Abstract

MARIPALLI, UDAY. The Human Factors Effects of Nine-Panel Logo Signs. (Under direction of Dr. Joseph E. Hummer.)

At many interchanges on North Carolina freeways, the number of businesses providing motorist services has grown. When the number of qualifying businesses providing a certain service at an interchange exceeds the number of logo panels allowed per sign—currently six—the NCDOT faces a dilemma. One option for the NCDOT is to increase the number of logos allowed per sign. The main concern is for motorist safety, in that drivers taking longer to read and comprehend signs may be distracted from more important parts of the driving task.

The objective of this project was to determine whether nine-panel logo signs cause negative impacts on drivers from a human factors point of view. In particular, this project attempted to determine:

1. How do drivers use logo signs?
2. Do the logo signs with more than six panels have any negative impacts on safety of the driver?

Objective one was achieved by administering a driver survey. A 10-question form was developed, and the survey was administered at two rest areas off of interstates that already have some pilot nine-panel logo signs. The survey data provided insight into how motorists use panel logo signs. It was found that more drivers scan logo signs for a particular brand than read all of the logos. It was also found that most drivers use logo signs at some point, and that the most-frequently used logo sign is for gasoline, followed by the sign for food. However, drivers do not scan for particular brands of gasoline as often as for food or lodging.

The second objective was achieved by conducting a slide-based experiment and by developing driver information load profiles. Thirty seven volunteer subjects participated in the experiment, in which the subjects were first given the name of a brand to scan for

and were asked to indicate with a “yes”, “no”, or “not sure” response whether the specific business was represented on the sign. Six-panel and mixed-use signs performed better than nine-panel signs. However, the margin of difference in many cases was not significant. It was concluded that nine-panel logo signs performed well from a human factors point of view. Their correct response percentages were usually competitive with, and sometimes surpassed, the mixed-use signs, and were not far behind those of the six-panel signs.

Driver information load profiles were developed using “Driver Information Load Software” developed by NCHRP to compare the load given to a driver by six panel logo signs to nine panel logo signs. A three lane highway of 11000 ft with one exit where the driver is assumed to make a maneuver was analyzed for six-panel and nine-panel logo signs. At a single point on the roadway, a nine-panel sign will likely distract some drivers away from the more important driving tasks longer than a six-panel or mixed-use sign. However, driver information load profiles showed that the information load demand for nine panel logo sign is only slightly higher than six panel sign; hence the distraction levels may not be substantial enough to cause a safety concern. It was concluded that nine-panel food or gas logo sign would impart equal amount of information load on driver as that of a six-panel double-exit logo sign. The research concluded that nine-panel logo signs performed well from a human factors point of view and there is no need to prohibit the use of nine-panel logo signs.

THE HUMAN FACTORS EFFECTS OF NINE-PANEL LOGO SIGNS

by
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Dedication

This work is dedicated to my mentor and graduate advisor Dr. Joseph E. Hummer.

Biography

Name	Uday Krishna Maripalli
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I am always grateful to my parents and grand parents, whose constant support, encouragement and blessings have made it possible for me to come to the United States to pursue my higher degree. I thank Mr. Slade McCalip for his valuable feed back and discussions on my report writings.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Introduction

Logo signs have been a popular and effective program of the North Carolina Department of Transportation (NCDOT) and nationally for a number of years. They provide information vital to motorists in an efficient manner that minimizes the need for billboards. Currently, logo signs are provided at many interchanges for gasoline, food, lodging, camping, and attractions.

At many interchanges on North Carolina freeways, the number of businesses providing motorist services has grown. When the number of qualifying businesses providing a certain service at an interchange exceeds the number of logo panels allowed per sign—currently six according to the *Manual on Uniform Traffic Control Devices*[1] —the NCDOT faces a dilemma. The NCDOT could simply refuse to add more logos; this might have negative consequences such as unhappy business owners, confused motorists, and encouragement for billboards. The NCDOT could spread logos from one type of service onto several signs, including splitting a sign between two types of services. This could also have negative consequences, including motorist confusion due to violation of longstanding signing conventions.

One other option for the NCDOT is to increase the number of logos allowed per sign. Allowing nine logos per sign would apparently accommodate most of the situations around the state where there are more than six qualifying businesses per type of service. As a test as of January 2006, the NCDOT had installed signs with more than six logos, and up to nine logos, at about 12 interchanges, with plans for about three more interchanges.

The Federal Highway Administration (FHWA), exercising its authority over signing on Interstate routes, has expressed concern about the logo signs with more than six-panels. The main concern is for motorist safety, in that drivers taking longer to read and

comprehend the larger signs may be distracted from more important parts of the driving task. The FHWA has requested the NCDOT to conduct investigations of logo signs with more than six logos to determine whether there are such safety affects, and if so how extensive they are.

1.2 Objective

The objective of this project was to determine whether logo signs with nine-panels cause negative impacts on drivers from a human factors point of view. In particular, this project attempted to determine:

1. How do drivers use logo signs? For example, do drivers scan signs just for one favorite business, scan until they see one of a set of acceptable businesses, scan just to see how many businesses are present, or scan using some other patterns? This was approached by creating and administering a driver survey. Data would show how drivers use logo signs, such as whether they scan them or read them, whether they look for specific businesses or just varieties of businesses, or whether they use them at all.

2. Given the answer to objective one, do the logo signs with more than six panels have any negative impacts on safety of the driver? For example, does it take drivers longer to read and comprehend the nine-panel signs? This objective was achieved through a laboratory study in which respondents sitting in a lab viewed images of logo signs projected on a screen and also by developing driver information load profiles for different cases of six and nine-panel logo signs.

Rural uncongested driving conditions existed for drivers taking the survey; subjects of the laboratory study and for the driver information load profile development. The remainder of this report is divided into three main parts. Chapter 3 describes the conduct and results of the motorist survey related to objective one above, Chapter 4 describes the conduct and results of the lab study related to objective two above, while Chapter 5 describes the methodology and software used to develop driver information

load profiles and their results. Two other chapters in this report are Literature Review (Chapter 2) and Conclusions and Recommendations (Chapter 6).

2. Literature Review

2.1 Introduction

Logo signs, officially known as specific service signs, are used to create and implement a system of signing for the purpose of displaying information to the traveling public about the services such as food, gas, lodging, etc. The MUTCD defines specific service signs as *"guide signs that provide road users with business identification and directional information for services and for eligible attractions"* [(1)]. Logo signs are installed to help the traveling public locate key services that are available near a particular interchange exit. These signs may be used on any class of highway but are primarily used on interstates and freeways in advance of interchanges. There are five types of logo signs that direct the motorist to a specific type of service. Those five types include gas and associated services, food services, lodging services, camping services and attraction services. On each panel, there is space for up to six individual business logos which alert the travelers to the services that are available at each interchange. Along the off-ramps at each interchange are smaller signs that indicate the direction and distance to each business from the exit ramp. This allows the motorist to quickly and easily locate required services. Figure 2.1 shows an example of logo sign.

Fig 2.1 Example of specific service sign

2.2 History of Logo Signs

Logo signs were known as service signs when they first came into existence. They had a blue background with combination of the words “FOOD,” “GAS,” LODGING,” and/or “PHONE” written depending upon the services that are offered at the next exit [(2)].

The “*Highway Beautification Act of 1965”* provided for logo signs on the Interstate system [(3)]. The Oregon Motorist Information Act of 1971 enabled all states to provide highway logo signs for businesses that provide gas, food, lodging or camping services from interstate highways [(4)]. Soon thereafter, several states developed pilot programs to test the effectiveness of this type of signing. Specific service signs were first incorporated into the MUTCD in the 1971 edition. At that time only two service categories and only two logo panels per service category were allowed on a specific service sign. The number of logo panels allowed on each sign was increased from four to six in 1988 edition of MUTCD [(2)]. The number of service categories allowed per sign was increased from two to three in the 1988 edition of the MUTCD. By 1990, thirty eight states displayed logos for identifications for various gas, food, lodging and camping facilities in their states, North Carolina being one of them [(5)]. At the same stage, another six states were in planning stage for adopting similar programs.

Initially, logo signs were reserved only for Interstates and controlled-access highway systems, but with support from motorists, logo signs were soon being installed on other major highways and in some cases, on two-lane roads. This expansion in the logo signing program forced many states to consider issues such as: number of signs on a panel, distance from the road to business location, number of panels on a motherboard, etc. All these presented challenges for new programs [(5)].

