Travel Time Displays at Freeway Entrance Approaches

PUBLICATION NO. FHWA-HRT-16-059
NOVEMBER 2017

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
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FOREWORD

Travel time information presented at key decision points such as freeway entrance approaches can be a powerful tool for operators and managers to better inform travelers. In turn, travelers can make make better decisions and take proper actions based on this information. In addition to location of information, optimal presentation increases the likelihood that a traveler will utilize it properly.

The purpose of the project "Travel Time Displays at Freeway Entrance Approaches" was to explore the optimal ways to provide travel time information at freeway entrance approaches to drivers and to evaluate the influence of travel time information on their route choices and diversion behaviors. The studies presented in this report provide both laboratory and field insights into message format and location, as well as resulting behaviors by commuters. The intended target audiences for this report are transportation professionals involved in the management, planning, engineering, research design, and operations of traffic on freeway and arterial facilities. This includes managers, supervisors, planners, researchers, engineers, designers, and traffic operations staff.

It is hoped that the guidance distilled from these studies will help operators and managers provide better travel time information to the traveling public. Implementing the findings of this report will help transportation operations professionals provide more complete travel time information on roadway networks and allow users to make better route choices, thereby decreasing travel times and congestion.

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA-HRT-16-059	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Travel Time Displays at Freeway Entrance Approaches		5. Report Date November 2017
		6. Performing Organization Code:
7. Author(s) Emanuel Robinson, Neil Lerner, Jeremiah Singer, Daniela Baragan, Kathryn Kulbicki, Janna Kline, and Daniel Kellman		8. Performing Organization Report No.
9. Performing Organization Name and Address Leidos, Inc. 11951 Freedom Drive Reston, VA 20190	Westat 1600 Research Boulevard Rockville, MD 20850	10. Work Unit No.
		11. Contract or Grant No. DTFH61-12-D-00045
12. Sponsoring Agency Name and Address Office of Safety Research and Development Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296		13. Type of Report and Period Covered Final Report; February 2014–June 2017
		14. Sponsoring Agency Code

15. Supplementary Notes
Government Task Manager: Brian Philips, 202-493-3468**,** Federal Highway Administration; Traffic Management Center Pooled Fund Study: Jimmy Chu, 202-366-3379, FHWA.

16. Abstract
The Federal Highway Administration as well as State and local agencies face the challenge of providing real-time travel time information to motorists in a manner that allows them to take full advantage of it. One factor contributing to the limited effects of current systems is that the travel time displays are not optimally located. The purpose of this project was to explore the best means of providing travel time information to drivers as they approach a freeway entrance and evaluate how this influenced route choice and diversion. The project consisted of two experimental tasks. The first task was a laboratory-based experiment in which participants were presented with scenarios and video of arterial travel time (ATT) displays and then were asked to provide ratings and to offer location recommendations. The second task was a field implementation over 11 weeks to investigate behavior, ratings, and use of both freeway and ATT information provided near a freeway entrance approach. Information was provided via a variable message sign and in-vehicle. A main outcome of both studies was a better understanding of optimal ways and preferred locations for presenting freeway and ATT information to commuters. Guidance and recommendations are provided.

17. Key Words Changeable message signs (CMS), arterial travel time (ATT), intelligent transportation systems (ITS), traveler information, decisionmaking, human factors, travel behavior		18. Distribution Statement No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161. http://www.ntis.gov	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 100	22. Price N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	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
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
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	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
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
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ATT	arterial travel time
CMS	changeable message sign
FHWA	Federal Highway Administration
FTT	freeway travel time
GPS	Global Positioning System
ITE	Institute of Transportation Engineers
ITS	intelligent transportation systems
MUTCD	*Manual on Uniform Traffic Control Devices*
TMC	Transportation Management Center
TRB	Transportation Research Board
US-1N	U.S. Route 1 North
VDOT	Virginia Department of Transportation

EXECUTIVE SUMMARY

Transportation agencies are investing resources in systems that provide real-time travel time information to motorists through the use of changeable message signs (CMSs). However, research suggests these sophisticated systems have relatively little impact on actual driver decisionmaking and route.[1–3] The Federal Highway Administration (FHWA), as well as State and local agencies, face the challenge of providing real-time travel time information to motorists in a manner that allows them to take full advantage of it. One factor contributing to the limited effects of current systems is that the travel time displays are not optimally located. This project explored the best means of providing travel time information to drivers as they approach a freeway entrance and evaluated how this influences route choice and diversion.

The purpose of this project was to investigate motorist response to real-time travel time displays at freeway approaches. The research aimed to determine the benefits and effectiveness of travel time signs on arterial approaches to freeways and develop recommendations for the design and use of such displays, including information content, format, sign location, and warrants. The focus was freeway travel time (FTT) information (the current state of practice), but some experimental attention was also directed to provision of arterial route travel time estimates.

OVERVIEW

The project consisted of two experimental tasks. The first task was a laboratory-based experiment in which participants were presented with scenarios and video of arterial travel time (ATT) displays and then were asked to provide ratings and to offer location recommendations. The second task was a field implementation over 11 weeks investigating behavior, ratings, and use of both freeway and ATT information provided near a freeway entrance approach. Information was provided via a CMS and in-vehicle. A main goal of both studies was to better understand optimal ways and preferred locations of presenting both freeway and ATT information to commuters.

LABORATORY TASK

The laboratory task was a within-subjects design with one group of commuters. Sign message content and scenario were manipulated throughout the task. In addition, participants provided ratings, qualitative responses, and sign location mapping preference.

The primary purpose of the laboratory study was to investigate the effectiveness of CMS travel time displays on arterial approaches to freeways. A secondary purpose was to examine the effectiveness of travel time information for arterial routes. Key measures included stated route preference and subjective ratings. Using a four-part method in a laboratory setting, the research team showed participants many different types of signs with different formats and features and determined their preferences, perception of ease of use, and perception of usefulness. In addition, the team gained an understanding of where, along their everyday commuting route, participants would find travel time signs most useful in making route decisions.

Signs with various features were presented to participants to examine preferences for presentation of travel time information. The best format appeared to be the "hybrid" signs; participants rated this sign format as high in ease and usefulness. In addition, participants seemed to have a strong mental model suggesting that ATT signs should include the time it would take them to get to the freeway. From the final part of the study in which participants selected the ideal location for travel time signs, it was evident that people had a preference for ATT signs rather than FTT signs, and they wanted those signs placed nearer downstream choice points.

FIELD EXPERIMENT

The primary purpose of the field study was to test a field implementation of travel time information presented on an arterial. The field evaluation was conducted with a before/after assessment on an experimental site (U.S. Route 1 North (US-1N) in Virginia). Participants were not provided with any travel time information during the pre-implementation stage (2 weeks) and provided with both arterial (via in-vehicle device) and freeway (via roadway sign) travel time following implementation for 9 weeks. The methodology was designed to be forward looking and allow testing of the display of travel time messages in locations that might not even have travel time signs. It also allowed for more accurate tracking of trip patterns to complement the usual approach of self-reported travel logs. In addition, using smartphone apps to provide this information was relevant because people rely more on smartphones.

Participants shifted route choices after being provided with freeway and ATT information. They used travel time information from the roadway sign and in-vehicle device but also continued using traditional media such as the radio. Participants reported that their routes were influenced by the roadway travel time sign but not much by the in-vehicle device and questioned the accuracy of the information or their ability to make the best decisions.

The results of this study were consistent with the laboratory experiment in the ways that participants desired receiving both freeway and arterial information when making route choices—with the usefulness of a sign decided by its placement at a key decision point. In addition, participants had difficulty understanding the sign format.

RECOMMENDATIONS

The following recommendations for the design and use of nonfreeway-based travel time displays are based on the current research and previous project findings detailed in the FHWA report *Driver Use of En Route Real-Time Travel Time Information*.(1) It should be noted that these general recommendations might not be consistent with some local signing practices and so might need to be adapted. Regardless, these recommendations should be taken into consideration when developing an ATT program when possible.

Also note that the size of ATT signs varies by location and jurisdiction. The *Manual on Uniform Traffic Control Devices* (MUTCD) provides guidance on CMS sign size (sections 2L.04, 2A.07, and 6F.52), providing a maximum length of 20 characters over three lines (for a total of 60 possible characters).(4) There is no specific guidance given for arterial signs. Most examples described in this section are based on the full-sized freeway-type sign (e.g., 20-character lengths) that is often used over freeways but occasionally used on arterials. If a smaller sign is required, the examples can be adjusted accordingly—removing the extra spaces or, if necessary, elements such as “MIN” after travel times.

Overall, a well-positioned sign should contain messages with the following elements to be the most effective:

- Position the sign at a key decision point (i.e., 0.5 mi from the freeway onramp) that allows the driver to switch lanes before approaching the onramp.
- Display destinations, not travel speeds or congestion descriptions, and indicate time units (MIN).
- Left-justify destinations and right-justify times.
- Use street names or towns for destinations (not exit numbers).
- Limit message text to three lines or five to six information units.
- Use simple linear diagrammatic signs if needed (no more than three destinations).
- Convey frequent updating using a fixed-sign component.
- Maximize route diversion by using the following elements:
    - Recommended alternate route (e.g., USE ALT RTE).
    - Specific route (e.g., VIA RTE 355).
    - Major delay or incident information (e.g., MAJOR DELAY).
    - Open-ended travel time estimate (e.g., 30+ MIN).
    - Travel times for both current and alternate route.

Example signs that use the optimal format and follow this guidance are shown in chapter 4, Summary and Recommendations.

Travel time information presented at key decision points, such as freeway entrance approaches, can be a powerful tool for operators and managers to better inform travelers. In turn, travelers can make better decisions and take proper actions based on this information. In addition to placing the sign in the best location, the information must be presented optimally for the traveler to use it properly. The studies presented in this report provide both laboratory and field insights into message format and location, as well as resulting behaviors by commuters. It is hoped that the guidance distilled from these studies will help operators and managers provide better travel time information to the traveling public.

CHAPTER 1. PROBLEM BACKGROUND AND OBJECTIVES

Transportation agencies have been investing resources in systems that provide real-time travel time information to motorists through the use of CMSs. However, research suggests these sophisticated systems have relatively little impact on actual driver decisionmaking and route.[(1–3)] FHWA, as well as State and local agencies, face the challenge of providing real-time travel time information to motorists in a manner that allows them to take full advantage of it. One factor contributing to the limited effects of current systems is that the travel time displays are not optimally located. There has been little research or evaluation on this issue. This project explored the best means of providing travel time information to drivers as they approach a freeway entrance and evaluated how this influenced route choice and diversion.

One additional factor raised in past research that is related to this project’s objectives is the provision of travel time or related information for arterial route alternatives to freeway routes. Studies have shown that drivers are more likely to divert from a planned route if they have information on travel time or congestion on the alternative route as well. Unfortunately, while many agencies have good real-time information on freeway travel, they do not have comparable information on surface streets. Furthermore, different agencies (State, county, local) are often responsible for operating various types of roadways. While the efficiency of the overall roadway system in an area is the overarching goal, the narrower interests of these various agencies may be in conflict. For example, diverting traffic off of an interstate highway may increase congestion on a roadway operated by a municipality or may cause neighborhood traffic to increase, resulting in resident complaints. It is beyond the scope of this project to try to resolve these sorts of operational issues. However, it is entirely appropriate to consider the potential benefits of providing travel time estimates for arterial routes. Because this sort of information is not typically available to motorists, there is little data on its actual benefits.

Many transportation agencies now provide real-time travel time information to motorists by means of CMSs. Travel time is an important item of information that is valued by travelers, and travel time displays are generally viewed positively by the public. In current practice, the provision of travel time by CMS is generally limited to information about travel times on freeway routes, provided by signs located on the freeway. However, past work has had difficulty identifying substantial effects of travel time displays on driver route choice and diversion. One possible reason is that the location of displays only on the freeway itself may not be optimal. Key driver decisions may be made before entering the freeway, and once on a particular freeway, it may be difficult to get people to divert. This may be especially so if there is no information about travel times on alternative routes, particularly arterial alternatives.

The purpose of this project was to compare and quantify motorist response to real-time travel time displays at freeway approaches compared with their response to displays located on the freeway itself. The research aimed to determine the benefits and effectiveness of travel time signs on arterial approaches to freeways and develop recommendations for the design and use of such displays, including information content, format, sign location, and warrants. The focus was FTT information (the current state of practice), but some experimental attention was also directed to provision of arterial route travel time estimates.

All parts of the study were conducted on behalf of the Transportation Management Center (TMC) Pooled Fund Study and FHWA.

BACKGROUND ON ATT DISPLAYS

Technology makes it feasible to provide drivers with real-time information about how long it will take to reach a given destination. Many jurisdictions within the United States provide such information on CMS displays. In almost all cases, these signs are located on freeways and provide text messages about travel time to upcoming exits, roadways, or landmarks. Cases where the information display is provided on nonfreeway roads, or where travel times on alternative routes are given, are rare. Figure 1 shows an example of typical practice.

©Lerner et al. (2009)

Figure 1. Photo. Travel time information display in Atlanta, GA.[(1)]

Practices for the design and use of travel time displays vary considerably across the country, and little is known about what options are most effective. For this reason, the TMC Pooled Fund Study, through FHWA, funded a study to assess the impacts of travel time displays on drivers, define the effective options, and develop preliminary guidance for practitioners. This study found that commuting drivers valued travel time information and were generally positive about travel time sign systems.[(1)] However, it was difficult to identify much influence of these signs on route choice and diversion. This is not to say that drivers did not use the travel time information but that such information, by itself, generally has limited effects.

These results parallel those of other studies using different survey and experimental methods.[(2,3,5)] Based on research and focus group findings, Lerner et al. suggested that one major reason for the absence of a stronger influence on route choice was that current practice does not locate the displays in such a way that the information is fully usable by the motorist.[(1)] Travel time is only displayed to drivers after they are already on the freeway. The problems with this include (1) key choice points for many commutes occur before entering the freeway, particularly choices between freeway and surface street routes; (2) once on the freeway, alternative route options may be very limited; (3) once drivers are on the freeway, inertia makes it difficult to get them to reroute, and greater motivation is required; and (4) information on the congestion and times of alternate routes is not available, so there is little confidence in rerouting decisions.

Recently, there has been greater interest in displaying travel times, not only on freeways, but on arterial approaches to freeways. Probably the most ambitious program is in the Chicago area, where the Illinois Department of Transportation has initiated a systematic program of travel time displays on approaches to freeways, with 14 sites implemented and more planned. Although various agencies have expressed interest in travel time signs at arterial locations, at this point, there is no guidance, or good basis for guidance, on what the displays should include, how information should be formatted, where displays should be located (relative to freeway entrances and/or commuter choice points), distraction and safety concerns, and so forth. Thus, the research team identified two general needs: (1) to assess the effectiveness of travel time signs at locations other than on freeways and (2) to develop recommendations for the optimal design, placement, and use of these nonfreeway displays. These are the primary issues this project addresses.

One additional factor raised in past research is related to this project's objectives—the provision of travel time or related information for arterial route alternatives to freeway routes. Studies have shown that drivers are more likely to divert from a planned route if they have information on travel time or congestion on the alternative route as well.[1] Unfortunately, while many agencies have good real-time information on freeway travel, they do not have comparable information on surface streets. Furthermore, different agencies (State, county, local) are often responsible for operating various types of roadways. While the efficiency of the overall roadway system in an area is the overarching goal, the narrower interests of these various agencies may be in conflict. For example, diverting traffic off an interstate highway may increase congestion on a roadway operated by a municipality or may cause neighborhood traffic to increase, resulting in resident complaints. It is beyond the scope of this project to try to resolve these sorts of operational issues. However, it is entirely appropriate to consider the potential benefits of providing travel time estimates for arterial routes as a supplementary objective. Because this sort of information is not typically available to motorists, there is little data on its actual benefits.

OBJECTIVE AND SCOPE

The purpose of this project was to compare and quantify motorist response to real-time travel time displays at freeway approaches. The research aimed to determine the benefits and effectiveness of travel time signs on arterial approaches in a laboratory study and a field study. For the field study, both freeway and ATT information was provided to participants, including the provision of ATT information with an in-vehicle device triggered near to a roadway sign.

CHAPTER 2. REVIEW OF CURRENT PRACTICE AND RESEARCH

REVIEW OF PRACTICE

Note that these review activities were initially conducted as part of a previous project detailed in the FHWA report *Driver Use of En Route Real-Time Travel Time Information.*[1] These findings are only briefly reviewed here. The research team began the review of practice by sending formal requests for information to the heads of various committees and professional associations to be disseminated among their members. The request was sent to the chairperson of each of the following committees and organizations:

- TMC Pooled Fund Study Group.
- Transportation Research Board (TRB) Intelligent Transportation Systems (ITS) Committee.
- Transportation Research Board Freeway Operations Committee.
- TRB Effects of Information and Communication Technologies on Travel Choices Committee.
- Institute of Transportation Engineers Management & Operations/ITS Council.
- American Association of State Highway and Transportation Officials Standing Committee on Highways.

These requests yielded responses from 13 individuals who either have implemented ATT systems or have considered doing so. Additional requests for information were sent to individuals who were identified as perhaps having knowledge of the state of practice.

In addition to the requests, the research team conducted keyword Internet searches to identify locations where ATT displays were present. Emails and telephone calls were also placed to key individuals who were expected to be knowledgeable about the current state of ATT practice.

The review of practice ultimately identified more than a dozen ATT implementations in the United States and abroad as well as a number of additional jurisdictions that were considering the use of ATT. Key individuals at seven jurisdictions with ATT were interviewed by telephone for further information, and others were contacted by email.

FTT DISPLAYS: RECENT DEVELOPMENTS

While FTT literature was not the focus of this review, it is important to consider the implications of FTT knowledge on ATT. The review of recent developments in FTT found that the use of FTT displays expanded in recent years. According to FHWA, as of 2014, travel time signs were used in 66 areas in the United States, and there were plans to begin using travel time signs in 11 additional areas.[6] Practice for the display of travel times on CMS remains diverse, with no apparent movement toward convergence of practice. Many State transportation departments have their own guidelines or policies for the display of travel times and other messages on CMSs, and the MUTCD provides Federal requirements and guidelines for some aspects of CMS message display, but no consensus or best practices have emerged for the display of travel times.[4] Similarly, no major evaluations of travel time implementations or research-based guidelines appear to have been published since the 2009 Lerner et al. review (see also Robinson, Lerner, Singer, Jenness, and Huey; and Singer, Robinson, Krueger, Atkinson, and Myers).[7,8]

ATT DISPLAYS

Most current ATT systems use CMSs located on arterial approaches to freeway entrance ramps to show FTTs. A smaller number of ATT systems, however, show travel times for arterial roads instead of or in addition to FTTs. Regardless of which road travel times are shown, ATT implementations have the potential to overcome many of the limitations of FTT displays because they are presented before drivers commit to a freeway route while they have more routing options available and can avoid freeway congestion simply by remaining on arterial roads.[9–13]

Drivers are largely in favor of ATT displays. Benson surveyed drivers in the Washington, DC, area and found that roughly 90 percent approved of the idea of ATT signs because they wanted to be alerted to freeway conditions when alternative routes were still available.[14] Likewise, a survey of Milwaukee-area drivers found that 76 percent believed ATT displays were useful in providing travel information, and 62 percent reported getting information from ATT displays more than once a week.[10]

Research suggests that drivers want to know travel times for various route options so they can make their own routing decisions rather than simply receive prescriptive routing instructions or qualitative statements.[2] In a stated preference survey, Polydoropoulou, Ben-Akiva, Khattak, and Lauprete found that as many as 58 percent of respondents would divert from a freeway if quantitative travel times provided for both freeway and an alternate route showed that the alternate route was faster.[15] High diversion rates have the potential to reduce freeway congestion by encouraging drivers to use alternate routes when the freeway is congested, although there is also the possibility that high rates of diversion could cause congestion on the arterial alternatives as well.[11–13]

Despite promising evidence from various research efforts, there have been very few formal evaluations of actual ATT displays or systems. Although some implementing agencies feel that their ATT displays benefit drivers and improve traffic flow, they lack data on these issues. One survey effort, however, has found positive effects of ATT displays. An Internet survey of drivers in Chandler, AZ, found that 76 percent believed the ATT displays (which showed travel times for major commuter routes that included both arterial roads and freeways) were helpful, 86 percent found the information easy to understand, and 88 percent considered the information to be accurate.[16]

Summary of Practice

The review of practice identified more than a dozen domestic jurisdictions where travel time displays were located on arterial or other off-freeway roads, as well as three jurisdictions with plans to begin displaying ATT soon. All implementations have been active for fewer than

10 years, and many have only existed for a few months or a few years at the time of this writing. Most ATT implementations show only FTTs, but some jurisdictions have taken advantage of new and improved vehicle detection and speed calculation technologies to be able to provide travel times for arterial roads themselves. Table 1 summarizes a subset of sites of implementation found in this literature review for which the research team was able to obtain detailed information from contacts.

Table 1. Summary of travel time practice for select implementations.

