more are either under construction or being planned. Depending on its pricing scheme, an express lane facility can require significantly more information to be communicated to drivers than other traditional lane management strategies, such as high-occupancy vehicle (HOV) lanes. Typical information communicated to the drivers using an express lane facility includes:

- entry/exit points,
- toll amounts,
- vehicle and occupancy requirements,
- accessibility status (e.g., OPEN or CLOSED), and
- operating agencies.

In addition to this information, some agencies may choose to display traffic information such as travel times to the exit points to help drivers make their decisions on whether or not to use an express lane facility. Some agencies have further considered displaying comparative travel times on the express and general-purpose (i.e., free) lanes. All of this information is in addition to standard directional and informational signage and can quickly become overwhelming, especially for drivers who are unfamiliar with a facility.

1.2 Project Objectives

The main purpose of this project is to study the understanding and preferences of drivers regarding the display of guide sign information on express lane facilities. The specific objectives are as follows:

1. Review the current standards in the Manual on Uniform Traffic Control Devices (MUTCD) for express lane signs, and the use of signs on existing express lane facilities from across the country.
2. Conduct a focus group study on drivers' understanding of, and preferences for, different sign design alternatives on express lane facilities, with a special focus on signs near the entrance of express lane facilities, where signs are the most critical, especially in helping drivers make their decisions on whether to use the express lanes.

1.3 Report Organization

This report is organized as follows. Chapter 2 provides a comprehensive state-of-the-practice review of existing express lane signs from across the country. Chapter 3 describes the process adopted to recruit participants for the focus group study, the demographic characteristics of the study participants, and the focus group study administration. Chapter 4 lists the different sign designs and discusses the focus group study results. Finally, Chapter 5 summarizes the findings of this research effort.

CHAPTER 2 EXISTING PRACTICES

This chapter provides a comprehensive review of sign designs used on the express lanes currently in operation across the United States. It first provides a quick summary of the current standards in the MUTCD for signs on express lanes. It then presents a detailed summary of the existing express lane signs from across the country.

2.1 MUTCD Standards for Express Lane Signs

The current edition of the MUTCD does not dedicate a chapter to express lanes. However, express lanes are considered as a type of managed lane strategy and are discussed in Chapter 2E: Toll Road Signs, and in Chapter 2G: Preferential and Managed Lane Signs (Federal Highway Administration [FHWA], 2009). The following subsections discuss the provisions of regulatory signs, guide signs, and tolling agency's pictograph on express lanes that are provided in the MUTCD.

2.1.1 Regulatory Signs

Figure 2-1 shows several regulatory signs for express lane facilities. These signs are used to display the following information:

- Toll amount
- User restriction when vehicles with tollpass or high-occupancy vehicles are only allowed to use express lanes
- Hours of operation
- Vehicle occupancy for toll-free use
- Beginning and ending of express lanes

The toll amount and HOV occupancy that varies by time of day or day of week are provided in changeable message panels. When toll amount is displayed, the words EXPRESS LANE with white legend on green background are placed on the header panel.

2.1.2 Guide Signs

Figure 2-2 shows examples of guide signs to be placed before entrances to priced managed lanes. Figure 2-3 gives another example of a guide sign that shows comparative travel times between express lanes and general-purpose lanes. The travel times are displayed in changeable message panels within the guide sign.

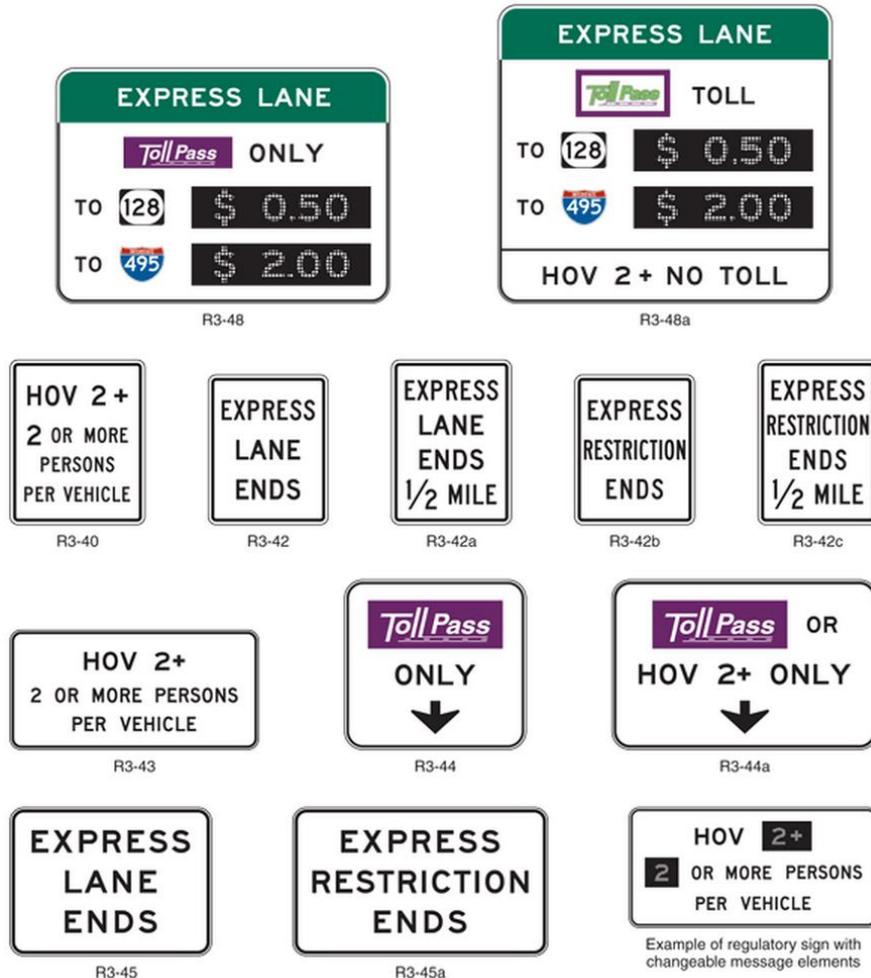


Figure 2-1: Regulatory Signs for Express Lanes (Source: FHWA, 2009)

2.1.3 Tolling Agency's Pictograph

Chapter 2E in the MUTCD suggests using either purple background or purple underlay with the tolling agency's pictograph. The following combinations of background and border colors should be used with the tolling agency's pictograph on express lane signs:

- When the pictograph itself has a purple background, use
 - a purple or other non-contrasting (e.g., green) background with a white border, or
 - a white or other contrasting background with no border.
- When the pictograph itself has a background other than purple, use
 - a purple background,
 - a purple underlay with a white contrasting border on a non-contrasting background, or
 - a purple underlay with no border on a white or other contrasting background.

A - ENTRANCE TO A PRICED MANAGED LANE FROM A GENERAL PURPOSE LANE



B - DIRECT ENTRANCE TO A PRICED MANAGED LANE FROM A CROSSROAD



Figure 2-2: Examples of Guide Signs before Entrances to Priced Managed Lanes (Source: FHWA, 2009)



Figure 2-3: Example of a Comparative Travel Time Information Sign for Preferential or Managed Lanes (Source: FHWA, 2009)

2.2 Express Lane Signs in Different States

As of 2016, express lanes are present in 10 states, including California, Colorado, Florida, Georgia, Maryland, Minnesota, Texas, Utah, Virginia, and Washington. The following subsections summarize the signs that were or are used on express lane facilities in these states. The express lane signs were observed from Google’s Street View. Accordingly, the signs are current only up to the time when the pictures in Street View were taken.

2.2.1 California

California has the highest number of express lane facilities, constituting over 48 miles in length. The following are the four express lane facilities that are currently operational in California:

1. I-680 Express Lanes in Alameda County
2. State Route (SR) 91 Express Lanes in Orange County
3. I-15 Express Lanes in San Diego County
4. SR 237 Express Lanes in Santa Clara County

I-680 Express Lanes

The I-680 Express Lanes facility is a 14-mile stretch going southbound on I-680 from SR 84 south of Pleasanton to SR 237 in Milpitas. Tolls on this facility vary from \$0.30 to \$7.50, depending on traffic volumes in the express lanes from Monday to Friday between 5 AM and 8 PM. During other times, any vehicle can use the facility for free (Alameda County Transportation Commission, 2012). Figure 2-4 shows an example of the signs used on this facility. Both the signs shown in Figure 2-4 are identical, yet provide different dynamic messages, such as toll amount or “OPEN TO ALL,” during different times of day. The information “HOV 2+ NO TOLL” indicates that vehicles with 2 or more persons (HOV2+) can use the facility free of charge during all times.

SR 91 Express Lanes

The SR 91 Express Lanes facility is a four-lane 10-mile toll road extending from the SR 55 and SR 91 interchange to just west of the SR 91 and SR 71 interchange in Orange and Riverside counties. Once the toll amount is adjusted for time of day and day of week, it is fixed for six months during peak hours, and for one year during non-peak hours (Orange County Transportation Authority [OCTA], n.d.). As shown in Figure 2-5, dynamic toll amounts are provided on a separate variable message sign.

I-15 Express Lanes

The I-15 Express Lanes facility is a four-lane 20-mile stretch between the I-15 and SR 163 split in San Diego and SR 78 in Escondido. The express lanes signs used on this facility provide travel time in addition to toll amount. The toll amount is updated every three minutes depending on traffic flow. As shown in Figure 2-6, “MINIMUM TOLL” indicates the minimum amount that drivers have to pay to enter the facility and travel to the next exit (Caltrans, n.d.).

SR 237 Express Lanes

The express lane facility along the SR 237 and I-880 corridor in Santa Clara County is located between North First Street on SR 237 and just south of Dixon Landing Road on I-880 (Santa Clara Valley Transportation Authority, n.d.). As shown in Figure 2-7, the signs on this facility display either the toll amount in the panel next to the destination name or the message “OPEN TO ALL” in the bottom panel.



(a) Displaying Toll Amount (Source: [Google Street View](#); Image Date: July 2016)



(b) Displaying Vehicle Eligibility (Source: Gan et al., 2012)

Figure 2-4: Signs Displaying Toll Amount and Vehicle Eligibility on I-680 Express Lanes



Figure 2-5: Separate Sign Displaying Toll Amount on SR 91 Express Lanes
(Source: [Google Street View](#); Image Date: June 2016)



Figure 2-6: Sign Displaying Travel Time and Toll Amount on I-15 Express Lanes
(Source: [Google Street View](#); Image Date: January 2016)



Figure 2-7: Sign Displaying Toll Amount on SR 237 Express Lanes
(Source: [Google Street View](#); Image Date: September 2016)

2.2.2 Colorado

The I-25 Express Lanes are two reversible lanes spanning 7 miles between 20th Street in downtown Denver and US 36 in Denver, Colorado. The reversible express lanes are open for southbound traffic from 5 AM to 10 AM during weekdays, and for northbound traffic from 12 PM to 3 PM on weekdays and on weekends. The facility is free for HOVs, including buses and carpools with at least two passengers. In addition, motorcycles can also use this facility without paying a toll. Similar to the other express lane facilities across the country, single-occupant vehicles with an ExpressToll transponder are allowed to pay the toll amount and use the facility. Figure 2-8 shows a dynamic message sign (DMS) that is used to display the toll amount for vehicles having the ExpressToll transponder and for vehicles without the transponder. The DMS can also show other messages, such as “HOV LANE CLOSED,” “DO NOT ENTER,” and “GATE CLOSED” (Colorado Department of Transportation, n.d.).



Figure 2-8: Dynamic Message Sign Upstream of I-25 Express Lanes
(Source: [Google Street View](#); Image Date: October 2016)

2.2.3 Florida

Florida has the following two express lane facilities:

1. The 95 Express Lanes in Miami-Dade and Broward Counties
2. The 595 Express Lanes in Ft. Lauderdale, Broward County

The 95 Express Lanes facility in Florida is a 21-mile stretch on I-95 and extends from Golden Glades Interchange in Miami-Dade County to just south of Broward Boulevard in Broward County. The facility can be used by vehicles with no more than two axles, with the exception of emergency vehicles and registered buses. Vehicles other than registered carpools with at least three persons, registered hybrid vehicles, buses, registered vanpools, motorcycles, emergency vehicles, and registered over-the-road motor coach vehicles need to pay a minimum toll of \$0.50. Toll amounts vary based on traffic flow on the express lanes. Figure 2-9 shows one of the signs used on this facility. The sign shows toll amounts for vehicles that have a SunPass transponder with two messages: (1) registered carpools are free, and (2) cash is not accepted at toll plazas (95 Express, n.d.).



Figure 2-9: Sign Displaying Toll Amount on 95 Express Lanes
 (Source: [Google Street View](#); Image Date: May 2015)

The 595 Express Lanes in Ft. Lauderdale are reversible lanes. The facility consists of three lanes, and is open to multi-axle vehicles. Toll rates vary by number of axles. On weekdays, the facility is open to eastbound traffic between 4 AM and 1 PM and to westbound traffic between 2 PM and 2 AM (FDOT, n.d.). Figure 2-10 shows a sign used on this facility.