2.3 Current Guidelines and Standards

MUTCD standards define a logo sign (specific service sign) as, guide signs that provide road users with business identification and directional information for services and for eligible attractions [(1)]. According to the MUTCD, logo signs can only be installed in rural areas or in areas where adequate sign spacing can be maintained. It is not recommended to install a logo sign at interchanges where the traveler cannot easily reenter the freeway to travel in same direction. For businesses to get qualified to appear on logo signs, the businesses must comply with all applicable laws concerning the provision of public accommodations without regard to race, religion, color, age, sex, or national origin. Each specific category has its own requirements to get qualified for representation of business on logo sign [(1)].

- **Gas services** should be licensed; provide fuel, oil, and water, free air or tire repair; have restrooms; have public telephone; sanitary facilities and operate at least 16 hours per day, seven days a week, for freeways and expressways.
- **Food services** should be licensed, provide at least two meals a day, and be open six days a week, and have a public telephone.
- **Lodging services** must be licensed, provide adequate sleeping accommodations, have a public telephone, and have proper sanitary facilities.
- **Camping services** should be licensed, provide adequate parking facilities, have a public telephone, and have modern sanitary facilities.
- **Tourist Attractions** should have regional significance and provide adequate parking facilities.

The MUTCD limits the number of logo signs at an interchange to maximum of four with spacing of at least 800 ft between each logo sign [(1)]. Logo signs shall appear in the following order: attraction, camping, lodging, food, and gas services. The words GAS, FOOD, LODGING, CAMPING, or ATTRACTION and direction such as exit number should be displayed on every logo sign. Logo signs should be installed between the previous and next interchange at least 800 ft before the exit direction sign. Logo signs should be located such that they have the least scenic environmental impact and that

they avoid visual conflict with other highway signs. Figure 2.2 shows the spacing criteria for installation of logo signs.

According to current guidelines in the MUTCD, there are limitations on number of panels on a logo sign [1]. Section 2F.04 mentions that each logo sign shall be limited to maximum of six logo panels. However, the MUTCD does not provide any support or guidance justifying the limit of number of logo panels to six on a specific service sign.

The specific service signing program of NCDOT is responsible for placing logo signs, producing logo panels, and contacting vendors to see if they would like to participate in the program [6]. It provides eligible businesses the opportunity to be listed on official-signs within the right-of-way of fully access controlled highways. The Traffic Engineering and Safety Systems Branch of NCDOT is responsible for administering the program and receiving requests for information concerning the program.

2.4 Research on Logo Signs

A literature review produced one document showing research related to the human factor effects of nine-panel logo signs. There have been a couple of projects done on other aspects of logo signs (dual panel, logo signs with more than one service type, etc.).

<u>Evaluating Options to Increase Specific Service (Logo) Signs From Six Businesses to Nine Businesses per Service.</u> [7]

The objective of this study was to evaluate whether implementation of nine-panel and overflow combination signs have a negative effect on highway safety. To evaluate the effect of new signs on interstate motorists, the driving behaviors of motorists were observed for erratic driving behaviors at five 9-panel locations, five overflow locations and six standard 6-panel locations. Data collection entailed recording traffic data for one hour using a digital video camera. Tapes were viewed by an observer and instances of unusual behaviors, including braking, drifting, and lane line encroachment were recorded. The rates of these unusual behaviors between both types of experimental

designs (9-panel and overflow) and the control group (6-panel) were not found to be significantly different. It was concluded that 9-panel and overflow sign designs do not increase motorist distraction and therefore do not have negative effects on safety. [7]

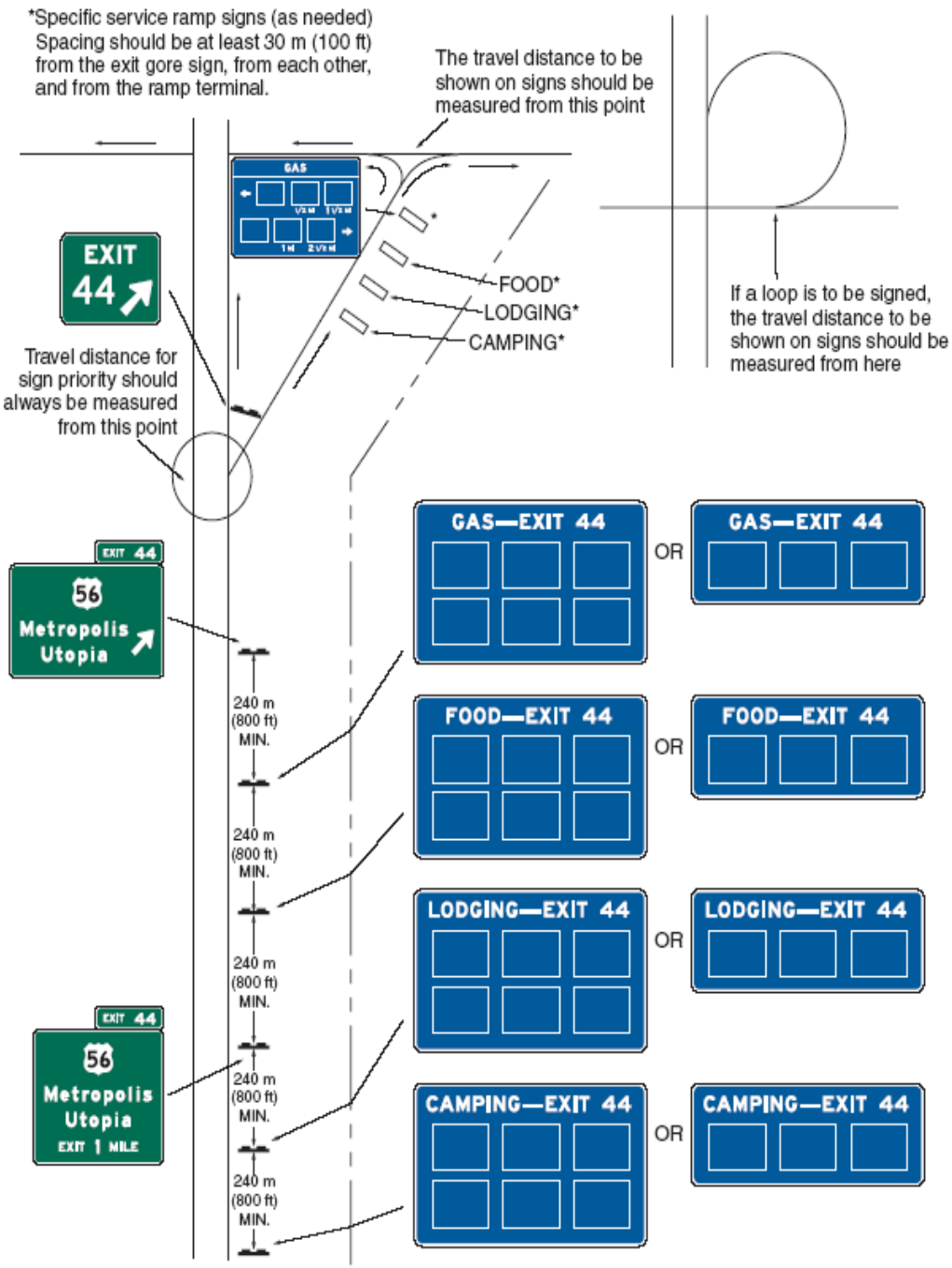

Figure 2.2 Spacing criteria for installation of logo signs [1]

Traffic Control Device Evaluation and Development Program. [2]

Texas Transportation Institute carried out a research project to evaluate various traffic control devices in 2004. Part of their effort included evaluating the effectiveness of dual logo signs. A dual logo sign is a sign which has a logo panel with two businesses listed within it (For example, a restaurant and gas station located in the same business place). The main objective of their research activity was to determine the impact of dual logo signs. A driver survey was conducted by the research team to assess how well drivers identified logos in single and dual logo signs. By comparing the responses for dual logo signs to the responses for single logo signs, the researchers were able to estimate the impact of dual logos.

A power point presentation survey was conducted showing images of specific service signs and subjects were asked to indicate whether a specific business was shown. Images were shown for 0.8, 1.3 and 1.8 seconds. The survey was administered to individual subjects using a laptop computer. The total survey sample was 205 subjects. It was concluded that the percentage of correct responses was higher for familiar logos than for unfamiliar logos and that the difference in correct response rate between single and dual familiar logos diminished with longer time exposures. It was estimated that at 3 seconds of exposure time single and dual logo signs would have equal correct comprehension rates. It was concluded that the results did not indicate a need to prohibit the use of dual logo panels. The research also concluded that mixing food and gas logos in a dual logo panel did not significantly impact the effectiveness of the logo sign.