State	Minnesota	Missouri	Georgia	Wisconsin
Area	Minneapolis area	St. Louis area	Cobb County (Atlanta area)	Milwaukee area
Number of arterial signs	12–16	28	4	13
ATT on arterials	No	Yes	No	No
FTT on arterials	Yes	Yes	Yes	Yes
FTT on freeways	Yes	Yes	Yes	Yes
Description	Arterial signs show travel times to downtown Minneapolis via car versus bus	Signs on three major arterial routes that provide travel times for arterial, freeway, or both	Arterial signs that show FTT and average speed to destinations in the direction of Atlanta	Arterial signs that show FTTs to destinations in the direction of Milwaukee
Type and features	Static navigation-type sign with dynamic cutout for travel times, mounted on roadside	Dynamic, pole-mounted on roadside; most signs can display up to 3 lines of text with up to 20 characters per line, 12-inch character height	Dynamic, cantilever over roadway; 2 rows of 15 characters each; 18-inch character height	Dynamic, cantilever over roadway; sizes vary
Road-type placement	Major arterial roads 0.5–1 mi from freeway entrances; on approaches to park and ride lots	Major arterial roads, at least 500 ft from any signaled intersection; allow for a 750-ft sight distance	Major arterial roads on approaches to I-75 or on arterial alternative route	High volume arterial routes on approaches to freeway, before key decision points
Number of phases	1	1	2	1, 2
Destinations per sign	1	2	1	1, 2
Example	FWY TIME TO DOWNTOWN MPLS CAR 20 MIN BUS 15 MIN	FROM I-55 TO:I-270 VIA 55N 5 MIN RT M VIA 55S 8 MIN	Phase 1: I-75 SOUTH FROM BARRETT TO I285 Phase 2: TIME: 10–12 MIN SPEED: 40–50 MPH	FREEWAY TIME TO DOWNTOWN 8 MIN HWY F 8 MIN

LITERATURE REVIEW CONCLUSIONS

The review of literature on ATT revealed that very little research has directly addressed the effects of ATT displays and systems. While evaluations of ATT are scarce, there is a broader base of literature on related topics such as route choice behavior. Research has generally found that drivers are hesitant to divert from their planned route, particularly once they are on a freeway, unless they receive clear and trustworthy information that an alternative route will save a meaningful amount of time. ATT systems that provide drivers with travel time information before they commit to a freeway have the potential to provide drivers with the information and motivation they need to make informed route choice decisions. Surveys have found that drivers generally desire ATT information and like having it. Similarly, ATT implementers believe that their systems are working well and benefitting drivers. Despite these promising indicators, however, there are no clear empirical data that show measurable benefits of ATT such as driver time savings, improved traffic flow, or safety benefits, nor is there any evidence comparing various options for ATT systems such as display features, sign locations, and so forth. While the presentation of ATT information in any form may result in some benefits, particular system or message features could potentially result in greater benefits than others.

ATT is an emerging application of ITS technology and has only been implemented in a few States. The review of practice revealed a diverse range of practices for the display of travel times on arterial-based CMSs with no signs of convergence of practice. In fact, no two implementations summarized in the review of practice took the same approach to ATT display. This diversity is due in part to the different strategies of each implementation. While all implementations shared the common goals of informing drivers and improving the use of the roadway system, specific strategies included displaying the following information:

- FTTs to one or more destinations in the same direction.
- FTTs to one or more destinations in different directions.
- ATTs to one or more destinations.
- Travel times for a route that includes both freeway and arterial roads.
- Travel time via two routes to a common destination.
- Travel times via two modes (car and bus) to a common destination.
- Average speed or incident information as a supplement to travel times.

In addition to the variety of ATT strategies employed by various implementing agencies, other possible reasons for the diversity of practice include the following:

- Constraints imposed by existing technologies (e.g., pre-existing CMS), funding, and broader agency objectives.

- Lack of guidelines for ATT deployment (while the MUTCD provides standards and guidance for the use of CMSs, there are no guidelines specific to travel time messages).[4]

- Lack of implementers' knowledge about deployments in other regions.

The different approaches of various jurisdictions resulted in significant differences among jurisdictions in terms of the content and appearance of travel time information, including the following:

- Number of information elements per message.
- Message context (e.g., inclusion of freeway name).
- Message syntax (i.e., order of information elements).
- Message layout (e.g., centered versus left/right justified).
- Use of capitalization.
- Phrasing of messages.
- Sign dimensions and character height.
- Mounting (i.e., roadside versus above roadway).
- Color coding.

Although there are significant differences between ATT implementations in different areas, there are also the following noteworthy commonalities (as of 2012):

- All U.S. ATT systems use dynamic elements that feature amber characters on a black legend. The two implementations that use static/dynamic signs (Minneapolis and Utah County) both provide static sign information using white characters on a green legend in compliance with MUTCD Standard 2D.03.02.(4) As full-color, full-matrix CMSs become more common, other practices may emerge.

- In the United States, all ATT implementations show a maximum of two destinations per sign, whether on a single phase or two phases.

- Locations that show FTTs on ATT displays typically have ATT CMSs placed from 0.2 to 1 mi from the freeway interchange, with the location optimized to allow drivers to choose a nonfreeway route as an alternative. In Chandler, AZ, where ATT CMSs are up to 2 mi from the freeway interchange, travel time estimates include the travel time to the freeway entrance.

Despite some promising evidence of driver satisfaction from surveys, no empirical evaluations of ATT displays have been conducted in the United States. As a result, it is difficult to determine how various ATT systems, as well as the particular features of those systems and the roadway environment in which they exist, affect route selection, driver comprehension, safety effects (e.g., distraction), and roadway network performance. The subsequent tasks in the present research effort (task 3, Evaluation of Alternative Displays, and task 4, Evaluation of Field Implementation) will seek to provide data to address many of these questions.

CHAPTER 3. OVERVIEW OF STUDIES

The project consisted of two experimental tasks. The first task was a laboratory-based experiment in which participants were presented with scenarios and video of ATT displays and then were asked to provide ratings and to offer location recommendations. The second task was a field implementation over 11 weeks investigating behavior, ratings, and use of both freeway and ATT information provided near a freeway entrance approach. Information was provided via CMS and in-vehicle. A main goal of both studies was to better understand optimal ways and preferred locations for presenting both freeway and ATT information to commuters.

STUDY 1: OPTIONS FOR PRESENTING NONFREEWAY-BASED TRAVEL TIME INFORMATION (LABORATORY STUDY EVALUATING ALTERNATIVE DISPLAY MESSAGES)

Study 1 investigated options for presenting nonfreeway-based travel time information using a laboratory-based experiment. This section describes the methods and results.

Methods

This subsection describes the design, participants, and procedure used for study 1.

Design

The laboratory task was a within-subjects design with one group of commuters. Sign message content and scenario were manipulated throughout the task. In addition, participants provided ratings, qualitative responses, and sign location mapping preference.

The key dependent variables in this study were the following:

- Willingness to change routes.
- Confidence in route choice.
- Ease-of-understanding ratings.
- Sign location selection.

Participants

There were a total of 51 participants for the laboratory study. All participants were licensed drivers from the Washington, DC, metropolitan area who were regular commuters on the I-270 corridor. There were no freeway or ATT signs on this corridor. All participants lived in the vicinity of Germantown, MD, and therefore were familiar with the I-270 interchanges in the area. When surveyed, on average, participants reported that 94.24 percent of their morning commute trips were via I-270. Participants received $75 compensation for participation in the study.

All sessions took place in the research team’s computer laboratory. Sessions were run in groups of up to 15 participants at a time and lasted between 1.5 and 2 h. Each participant was seated at a computer terminal. The experiment had four parts.

Procedure

At the beginning of the session, participants were given background information about travel time signs. The experimenter then gave a brief overview of the purpose of the study and the tasks the participants would be performing. Next, the experimenter walked the participants through practice trials of the computer task for part 1 of the study. After the practice trials, the experimenter answered any questions about the task.

After the practice trials, participants moved on to part 1 of the study, which was a self-paced computer-based procedure in which a computer display placed participants in a familiar commuting situation and presented various scenarios regarding traffic and travel time messages. This was done through the use of video clips and displays presented to the participants via their computer monitor. For each trial of the procedure, the participant was placed in a defined scenario. Scenario variables included participants' current location (on an arterial approach to I-270 or already on I-270), destination (participants' actual workplace or Shady Grove Metro station), and traffic conditions (free flow, moderate traffic, heavy traffic). In cases where travel time was provided via both I-270 and an arterial alternative (Route 355), traffic conditions could vary between the two routes. The scenario was defined by a written description and a brief video clip showing the current traffic condition at the actual location the participants were to imagine that they were located. The video allowed a participant to have a realistic perception of the immediate speed and traffic conditions. Figure 2 shows an example of a map participants were shown to indicate their current location. Figure 3 shows such a description and still from the video clip presented to participants in the laboratory study. The scenario is on Route 355.

Figure 2. Map. Participants' current locations in the hypothetical scenario.(17)

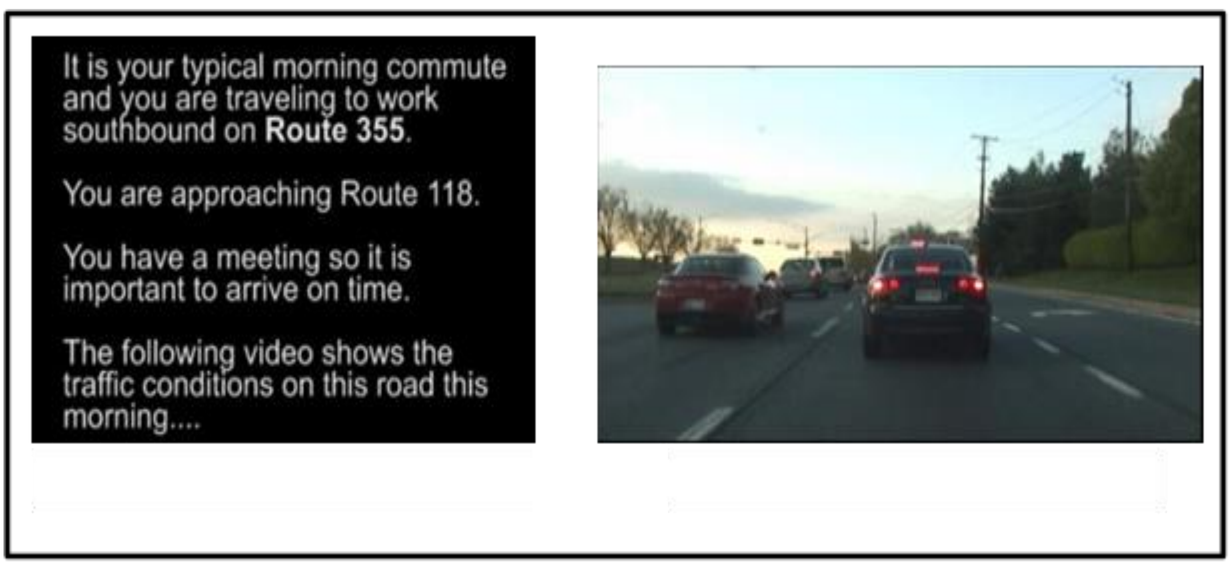


Figure 3. Screenshot. Example of scenario presented to participants.

After the scenario was defined, a travel time display was presented on the screen. Participants were instructed to click a mouse button as soon as they felt they had acquired the relevant information. In addition to travel time signs, a few signs with no travel time information were presented as baseline measures. These signs included information such as Amber alerts, road work signs, silver alerts, etc. The time to process the display was recorded. Once the mouse click occurred, the travel time display disappeared, and three 10-point rating scales appeared (see figure 4). Participants rated the display in terms of subjective ease of use, their willingness to divert to another route, and confidence in their knowledge of the best route.

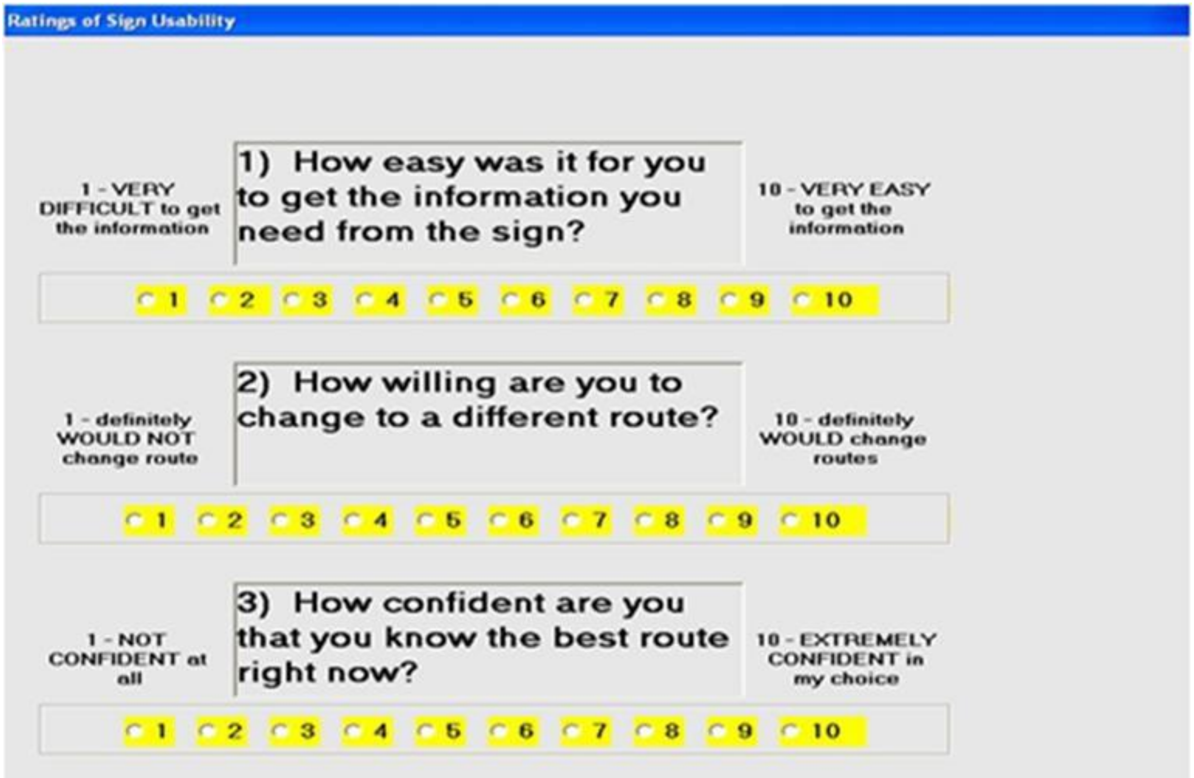


Figure 4. Screenshot. Rating form given to participants.

Part 2 of the study began with the participant being shown an area map on a projector screen. Participants were asked to imagine that they were driving south on Route 355, approaching Route 118. On their computer monitors, a series of travel signs were presented. For each sign, they indicated whether they thought that the posted travel time via I-270 was calculated for the current location on Route 355 or from the I-270 entrance ramp. This task investigated participants' understanding of whether the travel time information included travel time from the current location to I-270 or just travel time on I-270. Each travel time display included different wording and/or formatting. Some displays were intended to suggest from what location the travel time was calculated, while others were ambiguous. After selecting an answer, participants rated how confident they were that their answer was correct. Eleven signs were presented to the participants in this part of the study. Figure 5 through figure 16 show the 12 signs used in this portion of the study. Note that figure 8 and figure 9 contain phases 1 and 2, respectively, of stimulus 4. The results of this task were intended to help traffic engineers to choose a sign format that most effectively displayed information to drivers.

Figure 5. Illustration. ATT content and format: Stimulus 1.

Figure 6. Illustration. ATT content and format: Stimulus 2.

Figure 7. Illustration. ATT content and format: Stimulus 3.

Figure 8. Illustration. ATT content and format: Stimulus 4, phase 1.

Figure 9. Illustration. ATT content and format: Stimulus 4, phase 2.

Figure 10. Illustration. ATT content and format: Stimulus 5.

Figure 11. Illustration. ATT content and format: Stimulus 6.

Figure 12. Illustration. ATT content and format: Stimulus 7.

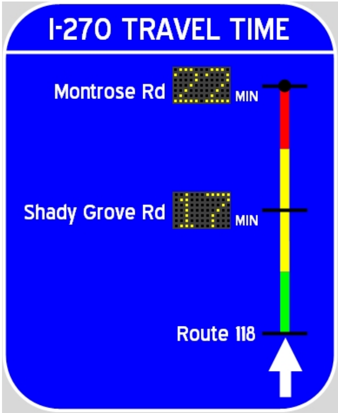


Figure 13. Illustration. ATT content and format: Stimulus 8.

Figure 14. Illustration. ATT content and format: Stimulus 9.

Figure 15. Illustration. ATT content and format: Stimulus 10.

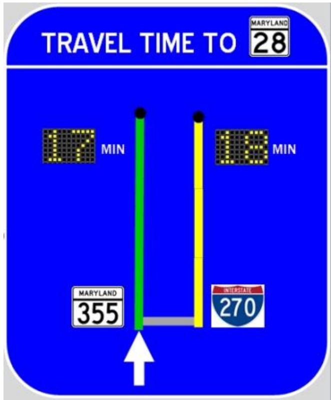


Figure 16. Illustration. ATT content and format: Stimulus 11.

For part 3 of the experiment, participants were given one of two sets of pictures of different signs displaying travel time information. Set 1 had signs that showed travel time via I-270, and set 2 had signs that showed travel times via both I-270 and Route 355. Participants viewed either set 1 or set 2. Participants were told to imagine that these signs would be shown on an arterial approach to I-270. Their task was to rank their top five favorite signs in order of preference by writing the number on the sign on the answer sheet. Participants were then asked to write an explanation of why they thought the sign they rated as number one was the best.

For the final part of the experiment, participants were provided with a personalized map of the area around where their morning commute began. This information was obtained during the telephone screening for participation. On the personalized map, the area where their morning commute began was marked with a red circle. Participants were asked to use a highlighter to trace the route they took most often to work in the morning. The experimenter then asked participants to think about where on their commute route they thought a travel time sign would be most useful and what the sign would look like. They were then asked to use a pen to mark an X on the map where they would like the sign to be but were instructed that the X should not be placed on I-270 or any other freeway. After choosing the location, they were asked to use the blank space on the map to write the message they would like to see on the sign.

After the final part was completed, the experimenter collected all materials and paid the participants, and the session ended.

Results

The following subsections describe the results of the main computer task, the sign location task, the route choice factors questions, and personalized map sign location task.

Main Computer Task

The following results section is divided into key comparisons of certain sign features. All of the sections follow the same format. First, brief information about the importance of the comparison is given. Then, a table shows the sign number (a combination of group and sign, e.g., “3-2” is group 3, sign 2), an image of the actual display, the location of the sign, the percentage of participants who said they would continue their current route (e.g., the sign would not change their plan), the average rating of confidence in their knowledge to make the best choice, the average rating of ease of use of sign, and the average rating of their willingness to divert to another route. Ratings for confidence in knowledge to make best decision, ease of use, and willingness to divert to another route were made on a scale of 1 to 10 with 1 meaning not confident at all, very difficult, and definitely would not change route, respectively, and 10 meaning extremely confident, very easy, and definitely would change route, respectively. Following the table is a brief synopsis of the data presented in the table.

Effect of Arterial Location Versus Freeway Location

One of the main goals of this study was to examine whether receiving travel time information on an arterial versus on a freeway resulted in behavior change among drivers, particularly in willingness to divert route. Participants were shown the same sign with one key difference: they were told that one sign was located on I-270, and the other sign was located on an arterial (MD Route 355). Table 2 shows the results.

Table 2. Arterial location versus freeway location.

Sign Number	Display	Location of Display	Percent Use Freeway	Average Confidence	Average Ease of Use	Average Willing to Divert
2-5	I-270 TIME TO SHADY GR RD 17 MIN MONTROSE RD 22 MIN	Arterial	76	8.4	8.6	8.4
10-3	TRAVEL TIME TO SHADY GR RD 17 MIN MONTROSE RD 22 MIN	I-270	86	8.4	8.4	8.4

Comparing these two signs revealed that participants' ratings of confidence in knowledge of best route, ease of use, and willingness to divert to another route were relatively the same regardless of the location of the sign. However, table 2 revealed that when presented with travel time information while on I-270, 86 percent of people would continue driving on I-270. However, when presented with this information on an arterial road, 76 percent of people would continue on to I-270. This 10-percent difference in willingness to drive on the highway indicates that when presented with a travel time sign on an arterial roadway, more people would consider alternate routes to the freeway than if they were already on the freeway when they received that information. This finding suggests that drivers are more willing to take an alternate route before they have committed to the freeway route.

Effect of Receiving Freeway-Only Information Versus Freeway and Arterial Information

Travel time signs displaying information about just one location may not provide drivers with enough information to divert their route. The research team presented drivers with a sign showing two destinations both via I-270 (only one route option) and another sign with travel time information to an arterial destination via I-270 and an arterial route (two route options). Comparing these two signs provided insights into drivers' preferences for CMS travel time displays (see table 3).

Table 3. Freeway-only information versus freeway plus arterial information.

Sign Number	Display	Location of Display	Percent Stay Same Route	Average Confidence	Avg. Ease of Use	Avg. Willingness to Divert
2-5	I-270 TIME TO SHADY GR RD 17 MIN MONTROSE RD 22 MIN	Arterial	**24**	8.4	8.6	8.4
6-4	TO MONTROSE RD VIA I-270 22 MIN VIA RT 355 22 MIN	Arterial	**32**	8.7	8.9	8.8

Avg. = average.

These data indicate that when given more information (i.e., travel time information about both a freeway and an arterial), drivers are more likely to stay on their current route when it is an arterial. In other words, drivers who receive only information via a freeway route are more likely to divert and continue onto the highway, which may be potentially congested. In addition, drivers had higher ratings in confidence of knowledge of best route, ease of use, and willingness to divert when given more information (two potential routes).

Effect of Receiving Freeway-Only Information Versus Freeway and Arterial Information for a Metro Location

The previously discussed effect of freeway-only versus freeway plus arterial information may be confounded by the fact that all participants were imagining driving on their morning commute to work, which varied among participants. Therefore, the same comparison can be made by looking at data when similar signs were presented and all drivers were asked to imagine that the Shady Grove Metro station was their final location (see table 4).

Table 4. Freeway-only information versus freeway plus arterial information for a Metro location.

Sign Number	Display	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
5-2	SHADY GROVE METRO VIA I-270 19 MIN	Arterial	50	8.5	8.8	8.5
9-2	TO SHADY GR METRO VIA I-270 19 MIN VIA RT 355 15 MIN	Arterial	82	9.0	8.8	9.1

These data show a similar pattern as that shown in table 3; however, the percentage of people staying on the same route is markedly increased in the Metro destination scenario. In the case with a Metro destination, there is an increase of 32 percentage points of people who would stay on the arterial route if given information about both the freeway and the ATT rather than just FTT (compared with 8 percentage points more in the work destination scenario). In addition, the average confidence in knowledge to choose the best route and willingness to divert route were higher for the freeway plus ATT sign, and average ease of use was the same as for the freeway-only sign.

Effect of Color Coding Times

Some of the signs presented to participants during the laboratory study were color coded with red indicating bad traffic and green indicating lighter traffic. Signs with the same information about destination and travel time were presented with different color-coding options. See table 5 for results.

Table 5. Color-coded signs.