Figure 2-10: Sign Displaying Toll Amount on I-595 Express Lanes
 (Source: [Google Street View](#); Image Date: August 2016)

2.2.4 Georgia

The I-85 Express Lanes in Atlanta, Georgia, are 16 miles long and extend from south of I-285 to Old Peachtree Road in Gwinnett and DeKalb counties. The facility can be used by vehicles with two or fewer occupants with a toll and by carpools with three or more occupants, buses, motorcycles, emergency vehicles, and alternative fuel vehicles (AFVs) with proper AFV license

plate with no cost (State Road and Tollway Authority, n.d.). Figure 2-11 shows a sign used on this facility. The sign displays two toll amounts: (1) the toll amount to the next exit, and (2) the toll amount to the last exit on the facility.



Figure 2-11: Sign Displaying Toll Amount on I-85 Express Lanes
(Source: [Google Street View](#); Image Date: July 2016)

2.2.5 Maryland

The I-95 Express Toll Lanes in Maryland are 8 miles long and span between I-895 and just north of White Marsh Boulevard in Northeast Baltimore. The toll amounts on this four-lane facility vary depending on peak, off-peak, or overnight hours; the direction of travel; the number of axles; and the presence of an E-ZPass transponder on the vehicle. Unlike other express lanes, motorcycles are tolled on the I-95 Express Toll Lanes in Maryland (Maryland Transportation Authority, n.d.). Figure 2-12 shows a sign used on this facility. The sign displays two toll amounts: (1) the toll amount to the next exit, and (2) the toll amount to the last exit on the facility. The toll amounts are applicable to two-axle vehicles only, as indicated by “2 AXLE” in the bottom dynamic panel.



**Figure 2-12: Sign Displaying Toll Amount on I-95 Express Lanes in Maryland
(Source: Cross Country Roads, n.d.)**

2.2.6 Minnesota

The I-35W and I-394 Express Lanes facilities are currently operational in Minnesota. The two facilities have adopted similar sign designs. The I-35W Express Lanes facility has two segments: one from Highway 13 in Burnsville to I-494, and the other from I-494 to downtown Minneapolis. The I-394 Express Lanes facility also has two segments: one from Wayzata Boulevard to Highway 169, and the other from General Mills Boulevard to just east of Park Palace/Xenia Avenue (Minnesota Department of Transportation, n.d.). Figures 2-13 and 2-14 show the signs used on the I-35W and I-394 Express Lanes facilities, respectively. In addition to the toll amount, the information displayed on these signs includes the following:

- “OPEN” on both signs indicates that the corresponding express lane facility is open to all traffic at no charge.
- “\$ AT 76TH” on the sign in Figure 2-13 indicates that a toll will be charged from that specific location (i.e., 76th Street).



Figure 2-13: Sign Displaying Toll Amount to Two Destinations on I-35W Express Lanes
(Source: [Google Street View](#); Image Date: November 2016)

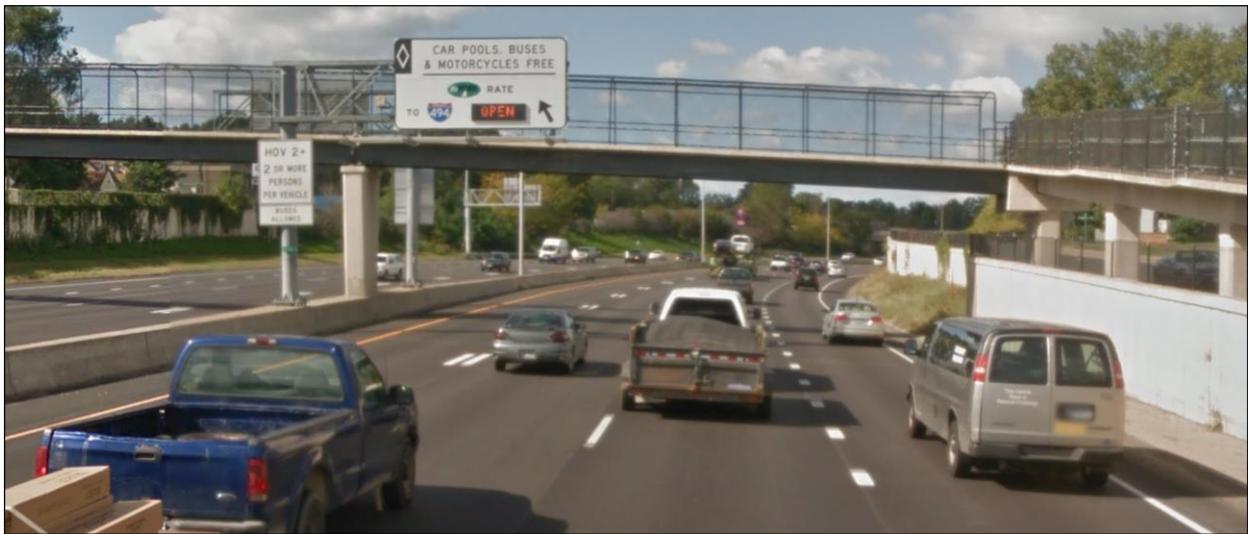


Figure 2-14: Sign Displaying Toll Amount to Two Destinations on I-394 Express Lanes
(Source: [Google Street View](#); Image Date: September 2016)

2.2.7 Texas

The Katy Tollway is a four-lane 12-mile section on I-10 spanning between SR 6 and I-610 just west of Houston in Harris County. Figure 2-15 gives an example of a sign displaying toll amounts to three destinations. A separate sign is used to display occupancy and time restrictions. Single-occupant vehicles with an EZ Tag can use the facility 24 hours a day by paying a toll. Toll rates are based on time of day, vehicle occupancy, and axle count. As can be inferred from the sign shown in Figure 2-16, the facility is free for HOV2+ and motorcycles during peak hours Monday through Friday from 5 AM to 11 AM and from 2 PM to 8 PM. Trucks or trailers with three or more axles are charged

a flat fee of \$7 at all times for each segment of the three destinations, for a maximum of \$21 for the entire facility (Harris County Toll Road Authority, n.d.).



Figure 2-15: Sign Displaying Toll Amounts to Three Destinations on I-10 Katy Tollway
(Source: [Google Street View](#); Image Date: July 2016)

2.2.8 Utah

When opened in 2010, the I-15 Express Lanes facility in Utah extended from 400 South in South Utah County to Layton Parkway in North Davis. The facility was initially divided into six payment zones, and signs at the boundaries of each of these zones show the pricing for traveling through the zone. The pricing for each zone varied from \$0.25 to \$1.00 based on the level of congestion. Figure 2-16 gives an example of a toll sign used on the I-15 Express Lanes facility. The sign shows the toll amount only for the zone ahead and not for more than one zone. At the bottom of the sign, the information “HOV 2+ NO TOLL” is provided to indicate that the express lanes are free for carpools with two or more passengers and, accordingly, the toll displayed in the dynamic panel is not applicable for these vehicles. In addition to the toll amount, the dynamic panel may display the following word messages (Utah Department of Transportation, n.d.):

- “FREE” to indicate any vehicle regardless of occupancy can use the facility for free
- “HOV ONLY” to indicate only carpools, buses, motorcycles, commercial decal vehicles, and emergency vehicles may use the facility
- “CLOSED” to indicate all drivers must exit the facility at the next exit point



Figure 2-16: Sign Displaying Toll Amount on I-15 Express Lanes
(Source: [Google Street View](#); Image Date: June 2016)

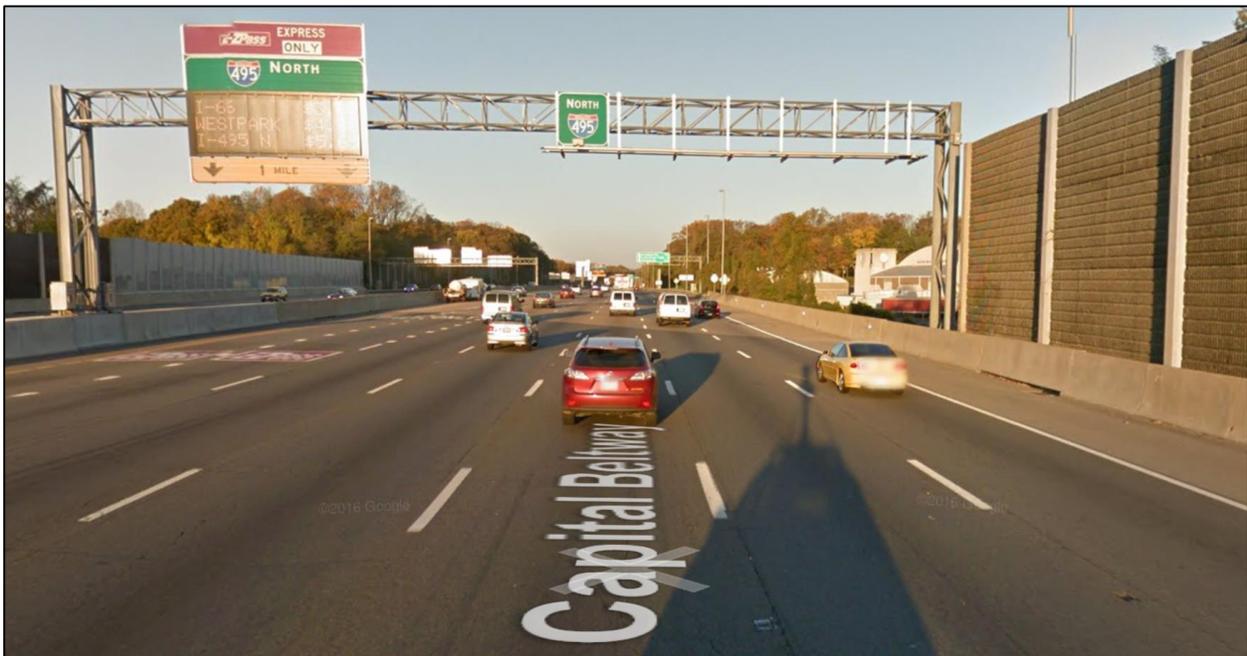
2.2.9 Virginia

Two express lane facilities, 495 Express Lanes and 95 Express Lanes, are currently operational in Virginia. The four-lane 495 Express Lanes are 14 miles long and are located in the center of the I-495/Capital Beltway extending from the Springfield Interchange to just north of Dulles Toll Road on the Virginia side. The 95 Express Lanes are 29 miles long and are located in the center of I-95 from Garrisonville Road in Stafford County to the vicinity of Edsall Road on I-395 in Fairfax County. The 95 Express Lanes are reversible. The two facilities are free for carpools with three or more occupants, buses, and emergency vehicles with an E-ZPass and for motorcycles not requiring an E-ZPass. Based on real-time travel conditions, tolls may vary from as low as \$0.20 per mile during less congested times up to approximately \$1.00 per mile in some sections during rush hour (495/95 Express Lanes, 2016).

Figure 2-17 shows two pricing signs used on the 495 Express Lanes. The sign in Figure 2-17(a) displays toll amounts to three locations. The first two locations on the sign are the most popular destinations ahead and the third location is the last exit on the facility. As shown in Figure 2-17(b), the sign provides the toll amount and the status of the connecting 95 Express Lanes in both directions from the 495 Express Lanes' access points. Figure 2-18 shows the sign used at the entrance of the 95 Express Lanes facility. The sign provides a dynamic message in two lines.



(a) Displaying Status of Connecting Express Lanes and Toll Amount
 (Source: [Google Street View](#); Image Date: November 2016)



(b) Displaying Toll Amount to Three Destinations
 (Source: [Google Street View](#); Image Date: November 2016)

Figure 2-17: Express Lanes Signs on 495 Express Lanes



Figure 2-18: Express Lanes Signs on 95 Express Lanes
(Source: [Google Street View](#); Image Date: December 2015)

2.2.10 Washington

Washington currently operates two express lanes, the SR 167 high-occupancy toll (HOT) lanes and the I-405 Express Toll Lanes. The SR 167 HOT lanes span approximately 10 miles between Auburn and Renton. The I-405 Express Lanes are 17 miles long and are located between Bellevue and Lynnwood. Depending on the congestion level, toll rates on the SR 167 HOT lanes vary from as low as \$0.50 up to \$9.00 and those on the I-405 Express Toll Lanes vary from \$0.75 to \$10.00. Both facilities are toll free between 7 PM and 5 AM (Washington State Department of Transportation, n.d.). Figure 2-19 shows a tolling sign used on the SR 167 HOT lanes. The legend shown on the top conveys that buses and carpools with two or more passengers are allowed to use the facility for free. The dynamic message indicates the toll amount to be paid for use of the facility by registered vehicles with *GoodToGo* transponders.