Evaluation of Safety And Acceptance of Logo Motherboards Containing More than One Service Type. [8]

The main aim of the project was to test the safety and acceptance of logo motherboards containing more than one service type. As a part of pilot program started by the Virginia Department of Transportation, full service food logo signs were added to the camping motherboard at seven interchanges to test the safety and acceptance of logo motherboards containing more than one service type. It was assumed that that allowing

two full service food logos on another motherboard with vacant space, when there is already a motherboard with six food logos, would provide more information to the motorist and thus a better level of service. The research team conducted a telephone survey of residents of the Commonwealth of Virginia along with a before and after collision analysis.

The results of the research showed that people generally reported low levels of confusion with sharing motherboard space. Around 65% of respondents said that it was not at all confusing to have more than one service type on each sign and 34% people said that it was confusing.

Analysis showed no sign of an increase in the number of crashes at the test exits after the new signs were added. Crash data results showed that there was no increase in the number of crashes either during the year after the signs were installed as compared to previous year or as compared to test control sites.

Supplemental Interchange Signing and Driver Control Behavior. [8]

A study was conducted to determine the effect of supplemental interchange signing on rural freeways, including various combinations of tourist-oriented attraction and service signs on driver behavior. Test subjects were asked to drive the FHWA driving simulator over a 40-mi freeway course with 14 interchanges. There were a total of thirty-six test subjects. Subjects were requested to scan the signs presented on an interchange approach and to exit the freeway if they saw a sign for the attraction or service they were seeking. The researcher collected speed, acceleration data, and lateral placement data from the simulated vehicles on interchange approaches, and collected the distances from the signs at which the subjects recognized the logo or legend they were seeking. The researcher concluded that the supplemental signing in addition to that already permitted on a rural freeway interchange approach was generally detrimental to driver control behavior.

2.5 Research on Billboards

A billboard is an outdoor advertising structure, found in high traffic areas such as interstates, highways and downtown streets. Billboards present large images to passing pedestrians and drivers. Billboards have long been accused of being distracting to drivers and causing collisions. Extra billboards and tower advertising signs seem inevitable if the number of logos is restricted. It would be interesting to compare the effects of these billboards and nine-panel logo signs. Signs with bright colors and eye-grabbing pictures may cause drivers to look away from the road during a crucial moment [(10)]. Electronic, animated signs in particular have been singled out as a cause for collisions [(12)]. Studies have also shown that billboards at junctions and on long stretches of highway may have a particularly detrimental effect on road safety[(10)].Researchers at the University of North Carolina prepared a thorough report on driver distraction for the AAA Foundation for Traffic Safety. This study, released in June of 2001, said: "The search appears to suggest that some items--such as CB radios, billboards, and temperature controls--are not significant distractions."

<u>Driving Performance in the Presence and Absence of Billboards.</u> [(11)]

The main aim of the research was to determine if there is any change in driving behavior in the presence or absence of billboards. The participants in the study were made to drive a vehicle which was equipped to record driver's faces and eyes. Vehicle data such as speed, lane deviation, GPS location were also collected at the rate of ten times per second. The driver behavior at sites with billboards was compared with six comparison sites (e.g., logo signs, on-premises signs, etc.) and six baseline sites (i.e., no visual elements such as buildings or signs present). It was concluded that presence of billboards did not cause a change in driver behavior, in terms of visual behavior, speed maintenance, or lane keeping.

External-To-Vehicle Driver Distraction. [10]

The purpose of this research was to evaluate the driver distraction caused due to roadside advertising. A literature review on driver distraction was conducted to see whether external driver distraction is a significant factor in road collisions.

It was concluded that a significant amount of driver distraction is due to external-to-vehicle agents such as billboards and advertising signs and information from collision databases showed that this is a major contributory factor to collisions. The literature review conducted by the research team concluded that advertising billboards cause driver distraction.

Attraction and Distraction of Attention with Roadside Advertisements. [12]

The main purpose of this study was to compare street-level advertisements with raised advertisements on their ability to distract drivers. Study participants were made to watch video clips taken from the driver's perspective and were asked to rate the hazardousness on a scale of 1 to 7. A subsequent memory test was conducted where the participants were asked to mouse click on an advertisement they had seen. The results indicated that the street level advertisements are a source of potential hazards and street level advertisements were holding attention for longer duration than raised advertisements.

2.6 Summary

The literature review was directed towards answering a few questions related to safety of unconventional logo signs and billboards. Studies related to unconventional logo signs showed that they do not cause any negative impact on driver safety and effectiveness of logo signs. The review of billboard safety research did not give a clear indication of whether they cause driver distraction or not. Few studies indicated that billboards cause driver distraction and are one of the major contributing factors to cause collisions where as few other studies indicated the opposite.

3. Motorist Survey

3.1 Survey Method Selection

The objective of the survey was to find out how drivers use logo signs. The study team considered multiple survey methods including a telephone survey, an interview with participants, and a written survey. The team ruled out a telephone survey because of time constraints as well as the cost of a rapid dialing system. A written survey was a viable option because it would provide quick and concise answers to help determine the use of the logo signs. The team chose an interview style survey, where the surveyor completes a written form during the interview, as the best method for this survey. This option allows for the same questions to be answered by each participant in the study, just like a written survey. It also provided a more relaxed situation, encouraging conversation between surveyor and participant while still giving concise answers that can be analyzed by the project team. To ensure participation, it was important to keep the time and effort needed of the participant to be kept to a minimum. Therefore, we tried to keep the number of questions minimal, while still making sure that we gathered adequate data.

3.2 Survey Site Selection

As with the selection of the survey method, various options were considered for the location of the site for the survey. The team considered interchanges that currently have nine-panel logo signs, but we decided against those interchanges because there is no real central location at which we conduct the interviews. Because the survey would have to be given at a specific place of business (i.e., McDonalds, Cracker Barrel, Citgo, etc.) there would be a great deal of bias introduced into the study. After examining the alternatives, it was decided that rest areas off of interstates that already have some pilot nine-panel logo signs were the best places to conduct the surveys. The two rest areas we chose were the Alamance County rest area near Burlington on eastbound I-40/85 and the Johnston County rest area near Rocky Mount on southbound I-95. I-40/85 and I-95 are both major interstates traveled by many types of people

including business professionals, truck drivers, and those driving for leisure. Because of this range and the volumes of travelers that use these interstates, the team deemed them suitable to provide a nearly random population of drivers who would normally view logo signs in North Carolina.

3.3 Survey Method

While conducting the surveys and gathering data, it was important to conduct each interview in the same fashion. To ensure this, the surveyors used a written script. It took eight interviews to get all the wording exactly right, but surveys 9-325 were all done using the same wording. The surveyors were seated at a table in the rest area building, and the display table was also kept the same throughout the process. Figure 3.1 shows the survey script. At the end of the interview, the surveyor asked each participant if he or she would like to know the results of our study; if interested, he or she provided an address or email address where results could be sent. Because we recorded the addresses on a separate sheet, no survey answers were associated with particular respondents.

The survey was administered on I-40/85 on March 7, 2006 and on I-95 on March 9, 2006, from 9:00 am to 5:00 pm both days. The weather was cool but fair both days. A majority of people asked to respond did so with no hesitation. Although the team approached many females, very few agreed to participate. Also, the age range of participants seemed wide, but many of the participants looked to be aged 50-60. These demographics were not part of they survey because that they would not have a significant impact on the results and the survey team did not want to lose potential respondents by asking sensitive questions.

3.4 Results

Before the survey began, the project team established two key questions, questions number 2 and 7 (Figure 3.1), which were considered as utmost important in determining how drivers use panel logo signs. The expected split on these questions was used to determine the number of samples needed for a valid statistical analysis. For question 2 a 90/10 split was assumed, and the calculation showed that 120 samples are needed at the 95 percent confidence level. For question 7 a 60/40 split was assumed and needed sample size at the 95-percent level was 300. The final survey count was 325, so the sample size was sufficient for all analysis if those assumptions hold.

Table 3.1 shows a summary of all responses. All participants answered all questions unless directed to skip by the surveyor with the exception on one participant. This participant left mid-survey and only the answers given were used in the analysis.

With regards to question 2, the first key question, it appears that most drivers use these signs at least sometimes when making decisions about where to stop. Figure 3.2 shows the results, with the number of responses and the percentage next to each slice of the pie chart. It is clear that logo signs are a useful feature of the NC interstate system.

Driver Usage of Panel Logo Signs

Hello! I am a student at North Carolina State University. I am conducting this survey for the North Carolina Department of Transportation to determine how motorists use logo signs. These are the blue signs with specific logo panels for businesses for gas, food and lodging (show picture of sign). We are conducting this study to help maintain safety and maximize the effectiveness of these signs. It should only take about 3 minutes of your time. Please answer all questions based on a typical trip you would take along this interstate; all responses of this survey will remain confidential.