Sign Number	Display	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
6-4	TO MONTROSE RD VIA I-270 22 MIN VIA RT 355 22 MIN	Arterial	32	8.7	8.9	8.8
7-2	TO MONTROSE RD VIA I-270 22 MIN VIA RT 355 22 MIN[1]	Arterial	38	8.7	9.0	8.7
19-1	TO MONTROSE RD VIA I-270 32 MIN VIA RT 355 29 MIN	Arterial	42	8.5	8.8	9.1
19-2	TO MONTROSE RD VIA I-270 32 MIN[2] VIA RT 355 29 MIN	Arterial	58	8.7	8.9	9.1

[1]On the display, "22 MIN" shows in green lights.
[2]On the display, "32 MIN" shows in red lights.

The data indicated no significant differences between drivers on an arterial (Route 355) receiving color-coded travel time information about that arterial versus non-color-coded travel time information. However, when presented with color-coded travel time information about a freeway while on an arterial versus non-color-coded information, 16 percent more drivers would stay on their current route (the arterial). It appears possible that color coding has the greatest effect when drivers cannot visually confirm traffic conditions (e.g., on a roadway other than the one they are currently traveling).

Effect of Supplemental Information

Another variation in CMSs rated by participants was the addition of different types of supplemental information. For example, some of the travel time signs displayed average speed information or distance to location. Others included information about incidents and delays or travel alerts. It is possible that receiving additional information other than travel time may affect drivers' behaviors. See table 6 for results.

Table 6. Supplemental information.

Sign Number	Display	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
2-5	I-270 TIME TO SHADY GR RD 17 MIN MONTROSE RD 22 MIN	Arterial	24	8.4	8.6	8.4
3-4	I-270 TIME TO SHADY GR RD 17 MIN AVG SPEED 30 MPH	Arterial	49	8.2	8.5	8.4
1-5	I-270 TIME TO MONTROSE RD 22 MIN 11 MILES	Arterial	28	8.4	8.3	8.5
1-6	I-270 TIME TO I-370 15 MIN EXPECT DELAYS	Arterial	60	8.5	8.3	8.3
1-4	I-270 TIME TO MONT VLG AVE 9 MIN MONTROSE RD 22 MIN INCIDENT AT RT 28 EXPECT DELAYS	Arterial	40	8.3	8.5	8.4
3-6	I-270 TRAVEL ALERT SHADY GR RD 17 MIN MONTROSE RD 32 MIN I-270 TRAVEL ALERT SHADY GR RD 17 MIN MONTROSE RD	Arterial	41	8.3	8.0	8.4

The first three signs in table 6 displayed similar information, but the first sign exclusively displayed travel time, the second sign included average speed information, and the third sign included distance information. It seems as though having information about average speed, in addition to travel time, is useful for drivers. Compared with 24 percent for travel time only and 28 percent for distance and travel time information, 49 percent of participants said they would stay the same route when provided with travel time plus average speed information. It is possible that 30 mi/h is a clearer indication of traffic conditions than a travel time that reflects the same information. When general “expect delays” information was added to the travel time signs, 60 percent of participants reported that they would stay on Route 355. When this same information was provided as a second phase and an incident location was added, the participants reporting that they would stay on Route 355 dropped from 60 to 40 percent. The reason for this drop is unclear, but it could be that when drivers knew where an incident occurred, they realized that traffic should be clear beyond that location (congestion not indefinite).

Effect of Alternative Formats

Alternate sign formats were also tested in this study. The types of sign formats were the trailblazer sign, diagrammatic sign, and “hybrid” sign (sign 9-3, sign 2-3, and sign 9-1, respectively). Regular sign formats and these alternative sign formats with the same information can be compared with each other in figure 17 through figure 24. Correspondingly, table 7 through table 13 indicate participant responses to each sign type.

Figure 17. Illustration. Sign number 9-2.

Table 7. Participant responses to sign 9-2.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
9-2	Arterial	82	9.0	8.8	9.1

Figure 18. Illustration. Sign number 9-1.

Table 8. Participant responses to sign 9-1.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
9-1	Arterial	82	9.1	9.3	9.4

Figure 19. Illustration. Sign number 9-3.

Table 9. Participant responses to sign 9-3.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
9-3	Arterial	68	8.6	7.5	8.3

Figure 20. Illustration. Sign number 2-5.

Table 10. Participant responses to sign 2-5.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
2-5	Arterial	24	8.4	8.6	8.4

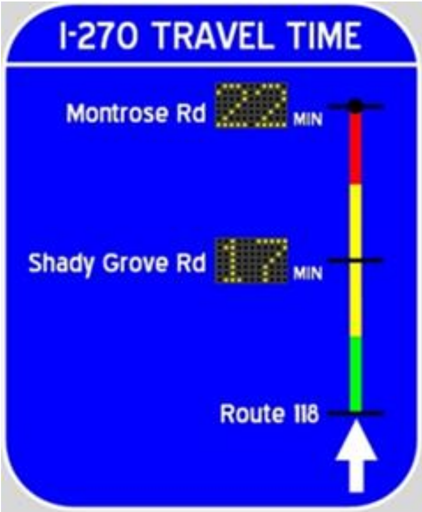


Figure 21. Illustration. Sign number 2-3.

Table 11. Participant responses to sign 2-3.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
2-3	Arterial	30	8.4	7.9	8.2

Figure 22. Illustration. Sign number 6-4.

Table 12. Participant responses to sign 6-4.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
6-4	Arterial	32	8.7	8.9	8.8

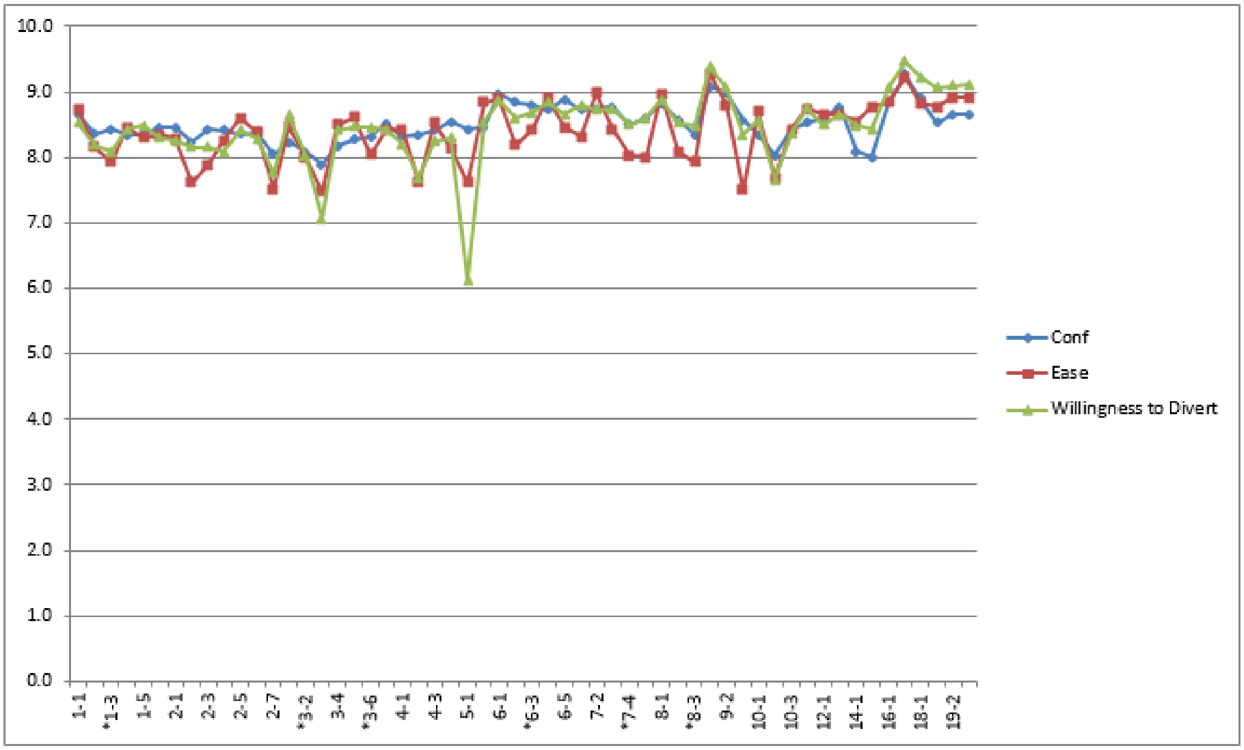
Figure 23. Illustration. Sign number 6-5.

Table 13. Participant responses to sign 6-5.

Sign Number	Location of Display	Percent Stay Same Route	Average Confidence	Average Ease of Use	Average Willingness to Divert
6-5	Arterial	44	8.9	8.5	8.7

Figure 18 depicts sign number 9-1, a hybrid-type sign. The hybrid sign format received the highest ratings on confidence in knowledge to make the best decision, ease of use, and willingness to divert to another route. This is compared with the trailblazer formatted sign, which received the lowest ease of use rating (7.5). Based on the ratings for different sign formats, it seems that participants preferred the “hybrid” sign as a means for receiving travel time information.

Figure 24 summarizes participant ratings on confidence in knowledge to make the best decision, ease of use of signs, and willingness to divert to another route for all signs presented during this experiment. This graph shows that participants generally rated all signs similarly, between about 8 and 9, on confidence in knowledge to take the best route, ease of use, and willingness to divert to another route. Several signs did deviate in terms of having slightly different ratings. For instance, sign 5-1 was rated much lower on willingness to divert to another route. This sign was presented in a scenario in which participants were told they were driving to the Metro. This specific and fixed destination may have contributed to the lower rating of willingness to divert to another route. In addition, sign 3-2 had lower ratings on willingness to divert to another route and ease of use. This was a two-phased sign, which may have caused difficulty in ease. One sign with overall higher ratings than most of the others was sign 18-1. This sign was an arterial-based sign displaying travel time information about both an arterial and a freeway. In this instance, the freeway had heavy traffic, and the arterial had light traffic. This contrast of travel time conditions could have contributed to the higher ratings.



Conf = confidence.

Figure 24. Chart. Average confidence, ease of use, and willingness to divert ratings for all signs. The asterisk denotes a 2-phased sign.

Sign Location Task

During part 2 of the study, participants were asked to imagine that they were driving south on Route 355, approaching Route 118. On their computer monitors, a series of travel signs was presented. For each sign, they indicated whether they thought that the posted travel time via I-270 was calculated for the current location on Route 355 or from the I-270 entrance ramp. Twenty-six percent of participants thought that the default freeway-only sign was calculated from the sign location. However, 64 percent of participants thought that the default freeway plus arterial information sign's I-270 travel time was calculated from the current location. Therefore, the mental models for freeway-only and freeway plus ATT may be different. The two freeway-only signs that were most explicit that travel time was calculated from the ramp had 6 and 16 percent of participants say it was calculated from the current location. The freeway plus ATT sign that was explicit still had 44 percent report it was calculated from current location, suggesting that the mental model in this case may be hard to overcome. Among other signs, the percentage of participants who said the travel time was calculated from the current location varied from 22 to 52 percent, suggesting that most sign formats lacking explicit statements cause confusion to a significant portion of drivers.

Route Choice Factors Questions

Before each session, participants filled out a survey about route choices that they made on their morning commute. They received the following instructions:

> Below you will find a list of statements about factors that might influence your route choice during your morning commute. Please rate each factor's role in your route choice decision for your morning commute. Make your ratings on a scale of one to seven, where one means "strongly disagree," where four means "neutral" or "no opinion.," and seven means "strongly agree." If any factors that influence your morning commute route are not listed below, please write them in at the bottom of the list.

Table 14 shows the survey questions and the mean rating of participants for each.

Table 14. Factors that influence route choice ratings.

Question	Mean Rating
I try to minimize total driving time/trip duration	6.27
I try to avoid traffic congestion	6.24
I try to avoid stress	6.16
I try to take a route that is familiar, habitual, or routine	5.89
I try to take a route that has predictable/consistent driving time from day to day	5.86
I try to take the shortest route (fewest miles)	5.16
I try to avoid difficult or challenging driving situations	5.09
I try to avoid stop lights and stop signs	4.91
I try to take a route for which traffic reports/information are available	4.84
I try to take a route that maximized fuel economy	4.70
I try to take a scenic/attractive route	3.33

Personalized Map Sign Location Task

For the last portion of the laboratory study, participants were given a personalized map of their daily commute and asked to indicate the location where they would most want a travel time sign to be displayed. In addition, they drew an image of what they would like this sign to look like. These data were entered into a database and coded based on the following characteristics: sign placement (number of alternatives before the freeway); use of color; design (graphical versus text-based); phases; presence of time, average speed and/or distance information; presence of delay information (general versus specific location); number of destinations; what destinations; and travel time via what roadways. Based on an analysis of these personalized signs, several characteristics stood out as most desired among drivers (i.e., features that had much higher frequencies than others).

Sign Placement

During the screening procedure for recruitment, participants' home addresses were collected. During the personalized map portion of the study, they received a map with a red circle indicating their home neighborhood. Figure 25 uses ArcGIS™ software to display participant neighborhoods and the locations where they placed their personalized signs.

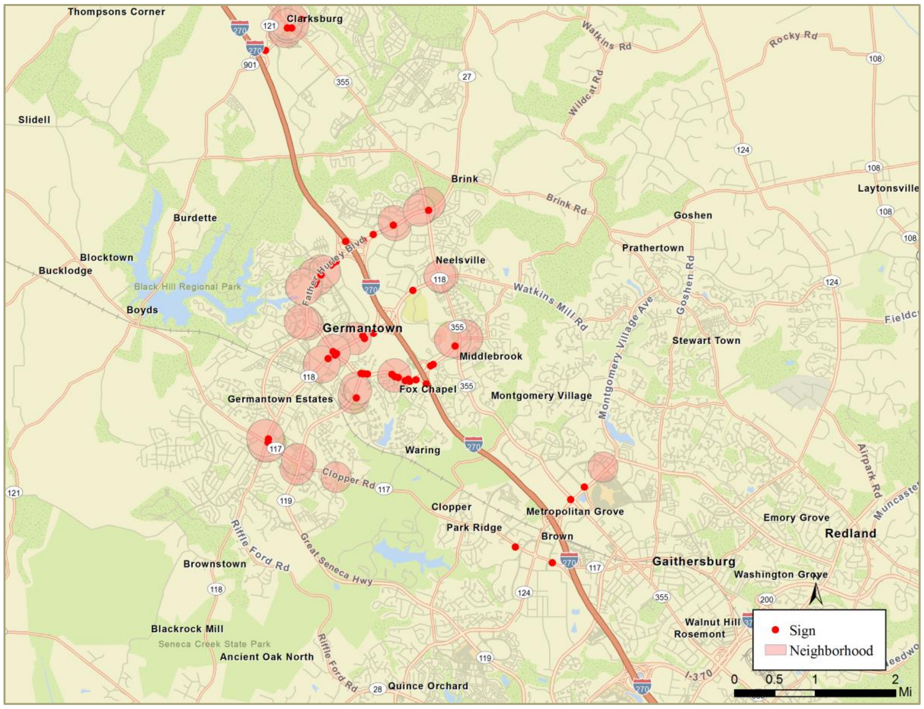


Figure 25. Map. ArcGIS™ map illustrates neighborhoods of participants and location of personalized signs.

The red dots on the map indicate sign placement. A cluster of red dots around the final approaches to I-270 is evident from figure 26. Only two participants placed the sign on the freeway. In addition, during the coding of the personalized CMS signs, sign placement was coded as the number of alternatives to the freeway still available. The coded data can be seen in figure 26.

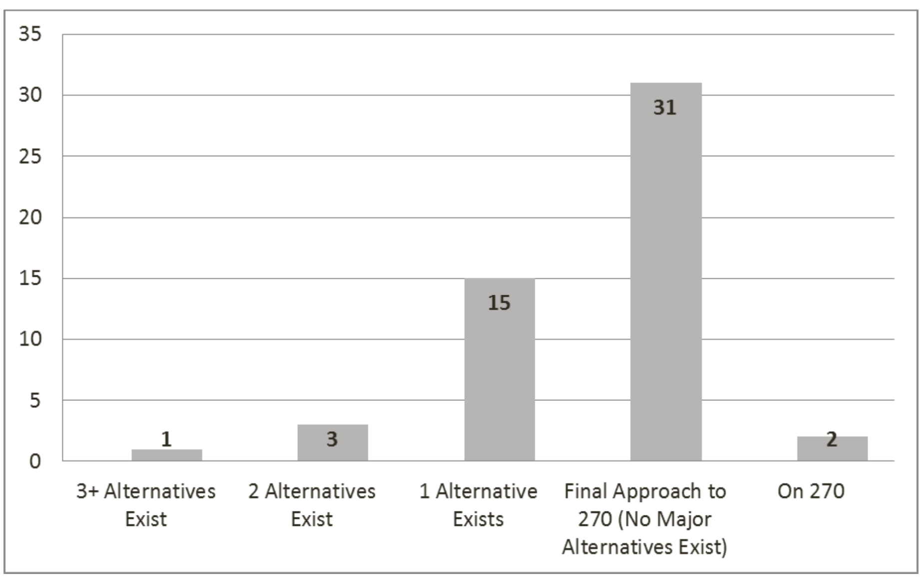


Figure 26. Chart. Sign placement.

Considered together, these data indicate that CMS displays of travel time may be most valuable to drivers on their final approaches to the freeway. As the number of alternative routes decreased, participants' desire for travel time signs increased. The majority of participants placed their personalized signs on the final approach to I-270 (31 participants), and another 15 participants placed their signs in a location where only one alternative existed. It is important to note that only two participants placed their sign on I-270. It seems that people want travel time information at a vital decision point in their drive and would prefer to see it on an arterial when approaching the freeway rather than on a freeway.

Additional geographical analysis was performed using population density by census block data. In figure 27, darker areas indicate more densely populated areas, and lighter areas are less densely populated areas. Overlaid on the population density map are the desired sign locations indicated by the participants.

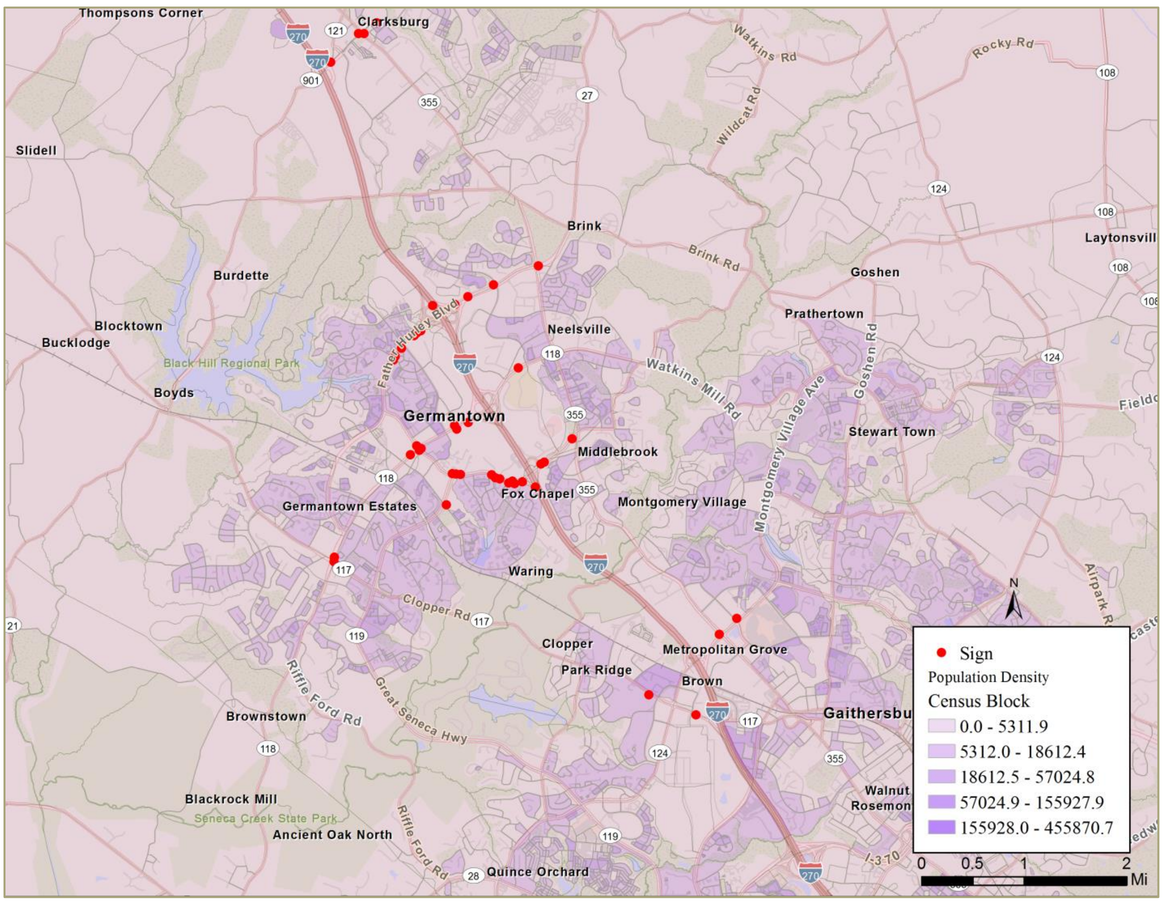


Figure 27. Map. ArcGIS™ map illustrates population density by census block.

Figure 28 shows that the personally optimal sign location is not necessarily in the most densely populated areas; rather, the participants' optimal sign location is clustered around entryways to the freeway.

Another geographical analysis demonstrated potential optimal routes to I-270. ArcGIS™ software was used, and as with other mapping software, it creates heuristic routing options. Figure 28 is a map of these optimal routes.