Figure 2-20 shows a sign used on the I-405 Express Toll Lanes. The sign displays two toll amounts to three destinations: the first two are to major destinations, and the last on the list is to the last exit on the facility. Unlike the sign on the SR 167 HOT lanes, the information regarding toll-free vehicles on the I-405 Express Toll Lanes is provided in the dynamic panel at the bottom of the sign.



Figure 2-19: Express Lane Sign on SR 167 HOT Lanes
(Source: Texas A&M Transportation Institute, 2011)



Figure 2-20: Express Lane Sign on the I-405 Express Toll Lanes
(Source: Arehart, 2016)

2.3 Summary

This chapter summarized the provisions in the MUTCD for regulatory signs, guide signs, and tolling agency's pictograph on express lanes. It also reviewed the express lane signs currently being used across the country. The following general observations can be made from this review:

- Many existing express lane signs have not been updated to meet the current MUTCD standards for express lane signs.
- The existing express lane signs vary across the different facilities not only in the types of information they display, but also in color, size, layout, and number of sign panels used.
- The existing express lane signs generally display information on toll amounts and accessibility status such as "OPEN" or "CLOSED."
- The I-15 Express Lanes in San Diego, California, are the only facility where the express lane signs display travel time on express lanes in addition to toll amount.
- None of the signs were found to display comparative travel times on express lanes versus general-purpose lanes.

Table 2-1 gives a summary of the information displayed on express lane signs on the 17 express lane facilities reviewed in this chapter.

Table 2-1: Summary of Information Displayed on Express Lane Signs across the United States

State	Number of Destinations	Toll Amount	Travel Time	Additional Information
California	1–2	Yes	Yes*	HOV2+ NO TOLL
Colorado	1–2	Yes	No	HOV FREE
Florida	1–2	Yes	No	REGISTERED CARPOOLS FREE, CASH NOT ACCEPTED
Georgia	2	Yes	No	
Maryland	2	Yes	No	2 AXLE
Minnesota	2	Yes	No	CAR POOLS, BUSES & MOTORCYCLES FREE
Texas	1–3	Yes	No	EZ TAG ONLY
Utah	1	Yes	No	HOV 2+ NO TOLL
Virginia	3	Yes	No	E-ZPASS EXPRESS ONLY
Washington State	1–3	Yes	No	

* Travel time and toll amount are displayed on the I-15 Express Lanes facility in San Diego, California.

CHAPTER 3

FOCUS GROUP STUDY

This chapter focuses on the process undertaken to evaluate different express lane sign design alternatives. It describes the focus group study development, participant recruitment, and study administration. The study was directed to assess participants' understanding of the different messages conveyed by the signs, to identify their preferences to different sign alternatives, and to obtain potential suggestions on issues related to sign design and implementation.

3.1 Institutional Review Board Approval

Approval from the Institutional Review Board (IRB) at Florida International University (FIU) is required for all research projects involving human subjects, such as public opinion surveys, focus groups, stated preference surveys, etc. The researchers requested and obtained the IRB approval to conduct the focus group study.

3.2 Participant Recruitment

To recruit participants for focus groups, the research team distributed flyers through the FIU mailing lists. Figure 3-1 provides the application form used to recruit participants for this focus group study. Interested subjects with a valid U.S. driver's license were required to email back additional information. Subjects were then asked for their consent to participate in this study. After their consent was provided, subjects were scheduled for the study per their convenience. The research team made sure that there was enough representation of older drivers, and that the college students were not overrepresented. Finally, a total of 49 people from different age, gender, and ethnic groups were recruited by the research team for the focus group study. Note that the focus group strategy adopted in this research is intended to provide a representative opinion of the driving population, which might not reflect statistically significant inferences.

3.3 Study Procedure

A total of five focus group meetings were held in the summer of 2015. The meetings were scheduled on two Saturdays, July 18, 2015, and July 25, 2015. The focus groups met in the conference room in the FIU Engineering Center (Address: Room EC 3350, 10555 West Flagler Street, Miami, FL, 33174).

As participants of the focus groups gathered, team members checked their driver's licenses to confirm their eligibility to participate in the study. To be eligible, participants needed to have a valid U.S. driver's license and be 18 years or older. All the eligible participants were given the Informed Consent Form to be signed and returned. The participants were given two sets of questionnaires: one for providing their demographic information, and the other for answering the questions and writing down comments during the presentation. The two questionnaires are provided in Appendix A. The demographic questions include the following:

- City of residence
- Gender
- Age

- Ethnicity
- Level of education
- Years of driving in the U.S.
- Estimate of miles driven per year
- Type of vehicle used to drive



Focus Group Study Participants Needed!

*Tired of traffic signs that are too difficult to read and understand?
Then come join us in a study to improve traffic sign designs while
making some extra cash for your next shopping trip!*

PERFORMING ORGANIZATION: Lehman Center for Transportation Research, Florida International University

SPONSOR: United States Department of Transportation (USDOT) through the National Center for Transportation Systems Productivity and Management (NCTSPM).

WHEN: Weekend sessions to be held during the month of July, 2015. About 1.5 hours a session. Limit one session per person.

WHERE: FIU Engineering Center, 10555 West Flagler Street, Miami, FL 33174

ELIGIBILITY: Must be 18 years or older and with a valid US driver's license (must show at time of study)

COMPENSATION: A \$40 gift card for each participant who completes a full session.

HOW TO APPLY: Fill out the information below and email the complete form to Mr. Carlton Ng at cng001@fiu.edu by **5:00 pm, June 25, 2015**. All applicants will be informed of their application results by June 30, 2015.

QUESTIONS: Email Mr. Carlton Ng at cng001@fiu.edu.

Name: Age:

Gender: Male Female

Ethnicity: Native American Hispanic African American
 White/Non-Hispanic Asian/Pacific Islander Other

Phone Number: Email:

Able to understand English Spanish

Have a valid US driver's license: Yes No

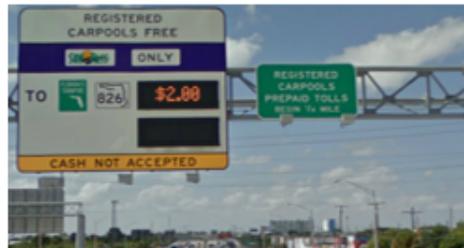


Figure 3-1: Focus Group Participant Application Form

Table 3-1 gives the summary of demographic information of the participants. The first questionnaire also included questions about the participants' experience driving on express lanes. When asked about how often they use I-95 Interstate Highway in Miami-Dade County, the location that includes express lanes in Florida, about 96% (47 of 49) stated that they either regularly or occasionally use I-95 in Miami-Dade County. When asked how often they use the express lanes on I-95, 44.9% (22 of 49) stated that they have never used the I-95 Express Lanes, while the remaining 55.1% (27 of 49) stated that they have used that facility.

Table 3-1: Demographic Information of Participants

Category	Frequency (Percentage)¹
Gender	
Female	25 (51.0%)
Male	24 (49.0%)
Age groups	
18–30 years	18 (36.7%)
31–50 years	19 (38.7%)
51+ years	12 (24.6%)
Born in the U.S.	
Yes	21 (42.8%)
No	28 (57.2%)
Race and ethnicity	
Hispanic/Latino	34 (69.4%)
White (not of Hispanic origin)	4 (8.2%)
African American	4 (8.2%)
Native American	0 (0.0%)
Asian or Pacific Islander	7 (14.2%)
Other	0 (0.0%)
Level of education	
Less than high school	1 (2.0%)
High school diploma / GED	4 (8.2%)
Some college	7 (14.2%)
College degree	21 (42.0%)
Advanced college degree	16 (33.6%)
Number of years driving in U.S.	
1–10 years	17 (34.7%)
11–25 years	21 (42.0%)
26+ years	11 (23.3%)
Miles driven per year	
0–7000 miles	10 (20.4%)
7001–15,000 miles	26 (53.0%)
15,001+ miles	13 (26.6%)
Type of vehicle	
Passenger cars	47 (96.0%) ²
Pickup	3 (6.1%) ²
Commercial vehicle	2 (4.1%) ²
Motorcycle	1 (2.0%) ²

¹ Participants were primarily from South Florida; ² Some participants drive more than one type of vehicle.

Each focus group session was facilitated by the same member of the research team, who was assisted by two note-takers and one translator for any participants who speak only Spanish. Note that the translation services were not utilized, as all the participants were English-literate. The session facilitator first provided a brief introduction about the background of the research and the study objectives. The sign alternatives were then introduced to the participants using PowerPoint slides. The slides primarily included the proposed signs and their alternatives, typical layouts, and digitally edited photographs. For each scenario, a set of questions was asked to capture the participants' understanding of the signs. Participants provided written responses to these questions. Next, a discussion was initiated to gather participants' opinions on the sign's applicability, legibility, design, and preference. This approach made sure that the participants' responses to the questions were not influenced by each other's opinions. Note that no unusual occurrences that may have influenced some of the study results occurred during the focus group sessions. Appendix B provides the presentation slides.

Each focus group took about 60 to 90 minutes to complete. At the end of the focus group meeting, participants each received a \$40 gift card as compensation and appreciation for their time and contribution to the study.

CHAPTER 4 FOCUS GROUP STUDY RESULTS

In this chapter, results from the focus group study on sign design alternatives, as categorized below, are presented:

1. Sign legend preference for toll-exempt vehicles in Florida
2. Display of travel time
3. Display of average speed in lieu of travel time
4. Preferences for travel time vs. average speed
5. Display of comparative travel times on express lanes vs. general-purpose lanes
6. Preference for comparative travel times vs. comparative average speeds
7. Display of comparative travel times and toll amounts on express lanes and general-purpose lanes
8. Interpretation of high toll amount on express lanes sign

The following sections discuss the focus group results for each of these eight categories in detail. Participants' comments and suggestions are included.

4.1 Sign Legend Preference for Toll-exempt Vehicles in Florida

Express lanes are toll roads that are generally open to all drivers who choose to pay a toll to use the facility. However, a few vehicle types qualify to ride for free on almost all express lane facilities. For example, motorcycles can use express lanes for free on the I-95 Express Lanes (known as the “95 Express”) in Miami-Dade County in Florida. Buses and carpools can also ride for free, as long as they are registered with the agency. Since the toll-exempt vehicles vary by jurisdiction, displaying this information is helpful to drivers.

Figure 4-1 gives two sign alternatives for displaying toll-exempt vehicles on express lanes. Alternative A (an existing sign on the 95 Express) displays the toll-exempt vehicles using words alone, while Alternative B, the proposed alternative, displays this information using a combination of words and symbols. Participants were shown these two alternatives, and were asked to state their preference, and the reason(s) for their preference.

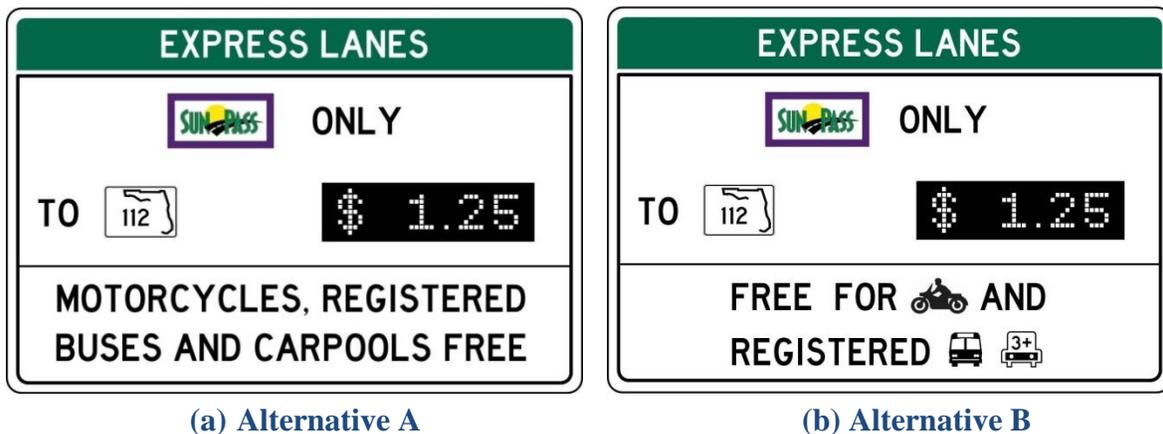


Figure 4-1: Sign Alternatives Displaying Toll-exempt Vehicles

Alternatives A and B were preferred by 49% (24) and 51% (25) of the participants, respectively. Table 4-1 provides the opinions of the participants about each alternative. Note that these results could be biased toward Alternative A since this sign is currently used on the 95 Express facility. Several participants who disliked the symbols stated that the symbols were small and difficult to understand. If the symbols are made more clear and larger, more participants might prefer this alternative. The participants generally preferred placing the word “FREE” at the start of the sentence compared to placing it at the end of the sentence.