1. Do you know what logo signs are?
____ Yes ____ No

2. When driving on the interstate, do you typically use logo signs to help determine where you will stop?
____ Yes ____ No (if no skip to **question 9**)

3. How often do you typically use these signs? (1-never; 2- rarely; 3-sometimes; 4-frequently; 5-always)

Gasoline	**1**	**2**	**3**	**4**	**5**	(If never, skip questions 4-5)
Food	**1**	**2**	**3**	**4**	**5**	(If never, skip questions 6-7)
Lodging	**1**	**2**	**3**	**4**	**5**	(If never, skip question 8)

Gasoline

4. Do you typically look for a minimum number of gas stations before deciding to stop?
___ Yes (skip to **question 6**) ___ No ___ *Sometimes*

5. When choosing an exit for gasoline, do you typically look for a specific brand of gasoline?
___ Yes ___ No ___ *Sometimes*

Food

6. When choosing an exit for food, do you typically look for:
____ A Specific Restaurant ____ A Variety of Restaurants

7. Do you typically:
____ Scan the Logo Sign ____ Read each individual panel on the sign

Lodging

8. Do you typically look for a specific hotel or a variety of options before deciding to stop?
___ Specific Hotel ___ Variety ___ Neither

9. How long is your typical non-commuting trip when using an interstate?
____ 0-20 mi ____ 100-200 mi
____ 20-100 mi ____ greater than 200 mi

10. Do you typically make longer trips on an interstates traveling: (check all that apply)
____ for business
____ with children
____ for leisure

****Thank participant and give them contact info if they would like to know results of study****

Figure 3.1 Survey script.

Table 3.1 Survey results summary.

Question 1	Do you know what Logo Signs are?					
Answers	**Yes**	**No**				
	317	**8**				
Question 2	Do you typically use logo signs to help determine where you will stop?					
Answers	**Yes**	**No**				
	309	**16**				
Question 3	How often do you use these signs?					
Answers		**1**	**2**	**3**	**4**	**5**
	Gas	**8**	**18**	**41**	**93**	**146**
	Food	**19**	**19**	**37**	**89**	**142**
	Lodging	**124**	**45**	**28**	**43**	**68**
Question 4	Do you look for minimum number of gas stations?					
Answers	**Yes**	**No**	**Sometimes**			
	87	**202**	**25**			
Question 5	Do you look for specific brand for gas?					
Answers	**Yes**	**No**	**Sometimes**			
	71	**134**	**112**			
Question 6	When choosing an exit for food, do you typically look for:					
Answers	**Specific**	**Variety**	**Neither**			
	131	**159**	**1**			
Question 7	Do you typically					
Answers	**Scan Logo Sign**	**Read everything**	**Both**			
	224	**83**	**18**			
Question 8	Do you look for a specific hotel or a variety of options before deciding to stop?					
Answers	**Specific**	**Variety**	**Neither**			
	82	**63**	**39**			
Question 9	How long is your typical non-commuting trip when using an interstate?					
Answers	**0-20 mi**	**20-100 mi**	**100-200 mi**	**Greater than 200 mi**		
	2	**26**	**65**	**231**		
Question 10	Do you typically make longer trips on an interstates traveling:					
Answers	**For business**	**With children**	**For leisure**			
	162	**19**	**192**			

Figure 3.2 Question 2 results.

The second key question, number 7, showed that a greater number of drivers scan the logo signs than read each logo panel. Figure 3.3 provides those results, again with the number of responses and percentage indicated. A Z-test for proportions confirmed that the proportion answering “scan signs” to this question was significantly greater than the proportion answering “read each panel” at the 95-percent confidence level. However, the proportion of respondents stating that they generally read each panel was nowhere near zero. During the design of the lab test portion of this study the findings of this question were taken into consideration.

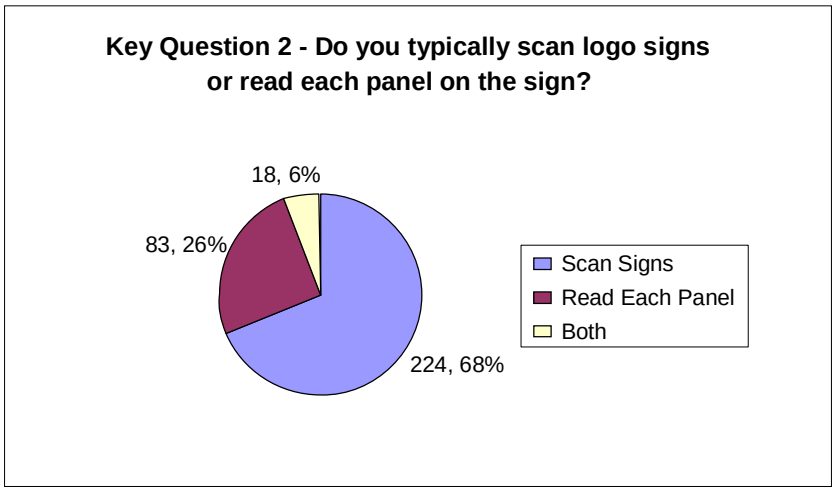

Figure 3.3 Question 7 results.

The results from question 3 show which signs are used most often. Based on the mean frequency, gasoline signs (mean of 4.15) are used most often, followed by food signs (mean of 4.03) and then lodging signs (mean of 2.63). In the case of gasoline, the standard deviation of 1.3 indicates that this is a fairly accurate indication of how drivers use fuel signs. In the case of food and lodging, however, higher standard deviations of 1.5 and 1.7, respectively, may indicate that more people typically answered this question at the extremes. This leads us to conclude that most people frequently use gasoline signs when deciding where to stop. However, some drivers do not use food logo signs, and the use of lodging logo signs is quite scattered.

In terms of specific service signs (questions 4, 5, 6 and 8), the results can be summarized as follows:

- A significant number of respondents do not look for a minimum number of gas stations before they decide to stop for fuel (question 4).
- A significant number of respondents are not looking for a specific brand of fuel (question 5).
- There was no real difference in the percentage of respondents who looked for specific restaurants and percentage of those that look for a variety of options (question 6).
- There is no significant difference between the number of drivers looking for a specific hotel and those looking for a variety; however there is a significant difference between those looking for one of those two options and those looking for neither (question 8).

Question 9 showed that the majority of people surveyed were traveling distances greater than 200 miles. This was expected for rest area users and is probably typical for logo sign users as well. Finally, question 10 showed that the majority of participants typically travel for business and/or leisure.

3.5 Conclusions

Overall, the survey was a successful way to approach objective one of the study. The data gathered provided insight into how motorists use panel logo signs. Perhaps most importantly it was found that a significant number of drivers scan logo signs. It was also found that most drivers use logo signs at some point, and that the most-frequently used logo sign is for gasoline, followed by the sign for food. However, drivers do not scan for particular brands of gasoline as often. These findings were helpful for designing the laboratory experiment to achieve the second objective.

4. Laboratory Study

4.1 Experiment Design

The objective of this experiment was to find out whether drivers using logo signs with more than six logos are distracted away from driving tasks more than drivers using logo signs with six-panels. The experiment was a slide-based simulation where the subjects were shown an image of a logo sign and asked to answer a question related to the image. The concept of the laboratory study was to show and have subjects respond to images of six-panel, and nine-panel, and mixed-use logo signs. Mixed use sign is a logo sign with two types of businesses listed on the same sign. Figure 4.4 shows a sample mixed use logo sign with food and gas businesses listed on same logo sign. Mixed use signs were tested because, if nine-panel logo signs are not approved, the agencies can split the sign between two types of services to accommodate the increased demand. This will provide sense of the difference in a driver's ability to perceive different messages on different types of logo signs, if any.

The basic premise of the experiment was based on the survey finding that motorists generally scan logo signs for a particular brand rather than read all of the logos. In this experiment, subjects were given the name of a brand to scan for. An image of a logo sign with a realistic highway background was then shown. The subject was then asked to indicate with a "yes", "no", or "not sure" response whether the specific business was represented on the sign.

Table 4.1 shows all 54 scenarios included in the experiment. The experiment asked subjects about gasoline, food, and lodging businesses. Asking about all three types of businesses lengthened the exercise, but the survey responses reported above showed that a fair number of motorists used all three types of logo signs, so the study team did not want to leave one out.

The experiment asked subjects to scan for three brands and logos which should be familiar to most respondents (Citgo gas, Hardee's food, and Holiday Inn lodging) and

one unfamiliar brand of food (Aunt Anne's Kitchen). The inclusion of the unfamiliar brand allowed us to test whether the results also hold true when drivers are scanning for unfamiliar logos. The experiment included some cases in which the desired logo did not appear on the displayed sign. This helped avoid a bias toward an automatic "yes" answer.