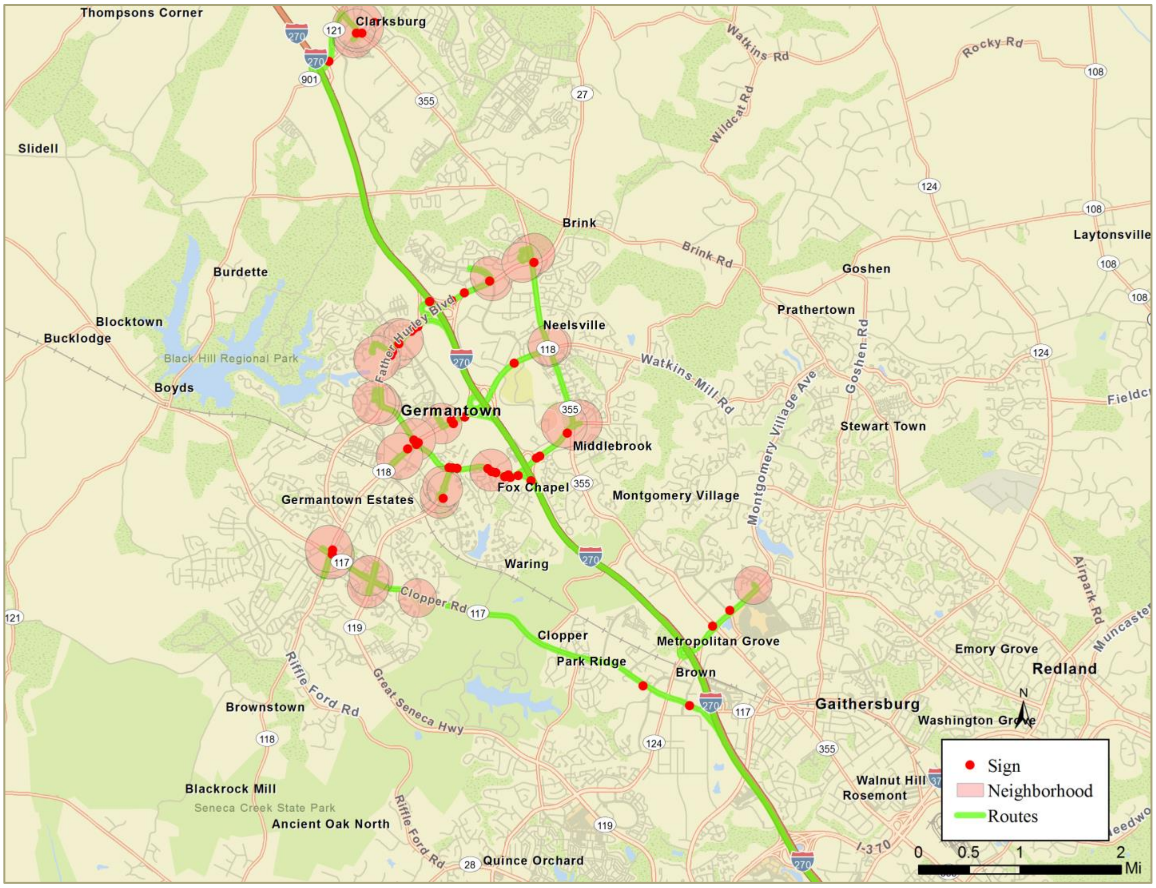


Figure 28. Map. ArcGIS™ map illustrates potentially optimal routes to I-270.

This map shows that the signs were not placed in typical optimally calculated routes. The research team does not know why this pattern of sign placement along a route other than the optimal route occurred. It is possible that participants reroute because they have another stop along their route during their morning commute, such as dropping a child off at school or carpooling. In addition, it could be that by driving on a "sub-optimal" route, they are able to drive toward areas with more alternative routes to the freeway; therefore, CMS travel time displays along these locations would allow them to make the best choice of their alternative routes.

A final analysis of distance of sign placement (in mi) from the freeway was calculated. On average, participants indicated that they would like CMS travel time signs to be placed 0.594 mi from the freeway. These data reinforce the idea that drivers want CMS signs to be located near their decision points for getting on the highway rather than early in their driving route (prior to the freeway approaches) or on the freeway itself.

Use of Color

Personalized signs were coded for use of color. A total of eight participants indicated that they would prefer any color coding (red, yellow, green, or highlighted) on their sign. This is not a large portion of participants, so it seems that color coding may not be optimal for design or that drivers do not find color coding to be particularly useful.

Graphical Versus Text-Based Design

The vast majority of participants' personalized signs were text-based rather than graphically based. Forty-three participants drew travel time signs that were text based compared with only 6 participants who drew graphically based signs. Text-based signs may be easier for drivers to process and may be more streamlined than graphically based signs.

Phases

CMS displays can be either one- or two-phased. Thirty-three participants drew one-phased signs, and 11 participants drew two-phased signs. Interestingly, many of the participants who drew a two-phased sign indicated that phase one would provide travel time information and that phase two would display information about delays/incidents.

Types of Information

CMS displays can include many different types of information, including travel time, average speed, distance, and information about delays and incidents on the roadway. Participants' personalized signs were coded for these different features. These features do not necessarily need to be independent of each other; CMS displays can include several of these information features at one time. Figure 29 shows types of information on personalized CMS signs.

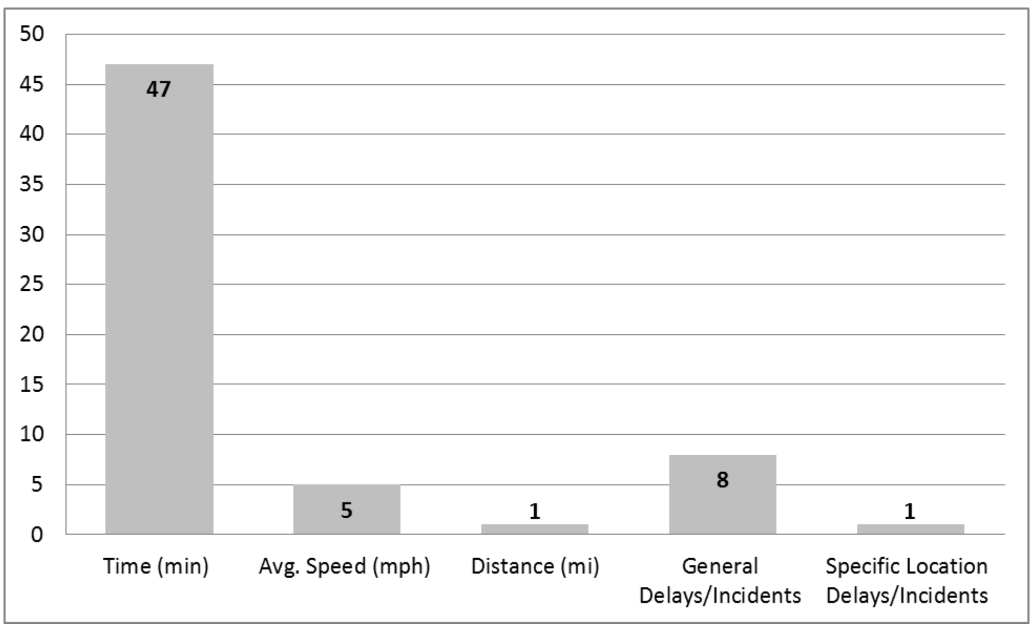


Figure 29. Chart. Type of information on personalized CMS signs.

The data indicate that travel time (in min) is the most desired information on these CMS displays. Relatively few participants included average speed or distance information on their personalized CMS displays. In terms of displaying information about delays and incidents, more participants indicated that they wanted general information versus specific location information.

Destination Information:

The personalized CMS displays that participants drew provided travel time for different numbers and types of destinations. Some people indicated travel time to only one destination, while others indicated travel time to more than three destinations. Figure 30 shows a simple breakdown of the number of destinations people indicated and the actual location of these destinations.

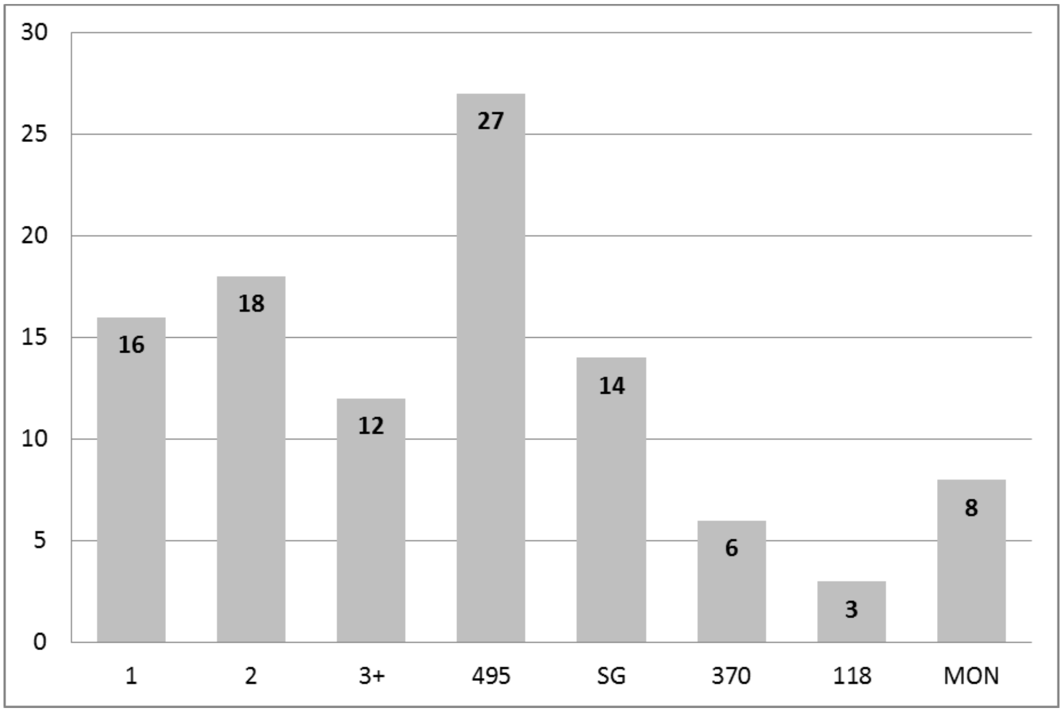


Figure 30. Chart. Number of destinations and destination locations.

Overall, it was evident that information regarding destination is highly variable among participants depending on their own personal commute or desired destination. Some interesting notes about destinations are that other than I-495, Shady Grove Road, 370, 118, and Montrose Road, participants listed other relevant destinations, including the Inter-County Connector, specific exits along the highway (e.g., Exit 8), or more local roads near their neighborhoods. These data further emphasized the specificity that participants had in mind while creating these CMS displays. In addition, many participants specifically stated that they wanted travel time information for the I-270 split or the I-495 spur, particular areas of traffic congestion locally. While congestion areas vary from region to region, the fact that participants specifically cited these two areas has important implications; people may most want information about the worst traffic areas.

In addition, participants indicated that they would like their CMS displays to reflect travel time information via a particular type of roadway—either freeway (I-270) or arterial (Route 355). The coded data for this feature of the personalized signs is shown in figure 31.

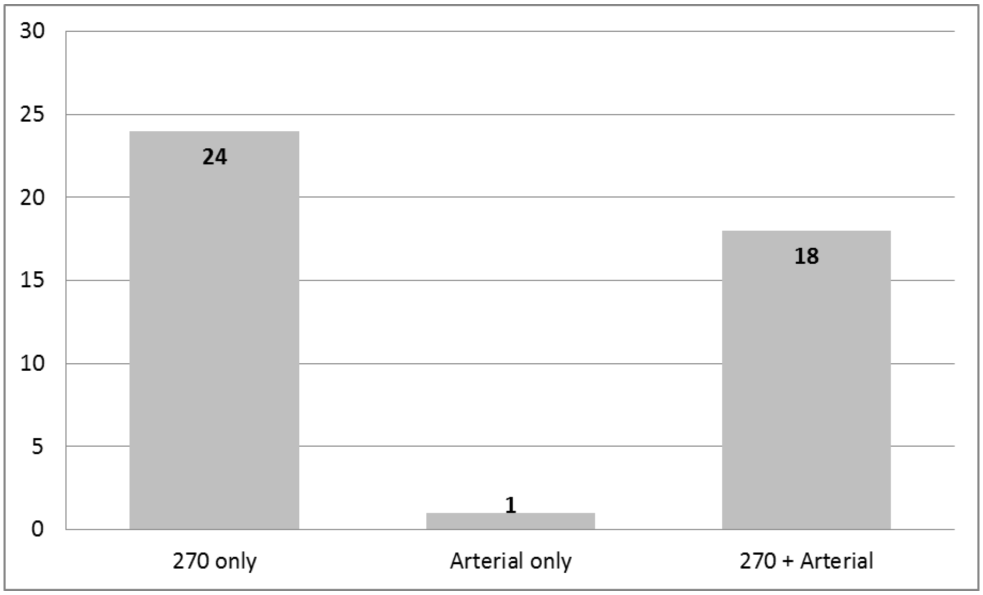


Figure 31. Chart. Destinations via different roadways.

Most participants wanted their travel time to be reflective of whether they were driving on a freeway. However, a high number of participants also drew signs that included both arterial and freeway routes. Only one participant indicated travel time via only an arterial roadway. These data indicate that information about the freeway is most important to drivers.

STUDY 2: ACTUAL COMMUTER EXPERIENCE WITH ALTERNATIVE PRACTICES OF TRAVEL TIME DISPLAYS (FIELD IMPLEMENTATION AND EVALUATION)

Study 2 investigated actual commuter experience with alternative practices of travel time displays using field implementation and evaluation. This section describes the methods and results.

Methods

This subsection describes the design, location selection, equipment, participants, and procedure used for study 2.

Design

The field evaluation was conducted with a before/after assessment on an experimental site. Participants were not provided with any travel time information during the pre-implementation stage but were provided with both arterial (via in-vehicle device) and freeway (via roadway sign) travel time following implementation.

The key dependent variables in this study were the following:

- Willingness to change routes (rating).
- Confidence in route choice and accuracy ratings.
- Ratings of likeability and usefulness.
- Sources of traveler information and effects on route choice.

- Diaries including travel choices, reasons, and information ratings.
- Global Positioning System (GPS) coordinates tracked for objective records of travel path and decisions.

Location Selection

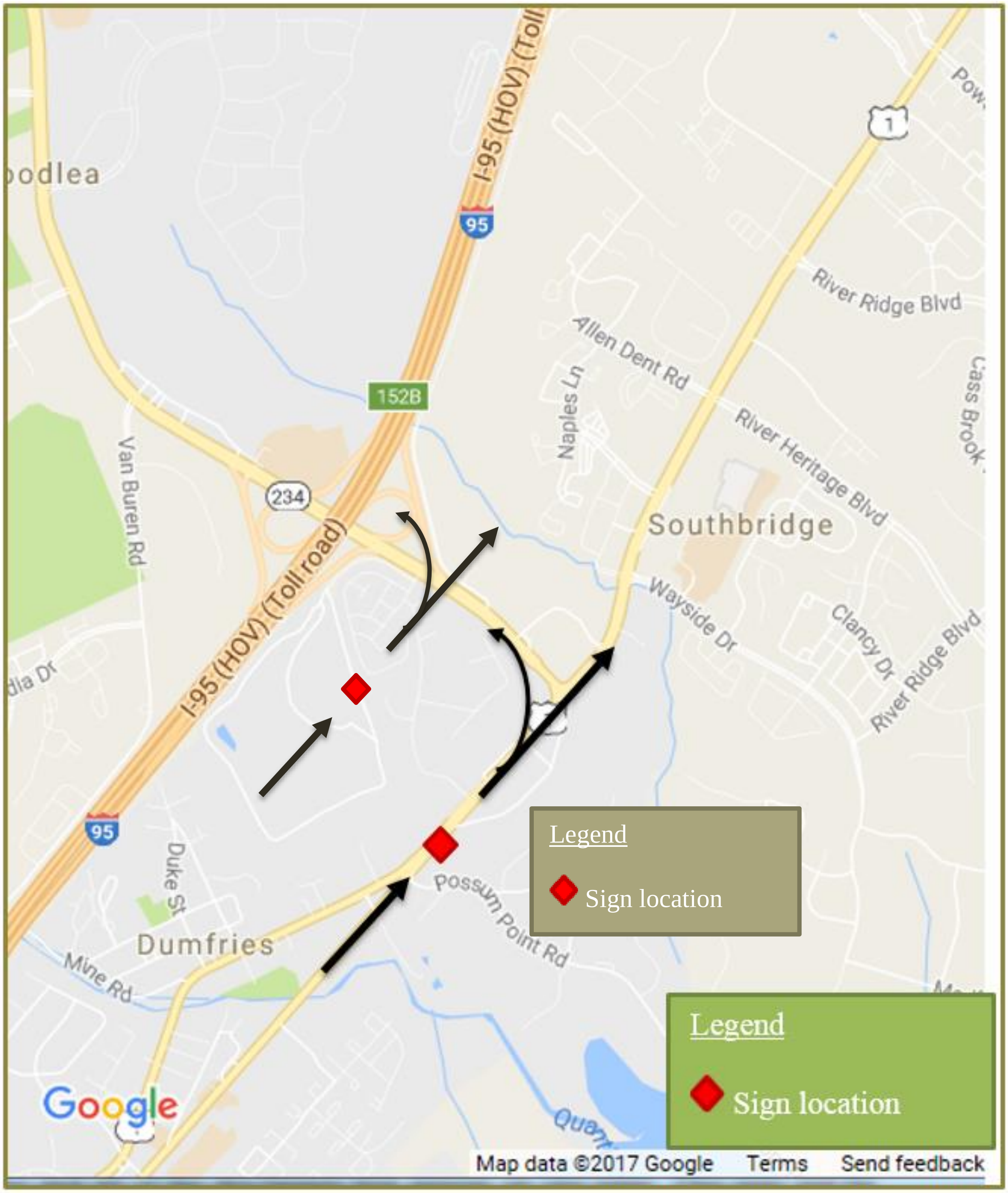
The key comparison of interest in this study was whether arterial-based travel time signing improves driver decisionmaking. The following criteria were used to choose location:

- Alternate routes.
- Location (shoulder or overhead).
- Size/type of display.
- Population density.
- Landmarks (including schools, malls, etc.).
- Frequency of existing sign usage.
- Distance from freeway to Metro.
- Congestion on freeway.
- Restricted access lanes (high occupancy vehicle, toll road).
- Direction of sign, message.
- Proximity of another sign in use.
- Visibility on approach and to the interstate.

The final sign location was selected from the following set:

- CMS 1720 (Richmond Highway).
- CMS 1810 (Dumfries Road).
- CMS 1840 (Prince William Parkway).
- CMS 1930 (Dale Blvd).

Based on the criteria listed above, the primary candidate for the final site chosen to implement the sign for the study was the CMS 1720 (Richmond Highway). Specifically, the sign was implemented along US-1N (Richmond Highway—CMS 1720), before VA 234. See figure 32 through figure 34.



©2017 Google®; map annotations by the research team.

Figure 32. Map. Field implementation sign location (latitude: 38.5717, longitude: –77.3173).(18)

Figure 33. Photo. Travel time information display in Dumfries, VA.

Figure 34. Illustration. Example of information shown on the travel time display.

Equipment

The in-vehicle display and GPS tracking devices were Nexus™ 5, Android™ 4.4.4 cellular telephones using KitKat®.

Features of the devices included the following:

- Is able to be installed and forgotten for weeks.
    - Powered while plugged into a provided adapter/splitter.
- Is aware of location and heading and able to respond to those cues.

- Allows driver to see and hear that it is working properly but provides no other information to affect a decision.
- Collects only morning commute data (5–10 a.m.) for trips toward the District of Columbia.
- Collects bread crumb data at 30-s intervals.
- Shows decision points but hides detailed origin and destination.
- Accesses real-time traffic data to feed the display algorithm.

Data logging details include the following:

- Location data from GPS is logged at 1 Hz.
- Travel time updates refresh each minute.
- Message is triggered within 984 ft of the road sign.
    - US-1N similar to CMS information on approach to sign.
- INRIX® travel time and location data are stored on device in SQLite database.
- Data are logged continuously while powered, providing a record of actual travel time.
- Nexus™ 5 devices securely transmitted data to Westat® servers regularly as cell coverage allowed. Tablet data were collected at study completion.
- Data were imported into a PostgreSQL database for analysis.
- Audio reminder is provided to "fill out online logs" on power down.
- There is no need for driver interaction after install.
- There is recognition of power state and continuous charging.
- Only one destination, distance, and time is displayed to participants (similar to Virginia Department of Transportation (VDOT) format for consistency).

Figure 35 shows an example of an in-vehicle display.

Figure 35. Illustration. Example of in-vehicle device display.

Participants

A total of 30 paid individuals participated in this field study. All participants were licensed drivers from the Washington, DC, metropolitan area who were regular commuters on US-1N and the I-95 corridor. All participants lived in the vicinity of Dumfries, VA, and were familiar with the I-95 interchanges in the area. Participants were selected who commuted at least 4 days a week and reported alternating use of I-95 and US-1N at least some of the time. They had to commute between 6:00 and 10:00 a.m., heading northbound on US-1N to or beyond RTE 234 (Dumfries) for at least part of their normal commute. Participants were 21 to 55 years old, and the sample was approximately balanced across age decades and genders.

Participants were recruited through the following variety of methods:

- Craigslist™.
- Facebook® and other social media (pay per click).
- The internal websites of the research team companies.
- Local newspaper (online and print).
- Neighborhood home owners' associations.
- Table at local Walmart®.
- Flyers—left on doorsteps and at local businesses.
- Referral bonus.
- Roadside signs.

Ads stated that commuters were needed for a traffic study but did not state that the study focused on travel time signs (see appendix A). Participants received $200 compensation for completion of the study. In addition, recruitment websites were set up for participants to find relevant information and appropriate contacts.

Procedure

Field implementation for this study was completed in two phases spanning 11 on-task weeks total, with a 2-week break period between the phases. The first phase of the study spanned 2 weeks of pre-implementation, in which participants were not presented with any travel time information. In the post-implementation phase, participants were given travel time information in-vehicle via mobile device as well as on the CMS.

Once participants were screened, they received mailed packages containing information about the study as well as instructions for completing the study. Participants were instructed to set up the travel time device as well as to complete trip logs online twice a week (every Tuesday and Wednesday) during each phase. The first 2 weeks of the study, comprising phase 1, started December 8, 2014, and ended December 19, 2014. In this phase, participants did not receive any travel time information from the device or the CMS except for a daily reminder at the end of their commute to fill out trip log surveys. There was a break between December 20, 2014, and January 4, 2015. This break was to avoid data collection during unusual holiday traffic patterns. Phase 2 began January 5 and ended February 20, 2015. During this phase, travel time information for a segment of their commute along US-1N was presented in-vehicle through a travel time display device as well as the CMS. Table 15 summarizes pre- and post-implementation activities.

Table 15. Pre- and post-implementation summary.