Table 4-1: Opinions of Participants on Sign Alternatives Displaying Toll-Exempt Vehicles

A: Alternative with Words Alone		Freq.	B: Alternative with Words and Symbols	Freq.
Positive	The sign is easy to understand.	15	The sign can be recognized faster.	13
	The sign is less distracting.	3	The sign is easy to understand.	8
	The letter size is better to read.	2	The sign has less information to read.	4
	The sign can be recognized faster.	2	The sign is easier to understand by people who do not speak English.	2
			The sign is less distracting.	1
			Good information display.	1
Negative	The sign has too much information to read.	5	It is difficult to understand the symbols.	15
	It is difficult to understand the sign.	1	The symbols are small.	2

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 24 participants, and Alternative B was preferred by 25 participants.

Additional comments and suggestions from the participants that are not summarized in Table 4-1 include the following:

- Alternative B takes less time for me to read the sign and comprehend the “FREE” information. However, symbols probably can be drawn in a better way for better understanding.
- Wording in Alternative A is confusing, perhaps starting with “FREE FOR MOTORCYCLES” might be better; pictures are also quicker to read in the limited time you have while driving.
- In Alternative A, you can read well because the letters are big enough to read from a distance and while traveling at high speeds.
- In Alternative B, first, images are readable faster and people can understand them easier and faster. Second, the word “FREE” is at the beginning.
- I would prefer Alternative B if the symbols were larger. However, the one with words could be seen from a farther distance.
- The symbols in Alternative B are too small to see from a distance and understand. For example, “3+” is very small compared to the rest of the legend.

Participants were also shown Alternative B and were asked the meaning of “SUNPASS ONLY.” All the 49 participants correctly responded that only vehicles with a SunPass transponder can use the express lanes. When asked what “3+” on the car logo indicates, 65.3% (32) of the participants

correctly interpreted it to be carpools with at least three persons, while the remaining 34.7% (17) misinterpreted it to be carpools with more than three persons.

4.2 Display of Travel Time

The existing signs on the 95 Express provide the toll amount for using these facilities. However, they do not provide any information on travel time along the express lanes to help drivers assess the benefit of paying extra to use the express lanes. Figure 4-2(a) shows the design of a proposed sign that provides information on both travel time and toll amount. Participants were first shown this design and were asked to interpret the time information that is displayed on the sign. Only 59.2% (29) of the participants correctly interpreted the information on this sign to mean that it takes 10 minutes to reach SR 112, and the toll is \$1. Over 16% (8) of the participants misinterpreted the sign and thought that drivers need to pay \$1 every 10 minutes. Table 4-2 shows the frequency and percentage of different interpretations of the time displayed on this sign.

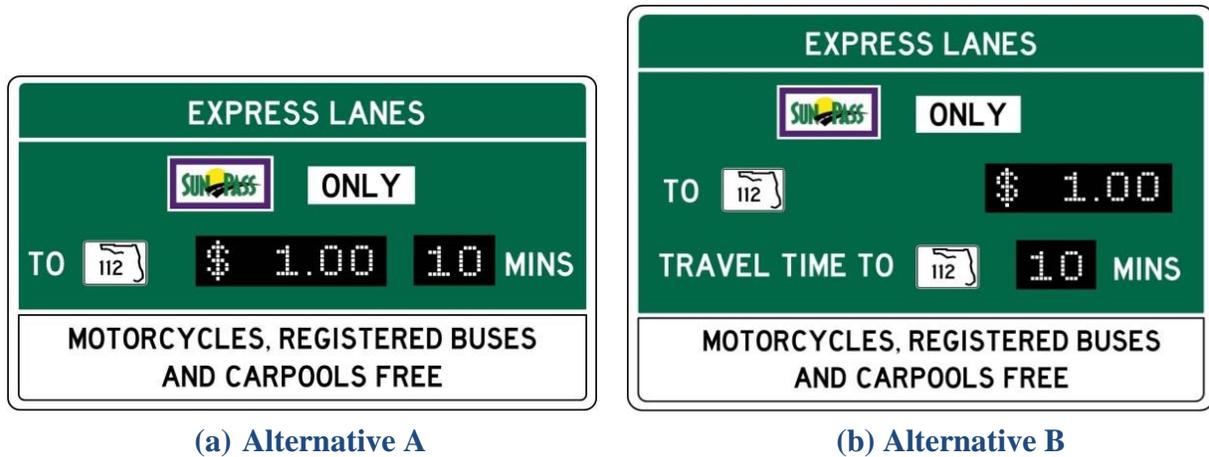


Figure 4-2: Sign Alternatives for Displaying Travel Time Information

Table 4-2: Interpretations of Time Displayed on the Express Lanes Sign

Interpretation	Frequency (Percentage)
Time to reach SR 112 ^a	29 (59.2%)
Pay \$1 every 10 minutes	8 (16.4%)
Time remaining for toll amount to change	3 (6.1%)
Time to reach/end the express lanes	3 (6.1%)
Time delay in the express lanes	3 (6.1%)
Express lanes will save 10 minutes	2 (4.1%)
Total	48 (98.0%) ^b

^a Correct interpretation; ^b One participant did not respond to this question.

Participants also were asked about the usefulness of travel time information. A majority (78%, 38) of the participants considered the travel time information as either *Very Useful* (26) or *Useful* (12). This result is consistent with several other studies (Chrysler and Nelson, 2009; Saha et al., 2014).

Participants then were shown Figures 4-2(a) and 4-2(b) side-by-side, which gave two sign alternatives for conveying travel time information. Alternative A displays toll amount and travel time information in the same row, whereas Alternative B provides the same information in two different rows. Participants were asked to state their preference and the reason(s) for their preference. Alternative B was preferred by over two-thirds (67.3%, 33) of the participants, while the remaining participants (32.7%, 16) preferred Alternative A. Table 4-3 provides the opinions of the participants about each alternative.

Table 4-3: Opinions of Participants on Sign Alternatives Displaying Travel Time

Alternative A		Freq.	Alternative B	Freq.
Positive	The sign has efficient layout.	14	The sign is easy to understand.	24
	The sign is easy to understand.	5	The sign states the phrase “TRAVEL TIME.”	8
	Less time is needed to read the sign.	3	The sign is bigger.	5
	The sign has bigger letters.	1	The sign has more information.	1
Negative	The meaning of “10 MINS” is ambiguous.	4	The sign has too much information.	6
	The sign looks congested.	1	The sign is too big.	2
	The sign needs too much time to interpret.	1	The sign is more distracting.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 16 participants, and Alternative B was preferred by 33 participants.

Several participants stated that Alternative A has an efficient layout because the sign is smaller and has fewer words. However, since it does not explicitly state what 10 MINS means, the information could be misinterpreted by unfamiliar drivers. Several other participants thought that Alternative B is easy to understand especially because the sign explicitly states, “TRAVEL TIME TO SR 112,” leaving no room for confusion. Alternative B is also larger in size and does not look crowded.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-3:

- Alternative A is simpler and delivers the message without making it too wordy or long. Maybe change the order of the sign, i.e., “10 MINS TO SR 112 \$1.00.”
- I would prefer Alternative A if “10 MINS” was before “\$1.00.” Otherwise, Alternative B is the obvious choice since it has more clarity. A better choice is: “10 MINS TO SR 112 \$1.00.”
- I prefer Alternative B because I can understand that 10 minutes is related in specific to the travel time. However, I would also like to know how much time I am saving.
- The legend in Alternative A is bigger and it is easier to read when the toll amount and the travel time information are in one line. “10 MINS” should be closer to SR 112.
- Alternative A is smaller, and has fewer words to read. I would include a time interval (e.g., 8–10 MINS) instead of the exact number. It is a good idea to display the time before the toll amount, i.e., “8–10 MINS TO SR 112 \$1.00” or “TO SR 112 8–10 MINS \$1.00.”

- Alternative B is much easier to understand at first sight, while it is difficult to interpret the information in Alternative A. I thought first that Alternative A means the \$1.00 toll amount was going to change in 10 minutes.
- Alternative B is clear and it leaves no room for misinterpretation. Actually, Alternative A with the phrase “TRAVEL TIME” over “10 MINS” would be better (and not repeating SR 112) compared to the phrase “10 MINS TO SR 112 \$1.00.”
- I think Alternative B is very clear for interpretation. In Alternative B, the words “TO SR 112” need to be eliminated.

Since express lanes often serve multiple destinations, a new sign displaying travel time and toll amount information to two sequential destinations, with SR 826 being the first destination and I-595 being the second and farther destination, was designed and shown to the participants (see Figure 4-3). Similar to the sign in Figure 4-2(a), this sign does not explicitly state what the time means. Since this sign was presented immediately after discussing signs in Figure 4-2, participants already knew that the time displayed is travel time to the destination.



Figure 4-3: Travel Time and Toll Amount Information to Multiple Destinations

To understand if this sign clearly conveys the correct travel time and toll information, participants were asked to determine the travel time and toll amount to I-595 based on the information provided on this sign. For travel time, participants were given two options: (a) 24 minutes, and (b) 9 minutes + 24 minutes = 33 minutes. Similarly, for toll amount, participants were again given two options: (a) \$2.50, and (b) \$1.00 + \$2.50 = \$3.50. The correct answer is (a) in both cases, as the practice is to treat the two destinations independently.

A high 93.9% (46) of the participants correctly stated that it takes 24 minutes to reach I-595, while the remaining 6.1% (3) of the participants responded incorrectly. As expected, also a high 91.8% (45) of the participants correctly stated that it costs \$2.50 to reach I-595, while the remaining 8.2% (4) of the participants responded incorrectly. The results show that a majority of the participants correctly interpreted the information conveyed on these signs.

Finally, the participants were asked if the sign has too much information. Over three-fourths (79.6%, 39) of the participants noted that they do not feel that the sign has too much information, while the remaining 20.4% (10) stated that the sign has too much information.

4.3 Display of Average Speed in Lieu of Travel Time

The research team hypothesized that using average speed in lieu of travel time (as in Figure 4-2) could provide better information for drivers to assess traffic conditions on a facility. Unlike travel time, which depends on distance that is known only to drivers familiar with the area, average speed has a fixed range that is independent of distance. It should be clear to all drivers that a low average speed on an express lane facility implies that the facility is congested, while a high average speed implies otherwise. However, there was a concern that the drivers may misinterpret the average speed as the speed limit.

To test this scenario, the sign in Figure 4-4(a), which displays the average speed on express lanes using a speed number that is a multiple of five, was presented to the participants who were first asked what “MPH” represents. All participants correctly stated that it refers to miles per hour. Participants were then asked what “55 MPH” indicates, and were presented with three options to choose from: (1) the speed limit on the express lanes, (2) the driving speed of the driver, and (3) the average speed on the express lanes. About two-thirds (61.2%, 30) of the participants thought that 55 MPH is the *speed limit* on the express lanes, 34.7% (17) thought that the speed on the sign is the *average speed* on the express lanes, and the remaining 4.1% (2) thought that the speed is the *actual driving speed of the driver*.

Without revealing the correct answer to “55 MPH” in Figure 4-4(a), a second sign as shown in Figure 4-4(b) was presented to the participants, with only the speed changed from 55 MPH to 47 MPH. Participants were asked what “47 MPH” indicates, and were again given the same three options to choose from. The percentage of participants giving the correct answer that the speed shown is the *average speed* increased from 34.7% (17) to 55.1% (27), while the remaining 44.9% (22) of the participants still answered incorrectly (see Figure 4-5). Based on this result, if an agency should decide to use average speed in lieu of travel time, it is recommended to use average speeds that are not multiples of five. This can easily be done by adding or subtracting 1 mph arbitrarily when the average speed estimate turns out to be a multiple of five. While the percentages of participants who misinterpreted the speed values are considered high in both cases, it can be expected that over time and with driver education, the level of misinterpretation will reduce significantly.