The position of the desired logo was a tricky issue in the experiment design. The study team wanted to be sure that the logo of interest did not appear in the same position all the time, so that subjects could anticipate its position. On the other hand, logos that appear in the top row are probably scanned first, so some control over logo position was desired to minimize bias. Our compromise design, shown in Table 2, allows some variety in position while maintaining some control. We designed "sets" of four scenarios that ask subjects to scan for a particular type of business with a particular exposure time, such as scenarios 5-8. Within the set, we showed the logo of choice in the same row for a six-panel logo sign, a nine-panel logo sign, and a mixed-use logo sign. The fourth scenario in the set was a nine-panel logo sign with the logo of interest in the bottom row, to test this "worst case". The only exceptions to this pattern were scenarios 4, 29, and 53, in which the logos of interest in a mixed-use logo sign had to appear in the bottom row because the standard sign design put food logos in that row.

For most scenarios (1-50), the image with the sign was shown for either 1.0 or 2.5 seconds. This was to allow data on sign performance across the range of driver scan times, from a quick scan that might be more common in heavy traffic to a longer look that might be more common in lighter traffic. Our choice of exposure times was guided by data from the classic study by Rockwell and Bhise [(13)]. The results of that research stated that drivers use between 0.5 seconds and 4.0 seconds to read a road sign.

In the last three scenarios listed in Table 2, 51-54, we used a different image exposure pattern at the suggestion of the NCDOT sponsors. To more closely simulate the real world situations, for these questions the image slide was flashed for three times for one second each, as if the driver had three glances at the logo sign, with a two-second gap

between each flash. With each successive flash, the image appeared larger (as detailed below) to simulate a vehicle approaching the sign.

Table 4.1 Experiment scenarios.

Scenario Number	Business Type	Sign Type	Logo Position	Exposure Time	Scenario Number	Business Type	Sign Type	Logo Position	Exposure Time
1	Familiar Food	6-panel	Row 1 right	1 sec	26	Familiar Food	6-panel	Row 1 right	2.5 sec
2		9-panel	Row 1 middle		27		9-panel	Row 1 middle	
3			Row 3 right		28			Row 3 right	
4		Mixed	Row 2 left		29		Mixed	Row 2 left	
5	Unfamiliar Food	6-panel	Row 2 middle		30	Unfamiliar Food	6-panel	Row 2 middle	
6		9-panel	Row 2 middle		31		9-panel	Row 2 middle	
7			Row 3 right		32			Row 3 right	
8		Mixed	Row 2 middle		33		Mixed	Row 2 middle	
9	Familiar Gas	6-panel	Row 1 middle		34	Familiar Gas	6-panel	Row 1 middle	
10		9-panel	Row 1 middle		35		9-panel	Row 1 middle	
11			Row 3 right		36			Row 3 right	
12		Mixed	Row 1 middle		37		Mixed	Row 1 middle	
13	Familiar Hotel	6-panel	Row 2 left		38	Familiar Hotel	6-panel	Row 2 left	
14		9-panel	Row 2 middle		39		9-panel	Row 2 middle	
15			Row 3 right		40			Row 3 right	
16		Mixed	Row 2 middle		41		Mixed	Row 2 middle	
17	Familiar Food	6-panel	Not present		42	Familiar Food	6-panel	Not present	
18		9-panel			43		9-panel		
19		Mixed			44		Mixed		
20	Familiar Gas	6-panel			45	Familiar Gas	6-panel		
21		9-panel			46		9-panel		
22		Mixed			47		Mixed		
23	Familiar Hotel	6-panel			48	Familiar Hotel	6-panel		
24		9-panel			49		9-panel		
25		Mixed			50		Mixed		
					51	Familiar Food	6-panel	Row 1 right	Sequence of images, each 1 sec
					52		9-panel	Row 1 right	
					53		9-panel	Row 3 right	
					54		Mixed	Row 2 left	

4.2 Presentation Images

The images used in the presentation were all generated using Adobe Photoshop. The NCDOT provided images of panel logo signs that were used as bases for six and nine-panel images. Two base images were used: one for all six-panel signs and one for all nine-panel signs. Both bases were similar in that they showed the full sign with some space above and below it. The base images were used to try and give a realistic look to the panel logo signs created by providing a background that is common on interstates, yet not distracting. The background in these images had trees, leaves and sky, but no cars or buildings for simplicity. Once the team selected the base images, the logos present on the sign were covered with the blue background of the sign itself.

The actual logos used on the signs were created in various ways. Some were created from scratch using Photoshop. Others were created in Photoshop by importing an image from the Internet and tidying the colors, lines, etc. Finally, the team brought two logos, Kangaroo and Citgo, into Photoshop directly from a file given to us by the NCDOT.

Each individual logo was saved as its own file and then duplicated as individual layers on top of the base image to create each needed sign. In this way, an image used on a given sign was the same image as the used on any other sign.

The first 50 scenarios shown above in Table 4.1 were shown to the subjects in a series of three slides. The first slide was the ‘question slide’ and showed the question to the subject. Figure 4.1 shows a sample question slide.

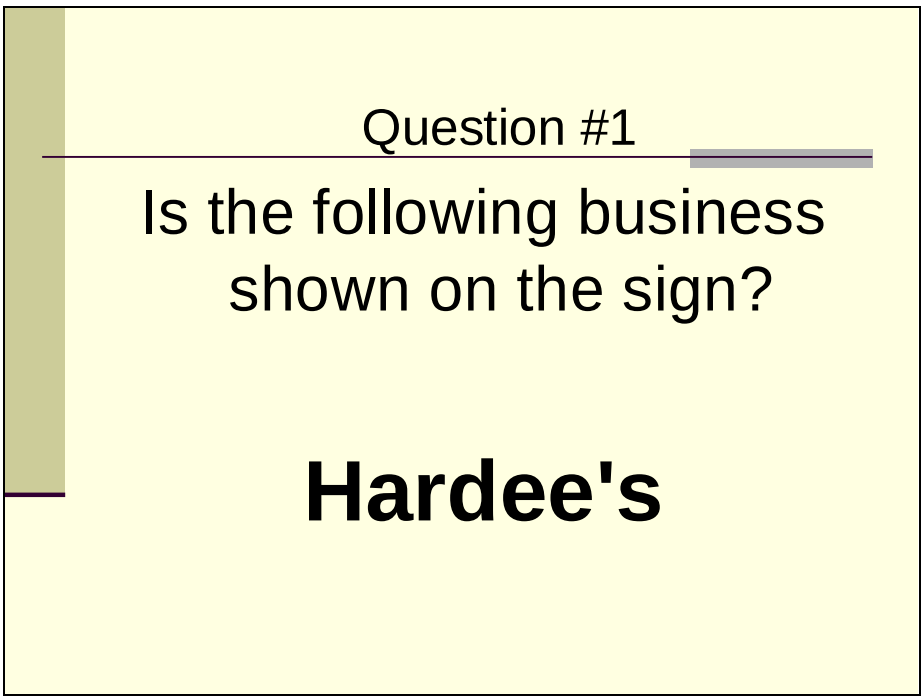

Figure 4.1 Sample question slide.

The wording used for question statement was similar for all questions, except for the name of the business that was to be identified by the subject. The question slide was shown for five seconds and the presentation automatically advanced to next slide.

The second slide was the ‘image slide’ that showed the image of a logo sign to the subjects. Figures 4.2, 4.3 and 4.4 show examples of six-panel, nine-panel, and mixed-use logo signs, respectively. The mixed-use logo signs had two rows of logos, with gas above food or food above lodging. The image slide was shown for a set period of time as described above and then the presentation automatically advanced to next slide.

Figure 4.2 Sample image of a six-panel logo sign.

Figure 4.3 Sample image of a nine-panel logo sign.

Figure 4.4 Sample image of a mixed-use logo sign.

The third slide was the ‘answer slide’ and a sample is shown in Figure 4.5. It repeated the question and provided the choices for answers (Yes, No, and Not Sure). The subjects recorded their answers on an answer sheet provided for them. Figure 4.6 shows the first answer sheet. The wording was similar on all answer slides except for the name of the business that was to be identified by the subject. The answer slide was shown for eight seconds before the next question slide came up. When the answer slide disappeared, the projector emitted a clicking sound to grab the attention of the subjects and indicate that the next question had appeared.