Pre-implementation	Post-implementation
GPS monitoring (and remote download)	Participants presented with travel time on the CMS and supplemental in-vehicle ATT
Fill out online driver log after selected commute days (Tuesday and Wednesday of each week)	GPS monitoring (and remote download)
	Fill out online driver log after selected commute days (Tuesday and Wednesday of each week)
	Complete final questionnaire
	Return devices

Driver trip logs and questionnaires were used to subjectively assess driver decisionmaking. Specifically, the driver trip logs were used to measure route diversion and route choice. In addition, driver decisionmaking was objectively measured through GPS. GPS location monitoring (with no display) was recorded. (See Equipment section earlier in this chapter for equipment and data logging details.)

Results

The study had three main components. First, participants were tracked with GPS via the in-vehicle devices that were used to display messages. Second, participants filled out online travel logs every Tuesday and Wednesday during the study. Finally, there was an overall travel log at the end of the study.

The results are separated into each of these three sections with particular questions or points of interest highlighted and discussed.

GPS Data and Location Tracking

Route Choice

Participants were tracked with GPS-enabled telephones throughout the study. This allowed for a count of trips taken along I-95 and US-1N. Figure 36 displays the individual GPS points collected along the corridor and highlights the ineligible trips because participants did not travel through the corridor and along decision points of interest. Figure 37 displays the percentage of trips for participants along I-95 and US-1N. Note that the proportions do not total 100 because not all trips went far enough beyond the corridor of interest to qualify for the I-95 or US-1N category for this graph.

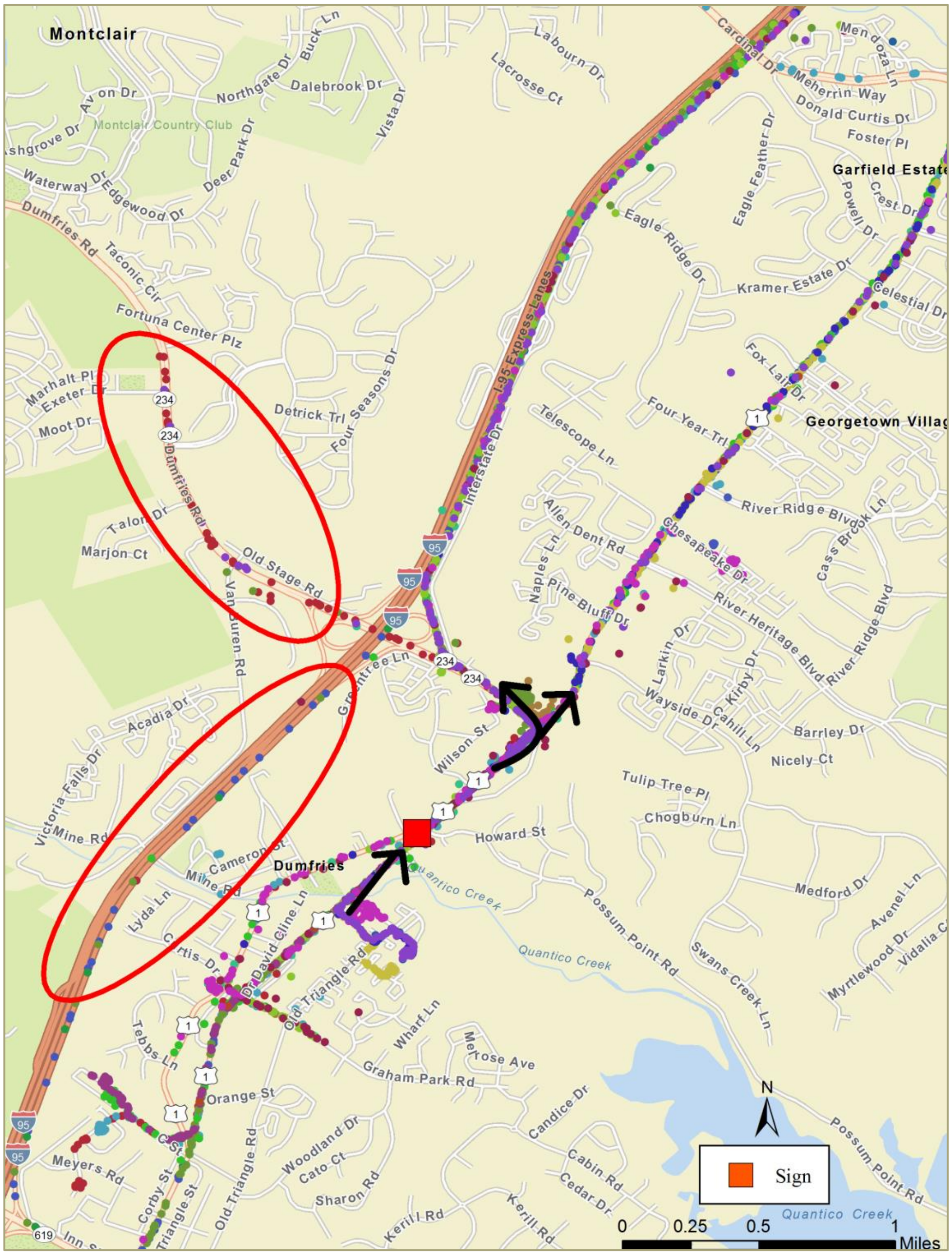


Figure 36. Map. ArcGIS™ map identifies GPS data points, including eligible (along US-1N and I-95) and ineligible trips (red circles).

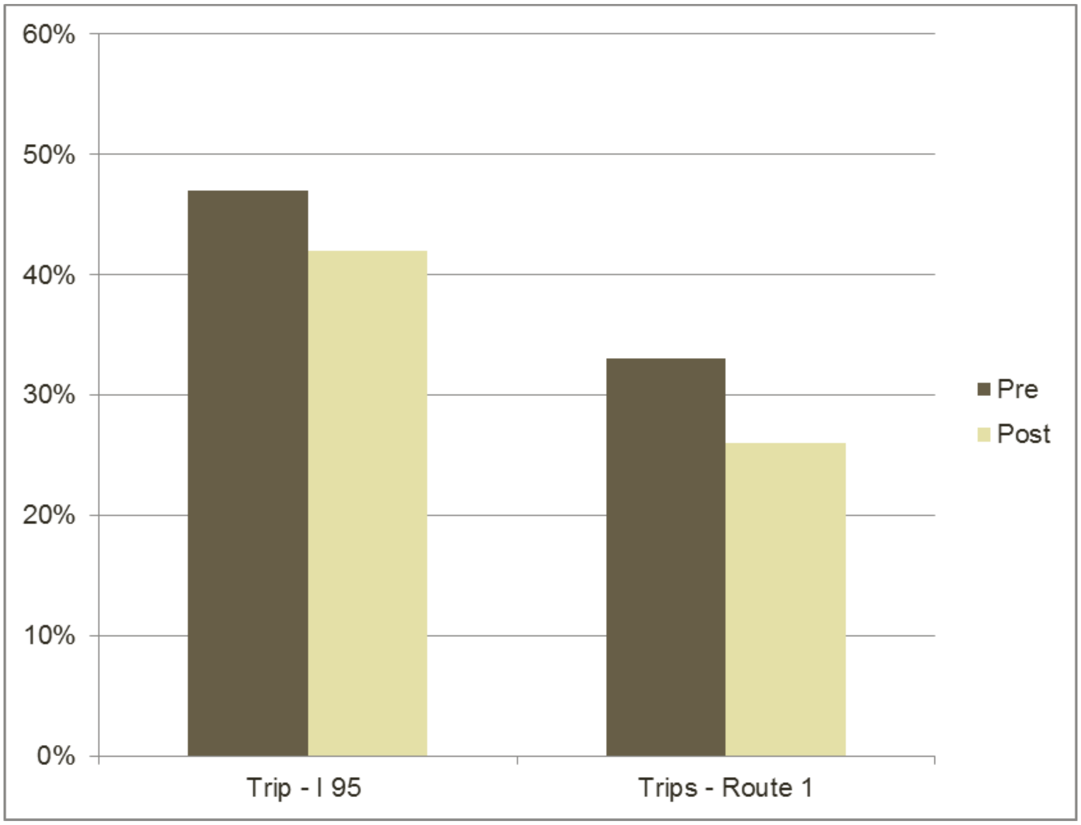


Figure 37. Chart. Percentage of trips using I-95 or US-1N.

Traveler Logs

Participants completed brief traveler logs on Tuesday and Wednesday of each week of the study. There were 2 weeks (i.e., four traveler logs) in the pre-implementation phase of the study and 7 weeks for the post-implementation phase (i.e., 14 traveler logs). Responses described are percentages of all responses for a given question.

Pre-Trip Information Sources

Figure 38 shows the distribution of responses when participants were asked the following question: "From what sources of information did you receive traveler information before starting the trip?" These included all responses, even if participants ultimately decided not to travel that day.

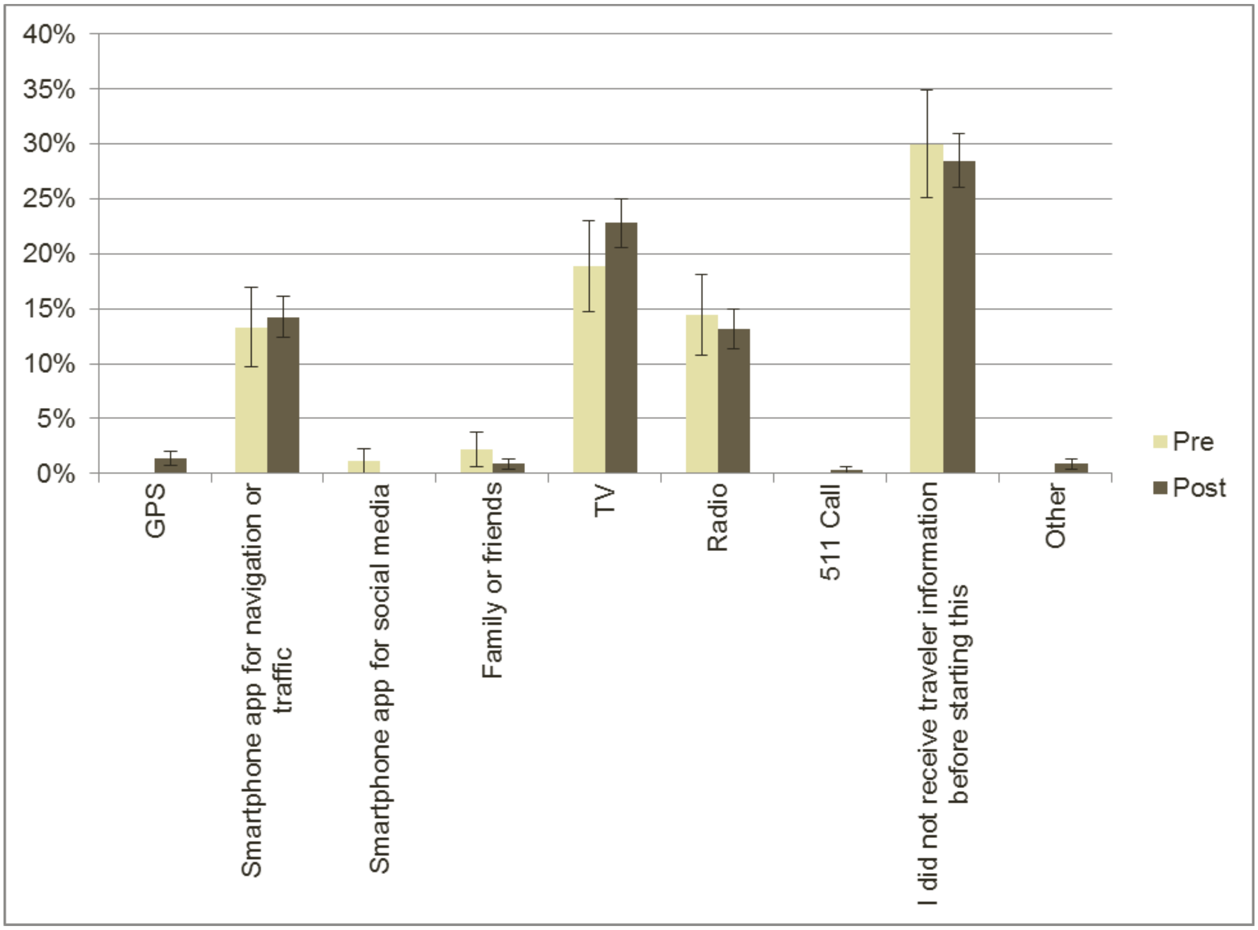


Figure 38. Chart. Pre-trip information sources.

The majority of responses indicated participants did not receive any traveler information before beginning a trip (30 and 29 percent for pre-implementation and post-implementation, respectively). TV, radio, and smartphone app were the remaining popular responses. Very few travelers reported using a GPS, social media app, 511, family/friends, or other. The distribution of responses was similar during the pre-implementation and post implementation phases.

If individuals who chose not to travel on a particular day (which could have been the result of prior plans or new information received prior to the trip) were excluded, the distribution of responses was largely unchanged (see figure 39).

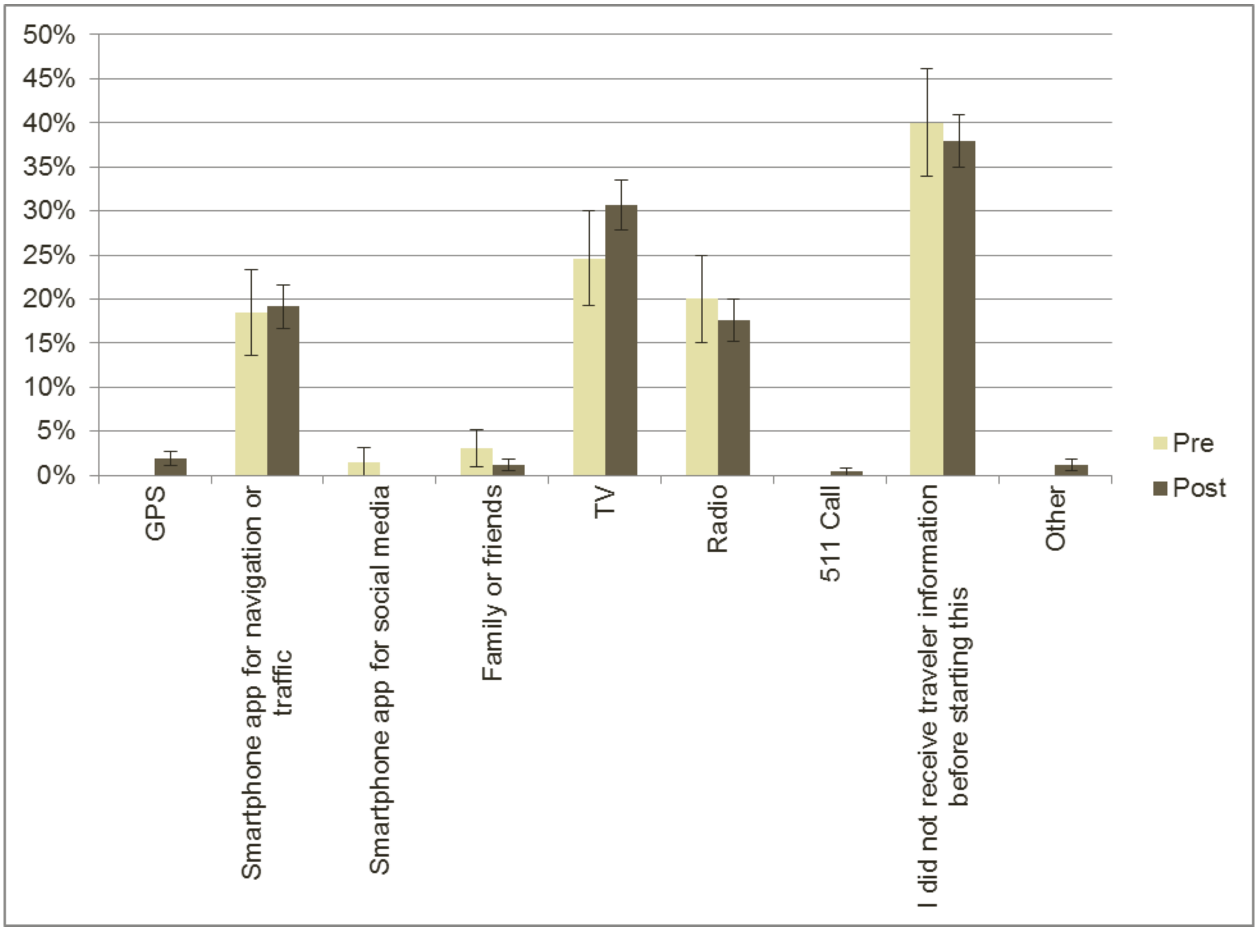


Figure 39. Chart. Pre-trip information sources reported for actual trips taken.

En Route Travel Time Information Sources

Figure 40 shows the distribution of responses when participants were asked the following question: "From what sources of information did you receive traveler information during the trip?" These responses include all participant trips, even if they did not pass directly by the sign. This information is still valuable because it reveals their overall trip patterns and usage of information sources. TV, radio, and smartphone apps were the most common responses, in addition to not receiving travel time information at all.

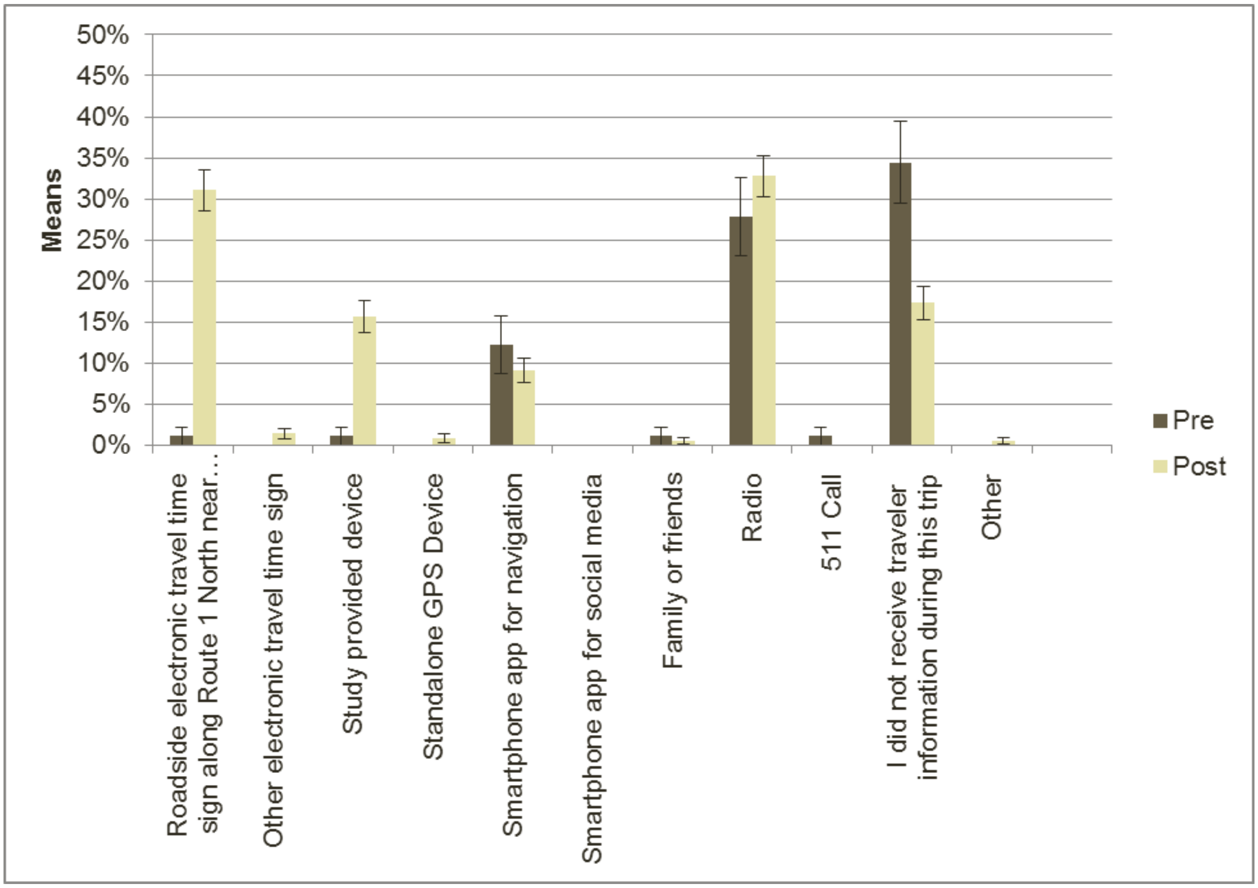


Figure 40. Chart. En route traveler information sources.

The majority of responses indicated participants did not receive any traveler information during a trip in the pre-implementation stage (34 percent). As expected, this number dropped drastically during the implementation phase of the study (17 percent).

A main question of this study was whether people would be aware of roadside and in-vehicle traveler information. Participants would receive roadside traveler information and in-vehicle traveler information if they passed by the researchers' study sign on US-1N, as described in the Methods section. Limiting reported sources to only trips that passed by the study sign showed a similar distribution of sources in both the pre- and the post-implementation phases (see figure 41).