(a) Express Lanes Sign with Average Speed in Multiples of Five



(b) Express Lanes Sign with Average Speed not in Multiples of Five

Figure 4-4: Average Speed Information on Express Lanes Signs

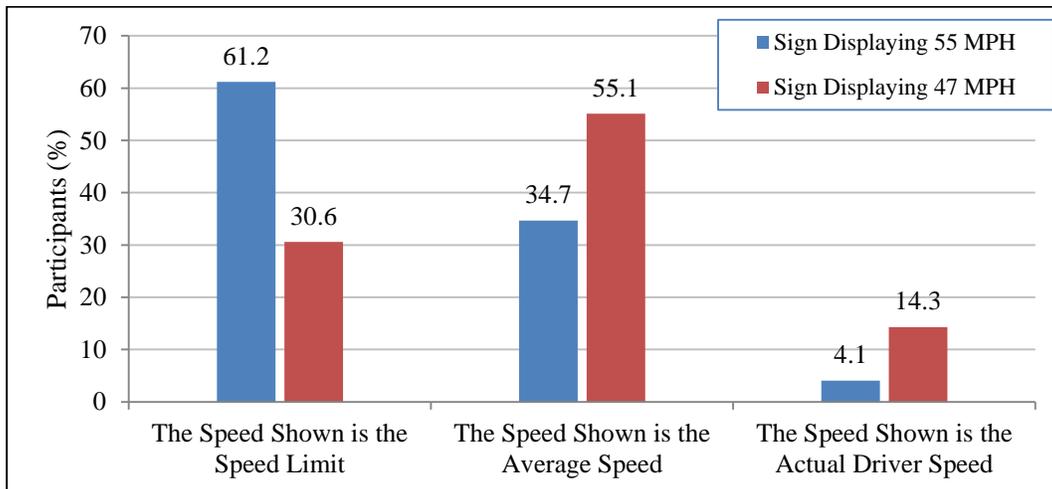


Figure 4-5: Participants' Interpretations of Average Speed Information on Signs

Next, participants were shown Figures 4-6(a), 4-6(b), and 4-6(c), which gave three sign alternatives for conveying average speed information. Alternative A displays toll amount and average speed information in the same row without explicitly stating the meaning of the speed,

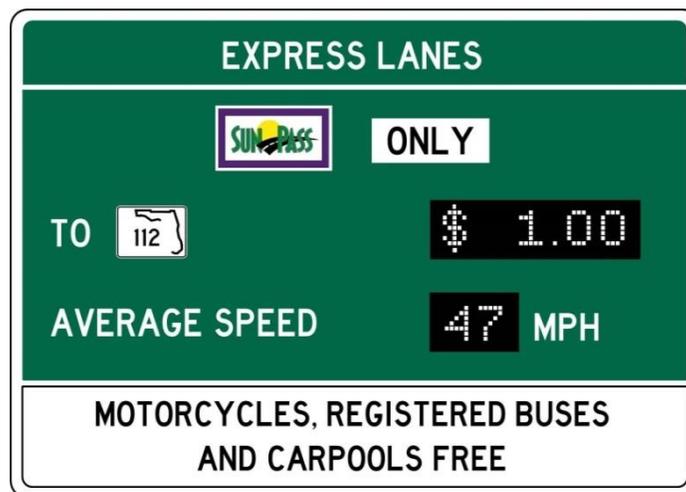
while Alternative B and Alternative C explicitly state “AVERAGE SPEED” on the sign. The toll amount and average travel speed are displayed in one row in Alternative B, while they are displayed in two rows in Alternative C.



(a) Alternative A



(b) Alternative B



(c) Alternative C

Figure 4-6: Sign Alternatives Displaying Average Speed Information

Participants were asked to state their preference and the reason(s) for their preference. Over half (57.1%, 28) of the participants preferred Alternative C, approximately one-third (32.7%, 16) of the participants preferred Alternative B, and only 8.2% (4) of the participants chose Alternative A. Table 4-4 provides the opinions of the participants about each alternative.

Table 4-4: Opinions of Participants on Sign Alternatives Displaying Average Speed

Alternative A		Freq.	Alternative B	Freq.	Alternative C	Freq.
Positive	It is easy to understand the sign.	2	This is a better layout.	9	It is easy to understand the sign.	22
			It is easy to understand the sign.	8	This is a better layout.	8
	Effective information display.	2	The sign states "AVERAGE SPEED."	3	The sign states "AVERAGE SPEED."	7
	The sign has fewer words to read.	1	The sign can be read faster.	1	The sign is bigger.	7
The sign can be read faster.					1	
Negative	The sign does not state "AVERAGE SPEED."	3	The sign looks congested.	5	The sign is too big.	3
	The sign looks congested.	1	It is difficult to understand the sign quickly.	1	The sign has too many words.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternatives A, B, and C were preferred by 4, 16, and 28 participants, respectively.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-4:

- Alternative A does not clearly state that the speed displayed is the average speed on the express lanes; it could be the speed limit. Alternative C is big, causing all other information to be smaller. Alternative B is straight to the point.
- Drivers are used to seeing "SUNPASS ONLY" as the only words at the top of a sign, so "AVERAGE SPEED" in Alternative B is easy to miss.
- Alternative C is less congested than Alternative B. Alternative A does not explicitly state that 47 MPH is the average speed; some might think it is the speed limit.
- Alternative A is the simplest, and easiest to read. No need to state "AVERAGE SPEED." To minimize drivers misinterpreting the speed to be the speed limit, avoid "55," "45," and other multiples of five.
- Alternative B looks nicer and more organized, and is easier to read while driving. Alternative C has a lot of empty space, and the words get lost; Alternative B stands out more.

4.4 Preferences for Travel Time vs. Average Speed

Since drivers pay a toll to use express lanes, real-time information on the level of congestion on express lanes helps drivers decide whether to use express lanes. Travel time and average speed are the two most common measures of congestion. In this test scenario, participants were presented with signs displaying travel time and average speed information, and were asked the following

question: *Which alternative makes it easier for you to decide whether or not to use the express lanes, and why?*

Figure 4-7 provides the two alternatives shown to the participants. Based on the information provided in these signs, it takes 24 minutes to reach SR 112 (see Alternative A), and the average speed on the facility is 20 MPH (see Alternative B). The toll amount is identical in the two alternatives. A majority (59.2%, 29) of the participants thought that Alternative B with average speed made it easier for them to decide whether to use the express lanes than Alternative A with travel time. Table 4-5 summarizes the opinions of the participants explaining their preferences. The most common responses indicate that average speed can best estimate the congestion level as it tells drivers how fast the traffic is moving.



(a) Alternative A: Travel Time Information



(b) Alternative B: Average Speed Information

Figure 4-7: Sign Alternatives Displaying Travel Time and Average Speed

Participants who preferred travel time information argued that this information will explicitly tell them how much time it takes to reach the destination, which is not directly available from average speed information unless the distance to the destination is also provided. However, travel time information might not be useful for tourists and unfamiliar drivers as they might not know the actual travel time to the destination (i.e., when the facility is not congested), and hence, cannot

predict congestion. Compared to travel time, average speed is preferred since it is independent of distance.

Table 4-5: Opinions of Participants about Sign Alternatives Displaying Travel Time and Average Speed

A: Sign Displaying Travel Time		Freq.	B: Sign Displaying Average Speed	Freq.
Positive	Time is more important to make decisions.	9	User can estimate the congestion based on how fast the traffic flows.	12
	The sign is easy to understand.	7	The sign is easy to understand.	6
	It is easier to know my total travel time.	5	The sign states the actual speed on the express lane facility.	5
			Easy to compare between average speed and the speed limit.	3
		User can estimate the travel time using the average speed.	1	
Negative	It is difficult to say how congested the facility is just based on travel time.	1	The average speed is useless information.	3
			It is difficult to estimate time using average speed.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 20 participants, and Alternative B was preferred by 29 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-5:

- The average speed helps me more when the facility is congested. Because 20 MPH is super slow, implying that the traffic is bad.
- It is easy to get the information based on the average speed. However, the toll amount did not tell the information about the level of congestion.
- I prefer Alternative B because we use speed to decide whether or not it is worth to pay high toll to go at a low speed.

4.5 Display of Comparative Travel Times on Express Lanes vs. General-purpose Lanes

The existing signs on express lanes provide the toll amount for using the express lanes. However, in addition to the toll amount, drivers may need information such as travel times along express lanes and adjacent general-purpose lanes to better assess the need/benefit of paying extra to use express lanes. Figure 4-8(a) and 4-8(b) show the two alternatives that display travel times along express lanes and general-purpose lanes. As can be observed from the figure, Alternative A shows the travel time on Express and Local (i.e., general-purpose) Lanes next to each other and separated by a vertical line, while Alternative B displays the same travel time information in two separate rows. Alternative A was preferred by a majority (87.8%, 43) of the participants, while the remaining participants (12.2%, 6) chose Alternative B. Table 4-6 provides the opinions of the participants about each alternative.

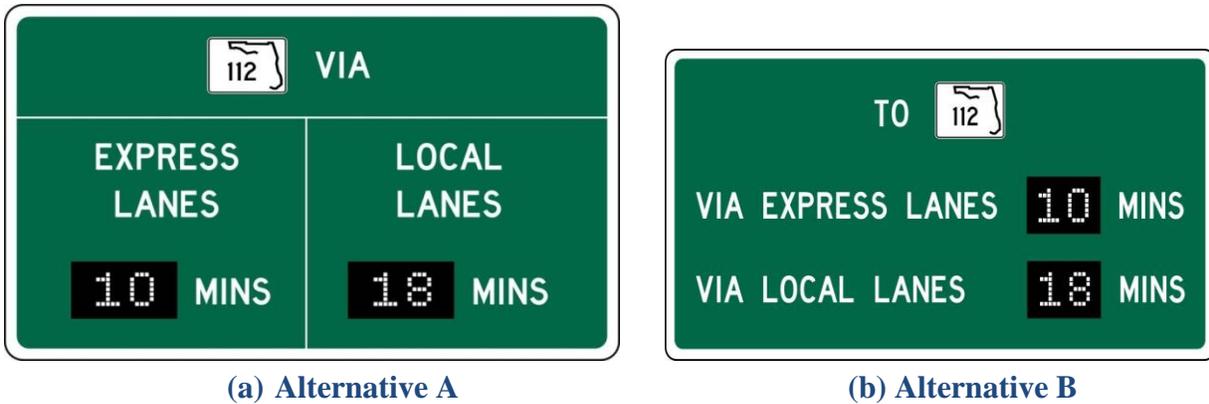


Figure 4-8: Comparative Travel Times on Express Lanes Sign

Table 4-6: Opinions of Participants about Sign Alternatives Displaying Comparative Travel Times on Express Lanes and General-purpose Lanes

Alternative A		Freq.	Alternative B	Freq.
Positive	The time next to each other matches with the location of the lanes.	28	The sign has a better layout.	2
	The sign is easy to understand.	19	The sign is easy to understand.	2
	The sign is bigger.	3	Preposition “TO” is easy to understand.	2
Negative	It is difficult to understand the sign.	1	There is too much information to read.	1
			The sign needs more interpretation.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 43 participants, and Alternative B was preferred by 6 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-6:

- Alternative B is a little bit clearer than Alternative A. I think “TO SR 112” in Alternative B is what makes the difference.
- In Alternative A, change “SR 112 VIA” to “TO SR 112.” Alternative A is easier to read.
- Alternative A is clear and drivers can figure out quickly, and can choose based on the travel times displayed. It is a good design.
- Alternative A is easier to read using graphic organizer. I would like to know the toll amount as well before I decide.
- Alternative A is easy to read and understand. I would use “toll lanes” and “regular” or “free lanes” to make it easier for the drivers to understand that express lanes require paying toll. In Alternative A, I do not like the word “VIA” as well. I prefer “TO SR 112.”
- Alternative A where the travel times on Express Lanes and Local Lanes are displayed side-by-side is a better design to help me understand and make a decision.
- Alternative B is more traditional. People already got used to it.
- I prefer Alternative A because it just looks better and then it has the split lines, so in my mind it is telling me to make a decision. In addition, I will add “TO” in front of SR 112.

- Alternative A is clear and easy to read.
- Alternative A is easier to focus on than Alternative B. Including “TO” would improve Alternative A.

4.6 Preference for Comparative Travel Times vs. Comparative Average Speeds

Drivers often decide whether or not to pay a toll to use express lanes by assessing traffic conditions on both express lanes and local lanes (i.e., general-purpose lanes that drivers can use without paying a toll). Since both travel times and average speeds were being considered in this study as measures of traffic conditions on a facility, two alternatives providing travel times and average speeds on both express lanes and local lanes were presented.

As shown in Figure 4-9, Alternative A provides comparative travel times to SR 112 using express lanes and local lanes. Similarly, Alternative B provides average travel speeds on both express lanes and local lanes. Participants were asked to choose the alternative that helped them decide whether or not to use express lanes. Alternative A was chosen by 75.5% (37) of the participants, and the remaining 24.5% (12) preferred Alternative B. Table 4-7 provides the opinions of the participants about each alternative. Several participants stated that the comparative travel time information helps them decide whether or not to use the express lanes, and also helps them calculate the time to destination. On the other hand, participants that chose the sign with comparative average travel speeds stated that average speed on a facility helps them estimate traffic congestion.