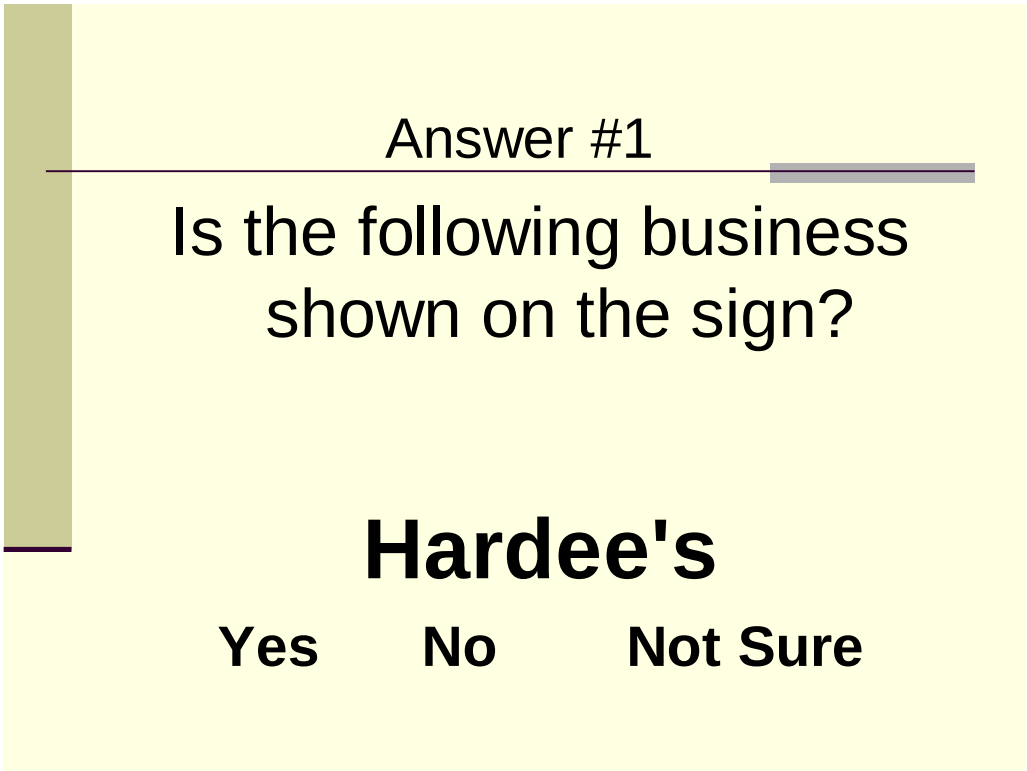

Figure 4.5 Sample answer slide.

Answer Sheet

****

Demographics

Age (check one)

__ 18 to 25 __ 26 to 35
__ 36 to 45 __ 46 to 55
__ 56 to 65 __ 66 to 75
__ +75

Sex (Check one)

__ Male __ Female

****

Example Answers (Check one):

Example Question #1

__YES __ NO __ NOT SURE

Example Question #2

__YES __ NO __ NOT SURE

****

Actual Answers (Check one):

Answer #1

__YES __ NO __ NOT SURE

Answer #2

__YES __ NO __ NOT SURE

Answer #3

__YES __ NO __ NOT SURE

Answer #4

__YES __ NO __ NOT SURE

Figure 4.6 First answer page.

The presentation of the images in scenarios 51-54 was different from the others. These were the scenarios in which we presented the image three times, each for one second, with two seconds gap between images. Assuming the speed of the vehicle to be 55 -60 mph and that the image of the logo sign presented in scenarios 1-50 was taken from distance of 100 ft, the first flash of the image slide for scenarios 51-54 was sized proportionally as if the logo sign was being viewed from a distance of 700 ft. Figure 4.7 shows a sample of this type of slide. Simply the amount of white space around the image was increased. After a blank slide for two seconds, the second image slide was shown. The second slide looked as if the logo sign was viewed from a distance of 400 ft, as Figure 4.8 shows, again simply by increasing the amount of white space around the image. Again a gap of two seconds was provided and then the third image slide appeared. As Figure 4.9 shows, this was the same size of logo sign as shown in scenarios 1-50, having no white space around the image.

A couple other notes on these scenarios are worth recording. The study team did not collect data on scenarios 51-54 from the first eight subjects tested and, the study team made an error and showed scenario 52 to the subjects twice, so the subjects actually answered questions on 54 scenarios and we have twice as much data from scenario 52 as from scenarios 51 and 54.

Figure 4.7 The first look at the logo sign in scenario 51-54.

Figure 4.8 The second look at the logo sign in scenario 51-54.

Figure 4.9 The third and final look at the logo sign in scenario 51-54.

4.3 Study Participants

For the experiment portion of this study, it was desirable to obtain data from a variety of volunteer subjects. Three sets of populations were tested, including college students, middle-aged adults, and senior citizens. The study was advertised, trying to obtain participants in a variety of ways, including fliers posted throughout Mann Hall, the civil engineering building at NC State; emails to current faculty, retired faculty, and staff of the Department of Civil, Construction, and Environmental Engineering; and fliers and announcements at the Cary Senior Center. Figure 4.10 shows a subject recruitment flier.

In the end, 37 participants were recruited and tested. All of them finished the complete set of questions. The students who participated were primarily undergraduate and graduate students at North Carolina State University. Some of the middle-aged adults were faculty and staff at NC State, while others were recruited from among a volunteer transportation citizen interest group Chapel Hill, NC. Several senior citizens were from the Cary Senior Center. All participants said that they had valid driver licenses. During the testing, all participants used whatever eyewear they typically use for driving.

WE NEED YOU!

North Carolina State University, in partnership with the North Carolina Department of Transportation wants to make interstate travel better for you! Our team is looking for volunteers to participate in a study on panel logo signs (blue service signs that indicate what businesses are located off of a given exit).

How can you help?

Attend a presentation in

Mann 321 on

Wednesday, May 10 at

10:30 am.

The presentation will consist of a slide show, and all you have to do is watch… and answer questions about the slides along the way.
** Your participation would greatly help our research and will take about 30 minutes. Refreshments will be served!! **

Figure 4.10 Subject recruitment flier.

4.4 Experiment Administration

Before starting the experiment, the subjects were provided with a brief introduction on a few slides that explained what logo signs are, the purpose of logo signs, and the purpose of conducting the experiment. The subjects had to sign an informed consent form (Figure 4.11) before they began answering questions. The form let subjects know that their responses would remain anonymous. The top of the answer sheet had the two demographic questions: age and sex. Subjects were provided with instructions on how to answer the questions, including the key instruction that they should not write their answer to a question until they saw the answer slide. Then, two example questions were presented and the subjects were showed the four logos they would be searching for during the main set of questions. The main questions did not start until all subjects were comfortable with the procedure.

The slide-based simulation experiment was administered to subjects using a multimedia projector and a screen. The slides were projected in such a way that the size of the slides remained same for all the experiment sessions (i.e., about six feet tall). The settings for all tests were classrooms or conference rooms where subjects sat from about 10 to 20 feet away from the screen.

There were six experiment sessions: four at North Carolina State University, one at the Cary Senior Center, and one at the Chapel Hill Town Hall. To avoid bias, the questions were presented in a different random order for each group.

Including the instructions and practice, the experiment took 30 to 40 minutes to complete. After the completion of the experiment, the subjects were asked to write comments about whether the sign images seemed realistic and whether they liked the nine-panel logo signs.

Informed Consent

****

You are being given the opportunity to volunteer and participate in a project conducted by North Carolina State University for the NCDOT Traffic Engineering Branch.

Logo signs are guide signs placed on interstates and other similar roads that let the motorist know about specific services offered at the next exit. The purpose of this research is to evaluate the effectiveness of Logo Signs. The objective of conducting this research is to improve the logo sign design and maximize the utility of Logo Signs.

The experiment will be a slide-based simulation where you will be shown the slides and asked to answer a question related to the slide. For each picture of a logo sign shown, you will be asked to indicate whether a specific business was represented on the sign. You will be presented with a practice example so that you will be prepared for answering the actual questions.

Your responses will remain anonymous. Your identity will not be associated in any way with the information collected from you or with the research findings from this study.

PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I agree to take part in this study as a research participant.

_____ _____

Participant's Name Date

_____

Participant's Signature

At any point of time if you wish more information of study, you can contact:
Dr. Joe Hummer (PI)
Civil Engineering Department
North Carolina State University
Ph: 919-515-7733
Email: hummer@eos.ncsu.edu

Figure 4.11 Informed consent form.

4.5 Analysis

Table 4.2 shows a summary of the responses for each scenario, with correct answers shaded. From Table 4.2 it is obvious that most answers were correct, but that there was a large variation in wrong answers between scenarios. Four scenarios with exposure times of 2.5 seconds—numbers 30, 32, 34 and 38—had 100 percent correct answers. Meanwhile, the worst-performing scenario was number 18, with a 1.0-second exposure when the logo of interest was not present, with only 16 percent correct responses.

Table 4.2 Results by scenario.