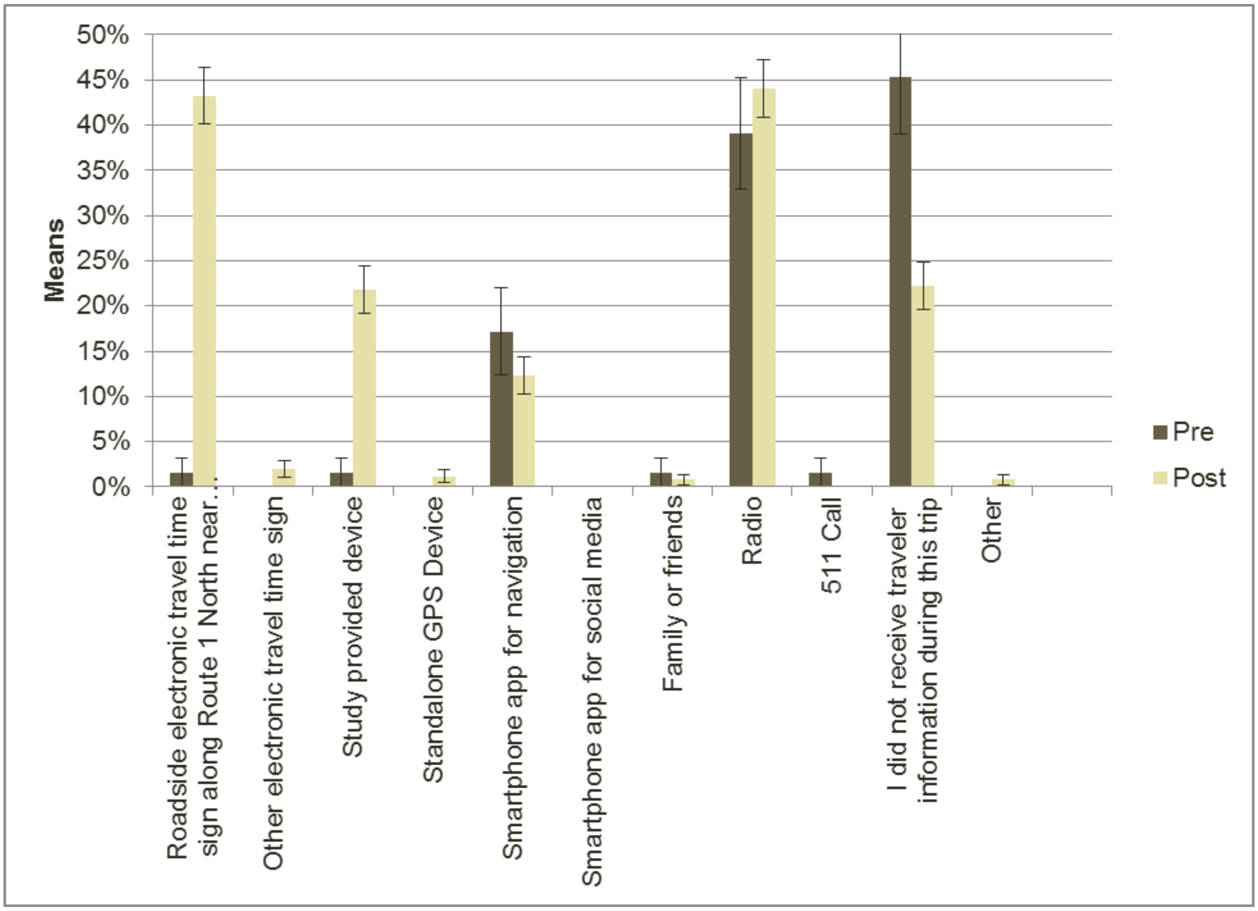


Figure 41. Chart. En route traveler information sources when traveling through the study corridor.

Influence on Route Choice

Participants were asked to provide agreement ratings on whether the traveler information on the sign and on the in-vehicle device influenced their trips. A scale from 1 to 5 was used with 1 = strongly disagree and 5 = strongly agree. Figure 42 shows mean agreement ratings for only actual trips that passed through the corridor of interest during the post-implementation phase. A Wilcoxon Signed-Ranks Test[1] indicated that the influence roadside travel time information was rated significantly higher than device travel time information, $Z = -3.30$, $p < .005$.

[1]The Wilcoxon Signed-Ranks Test is a paired difference test that compares two related samples, repeated measures, or matched pairs to determine whether the mean ranks differ.

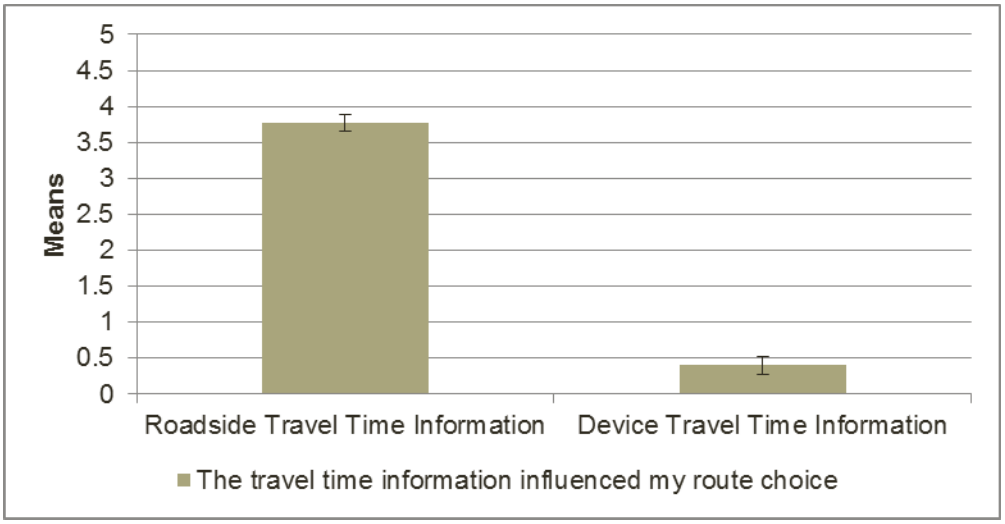


Figure 42. Chart. Mean agreement ratings for route choice influence.

Participants agreed that the roadside travel time sign influenced their route choice. As a reminder, the roadside travel time sign provided FTTs. In contrast, the information provided by the in-vehicle device had minimal impact on travelers' reported route choices. (In-vehicle information was only ATT.)

Usefulness

Participants were asked to provide agreement ratings on whether the traveler information on the sign and on the in-vehicle device was useful. A scale from 1 to 5 was used with 1 = strongly disagree and 5 = strongly agree. Figure 43 shows mean agreement ratings for only actual trips that passed through the corridor of interest during the post-implementation phase. A Wilcoxon Signed-Ranks Test indicated that usefulness of device travel time information was rated significantly higher than roadside travel time information, $Z = -3.51$, $p < .001$.

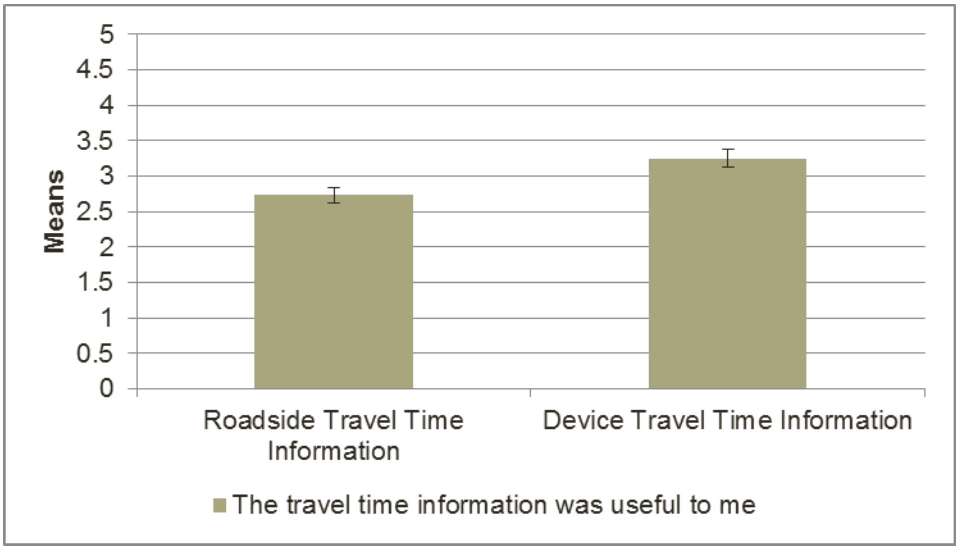


Figure 43. Chart. Mean agreement ratings for usefulness.

Participants rated the in-vehicle device (ATT information) as more useful. The roadside travel time information (FTT information) was also considered useful to the participants but only slightly above the scale midpoint.

Confidence

Participants were asked to provide agreement ratings on their confidence about the travel time information accuracy and whether they made the best decision for their route. A scale from 1 to 5 was used with 1 = strongly disagree and 5 = strongly agree. Figure 44 shows mean agreement ratings for only actual trips that passed through the corridor of interest during the post-implementation phase. A Wilcoxon Signed-Ranks Test indicated confidence in the device travel time information was rated significantly higher than roadside travel time information, $Z = -3.04$, $p < .005$. In contrast, there was not a significant difference between roadside travel time information and device travel time information with respect to confidence in decisions, $Z = -.24$, $p > .05$.

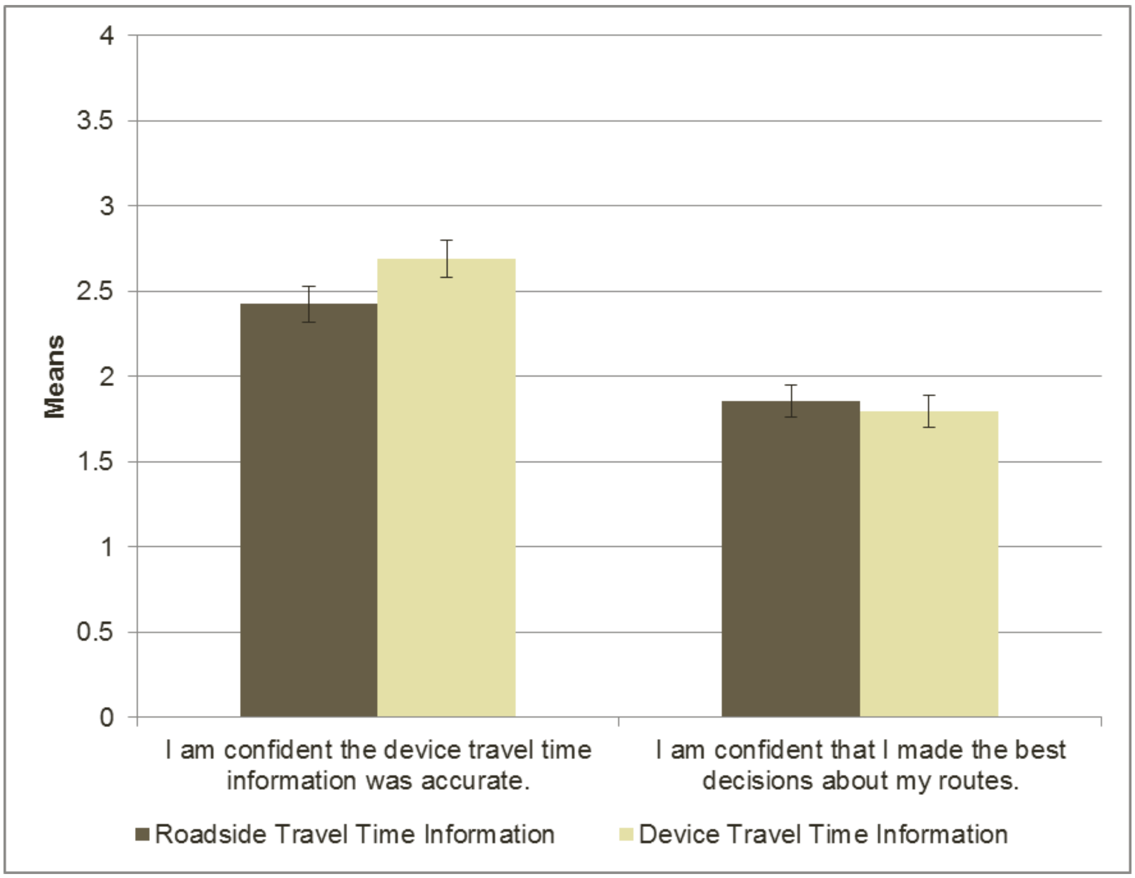


Figure 44. Chart. Mean agreement ratings for confidence.

Overall, participants were not particularly confident in either the accuracy of the travel time information (from both the sign and the in-vehicle device) or their decisionmaking.

Ease of Understanding and Overall Likeability

Participants were asked to provide agreement ratings on their ease of understanding the travel time information and their overall likeability regarding travel time information from both devices. A scale from 1 to 5 was used where 1 = strongly disagree and 5 = strongly agree. Figure 45 shows mean ease-of-understanding ratings and mean overall likeability ratings for only actual trips that passed through the corridor of interest during the post-implementation phase. A Wilcoxon Signed-Ranks Test indicated that ease-of-understanding device travel time information was rated significantly higher than roadside travel time information, $Z = -2.50$, $p < .05$. Similarly, overall likeability of the device travel time information was rated significantly higher than the roadside travel time information, $Z = -4.92$, $p < .001$.

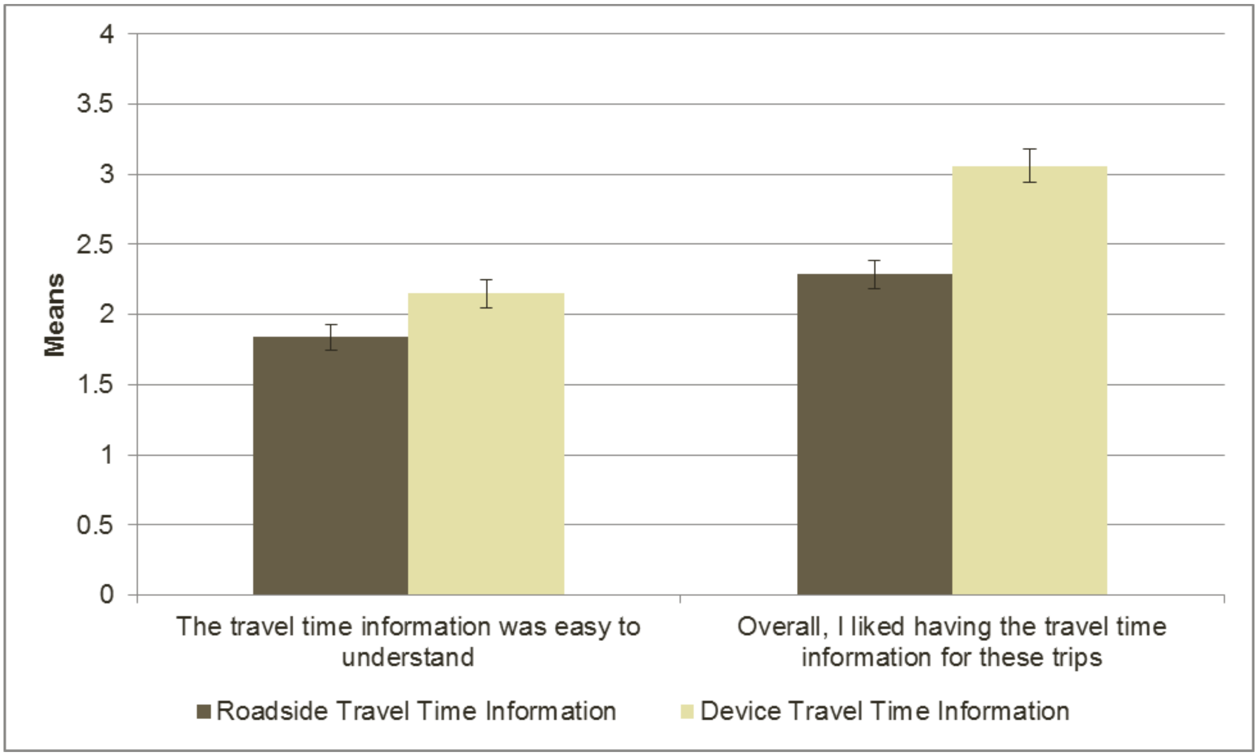


Figure 45. Chart. Mean agreement ratings for ease of understanding and overall likeability.

The ease-of-understanding ratings showed that participants had difficulty understanding both the roadway sign and the in-vehicle device. This may be because the format that VDOT uses for travel time information does not follow guidance from earlier work that showed certain formats are easier to process (see Lerner et al.).[1] Participants were more favorable to having travel time information provided by the in-vehicle device rather than via a roadside sign, but neither rating was particularly high.

Final Travel Log

All participants completed a final questionnaire at the end of the study. As with the weekly logs, participants provided ratings of confidence, ease of understanding, likeability, and influence for the overall study duration (not 1 particular week). A scale of 1 to 5 was used where 1 = strongly disagree and 5 = strongly agree. Figure 46 shows the average ratings on these dimensions.

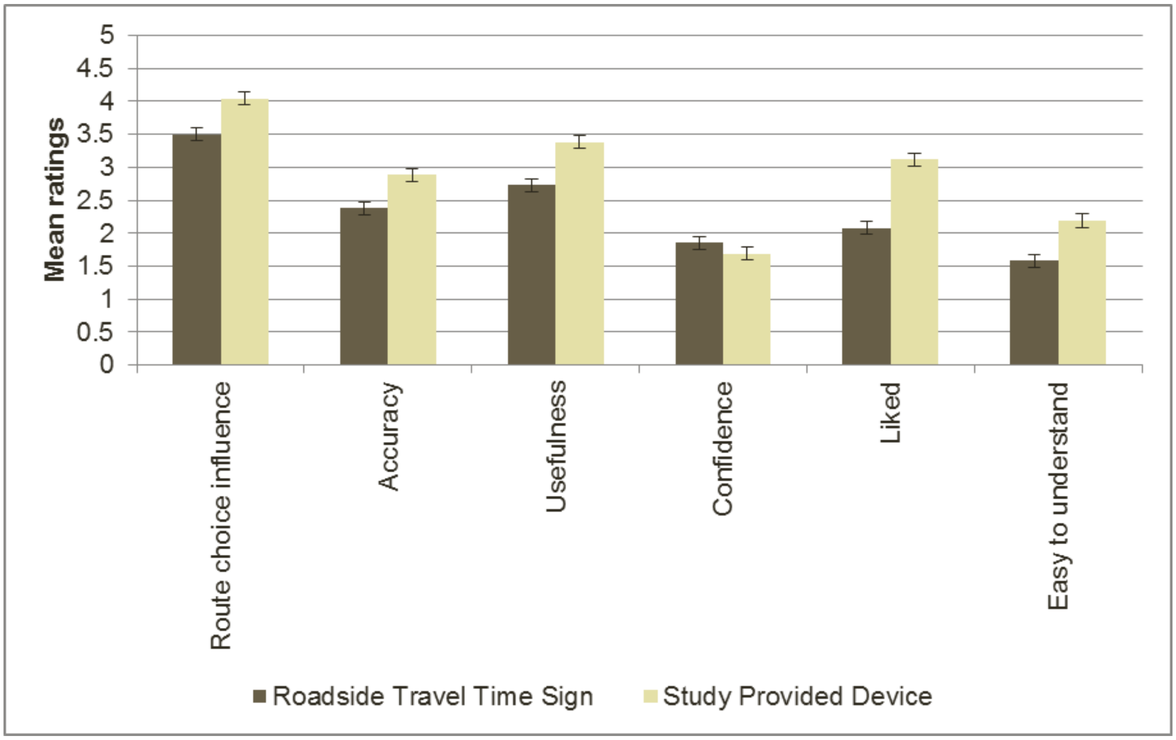


Figure 46. Chart. Mean overall ratings on several dimensions.

Not surprisingly, the patterns were similar to those of the weekly travel logs. Participants reported travel time information from the roadway sign and the in-vehicle device was useful and influenced their route decisions. They also reported liking the in-vehicle device more than the roadway sign for travel time information. Neither source was considered easy to understand, although participants had favorable comments about the presentation of the information in general. Interestingly, confidence was lower than the weekly logs.

When asked about usefulness ratings for both the roadway sign and the in-vehicle device, participants often cited accuracy as a reason. One participant who believed the roadside sign was the most useful said, “It was accurate, and I didn’t have to pull up an app on my phone,” while another who also chose the sign said the information provided was “on time.” When considering both the sign and the device together, one participant said, “The sign was accurate, which helped me make a decision on my route,” while another participant reported that the “info provided on both seemed to be accurate.”

Participants were asked how often the combination of the roadside sign *and* the in-vehicle device influenced their route choice over the course of the study. The ratings were done on a scale of 1 to 10 where 1 = never influenced and 10 = always influenced. Figure 47 presents the proportion of responses for each category of influence, ranging from never influenced (1) to always influenced (10).

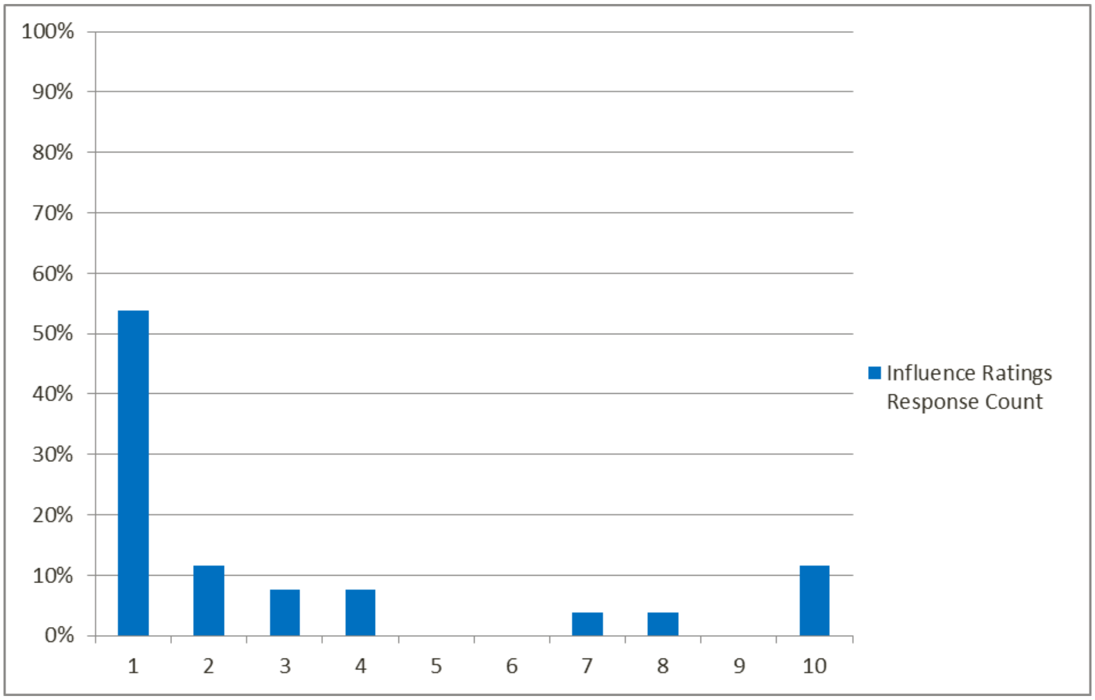


Figure 47. Chart. Mean percentage of responses of each influence rating for combination information.