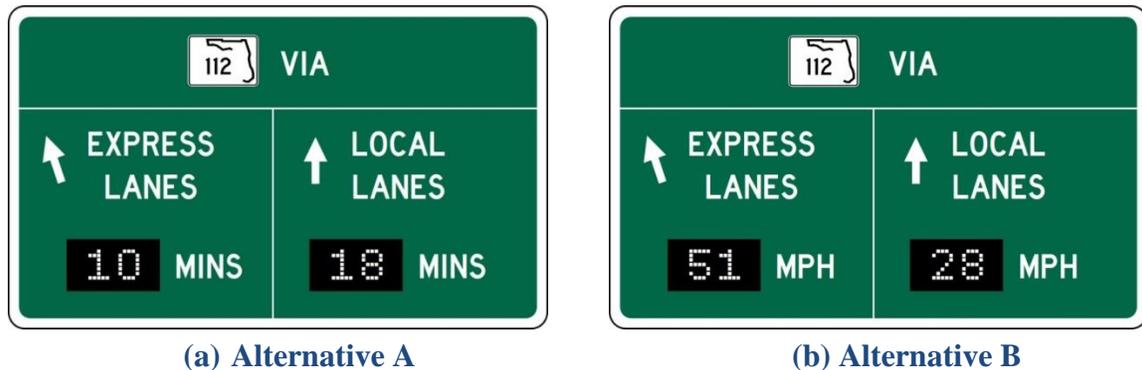


Figure 4-9: Sign Alternatives Displaying Travel Times and Average Travel Speeds on Express Lanes and General-purpose Lanes

Table 4-7: Opinions of Participants about Sign Alternatives Displaying Comparative Travel Times and Average Speeds

A: Use of Travel Time to Compare		Freq.	B: Use of Average Speed to Compare	Freq.
Positive	Information on travel time is better to make a decision.	15	The average speed is better to estimate traffic congestion.	4
	The sign helps to calculate the time to destination.	11	The sign is easy to understand.	3
	The sign is easy to understand.	5	The sign shows average speed on the express lanes.	1
	It is easier to calculate the time saved.	4		
	Travel time is more important.	3	Drivers can use average speed to calculate travel time.	1
Travel time is already calculated from average speed.	1			
Negative	Travel time information is useless for first time users.	1	Drivers have to calculate travel time from average speed.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 37 participants, and Alternative B was preferred by 12 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-7:

- I prefer to have travel time information. I will be able to know how much time I am saving as well as the congestion level. This is great for tourists.
- If I am traveling on this road for the first time (i.e., for tourists), I cannot compare the travel times to reach SR 112.

4.7 Comparative Travel Times and Toll Amount

As discussed previously, the existing signs on express lanes provide the toll amount for traveling through the express lanes. However, in addition to the toll amount, drivers may benefit from information such as travel times along express lanes and adjacent general-purpose lanes to better assess the need to/benefit of paying extra to use express lanes. The research team, therefore, proposed a new sign to provide comparative travel times along express lanes and general-purpose lanes, in addition to the toll amount on express lanes. Figure 4-10 shows the design of the proposed sign.

A majority of the participants rated the information displayed on this sign as either *Very Useful* (77.6%, 38), or *Useful* (12.2%, 6). Only about one-tenth of the participants (10.2%, 5) considered this comparative travel time information to be *Somewhat Useful*. None of the participants considered the sign to be *Not Useful*.

Participants were next asked to comment on the amount of information displayed on this sign. Over half (55.1%, 27) of the participants noted that the sign has too much information, while the remaining 44.9% (22) thought that the sign does not have too much information.



Figure 4-10: Comparative Travel Times with Toll Amount

4.7.1 Comparative Travel Times and Toll Amount Displayed on One or Two Signs

Since about half of the participants considered displaying the travel times on express lanes and general-purpose lanes, along with the current toll amount all on one sign to be too much information, the researchers contemplated splitting that information into two signs (i.e., toll amount and comparative travel times on two separate signs). Figure 4-11 provides the two alternatives. Alternative A displays both the comparative travel times and the toll amount on one sign, while Alternative B presents the comparative travel times on one sign and the toll amount on a separate sign.

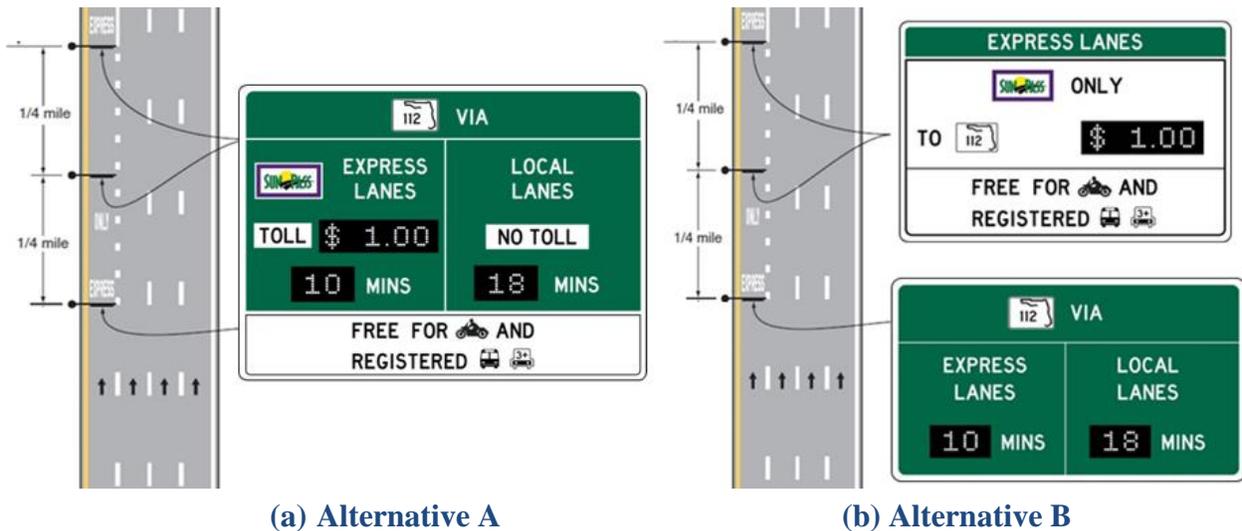


Figure 4-11: Comparative Travel Times and Toll Amount Displayed on One or Two Signs

Alternative B where the toll amount and travel time on express lanes and general-purpose lanes are displayed on two signs was preferred by 51% (25) of the participants, while the remaining 49%

(24) of the participants preferred Alternative A, where the same information is displayed on a single sign. Table 4-8 provides the opinions of the participants about the two alternatives.

Table 4-8: Opinions of Participants about Sign Alternatives Displaying Comparative Travel Times and Toll Amount on One or Two Signs

A: Information Displayed on One Sign		Freq.	B: Information Displayed on Two Signs	Freq.
Positive	The sign has all the information the drivers need to decide whether to use express lanes.	16	The information is split in two signs to understand it easily.	13
	The sign is easy to understand.	6	The sign is easy to understand.	5
	Drivers have more time to either use express lanes or stay on general-purpose lanes.	5	Drivers can decide faster whether to use express lanes.	2
	The same information is repeated several times.	4	The sign can be read faster.	2
Negative	One sign looks more congested.	1	Two signs result in more distraction to the drivers.	3
	Drivers need more time to understand the complete sign.	2		

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 24 participants, and Alternative B was preferred by 25 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-8:

- I want to decide based on both time and money. Also, two signs will require more time to decide. If only one sign is used, the only risk is missing it. If two signs are used, a driver may see comparative travel times first and switch lanes to take express lanes, then see the toll amount, and switch back to general-purpose lanes. Alternative B is therefore not great.
- Alternative A is better because fewer signs are better. I would rather read the same sign three times than have different signs. It is confusing to have multiple signs.
- Alternative A has too much information, and there is not enough time to read, process, and understand all the information being conveyed. It may also be dangerous to read and comprehend all the information in Alternative A while driving at 60 MPH.
- Alternative A has a lot of information and conveying the same information on two signs is better. However, it is better to know the comparative travel times and toll amount upstream of express lanes.
- Alternative A has too much information. However, I prefer to know the toll amount before I take the express lanes.
- My preference is time and not toll amount. So, I decide based on time. I already know express lanes are not free.

4.7.2 Order of Comparative Travel Times and Toll Amount Information Displayed on Two Signs

Irrespective of the participants' preference to view the comparative travel times and toll amount information on one or two signs, the participants' preferred order of display when two signs are to be deployed was collected. The sign's display order addresses whether the participants would like

to see the sign with comparative travel time information first or the sign displaying toll amount first. Participants were also requested to provide the rationale behind their preference.

Figure 4-12 illustrates the two alternatives presented to the participants. Alternative A displays the toll amount in the first sign, followed by the sign that shows the comparative travel times on the express lanes and general-purpose lanes. Alternative B presents the comparative travel times on the first sign, followed by the toll amount to use the express lanes on the second sign.

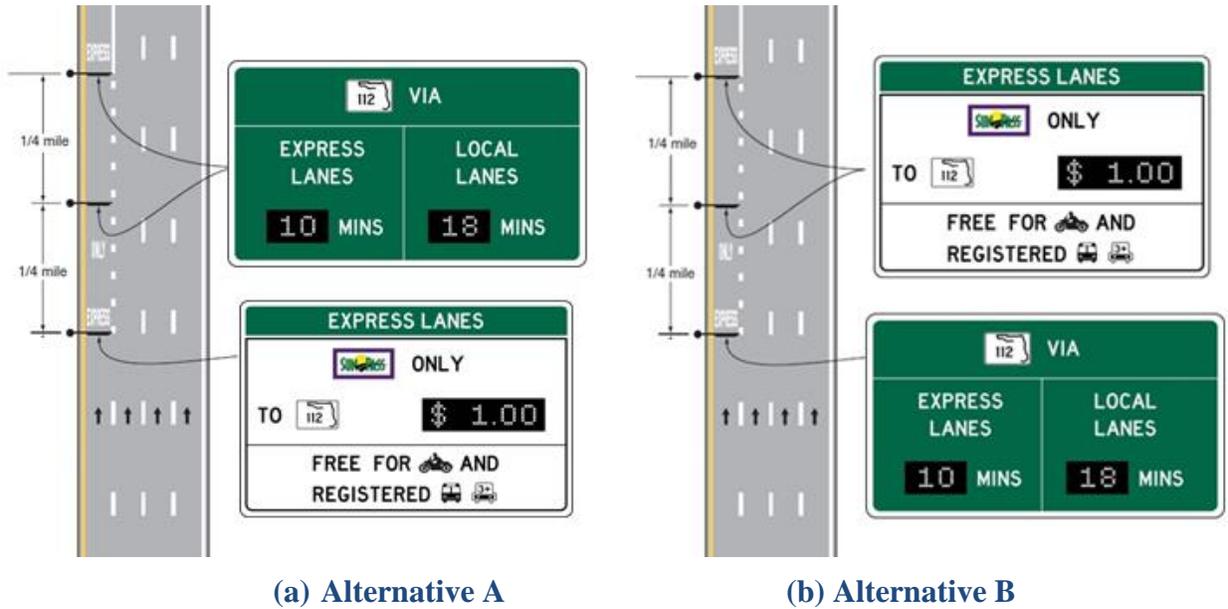


Figure 4-12: Sign Alternatives Displaying Different Order of the Information

When the comparative travel times and toll amount were displayed on two signs, 53.1% (26) of the participants preferred Alternative A where the toll amount was displayed first, and the remaining 46.9% (23) chose Alternative B where comparative travel times were displayed first. Table 4-9 provides the opinions of the participants about the two alternatives. Note that all the comments provided by the participants are positive.

Table 4-9: Opinions of Participants about Order of Information Displayed on Two Signs

A: Toll Amount Followed by Comparative Travel Times		Freq.	B: Comparative Travel Times Followed by Toll Amount	Freq.
Positive	The sign helps drivers to decide based on the toll amount before seeing the travel time.	18	The most important criteria to decide between express lanes and general-purpose lanes is travel time, and it is displayed first.	13
	Since the toll amount is displayed first, drivers have more time to decide before entering the express lanes.	2	Drivers get the information on comparative travel times on express lanes and general-purpose lanes sooner.	9
	Drivers have more time to switch to general-purpose lanes when toll amount is high.	1	This order gives travel time first and makes it easier for drivers to decide if paying toll amount is worth it.	8
	This alternative shows early that express lanes require tolls.	1		

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 26 participants, and Alternative B was preferred by 23 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-9:

- It is difficult to decide one alternative over the other. Time is more important for some people, while money is more important for some people. The preference depends on the person.
- If I decide to save time, I would prefer the see the sign displaying the toll amount first. Nonetheless, it is better to display all information together in one sign.

4.7.3 Sign Legend Preference for General-purpose Lanes

As discussed in prior sections, the general-purpose lanes that are adjacent to the express lanes are free for all vehicles. Although this term is common within the transportation community, it is not familiar among the general public. Besides, this phrase is wordy to display on a sign. As such, the research team proposed two alternative signs. As shown in Figure 4-13, Alternative A uses the phrase “LOCAL LANES,” which is currently used on the 95 Express, while Alternative B uses the phrase “NO-TOLL LANES.” Participants were shown these two alternatives, and were asked to state their preference, and the reason(s) for their preference. Table 4-10 provides the opinions of the participants about the two alternatives.