Scenario Number	Number of Answers			Percent Correct
	Yes	No	Don't Know	
1	28	3	6	75.68
2	30	3	4	81.08
3	21	3	13	56.76
4	25	7	5	67.57
5	33	0	4	89.19
6	35	2	0	94.59
7	32	1	4	86.49
8	33	1	3	89.19
9	25	4	8	67.57
10	11	10	16	29.73
11	23	4	10	62.16
12	24	9	4	64.86
13	33	2	2	89.19
14	33	0	4	89.19
15	25	2	10	67.57
16	33	1	3	89.19
17	3	20	14	54.05
18	12	6	19	16.22
19	1	26	10	70.27
20	1	15	21	40.54
21	2	13	22	35.14
22	9	19	9	51.35
23	4	25	8	67.57
24	3	19	15	51.35
25	3	26	8	70.27

Scenario Number	Number of Answers			Percent Correct
	Yes	No	Don't Know	
26	36	0	1	97.30
27	31	6	0	83.78
28	32	2	3	86.49
29	36	1	0	97.30
30	37	0	0	100.00
31	36	1	0	97.30
32	37	0	0	100.00
33	35	0	2	94.59
34	37	0	0	100.00
35	36	0	1	97.30
36	31	4	2	83.78
37	27	8	2	72.97
38	37	0	0	100.00
39	35	1	1	94.59
40	34	1	2	91.89
41	35	1	1	94.59
42	0	35	2	94.59
43	0	33	4	89.19
44	0	31	6	83.78
45	0	36	1	97.30
46	1	33	3	89.19
47	8	29	0	78.38
48	10	26	1	70.27
49	9	26	2	70.27
50	4	31	2	83.78

Scenario Number	Number of Answers			Percent Correct
	Yes	No	Don't Know	
51	27	1	1	93.10
52	26	0	3	89.66
53	20	2	7	68.97
54	23	5	1	79.31

Note: Correct answers are shaded.

4.5.1 Overall Results

Table 4.3 provides an overall summary of the results. There were 1541 correct responses to the 1966 questions asked, for an overall correct response percentage of almost 78.5 percent. Overall, there were more correct responses for the six-panel signs than other signs, and more correct responses for the mixed-use signs than the nine-panel signs.

Table 4.3 Overall sign type results.

Sign Type	Number Correct	Number Questions	Percent Correct
6-panel	450	547	82.3
9-panel	658	872	75.5
Mixed	433	547	79.2
All	1541	1966	78.4

Z tests	
Comparison	**Z-statistic**
6-panel vs 9-panel	3.01
6-panel vs mixed	1.30
9-panel vs mixed	-1.61

The Z-test for proportions was used to analyze the data, and Z-statistics are also reported in Table 4.3. The Z-test is a statistical test used in inference which determines if there is a significant difference between two proportions. The Z-Test was used for this study as the sample size is more than 30 and it was assumed that the data sample is independent. Since the sample size is greater than 30, it is not required to have a normal distribution to use Z-test for analyses [(15)]. A Z-statistic above 1.96 or below –1.96 means the difference is statistically significant at the 95-percent confidence level. The data in Table 4.3 show that there is a statistical difference between six-panel and nine-panel logo signs at 95% confidence level. Six-panel signs have significantly higher percentages of correct responses than nine-panel signs. Meanwhile, there was no statistically significant difference in percent correct responses between six-panel and mixed-use signs and between nine-panel and mixed-use signs.

4.5.2 Exposure Time

Table 4.4 provides results pertaining to the exposure time of the logo sign image. The first portion of the table shows that there was a huge difference between a 1.0-second and 2.5-second exposure—this difference was, in fact, the largest of all the factors analyzed for this report. A 1.0-second image exposure time led to 66.3 percent correct responses, while a 2.5-second exposure time led to 90 percent correct responses. This difference was obviously statistically significant. Clearly, respondents performed better when provided more time to scan the sign. The limited number of scenarios in which a sequence of three one-second looks was provided at the logo sign image led to 81.5 percent correct responses. This rate was significantly different from the rates for both 1.0-second and 2.5-second exposure.

Table 4.4 also examined how each sign type performed for each exposure time. For the 1.0-second exposure time, the six-panel and mixed-use signs had almost equal correct response percentages, while the nine-panel signs had significantly lower correct response percentages. For the 2.5-second exposure time, nine-panel signs led to 89.4 percent correct responses, which was only 4.8 percent less than the six-panel signs and was three percent higher than the mixed-use signs. The difference between six-panel and nine-panel signs was statistically significant while the difference between nine-panel and mixed-use signs was not. For the sequence of images, six-panel signs had a considerably higher correct response rate than nine-panel and mixed-use signs, although none of the differences were statistically significant due to the low sample sizes. In sum, these results show that respondents, and perhaps motorists on the roadways, will have more difficulties scanning nine-panel signs than six-panel or mixed-use signs when viewing times are short, but when given more time to scan the performance for nine-panel signs improves dramatically and may surpass mixed-use logo signs.

Table 4.4 Exposure time results.

Exposure time	Sign type	Number correct	Number questions	Percent correct		Z tests Comparison	Z-statistic
1 sec	All	613	925	66.3		1 sec vs 2.5 sec	-12.31
2.5 sec		832	925	90.0		1 sec vs sequence	-3.59
Sequence		96	116	82.8		2.5 sec vs sequence	2.34
1 sec	6-panel	179	259	69.3		6-panel vs 9-panel	2.14
	9-panel	248	407	60.9		6-panel vs mixed	-0.67
	Mixed	186	259	71.7		9-panel vs mixed	-2.87
2.5 sec	6-panel	244	259	94.2		6-panel vs 9-panel	2.12
	9-panel	364	407	89.4		6-panel vs mixed	2.97
	Mixed	224	259	86.5		9-panel vs mixed	1.15
Sequence	6-panel	27	29	93.1		6-panel vs 9-panel	1.65
	9-panel	46	58	79.3		6-panel vs mixed	1.52
	Mixed	23	29	79.3		9-panel vs mixed	0.00

4.5.3 Logo Presence and Position

Table 4.5 shows results for cases when the logo of interest was present and when it was not present. The table also reports results for the location of the logo of interest when it was present on a nine-panel sign. The first portion of Table 4.5 shows that there was a large, statistically significant difference in correct response percentages when the logo of interest was present versus when it was not present. This result makes sense; it should take longer to scan all the logos on a sign before deciding the logo of interest is not present, and sometimes the respondents ran out of time to make a correct decision.

The middle portion of Table 4.5 shows data for scenarios in which the logo of interest was present. These scenarios also allowed us to examine the effect of logo position on the correct response rate for nine-panel signs. Six-panel signs again led to the highest correct response rates, with significant differences over nine-panel signs (regardless of logo position) and over mixed-use signs. Having the logo of interest in row 1 or 2 of a nine-panel sign increased the correct response rate by about four percent over having the logo in row 3, which was not a statistically significant. Mixed-use signs have a

better percentage of correct response than nine-panel signs with the logo in row 3, but the difference were not statistically significant regardless of the position of the logo.

Table 4.5 Results for logo present or not present.

Logo presence	Logo position	Sign type	Number correct	Number questions	Percent correct		Z tests	
							Comparison	Z-statistic
Present	All	All	1092	1300	84.0		Present vs not present	8.45
Not present	Not applicable		449	666	67.4			
Present	All rows	6-panel	293	325	90.1		6-panel vs 9-panel all rows	3.60
	All rows	9-panel	528	650	81.2		6-panel vs mixed	2.54
	Row 1 or 2		247	296	83.5		9-panel all rows vs mixed	-0.82
	Row 3		281	354	79.4		9-panel row 1 or 2 vs row 3	1.32
	All rows	Mixed	271	325	83.4		6-panel vs 9-panel row 1 or 2	2.47
							9-panel row 3 vs mixed	1.33
Not present	Not applicable	6-panel	157	222	70.7		6-panel vs 9-panel	2.68
		9-panel	130	222	58.5		6-panel vs mixed	-0.52
		Mixed	162	222	73.0		9-panel vs mixed	-3.20

Nine-panel signs fared relatively poorly when the logo of interest was not present. Mixed-use signs had the best correct response percentage (73%) in these scenarios, next to six-panel logo signs (70.7%), while nine-panel signs led to a 58 percent correct response rate. The differences between the correct response rate for the nine-panel signs and the correct response rates for the other types of signs were statistically significant.