In what may be indicative of the roadway options along I-95 and US-1N, 54 percent of participants reported never being influenced by the travel time information provided by both the roadside sign and the in-vehicle device. Several qualitative comments indicated hopelessness in finding alternative routes and continuously congested traffic. There were not enough variable travel time data points matched with reported influence ratings by day to analyze conditional influence ratings based on congestion levels, which could have yielded additional insights into influence and diversion behavior. However, it is encouraging that 12 percent of respondents indicated the information always influenced their route choices.

CHAPTER 4. SUMMARY AND RECOMMENDATIONS

This chapter presents key findings of the study and recommended practices for nonfreeway-based travel time displays.

KEY FINDINGS

The primary purpose of the laboratory study was to compare the effectiveness of CMS travel time displays on arterial approaches to freeways compared with freeway-based signs. A secondary purpose was to examine the effectiveness of travel time information for arterial routes. Using a four-part method in a laboratory setting, the research team was able to show participants many different types of signs with different formats and features and determine their preferences, perception of ease of use, and perception of usefulness. In addition, the team was able to differentiate whether participants had a clear understanding about information provided on ATT signs—that is, whether the travel time included the route to the freeway or started at the freeway ramp. The team was then able to gain an understanding of where along their everyday commuting route participants would find travel time signs most useful in making route decisions.

The primary purpose of the field study was to test a field implementation of travel time information presented on an arterial. The field evaluation was conducted with commuters in a before/after assessment on an experimental site ((US-1N) in Virginia). Participants were tracked for 9 weeks and exposed to FTT information presented on a roadway sign and ATT information presented on an in-vehicle device. The methodology was designed to be forward looking and allow for testing the display of travel time messages in locations that might not even have travel time signs. It also allowed more accurate tracking of trip patterns to complement the usual approach of self-reported travel logs. In addition, using smartphone apps to provide this information was relevant because people are becoming more accustomed to using their telephones while driving for a variety of tasks.

Apart from the methodological advancements, the following themes were found throughout the responses provided by participants:

- There was a slight shifting of route choices after receiving freeway and ATT information.
- Participants did receive and use travel time information from the roadway sign and in-vehicle device but also continued using traditional media such as the radio.
- Overall, participants reported their routes being influenced by the roadway travel time sign but not much by the in-vehicle device. This may indicate the importance of roadside travel time signage in affecting traveler behavior regardless of the ubiquity of smartphones.
- Participants were not particularly confident in the accuracy of the information or their ability to make the best decisions.

- Participants want both freeway and arterial information when making route choices.
- Participants indicated the usefulness of a sign located at a key decision point.

The following additional options would be important to investigate in future research using this method: (1) various sign formats similar to the laboratory experiment, (2) comparisons of additional sign locations relative to the freeway entrance, and (3) diversion behavior based on various congestion levels and nonrecurring events. The current study had resource, logistical, and jurisdictional constraints that did not allow for these investigations. However, the research team sees these investigations as vital to better developing an efficient ATT program.

Overall, this study provides a field example of providing travel time information on freeway entrance approaches along with a novel methodology for testing sign location that can be used to investigate these and other research topics of interest for future applications.

RECOMMENDED PRACTICES FOR NONFREEWAY-BASED TRAVEL TIME DISPLAYS

A summary and discussion of information content, as well as recommendations for the design and use of nonfreeway-based travel time displays, follow and are based on the current research as well as the findings of previous research discussed in the FHWA report *Driver Use of En Route Real-Time Travel Time Information*.[(1)] This discussion and recommendations provide the practitioner with specific guidance based on recent research as well as supporting data for use in discussions about which recommendations to adhere to in his or her local community. It should be noted that these general recommendations may not be consistent with some local signing practices and so may have to be adapted according to the local conventions. Regardless, where possible, the information content discussion and CMS recommendations should be considered when developing an ATT program.

Note that in contrast to some foreign applications, travel time displays in the United States are typically provided via CMSs that are not specifically dedicated to travel time messages. Travel time information may be the default when other higher-priority messages are not warranted (e.g., incidents, adverse weather, or Amber alerts). This may preclude the use of fixed-sign elements that simplify the sign and allow additional sorts or amounts of information. The recommendations in this chapter are based on normal U.S. practice and the available findings.

Finally, the size of ATT signs varies by location and jurisdiction. The MUTCD includes guidance on CMS sign size (sections 2L.04, 2A.07, and 6F.52), providing a maximum length of 20 characters over 3 lines (for a total of 60 possible characters), but no specific guidance is given for arterial signs. Most examples described in this report's recommendations are based on a full-sized freeway-type sign (e.g., 20-character lengths) that is often used over freeways but occasionally used on arterials. If a smaller sign is required, practitioners can adjust the example signs accordingly—removing the extra spaces or, if necessary, elements such as "MIN" after travel times.

Information Content Summary and Discussion

This section presents a summary and discussion of recommendations regarding information content for ATT displays.

Message Content

The results of the current study's laboratory experiment showed that drivers who received only information via a freeway route were more likely to divert onto the highway even when the highway is potentially congested. When drivers were provided with both a freeway and an ATT, drivers were more likely to stay on their current route when it was an arterial (i.e., not choose the highway route, which was often considered the default). This is consistent with the research team's earlier work that found a higher propensity to divert if given alternative route information. (The arterials can be considered alternative routes in the current situation.) It is also consistent with the current field study that found individuals were willing to take alternative routes (i.e., arterial roads) when provided with that information, and the travel times were less than the highway times.

Effect of Receiving Freeway-Only Information Versus Freeway and Arterial Information

Travel time signs displaying information about just one location may not provide drivers with enough information to divert their route. When given more information (i.e., travel time information about both a freeway and an arterial), drivers were more likely to stay on their current route when it was an arterial. In other words, drivers who receive only information via a freeway route are more likely to divert and continue onto the highway, which may be potentially congested. In addition, drivers had higher ratings in confidence of knowledge of best route, ease of use, and willingness to divert when given more information (two potential routes).

Conclusion: Travel times to a destination for both arterial and freeway routes are clearly the preferred type of information, as opposed to average travel speeds or levels of congestion.

Effect of Color Coding Travel Times

Some of the signs presented to participants during the laboratory study were color coded, with red indicating bad traffic and green indicating lighter traffic. The data indicated no significant differences between drivers on an arterial receiving color-coded travel time information about that arterial versus non-color-coded travel time information. However, when presented with color-coded travel time information about a freeway while on an arterial versus non-color-coded information, 16 percent more drivers stayed on their current route (the arterial).

Conclusion: It appears possible that color coding has the greatest effect when drivers cannot visually confirm traffic conditions (e.g., on a roadway other than the one they are currently traveling). Also, color-coded travel time information may be more influential to drivers on arterial roads when they receive freeway information rather than arterial road information.

CMS Findings Summary and Recommendations

CMS displays can include many different types of information, including travel time, average speed, distance, and information about delays and incidents on the roadway. These features do not necessarily need to be independent of each other; CMS displays can include several of these information features at one time. The data indicate that travel time (in minutes) is the most desired information on these CMS displays. In terms of displaying information about delays and incidents, more participants indicated that they wanted general information versus specific location information (see figure 48).

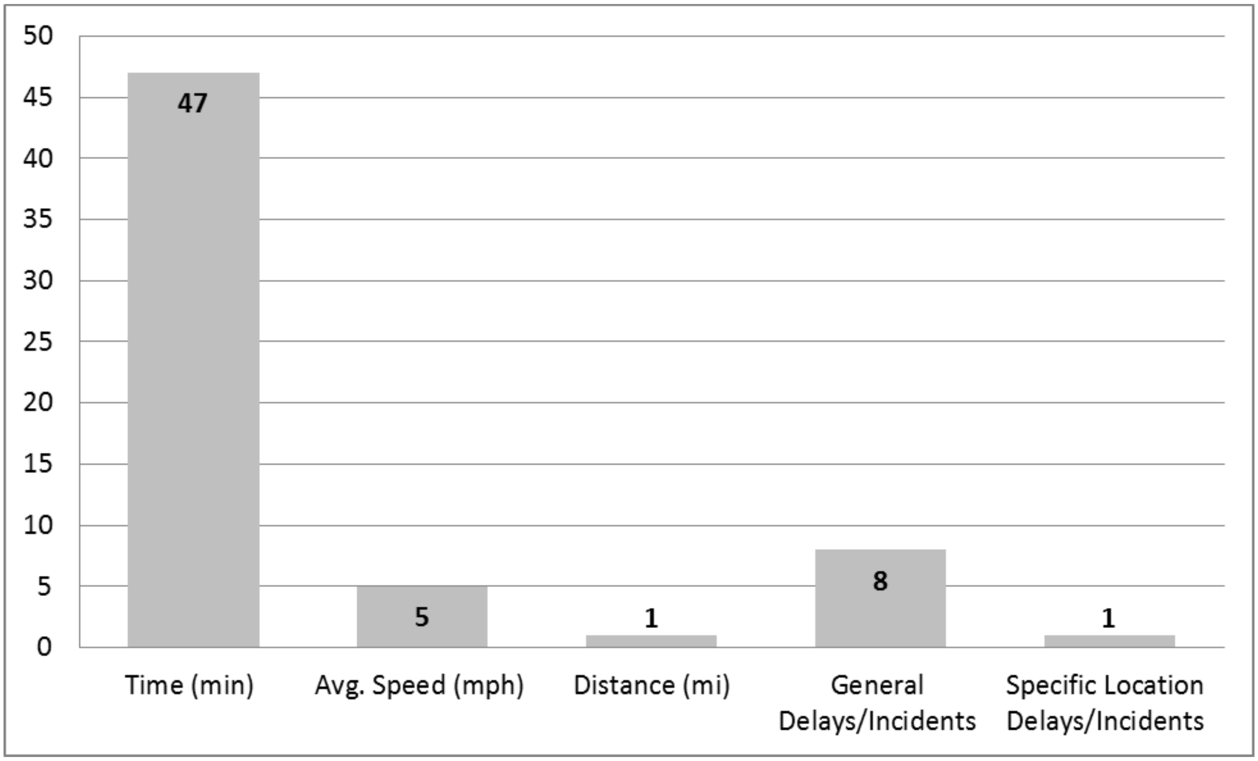


Figure 48. Chart. Type of information on personalized CMS signs chosen by participants.

To maximize route diversion in response to a freeway-based travel time display, the display features depicted in table 16 should be considered.

Table 16. Display features to consider.

Display Description	Display
Recommend using an alternate route (USE ALT RTE)	TRAVEL TIME TO FALLS RD 16 MIN USE ALT RTE
Indicate a specific alternate route (VIA RTE 355)	TRAVEL TIME TO FALLS RD 16 MIN USE ALT RTE VIA RTE 355 12 MIN or TRAVEL TIME TO DEMOCRACY 24 MIN HOV SAVES 5 MIN
Indicate major delay or incident (MAJOR DELAY)	MAJOR DELAYS AHEAD DETOUR SHADY GROVE
Provide an open-ended travel time estimate (30+ MIN)	TRAVEL TIME TO SHADY GROVE 10 MIN GW PKWY 30+ MIN
Show travel times for both current and alternate route	TRAVEL TIME TO PEACHTREE 18 MIN USE ALT RTE VIA RTE 33 7 MIN

Information Limits and Visibility/Legibility

Messages should be concise and to the point. Messages should be limited to no more than three lines of text (where possible) or five to six information units. Lengthy messages consisting of more than six words are discouraged because drivers are unable to read, process, and make a decision about the information all within a few seconds. Although this recommendation is based on freeway speeds and scenarios in earlier work, similar concerns hold for arterial traffic. Drivers may be approaching more slowly (although some arterials can see speeds of 50+ mi/h), but there is also more competing signage, richer environmental cues, and more closely spaced traffic, so drivers may also be limited in how long they can attend to a sign. Therefore, it is recommended that message content consist of only necessary but still coherent information with no more than six words. Each word should consist of less than eight letters. Finally, the use of abbreviations is encouraged. Figure 49 shows an example sign that contains many of these features.

Figure 49. Illustration. Travel time display featuring concise information.

Note that the discussion of information units is based on CMSs and stems from the research that resulted in the FHWA report *Driver Use of En Route Real-Time Travel Time Information*.[1] The MUTCD recommends four or five units, depending on the speed and visibility (see table 17).[4]

Table 17. MUTCD maximum information units and legibility distance by speed.

Speed (mi/h)	Maximum Units	Legibility Distance (mi)[1]
25	5	.5
35	5	.5
45	4	.5
55	4	.5

[1]Legibility distance is the maximum distance at which a driver can first correctly identify letters and words on a sign. The minimum legibility distance is 600 ft for daytime conditions and 800 ft for nighttime conditions. (Taken from 910.3.2.5, Legibility and Visibility of CMS (MUTCD 2L.03).)[(4)]

According to the 2009 MUTCD, for the more common CMS, the longest measured legibility distances on sunny days occur during midday when the Sun is overhead.[(4)] Legibility distances are much shorter when the Sun is behind the sign face (facing the driver), when the Sun is on the horizon and shining on the sign face, or at night. Visibility is the characteristic that enables a CMS to be seen without necessarily having the message processed by the driver. Visibility is associated with the point where the CMS is first detected, whereas legibility is the point where the message on the CMS can be read. Environmental conditions such as rain, fog, and snow affect the visibility of CMSs and can reduce the available legibility distances. During these conditions, there might not be enough viewing time for drivers to read the message, so taking into account environmental conditions is important. When environmental issues cause reduced visibility and legibility or when the legibility distances stated earlier cannot be practically achieved, messages composed of fewer information units should be used, and consideration should be given to limiting the message to a single phase.

In addition, the 2009 MUTCD (see paragraphs above and sections 2L.04, 2A.07, and 6F.52) also provides the following guidance for text size and spacing:[(4)]

- The spacing between characters in a word should be between 25 to 40 percent of the letter height. The spacing between words in a message should be between 75 and 100 percent of the letter height. Spacing between the message lines should be between 50 and 75 percent of the letter height.

- Word messages on CMSs should be composed of all uppercase letters. The minimum letter height should be 18 inches for CMSs on roadways with speed limits of 45 mi/h or higher. The minimum letter height should be 12 inches for CMSs on roadways with speed limits of less than 45 mi/h (which is relevant to most arterial signs).

- The width-to-height ratio of the sign characters should be between 0.7 and 1.0. The stroke width-to-height ratio should be 0.2.

Display Recommendations

This section presents a summary and discussion of recommendatinos regarding format for ATT displays.

Format Type

Simple hybrid signs that include travel times are an acceptable alternate format (see figure 50). These are signs with certain fixed display parts as well as dynamically changing sections. Although simple diagrammatic signs with a static linear depiction of the roadway and that include a dynamic display of travel time and congestion severity are recommended as acceptable, preference for nondiagrammatic hybrid signs has been observed. Nondiagrammatic hybrid signs are the preferred means for receiving travel time information compared with diagrammatic and trailblazer signs.

Figure 50. Illustration. Dynamic travel time information display.

Effect of Alternative Formats

The “hybrid” format received the highest ratings on confidence in knowledge to make the best decision, ease of use, and willingness to divert to another route. The trailblazer-formatted sign received the lowest ease of use rating. Based on the ratings for different sign formats, it seems that participants preferred the “hybrid” sign as a means for receiving travel time information.

More complex display configurations with more than three destinations appear to be too difficult to readily interpret under driving conditions (signs #2 and #3, in figure 51 and figure 52, respectively). These diagrammatic signs are dynamic and represent travel times as well as color-coded congestion information that changes based on conditions. It is important to note that acceptability is limited to no more than three destinations in either format. Note the difference between sign #2 (figure 51) and sign #1 (figure 53).

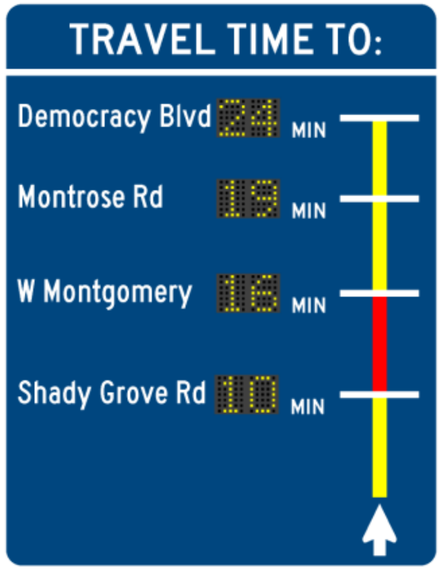


Figure 51. Illustration. Dynamic travel time sign #2.

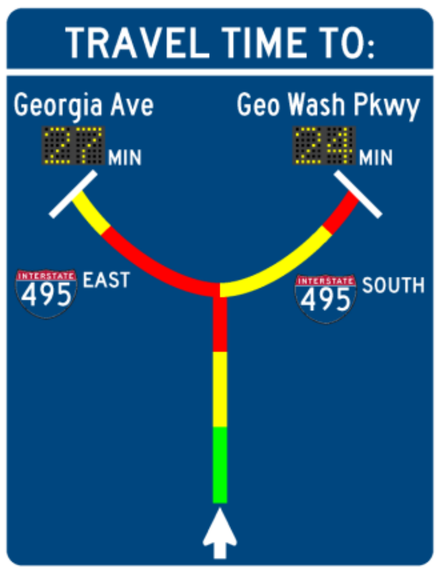


Figure 52. Illustration. Dynamic travel time sign #3.

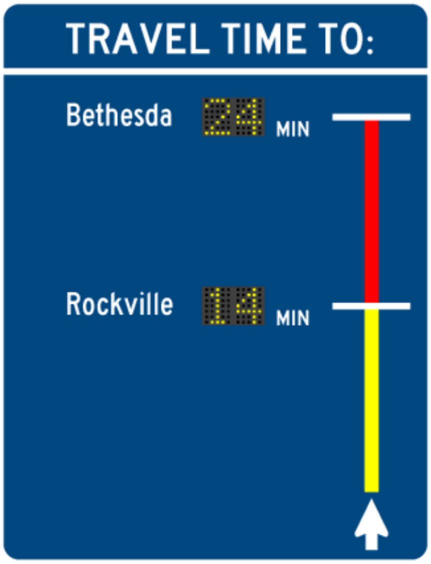


Figure 53. Illustration. Dynamic travel time sign #1.

Destination Information

Overall, it was evident that information regarding destination was highly variable among participants dependent on their own personal commute or desired destination. See figure 31 for the data describing the participants' destination information.

Destinations

As illustrated in the following figures, signs with four destinations (figure 54, sign 3) took longer to process than signs with three destinations (figure 55, sign 2), which in turn took longer to process than signs with two destinations (figure 56, base 1, and, figure 57, sign 19). This relative ordering also held for ease of use and confidence.

Figure 54. Illustration. Sign 3.

Figure 55. Illustration. Sign 2.

Figure 56. Illustration. Base 1.

Figure 57. Illustration. Sign 19.

In addition, the public should be made aware that travel times are updated frequently but the CMS should not be used for this purpose. Consider a fixed-sign component (e.g., UPDATED EVERY 3 MINUTES) and/or a public education campaign (see figure 58).

Figure 58. Illustration. Updated sign example.

Text Positioning

There was a clear preference for text positioning consisting of a centered heading, left justified destinations, and right justified travel times (see figure 59). This structure allows for clear organization of information into separate categories and quick recognition while approaching the sign.

Figure 59. Illustration. Example of a sign with left and right justifications.

Number of Elements

Limit displays to three lines of text with no more than six units of information and two units of information per line (see figure 60).

Figure 60. Illustration. Example of a sign featuring concise information.

Wording of Messages

Describe arterial destinations as street names or towns and freeways as their jurisdictional designation, assuming the display is intended primarily for regular commuters. When displaying travel times on arterials, include the words "TRAVEL TIME TO" for the ATTs and "I-___ TIME TO" for FTTs. The use of exit numbers for FTTs presented on arterials is not recommended.

Destination Type

Results from Lerner et al. indicate that drivers process signs that show street names and town labels faster than signs that label destinations using route numbers, exit numbers, or specific expressway locations (such as a split in the expressway or a State border).(1)

Capitalization and Abbreviations

All of the text should be in capital letters. Standard street abbreviations such as RD, BLVD, etc., should be included in the destination. In addition, the abbreviation MIN should be used to indicate the time units in minutes for travel times (see figure 61).

Figure 61. Illustration. Example of a sign demonstrating recommended capitalization and abbreviation.

Sign Placement Relative to Freeway Entrances Recommendations

This section presents a summary and discussion of recommendations regarding sign placement location for ATT displays.

Distance to Freeway Onramp

Sign position should be at a key decision point that allows the driver to switch lanes before approaching the onramp. Results of the current study indicate that drivers would like travel time CMSs to be placed approximately 0.5 mi from the freeway onramp. Note that this is the participants' preferred location and not the recommended location based on engineering and roadway considerations. Each jurisdiction will have to evaluate its own constraints to find the most optimal locations. However, if all else is equal, participants would prefer to see signs at this distance.

Sign Placement

In addition, drivers indicated that CMS displays of travel time would be most valuable on their final approaches to the freeway. It seems that people want travel time information at a vital decision point in their drive and would prefer to see it on an arterial approaching the freeway onramp rather than on a freeway. Participant responses also suggested that personally optimal sign location is not necessarily in the most densely populated areas. See figure 26 through figure 29 for a more detailed description of the participants' preferred location of personalized signs and for figures describing sign placement and population density surrounding the sign placements.

Concluding Recommendations

In conclusion, the following brief overview presents the qualities and elements of signs that can yield the most effective displays. Several recommendations are provided to improve the dissemination of travel time messages on ATT signs. Overall, a well-positioned sign should contain messages with the following elements to be the most effective:

- Position the sign at a key decision point (i.e., 0.5 mi from the freeway onramp) that allows the driver to switch lanes before approaching the onramp.
- Display destinations, not travel speeds or congestion, and indicate time units (MIN).
- Left justify destinations and right justify times.
- Use street names or towns for destinations (not exit numbers).
- Limit message to three lines of text or five to six information units.
- Use simple linear diagrammatic signs if needed (no more than three destinations).
- Convey frequent updating using a fixed-sign component.
- Maximize route diversion by using the following elements:
  - Recommended alternate route (e.g., USE ALT RTE.).
  - Specific route (e.g., VIA RTE. 355).
  - Major delay or incident information (e.g., MAJOR DELAY).
  - Open-ended travel time estimate (e.g., 30+ MIN).
  - Travel times for both current and alternate route.