(a) Alternative A: “LOCAL LANES”



(b) Alternative B: “NO-TOLL LANES”

Figure 4-13: LOCAL LANES and NO-TOLL LANES Alternatives

Table 4-10: Opinions of Participants about Sign Alternatives Displaying LOCAL LANES and NO-TOLL LANES

Alternative A: LOCAL LANES		Freq.	Alternative B: NO-TOLL LANES	Freq.
Positive	The phrase “NO TOLL” stands out.	12	The sign is easy to understand.	8
	It is easier to compare line by line.	6	The information is displayed efficiently.	8
	The sign is easy to understand.	5	The sign has less information to read.	5
	The information is displayed better.	1	The phrase “NO-TOLL LANES” is easier to understand.	4
This sign is more attractive.			2	
Negative	The name “LOCAL LANES” is confusing.	7	“NO-TOLL LANES” is easy to miss.	1
			This sign is more confusing.	1

Notes:

- Some participants provided more than one argument for/against their preference.
- Alternative A was preferred by 26 participants, and Alternative B was preferred by 23 participants.

The following are the additional comments and suggestions from the participants that are not summarized in Table 4-10:

- In general, both signs look similar; it is probably better to use “REGULAR LANES” in Alternative A.
- In Alternative A, the phrase “NO TOLL” is emphasized in white color and is easy to see. That is all the information that matters; how it is named does not matter.
- I think “LOCAL LANES” do not mean anything to the general users (i.e., drivers). “NO-TOLL” is easy to understand for a majority of the drivers.
- Despite the fact that I find the term LOCAL LANES a bit unclear; visually, the line-per-line comparison displayed in Alternative A is clearer and easier to comprehend.
- The phrase “LOCAL LANES” is ambiguous; it needs to be defined.
- It just looks better with the phrase “NO TOLL” in Alternative A; however, “NO-TOLL LANES” sounds better.
- Alternative A conveys the information clearly. Why does Department of Transportation have to explain?

4.8 Interpretation of High Toll Amount on Express Lanes Sign

As discussed previously, express lanes are exclusively separated from their adjacent general-purpose lanes, and using them requires paying a toll for non-qualified vehicles such as single-occupant vehicles. The toll charged is adjusted dynamically in real-time based on congestion on the express lanes. When an express lane is congested, drivers are charged a high toll amount to discourage more drivers from entering the facility. However, some drivers might misinterpret that the high toll amount implies that the adjacent general-purpose lanes are congested, and hence, there is a high demand for the express lanes. To test the participants’ understanding of high toll amounts, the participants were presented the sign in Figure 4-14 and were given the following two statements:

1. A high toll amount (e.g., \$10.00) on the express lanes tells the drivers that the local lanes are very congested, so there is a high demand for the express lanes.
2. A high toll amount (e.g., \$10.00) on the express lanes tells the drivers that the express lanes are very congested, so the toll amount is raised to discourage more drivers from using the express lanes.

The participants were then asked to determine whether the statements are true or false. Figure 4-15 summarizes the results. Note that the first statement is false while the second statement is true. Only 22.45% (11) of the participants correctly interpreted that a high toll amount implies that the express lanes are very congested, and so the toll amount is raised to discourage more drivers from using the express lanes.



Figure 4-14: High Toll Amount on the Express Lanes Sign

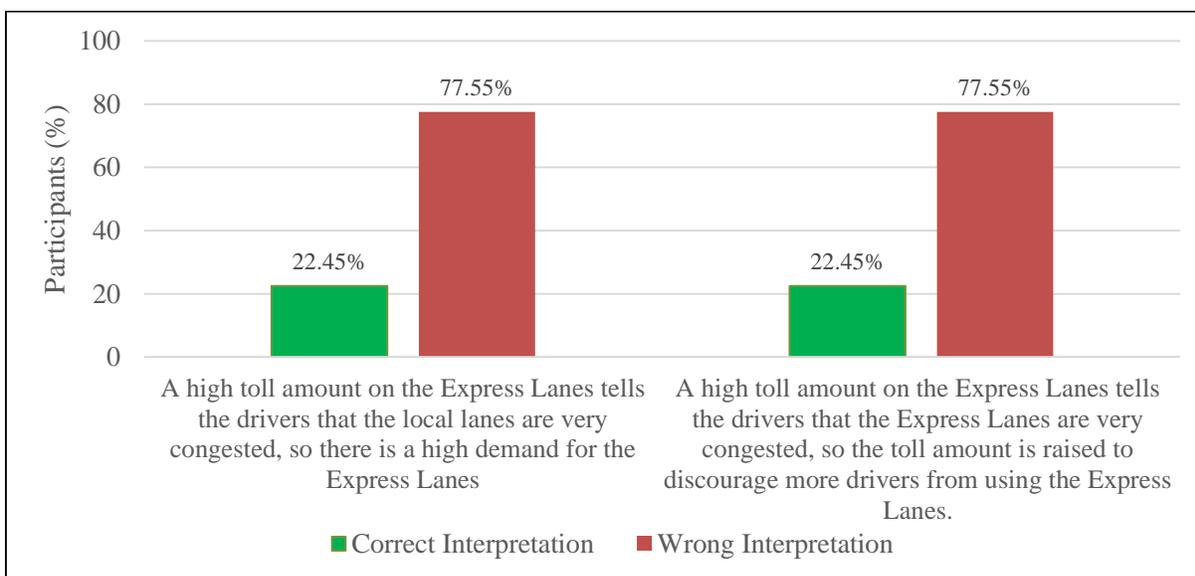


Figure 4-15: Participants' Interpretation of a High Toll Amount on Express Lanes Sign

Next, the research team presented to the participants the sign in Figure 4-16, displaying comparative travel times on the express lanes and general-purpose lanes in addition to the toll amount on the express lanes. The sign states that the toll amount to reach SR 112 on the express lanes is \$10.00. It takes 21 minutes to reach SR 112 on the express lanes, while it takes 22 minutes on the general-purpose lanes. From the comparative travel times, it is evident that the express lanes are congested. As the participants were shown this sign, they were given the following two statements:

1. The local lanes are very congested, so there is a high demand for the express lanes.
2. The express lanes are very congested, so the toll amount is raised to discourage more drivers from using the express lanes.



Figure 4-16: High Toll Amount with Additional Comparative Travel Times

A majority of the participants (73.5%, 36) correctly interpreted the information, saying that the express lanes are very congested, so the toll amount is raised to discourage more drivers from using the express lanes. On the other hand, 26.5% (13) of the participants misinterpreted the information and thought that the local lanes (i.e., general-purpose lanes) are very congested, so there is a high demand for the express lanes.

4.9 Summary

This chapter focused on assessing drivers' understandings, preferences, and opinions toward the guide signs upstream of express lanes. The following eight potential sign design alternatives were evaluated using a focus group study:

1. Sign legend preference for toll-exempt vehicles in Florida
2. Display of travel time
3. Display of average speed in lieu of travel time
4. Preference for travel time vs. average speed
5. Display of comparative travel times on express lanes vs. general-purpose lanes
6. Preference for comparative travel times vs. comparative average speeds
7. Display of comparative travel times and toll amounts on express lanes and general-purpose lanes
8. Interpretation of high toll amount on express lanes sign

CHAPTER 5

SUMMARY AND CONCLUSIONS

Express lanes are usually tolled freeway lanes that are separated from general-purpose lanes to provide a higher level of mobility for vehicles using the facilities. Guide signs in advance of express lanes are especially crucial as drivers have to read these signs and then comprehend and react to them accordingly while traveling at high speeds. These signs may convey information on entry/exit points, toll amounts, vehicle and occupancy requirements, accessibility status (e.g., OPEN or CLOSED), and operating agencies. In addition to this information, some agencies also display travel times to the exit points to help drivers decide whether or not to use express lanes. Some agencies have further considered displaying comparative travel times on express and general-purpose (i.e., free) lanes. All of this information is in addition to standard directional and informational signage and can quickly become overwhelming, especially for drivers who are unfamiliar with a facility.

This report presented a study and its results on drivers' feedback on different sign design alternatives for potential use on express lane facilities. It documented a review of the current standards in the MUTCD for express lanes signs and the use of signs on existing express lane facilities from across the country. It further documented the results from a focus group study on drivers' understanding of, and preferences for, different sign design alternatives on express lane facilities, with a special focus on signs near the entrance of express lane facilities, where signs are the most critical, especially in helping drivers make their decisions on whether to use the express lanes.

5.1 Existing Standards and Practice

The provisions of regulatory signs, guide signs, and tolling agency's pictograph on express lanes are provided in Chapter 2E: Toll Road Signs, and Chapter 2G: Preferential and Managed Lane Signs of the MUTCD. As of 2016, 17 express lane facilities are present in 10 states, including California, Colorado, Florida, Georgia, Maryland, Minnesota, Texas, Utah, Virginia, and Washington. Based on the review of these 17 express lane facilities, researchers made the following observations:

- Many existing express lane signs have not been updated to meet the current MUTCD standards for express lane signs.
- The existing express lane signs vary across the different facilities not only in the types of information they display, but also in color, size, layout, and number of sign panels used.
- The express lane signs generally display information on toll amounts and accessibility status such as "OPEN" or "CLOSED."
- The I-15 Express Lanes facility in San Diego, California, is the only facility where the express lanes signs display travel time on express lanes in addition to toll amount.
- None of the signs were found to display comparative travel times on express lanes vs. general-purpose lanes.

5.2 Focus Group Study

The research team conducted a focus group study to assess drivers' understandings, preferences, and opinions toward the guide signs upstream of express lanes. A total of five focus groups involving 49 participants of different age, gender, and ethnic groups were conducted. The following eight potential sign design alternatives were evaluated:

1. Sign legend preference for toll-exempt vehicles in Florida
2. Display of travel time
3. Display of average speed in lieu of travel time
4. Preference for travel time vs. average speed
5. Display of comparative travel times on express lanes vs. general-purpose lanes
6. Preference for comparative travel times vs. comparative average speeds
7. Display of comparative travel times and toll amounts on express lanes and general-purpose lanes
8. Interpretation of high toll amount on express lanes sign

The focus group participants were shown the sign alternatives using PowerPoint slides. The slides primarily included the proposed signs and their alternatives, typical layouts, and digitally edited photographs. For each scenario, a set of questions was asked to capture the participants' understanding of the signs. Some of the key observations are discussed in the following subsections.

5.2.1 Sign Legend Preference

Express lanes are usually open to all drivers who choose to pay a toll to use the facility. However, a few vehicles qualify to ride for free on almost all express lane facilities. For example, motorcycles and registered buses and car pools can use express lanes for free on 95 Express in Miami-Dade County, Florida. Since toll-exempt vehicles vary by jurisdiction, displaying this information is helpful for drivers. Two sign alternatives, one displaying toll-exempt vehicles using words alone, and the other displaying the same information using words and symbols, were provided to the participants. A slight majority (51%) of the participants preferred to have the information on toll-exempt vehicles in both symbols and words. However, these results could be biased toward the alternative that uses only words to display toll-exempt vehicles since this sign is currently used on 95 Express in Miami-Dade County and participants are familiar with it.

5.2.2 Measures of Traffic Conditions on Express Lane Facility

Travel time and average speed are good measures of traffic conditions on a facility. However, since these are rarely displayed on the signs, several participants misinterpreted this information. If not explicitly stated, participants could misunderstand average speed to be the speed limit on the express lanes. It is therefore recommended to educate drivers about these measures so that confusion and misinterpretation are minimized. Furthermore, since the average speed information could be misinterpreted as speed limit, it is recommended that average speeds that are not multiples of five be used.

Since providing both travel time and average speed information on a sign results in information overload, it is recommended to provide either one of the two performance measures. Participants who preferred average speed argued that average speed has a fixed range that is independent of distance. It should be clear to all drivers that a low average speed on an express lane facility implies that the facility is congested, while a high average speed implies otherwise. On the other hand, participants who preferred travel time information argued that this information will explicitly tell them how much time it takes to reach the destination. However, travel time information might not be useful for tourists and unfamiliar drivers as they might not know the actual travel time/distance to the destination, and hence, cannot predict congestion.

5.2.3 Measures of Traffic Conditions on Express Lanes and General-purpose Lanes

The existing signs on express lanes provide the toll amount for using express lanes. However, in addition to the toll amount, drivers may need information such as travel times along express lanes and adjacent general-purpose lanes to better assess the benefit of paying extra to use the express lanes. When the traffic conditions (i.e., travel time or average speed) on both express lanes and general-purpose lanes are provided on a single sign, a majority of the participants stated that comparative travel time information (and not comparative average speed information) helped them decide whether or not to use the express lanes.

Almost all the participants considered the sign displaying comparative travel times on express lanes and general-purpose lanes and the toll amount on the express lanes to be useful. However, over half of the participants noted that the sign has too much information and preferred to display this information (i.e., comparative travel times and toll amount) on two separate signs. Nonetheless, a few participants preferred to see the same sign with all the information multiple times, instead of two separate signs.

5.2.4 Interpretation of High Toll Amount on Express Lanes

Express lanes provide a higher level of mobility and reliability by maintaining a certain level of traffic flow. Traffic volumes on express lanes are usually maintained by adjusting the toll amount. When the facility is congested, drivers are charged a high toll amount to discourage more drivers from entering the facility. Over 75% (38) of the focus group participants misinterpreted the high toll amount on the express lanes, and thought that it indicated the local (i.e., general-purpose) lanes are congested, and hence, there is a high demand for the express lanes.

Congestion on express lanes could be better assessed if information such as comparative travel times on the express lanes and the general-purpose lanes are provided in addition to the toll amount. However, 26.5% (13) of the participants misinterpreted the high toll amount on express lanes even when comparative travel times were provided. Drivers, therefore, need to be educated to minimize confusion and misinterpretation.

5.3 Conclusions

In summary, this study focused on determining the optimal amount and type of information to display on guide signs upstream of express lanes. Based on the results from the focus group study,

it can be concluded that additional real-time information on traffic conditions on express lanes help drivers decide if they want to use express lanes. Participants were receptive to the two real-time performance measures, travel time and average speed. Although this additional information is useful to drivers, care needs to be taken to not overload drivers with too much information. It is imperative to consider the other existing signs and the fact that drivers need to comprehend this information while driving at high speeds. As such, future research is needed to evaluate drivers' comprehension and understanding of the new signs while driving at freeway speeds. Furthermore, extensive education efforts need to be undertaken so that drivers correctly interpret information on these new signs; otherwise, these signs fail to serve their intended purpose.

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**APPENDIX A:
PARTICIPANT INFORMATION SHEET AND
STUDY QUESTIONNAIRE**

Participant #: _____

Participant Information

Research Staff: Eligibility Confirmed (valid U.S. driver’s license and 18+ years old)?

- Yes, person is eligible
- No, person is not eligible

-
- **City of Residence:** _____
 - **Gender:** Male Female
 - **Age:** _____ years
 - **Were you born in the U.S.?** Yes No
 - **What is your race and ethnicity?**
 - Mixed Race/Biracial/Multiracial (**If you checked this selection, please check all that apply, below**)
 - Hispanic or Latino
 - White (not of Hispanic origin)
 - Black or African American
 - Native American or American Indian
 - Asian or Pacific Islander
 - Other, _____
 - **What is your highest level of education?**
 - Less than high school
 - High school diploma/GED
 - Some college
 - College degree
 - Advanced college degree
 - **How many years have you been driving in the U.S.?** _____ years
 - **How many miles do you drive per year?** _____ miles (approximately)
 - **What type of vehicle do you usually drive?**
 - Passenger Cars
 - Pickup
 - Commercial Vehicle
 - Bus
 - Motorcycle
 - Others, please specify: _____

Q1. How often do you use the I-95 Interstate Highway in Miami-Dade County?

- Never
- Occasionally
- Regularly

Q2. How often do you use the I-95 Express Lanes?

- Never
- Occasionally
- Regularly

Q3. Please list any other Express Lanes you have used.

Q4. What does “SunPass ONLY” mean?

Q5. Who can use the Express Lanes for FREE?

Q6. What does “3+” on the car logo mean?

- Carpool with at least 3 persons
- Carpool with more than 3 persons

Q7. Which alternative do you prefer? Why?

- Alternative “A” with words only
- Alternative “B” with words and symbols

Reason: _____

Q8. What is "MINS"?

Q9. What does "10 MINS" tell you?

Q10. How useful is this additional information in helping you decide whether or not to use the Express Lanes?

Very useful

Useful

Somewhat useful

Not useful

Q11. Which alternative do you prefer? Why?

Alternative "A"

Alternative "B"

Reason: _____

Q12. What is the travel time to I-595?

24 minutes

$9+24 = 33$ minutes

Q13. What is the toll amount to I-595?

\$2.50

$\$1.00 + \$2.50 = \$3.50$

Q14. Do you feel that this sign has too much information?

Yes

No

Q15. What is "MPH"?

- Q16. What does “55 MPH” indicate?
- The speed limit on the Express Lanes is 55 MPH
 - My driving speed is 55 MPH
 - The average speed on the Express Lanes is 55 MPH

- Q17. What does “47 MPH” indicate?
- The speed limit on the Express Lanes is 47 MPH
 - My driving speed is 47 MPH
 - The average speed on the Express Lanes is 47 MPH

- Q18. Which alternative do you prefer? Why?
- Alternative “A”
 - Alternative “B”
 - Alternative “C”

Reason: _____

- Q19. Which alternative makes it easier for you to understand the level of congestion on the Express Lanes? Why?
- Alternative “A” with travel time
 - Alternative “B” with average speed

Reason: _____

- Q20. Which alternative makes it easier for you to understand the level of congestion on the Express Lanes? Why?
- Alternative “A” with travel time
 - Alternative “B” with average speed

Reason: _____

Q21. Which alternative do you prefer? Why?

- Alternative "A"
- Alternative "B"

Reason: _____

Q22. Which alternative makes it easier for you to decide whether or not to use the Express Lanes? Why?

- Alternative "A" with travel time
- Alternative "B" with average speed

Reason: _____

Q23. How useful are the comparative travel times in helping you decide whether or not to use the Express Lanes?

- Very useful
- Useful
- Somewhat useful
- Not useful

Q24. Do you feel that this sign has too much information?

- Yes
- No

Q25. Which alternative do you prefer? Why?

- Alternative "A" with all information displayed on one sign
- Alternative "B" with information displayed on two separate signs

Reason: _____

Q26. If two separate signs are used, in which order should they be displayed? Why?

- Alternative "A" with toll amount first
- Alternative "B" with travel time first

Reason: _____

Q27. Which alternative do you prefer? Why?

- Alternative "A" with "LOCAL LANES"
- Alternative "B" with "NO-TOLL LANES"

Reason: _____

Q28. A high toll amount (e.g., \$10.00) on the Express Lanes tells the drivers that the local lanes are very congested, so there is a high demand for the Express Lanes.

- True
- False

Q29. A high toll amount (e.g., \$10.00) on the Express Lanes tells the drivers that the Express Lanes are very congested, so the toll amount is raised to discourage more drivers from using the Express Lanes.

- True
- False

Q30. With the additional comparative travel times, what does the high toll amount tell the drivers?

- The local lanes are very congested, so there is a high demand for the Express Lanes.
- The Express Lanes are very congested, so the toll amount is raised to discourage more drivers from using the Express Lanes.

Thank you for your participation!
Please turn in your completed handouts.

**APPENDIX B:
POWERPOINT PRESENTATION SLIDES
FOR THE FOCUS GROUP STUDY**

Welcome!

Study on Traffic Sign Alternatives at Entrances to Express Lanes

Conducted by:

Priyanka Alluri, Ph.D., P.E.

Assistant Professor

Department of Civil and Environmental Engineering

Florida International University (FIU)

Sponsored by:

National Center for Transportation Systems Productivity
and Management (NCTSPM)



Instructions

- **LISTEN** to the moderator attentively.
- **ANSWER** all the questions.
- **MARK** only one choice for each question.
- **DO NOT** change your answers.
- **DO NOT** read/answer the questions ahead of the group.
- Where applicable, please provide as detailed responses as you can.

HOV Lanes vs. Express Lanes



HOV Lanes

- Only vehicles with a minimum number of occupants are allowed during certain hours.
- HOV Lanes are **FREE**.



Express Lanes

- All eligible vehicles with a transponder (e.g., SunPass) can use Express Lanes.
- Express Lanes are **TOLLED**.

3

Your Experience in Using the Express Lanes

Q1. How often do you use the I-95 Interstate Highway in Miami-Dade County?

- Never
 Occasionally
 Regularly

Q2. How often do you use the I-95 Express Lanes?

- Never
 Occasionally
 Regularly



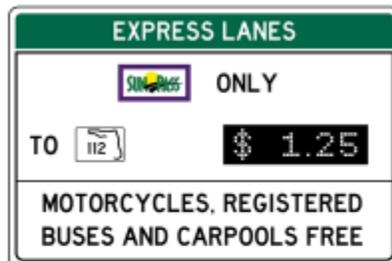
Q3. Please list any other Express Lanes you have used.

4



- Q4. What does "SunPass ONLY" mean?
- Q5. Who can use the Express Lanes for FREE?
- Q6. What does "3+" on the car logo mean?
- Carpool with at least 3 persons
 - Carpool with more than 3 persons

5



Alternative "A"



Alternative "B"

- Q7. Which alternative do you prefer? Why?
- Alternative "A" with words only
 - Alternative "B" with words and symbols

6



Q8. What is "MINS"?

Q9. What does "10 MINS" tell you?

Q10. How useful is this additional information in helping you decide whether or not to use the Express Lanes?

- Very useful
- Useful
- Somewhat useful
- Not useful

7



Alternative "A"



Alternative "B"

Q11. Which alternative do you prefer? Why?

- Alternative "A"
- Alternative "B"

8



Q12. What is the travel time to I-595?

- 24 minutes
- 9+24 = 33 minutes

Q13. What is the toll amount to I-595?

- \$2.50
- \$1.00 + \$2.50 = \$3.50

Q14. Do you feel that this sign has too much information? (Y/N)

9



Q15. What is "MPH"?

Q16. What does "55 MPH" indicate?

- The speed limit on the Express Lanes is 55 MPH
- My driving speed is 55 MPH
- The average speed on the Express Lanes is 55 MPH

10



Q17. What does “47 MPH” indicate?

- The speed limit on the Express Lanes is 47 MPH
- My driving speed is 47 MPH
- The average speed on the Express Lanes is 47 MPH

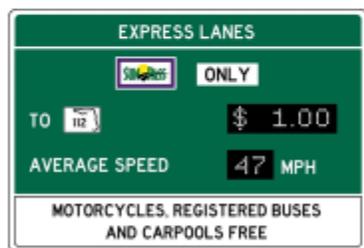
11



Alternative “A”



Alternative “B”



Alternative “C”

Q18. Which alternative do you prefer? Why?

- Alternative “A”
- Alternative “B”
- Alternative “C”

12



Alternative "A" with Travel Time



Alternative "B" with Average Speed

Q19. Which alternative makes it easier for you to understand the level of congestion on the Express Lanes? Why?

- Alternative "A" with travel time
- Alternative "B" with average speed



Alternative "A" with Travel Time



Alternative "B" with Average Speed

Q20. Which alternative makes it easier for you to understand the level of congestion on the Express Lanes? Why?

- Alternative "A" with travel time
- Alternative "B" with average speed

Comparative Travel Times



15



Alternative "A"



Alternative "B"

Q21. Which alternative do you prefer? Why?

- Alternative "A"
- Alternative "B"

16



Alternative "A"



Alternative "B"

Q22. Which alternative makes it easier for you to decide whether or not to use the Express Lanes? Why?

- Alternative "A" with travel time
- Alternative "B" with average speed

17



Q23. How useful are the comparative travel times in helping you decide whether to use the Express Lanes?

- Very useful Somewhat useful
- Useful Not useful

Q24. Do you feel that this sign has too much information? (Y/N)

18

Alternative "A"
One sign

Alternative "B"
Two separate signs

Q25. Which alternative do you prefer? Why?

Alternative "A" with all information displayed on one sign

Alternative "B" with information displayed on two separate signs

19

Alternative "A"
Toll Amount First

Alternative "B"
Travel Time First

Q26. If two separate signs are used, in which order should they be displayed? Why?

Alternative "A" with toll amount first

Alternative "B" with travel time first

20



Alternative "A" with "LOCAL LANES"



Alternative "B" with "NO-TOLL LANES"

Q27. Which alternative do you prefer? Why?

- Alternative "A" with "LOCAL LANES"
- Alternative "B" with "NO-TOLL LANES"

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Q28. A high toll amount (e.g., \$10.00) on the Express Lanes tells the drivers that the local lanes are very congested, so there is a high demand for the Express Lanes. (True/False)

22



Q29. A high toll amount (e.g., \$10.00) on the Express Lanes tells the drivers that the Express Lanes are very congested, so the toll amount is raised to discourage more drivers from using the Express Lanes. (True/False)

23



Q30. With the additional comparative travel times, what does the high toll amount tell the drivers?

- The local lanes are very congested, so there is a high demand for the Express Lanes.
- The Express Lanes are very congested, so the toll amount is raised to discourage more drivers from using the Express Lanes.

24

**Thank you for your
participation!**

Please turn in your
completed handouts.

25