Figure 62 and figure 63 are example signs that use the optimal format and follow this guidance.

Figure 62. Illustration. Travel time information display with optimal format (example #1).

Figure 63. Illustration. Travel time information display with optimal format (example #2).

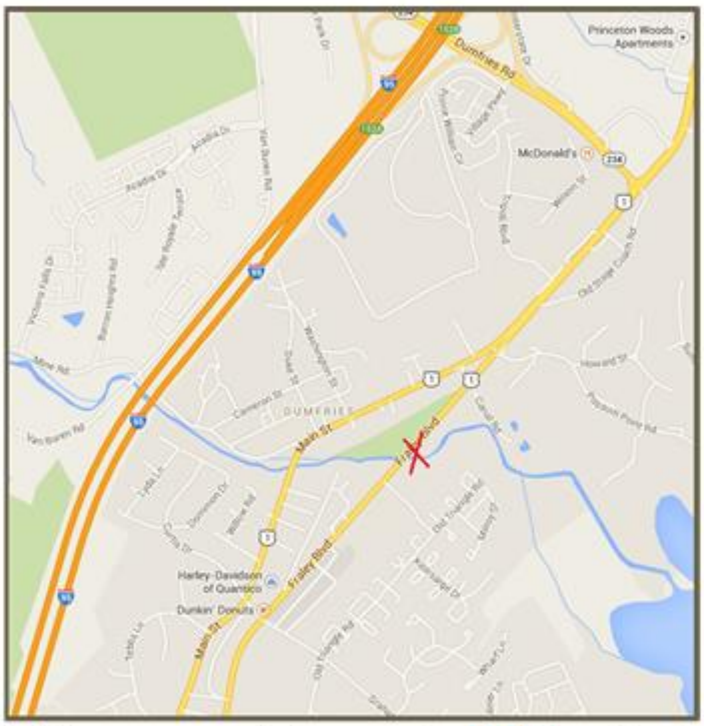
Travel time information presented at key decision points such as freeway entrance approaches can be a powerful tool for operators and managers to better inform travelers. In turn, travelers can make better decisions and take proper actions based on this information. In addition to placing the sign in the best location, information must be presented optimally for the traveler to use it properly. The studies presented in this report provide both laboratory and field insights into message format and location, as well as resulting behaviors by commuters. It is hoped that the guidance distilled from these studies will help operators and managers provide better travel time information to the traveling public.

APPENDIX A. RECRUITMENT FLYERS AND ADVERTISEMENTS

This appendix contains copies of the flyer and advertisements that were used by the research team to recruit drivers to participate.

Drivers needed for traffic study

- ✓ Do you drive along Route 1 North to work?
- ✓ Help improve traffic information in your community!
- ✓ Receive **$200** for participation!
- ✓ Refer an eligible friend for an **extra $20**!



*To be eligible, you must drive past the **red X** on Route 1 North during your morning commute*

Contact Us:

- Visit www.VAcommuters.org
- Call (301) 738-8341
- E-mail TravelTimeStudy@westat.com

We need your help to improve traffic information for Virginia commuters!

If you live in the Dumfries or Triangle areas you may be eligible to participate in a traffic study and receive $200.

To be eligible to participate, you must:

✓ Commute northbound during the morning rush hour
✓ Typically drive on Route 1 North to or beyond Route 234 (Dumfries Road) for at least part of your normal commute

Participants will receive a device to place in their cars for up to nine weeks. The device will identify your route choice **only** during your morning weekday commutes. The device will not identify where your trip begins and ends. Some participants will receive new technology displaying travel time information. Participants will also be asked to complete brief questionnaires. Only one person per household is eligible to participate.

Referral Program

Whether or not you participate in this study, you can earn $20 for each person that you refer to us who is accepted into the study. To earn a referral, have someone who meets the requirements for this study call Westat and provide us with your name, telephone number, and/or email address. We will contact you and arrange to send you a check for $20 per referral. There is no limit to the number of referral bonuses you can earn.

Contact Us

For more information, please call **(301) 738-8341** or send an e-mail to TravelTimeStudy@westat.com.

This study is funded by the U.S. Department of Transportation and conducted by Westat, a research firm located in Rockville, MD.

APPENDIX B. INSTRUCTIONS FOR IN-VEHICLE DEVICE

This appendix provides a copy of the information packet given to the participants in the study conducted for this report.

Travel Time Study for VA Morning Commuters

Participant Information Packet

December 4, 2014

Sponsored by:

The US Department of Transportation
Federal Highway Administration

Packet Contents

Welcome

Welcome to the Travel Time Study for VA morning commuters!

This packet provides useful information about your participation in the study. Please keep this packet throughout the duration of the study and refer to it as necessary.

If you have any questions about the study, please do not hesitate to contact us.

Equipment Technical Support

(Includes evening and weekend support)

- By Phone: (240) 888-1954
- By Email: TravelTimeStudy@Westat.com

General Study Questions

- Diane Snow: (301) 738-8341
- Dan Kellman: (301) 610-4903
- Email: TravelTimeStudy@Westat.com
- Website: www.VAcommuters.org

About the Study

The purpose of this study is to learn how commuters make decisions about their trips and how they use traveler information. Your participation will help guide decisions about how traffic information should be conveyed to the public.

You are being provided with an electronic device which will connect to a power outlet in your car. The device will identify the route you take only during morning weekday commute hours. Data will not be stored that identify where your trip begins and ends, and the device will not collect information about any other trips you make throughout the day. The device will occasionally provide you with new technology displaying travel time information when you are traveling along Route 1 North. During the study, you will be asked to complete trip logs and questionnaires about your trips and your commuting habits.

The study will be conducted in two phases that last from December 8, 2014 through February 20, 2015.

- **PHASE 1: Monday, December 8, 2014 – Friday, December 19, 2014 (2 weeks)**
- BREAK: Saturday, December 20, 2014 – Sunday, January 4, 2015 (2 weeks)
- **PHASE 2: Monday, January 5, 2015 – Friday, February 20, 2015 (7 weeks)**

Although the device will be in your car through mid-February, this study will only require a total of about 3 hours of your active involvement. During the break, you will not be responsible for completing any trip logs. Also, during the break, please shut down and place your device in a safe location.

You will receive $200 for completing the full study.

This study is sponsored by the US Department of Transportation in cooperation with the Virginia Department of Transportation, and is being conducted by Westat, a research company located in Rockville, Maryland.

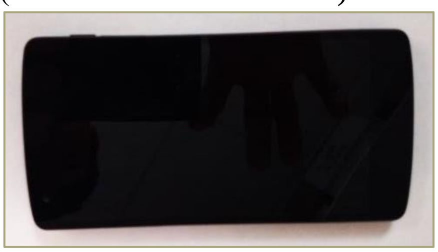
Package Materials

The following materials are included in this package. Please check your package to make sure all of the listed materials are included. If you did not receive any of these items, or if you think there might be a problem with any of the items you received, please contact Westat immediately.

Please keep all packaging, including bubble wrap and the FedEx box, so you can use it again to return the materials when the study ends.

1. Information Packet (this document)
2. Consent Forms – 2 copies
3. Business Reply Mail Envelope
4. Tape (optional for securing cords)
5. Goo Gone (optional for removing tape residue)
6. Pre-paid FedEx Packaging Sticker for returning the equipment at the end of the study

7. Nexus 5 Travel Time Device (referred to as '*the device*')



8. Windshield Mount

9. USB Charging Cable

10. Car Port Power Splitter

Completing the Consent Form

There are two copies of the consent form. Please **<u>review and sign one copy and return it to Westat as soon as possible</u>**. Do so by placing the signed consent form in the Business Reply Mail Envelope. You do not need to pay postage. The other copy of the consent form is yours to keep for your records. Equipment Setup Instructions

Once you receive this package, it's important to set up the device to ensure that you are comfortable with the device and that everything works properly. Please follow the instructions below as closely as possible and set up the device **prior to the December 8th start date**. If you have any questions about the equipment during the duration of this study, please contact us at (240) 888-1954, or email TravelTimeStudy@Westat.com.

For the first few steps, you'll need the following items:

1. Windshield Mount
2. Travel Time Device
3. USB Charging Cable
4. Car Port Splitter
5. Damp paper towel or cloth

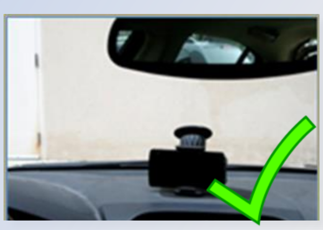
Step 1: Selecting a Mounting Location

Before setting up the mount, please consider the following recommendations about where to place the mount:

- **Do not place the mount in a location that blocks your vision or obstructs your view of the road.**
- **Place the mount in a spot that will enable you to glance quickly at the device, while keeping your eyes on the road as much as possible.**
- **Please note that a cord will be attached to the device in the mount. As you decide where to place the mount, keep in mind how the cord may hang from the device.**

Recommended location:

Place the mount low down on your windshield near the center of your dashboard.



Alternate location:

Place the mount up high, just below your rear view mirror.

NOT RECOMMENDED:

Do not place the mount in a way that obstructs your view of the road, like in the center of the windshield.

Step 2: Placing the Mount

Once you have decided where to place the mount, follow these instructions to secure the mount to your windshield.

1. **Clean mount area**. Use a damp paper towel or cloth to clean the area that you intend to place the mount. Wait for the area to dry.
2. **Secure suction cup**. To place the mount, hold the mount by its base, with the suction facing up. Press the suction cup against the windshield using two hands.
3. **Rotate wheel clockwise**. While applying pressure, twist the wheel clockwise until the mount feels secure and you feel resistance.
4. **Check for secure hold**. Once attached, gently tug on the mount to make sure it is sturdy.

Step 3. Twist the wheel clockwise to tighten the mount.

Step 3: Making Adjustments

Adjust the hinges on the mount so that the face of the mount is facing towards the driver's seat. Press the round buttons that say "press" to adjust the hinges. Then, rotate the face of the mount so it sits horizontally in a position that is comfortable for you. You can always make adjustments to the mount position later if you decide you need to.

Mount adjustment buttons

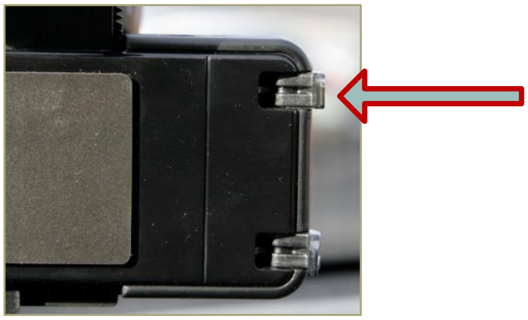
Removing the mount

Once the mount is up, you won't need to remove it until the study is over. However, if you need to remove the mount for any reason, twist the wheel counter-clockwise. Once it has loosened, use the small tab on the suction cup to peel the suction away from the windshield and lightly tug on the mount to remove it.

Step 4: Placing the Device

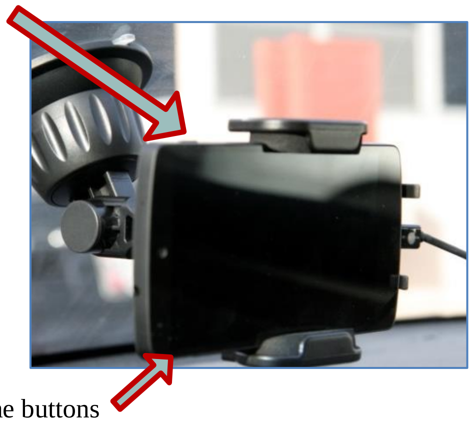
Once the mount is adjusted and secured, you are ready to place the device into the mount.

1. **Lift up the small plastic hinges** on the front of the mount. These pieces will secure the device in place.



2. **Press the small black button on the back of the mount face**. This should open up the prongs on the top and bottom of the face of the mount.

3. Once opened, **place the device inside the prongs and close the prongs tightly around the device**. When you close the prongs, they may hold down the volume buttons on the bottom of the device. This may cause settings to change on your phone. If necessary, reposition the device so that the buttons are not being held down.



Step 5: Checking Your Car's Power Supply

For the next step, you'll need the splitter that fits into the car port/cigarette lighter.

<u>While your car is turned off and the keys removed</u>, plug the splitter into your cigarette lighter. When you plug the splitter into your cigarette lighter, **pay close attention, as the splitter will have one of two reactions**:

<u>RESULT 1</u>: The red light indicator on the splitter DOES NOT turn on.

Splitter with light turned off

This means that your car **does not** provide power through the charging port unless the car is turned on. If the red light indicator does NOT turn on when you plug in the splitter, **you will always be able to leave your device plugged in**.

OR

<u>RESULT 2</u>: The red light indicator on the splitter DOES turn on.

Splitter with light turned on

This means that your car provides power through the charging port, even when the car is turned off. If the red light indicator DOES turn on when you plug in the splitter, **you should <u>NOT</u> leave the device plugged in except during the morning commute.** Instead, throughout the study, you should:

1. PLUG THE DEVICE IN every morning when you enter the car, AND
2. UNPLUG the device every morning when you have arrived at your destination and are turning off your car.

The device requires very little power, so if you do happen to leave it plugged in it is very unlikely that your car's battery will die. But, to be extra cautious, we recommend unplugging the device (or simply unplugging the splitter) every time the car is turned off.

If you have any questions about whether your device can stay plugged in or not, please feel free to contact us at (240) 888-1954, or email TravelTimeStudy@Westat.com.

Step 6: Setting up the Charger/Splitter

> ***Note:*** *IF YOU HAVE AN AVAILABLE USB PORT IN YOUR VEHICLE, you do not need to use the splitter, but you are still welcome to use it if you would like. Otherwise, you can simply use the USB port in your vehicle to plug in and charge the device. However, please still follow the instructions in Step 5 to test whether or not you should keep the device plugged in when the car is turned off. If you have any questions, please contact us.*

1. If not already plugged in, plug the splitter into the car port/cigarette lighter on your car. Then, plug the device charging cable into one of the USB slots on the splitter.

Splitter with USB charger plugged in

2. Next, plug the other end of the device charging cable into the Travel Time device. If you'd like, use the tape provided to secure the cord and keep it in a stable position while you drive. Place the splitter in a location where it will stay out of your way for the duration of the study. The other car port/cigarette lighter is available for your personal use.

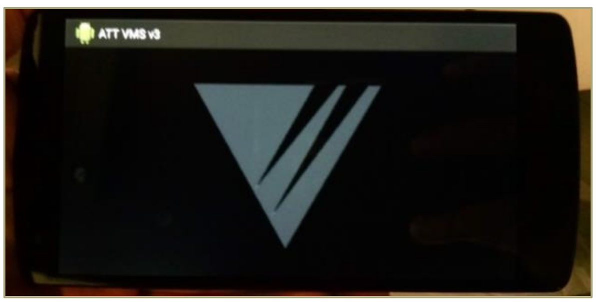
Mounted device with cable plugged in

Step 7: Turning on the Device

Once you've set up the mount, inserted the device, and plugged everything in:

1. **Turn on the ignition to your car**.
2. **Locate the power button on the side of the device.**
3. To turn on the device, **press and hold down the power button** located on the side of the device until you see the screen light up.

Power button



Travel Time Application (ATT VMS) screen

The device should briefly show the main home screen before automatically opening up the ATT VMS Travel Time application (app screen shown to the left).

IF YOU DO NOT SEE THE ATT VMS APPLICATION SCREEN (pictured above), open the application manually by clicking on the ATT VMS icon from the home screen of the device. The ATT VMS app icon has a small picture of the Android logo (pictured to the right).

IF YOU THINK THERE IS A PROBLEM WITH THE DEVICE, call the technical assistance number right away at (240) 888-1954, or email TravelTimeStudy@Westat.com.

Once you have confirmed the device is on and see the ATT VMS home screen, you can turn off the ignition to the car and remove and unplug the device **until the morning of December 8th**. **DO NOT TURN OFF THE DEVICE**. **The device will go into a power saving mode.** The next time the device is plugged in and the car ignition is turned on, the ATT VMS application will start up automatically.

Note: The device cannot receive any calls or messages. Do not attempt to make calls, download apps, or use the device in any other way than the purposes outlined in this document.

Your Role

<u>BEGINNING DECEMBER 8, 2014, every weekday morning, when you get into the car:</u>

- Place the device into the mount.
- Plug the USB charging cable into the device.
- Check to make sure the other end of the USB charging cable is plugged in to the splitter and that the splitter is plugged in to the car port.
- Turn on the car.
- The device should be turned on. If it is not, hold down the power button to turn on the device.
- Make sure the ATT VMS application is running. If the application is not running, manually launch the application by clicking on the ATT VMS icon.

<u>Every weekday morning, when you arrive at your destination and turn off the car:</u>

- The device screen will go dim, and the device will go into a power saving mode. During the study period**, do not turn the device completely off. It is designed to run constantly with minimal drain on the battery**.
- When you turn off the car, the device will display a message reminding you to fill out your trip log. Although you will see this reminder every day, you will only need to fill out your trip log if it is a **Tuesday or a Wednesday** (see calendar on page 11). **If it is a Tuesday or a Wednesday, please complete your trip log for that day, <u>whether or not you drove to work.</u>**
- Then, for security, we recommend that you remove the device from the mount and place it in a secure location within the car, such as a glove compartment, console, or under the seat.
  DO NOT TURN OFF THE DEVICE. You may leave the device stored until the next morning, when you should re-mount the device (and if necessary, re-plug in the device).

Note: IF YOUR CAR CONTINUES TO PROVIDE POWER THROUGH THE CAR PORT WHEN THE CAR IS OFF (SEE STEP 5), YOU WILL ALSO NEED TO UNPLUG THE DEVICE AFTER EACH MORNING COMMUTE. OTHERWISE.

For the first two weeks of the study, you will not receive any information from the device. However, starting on January 5th, 2014, you will receive information about travel time for a segment of your commute along Route 1 North. **If you notice that you are not receiving any travel time information on or after January 5th, please contact us.**

Throughout the study, in order for the device to collect data, the splitter and the device charger must be plugged in during your morning commute and the device must be on. Please be sure to always have the splitter and device charger cord plugged in every morning before you begin to drive.

Study Calendar and Trip Log Schedule

As part of your participation in the study, you will complete brief trip logs about some of your morning commutes. **Beginning on Tuesday, December 9th, you will be complete a trip log for every Tuesday and Wednesday morning trip. The trip logs will be emailed to you daily with a unique link to complete the log. Always try to fill out your trip log as soon as possible after your trip is completed. Even if you don't travel that day, or if you don't commute to work, you still need to complete the log.**

Reminder: In order to receive the full $200, completing all trip logs in a timely fashion is required.

During the break, please power down the device and place it in a safe location.

December 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
7 Set up equipment by today.	**8** PHASE 1 START	**9** TRIP LOG	**10** TRIP LOG	11	12	13
14	15	**16** TRIP LOG	**17** TRIP LOG	18	**19** PHASE 1 END	20
21	22	23	24	25	26	27
28	29	30	31			

BREAK: DECEMBER 20 - JANUARY 4

January 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	**5** PHASE 2 START	**6** TRIP LOG	**7** TRIP LOG	8	9	10
11	12	**13** TRIP LOG	**14** TRIP LOG	15	16	17
18	19	**20** TRIP LOG	**21** TRIP LOG	22	23	24
25	26	**27** TRIP LOG	**28** TRIP LOG	29	30	31

BREAK: DECEMBER 20 - JANUARY 4

February 2015

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	**3** TRIP LOG	**4** TRIP LOG	5	6	7
8	9	**10** TRIP LOG	**11** TRIP LOG	12	13	14
15	16	**17** TRIP LOG	**18** TRIP LOG	19	**20** PHASE 2 END	Study end. Return equipment.

Mailing Back the Equipment

Your participation in the study will be completed after February 20, 2015. As soon as possible after the study is over, please pack the equipment back into the box you received the materials in. Once the box is packed, you can use the provided pre-paid FedEx packaging slip to mail the package to Westat.

- **Step 1:** Wrap the Nexus 5 Travel Time device and windshield mount in the bubble wrap.
- **Step 2:** Place the following items into the box and seal the box with packing tape (if you do not have tape to seal the box, please contact us).
    - Nexus 5 Travel Time device
    - Device USB charger
    - Device windshield mount
    - Car port power splitter
- **Step 3**: Write the current date on the pre-paid FedEx sticker, and place the sticker on the box. Keep the "Sender's Copy" top page for your records.
- **Step 4:** Use one of the following return options to mail back the FedEx package:

  Option 1: Take the package to a FedEx Drop Box or to FedEx Office Location.

  To find the nearest location, visit www.fedex.com, or call 1-800-GO-FEDEX (1-800-463-3339).

  Option 2: Schedule a FedEx pickup at your home or office.

  To schedule a pickup, visit www.FedEx.com/pickup, or call 1-800-GO-FEDEX (1-800-463-3339). Tell the FedEx representative you have a pre-paid return package.

Study Completion and Payment

Once the package has been returned to Westat, we will mail you a check for $200 to thank you for your participation in the study.

If you have any questions about the study or receiving your payment, please contact us. Thank you for your participation and for helping to improve traffic information for VA commuters!

ACKNOWLEDGEMENTS

The research reported herein was performed under the Federal Highway Administration's TMC Pooled Fund Study under contract DTFH61-06-D-00007. The original maps included in this report are the copyright property of Google® Maps™ and others and can be accessed from http://maps.google.com. The map overlays were developed as a result of this research project. The overlays include lines, arrows, and labels.

The authors give special thanks and acknowledgement to Dr. Brian Philips, who served as the Federal Highway Administration Government Task Monitor for this project, as well as Jimmy Chu, who served as the TMC Pooled Fund Study liaison. In addition, the authors would like to acknowledge TMC Pooled Fund Study panel members who provided advice and reviews throughout the project.

The authors also would like to give special thanks to the Virginia Department of Transportation for graciously offering use of dynamic message signs for the field implementation study, coordinating usage with in-vehicle messaging, and providing guidance for the best time to perform the field study. The field implementation study would not have been possible without its assistance.

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