4.5.4 Familiarity of Business

The experiment included eight scenarios in which the respondents were searching for an unfamiliar food logo (Aunt Anne's Kitchen). Having an unfamiliar food logo in the experiment gave a chance to compare these results against the results for the eight scenarios (not including scenarios 51-53 with the sequences of logo sign images) in which the respondents were searching for a familiar food logo (Hardee's). Table 4.6 shows the unexpected results from this comparison: respondents performed much better searching for the unfamiliar logo than the familiar logo. The difference over all types of signs was about 13 percent. This result may be due in part to respondents being able to more easily pick out the unfamiliar logo on signs otherwise containing mostly familiar logos. For the familiar food logo, six-panel signs led to the highest

correct response rate, with mixed-use signs and nine-panel signs following, although none of the differences was statistically significant due to the small sample sizes. For the unfamiliar food logo, all three types of signs led to high correct response percentages. Six and nine-panel logo signs had exactly the same percentage of correct responses with mixed-use signs having slightly lower percentage.

Table 4.6 Logo familiarity results.

Business type	Sign type	Number correct	Number questions	Percent correct		Z tests	
						Comparison	Z-statistic
Familiar food	All	239	296	80.8		Familiar vs unfamiliar	-4.82
Unfamiliar food		278	296	94.0			
Familiar food	6-panel	64	74	86.5		6-panel vs 9-panel	1.67
	9-panel	114	148	77.1		6-panel vs mixed	0.68
	Mixed	61	74	82.4		9-panel vs mixed	-0.99
Unfamiliar food	6-panel	70	74	94.6		6-panel vs 9-panel	0.00
	9-panel	140	148	94.6		6-panel vs mixed	0.65
	Mixed	68	74	91.9		9-panel vs mixed	0.78

4.5.5 Type of Business

Table 4.7 provides a comparison of correct response rates by the type of business the respondents were searching for. The table only includes results from scenarios 1-50, leaving out the results from the sequences of sign images because those only involved food logos and may have introduced bias into the analysis. The first part of the table shows clearly that gasoline was the type of business that led to the lowest correct response percentages. Food signs had the best correct response rate of 82% and lodging had almost equal correct response rate of 81%, about 12 percent higher than gas on average. The survey described in chapter three of this report provided some evidence that motorists scan more often for a specific brand of food or lodging than gasoline, and that may be reflected in these results.

For the gasoline logo, six-panel signs performed significantly better than nine-panel and mixed-use signs. Nine-panel and mixed use logo signs had virtually similar percentage of correct response. Even though mixed use signs had a lower percentage of correct

responses than six-panel logo signs, there was no statistical difference between them. For food logos, six-panel signs led to the highest correct response percentage, followed by mixed-use signs and nine-panel signs. This is one case where there was no statistical difference between any of the sign types. For lodging signs, mixed-use signs performed slightly better than six-panel signs, with nine-panel signs lagging six-panel logo signs by only four percent. Even in this case none of the differences are statistically significant.

Table 4.7 Results by type of business.

Business type	Sign type	Number correct	Number questions	Percent correct		Z tests	
						Comparison	Z-statistic
Gas	All	59	518	69.3		Gas vs food	-5.40
All food		668	814	82.1		Gas vs lodging	-4.23
Lodging		418	518	81.0		Food vs lodging	0.62
Gas	6-panel	113	148	76.4		6-panel vs 9-panel	2.09
	9-panel	147	222	66.2		6-panel vs mixed	1.80
	Mixed	99	148	66.9		9-panel vs mixed	-0.13
All food	6-panel	189	222	85.1		6-panel vs 9-panel	1.80
	9-panel	293	370	79.2		6-panel vs mixed	-0.13
	Mixed	186	222	83.8		9-panel vs mixed	-1.38
Lodging	6-panel	121	148	81.8		6-panel vs 9-panel	0.99
	9-panel	172	222	77.5		6-panel vs mixed	-0.62
	Mixed	125	148	84.5		9-panel vs mixed	-1.65

Note: Questions involving sequence of signs (scenarios 51-54) not included.

4.5.6 Respondent Age and Gender

The answer sheet asked respondents to state their age range and gender, so we were able to analyze the results pertaining to those factors. Table 4.8 shows the results by age range. The age ranges reported by the respondents were as follows:

- 18 to 25 years: 15 respondents
- 26 to 35 years: 5 respondents
- 36 to 45 years: 5 respondents
- 46 to 55 years: 6 respondents
- 56 to 65 years: 1 respondent
- 66 to 75 years: 5 respondents

No respondent stated that he or she was over 75 years old. To create more adequate sample sizes for analysis, the respondents were divided into three groups, including a younger group 18 to 25 years old, middle group 26 to 55 years old and an older group 56 to 75 years old. This also roughly correlates with a group of inexperienced drivers, a group of experienced drivers with peak physical and cognitive skills, and a group of experienced drivers with less than peak physical and cognitive skills. Table 4.8 shows that, overall, age group made a difference in the percentage of correct responses. The middle group performed better than the younger and older groups, and the differences were statistically significant, while the younger and older groups had no real difference between them. It is surprising to see that there was no statistical difference between younger and older drivers. Six-panel logo signs had the highest percent correct for all three age groups but for younger and middle age group drivers, there was no statistical difference between any of the sign types. Six-panel and mixed use signs had equal correct percentages in the case of older drivers, with nine-panel signs having the lower rate of 69%. Looking at the performance of the sign types by age group, nine-panel signs performed relatively better with younger respondents and middle aged respondents and relatively worse with older respondents.

Table 4.8 Results by age group.

Respondent age group	Sign type	Number correct	Number questions	Percent correct		Z tests Comparison	Z-statistic
Younger	All	597	678	76.0		Younger vs middle	-2.92
Middle		697	856	81.4		Younger vs older	-0.11
Older		247	324	76.2		Middle vs older	1.99
Younger	6-panel	176	219	80.4		6-panel vs 9-panel	1.40
	9-panel	262	348	75.3		6-panel vs mixed	1.92
	Mixed	159	219	72.6		9-panel vs mixed	0.71
Middle	6-panel	200	238	84.1		6-panel vs 9-panel	1.79
	9-panel	297	380	78.2		6-panel vs mixed	0.00
	Mixed	200	238	84.0		9-panel vs mixed	-1.79
Older	6-panel	74	90	82.2		6-panel vs 9-panel	2.28
	9-panel	99	144	68.8		6-panel vs mixed	0.00
	Mixed	74	90	82.2		9-panel vs mixed	-2.28

Note: Younger = 18 to 25 years, Middle = 26 to 55 years, Older = 56 to 75 years

Table 4.9 shows results by respondent gender. Twenty-five men and twelve women participated in the experiment. Overall, Table 4.9 shows that women had a higher correct response rate than men but the difference was not statistically significant. Women had a higher correct response percentage for all the sign types and performed especially well for mixed-use signs.

Table 4.9 Results by respondent gender.

Respondent gender	Sign type	Number correct	Number questions	Percent correct		Z tests	
						Comparison	Z-statistic
Men	All	1023	1322	77.6		Men vs women	- 1.54
Women		518	644	80.4			
Men	6-panel	299	368	81.3		6-panel vs 9-panel	2.17
	9-panel	440	586	75.1		6-panel vs mixed	1.84
	Mixed	284	368	77.2		9-panel vs mixed	-0.16
Women	6-panel	151	179	84.4		6-panel vs 9-panel	2.40
	9-panel	218	286	76.2		6-panel vs mixed	0.79
	Mixed	149	179	83.2		9-panel vs mixed	-1.56

5. Driver Information Load

5.1 Introduction

Driver information load can be defined as the information load imparted on the driver because of the roadway signs encountered, information provided by the sign, complexity of information provided, roadway context in which the sign occurs, traffic conditions, characteristics of the driver, and navigational task. When drivers encounter more information than they can process a “driver information overload” condition occurs. Driver information overload can be defined as providing the motorists with too much information, through a series of devices of conditions, for the driver to have adequate time to perceive and respond properly [(14)]. Driver information overload may cause drivers to decelerate inappropriately, make erratic maneuvers, ignore important information or other traffic conditions, and take an improper route.

Driver information overload is difficult to calculate as the amount of information perceived varies from driver to driver. For example, drivers encountering the same set of roadway characteristics and roadway signs may have different information loads imposed on them. A driver who is familiar with the roadway will have lesser information load on him/her than a driver who is unfamiliar with the roadway. This means that the information load is not equivalent for all drivers.

5.2 NCHRP Driver Information Load Model

This chapter addresses driver information load issues by means of estimating information load and developing driver information load profiles for six and nine-panel logo signs using the driver information load software/model developed by National Cooperative Highway Research Program. Since the driver information load can not be generalized for all road users it is not possible to draw a “red line” that indicates information overload. The driver information load (DIL) does not provide any threshold for information overload. The model provides output which is quantitative and relative.

Hence this model can be used to compare relative complexities of alternate sign system scenarios under varied conditions for better or worse.

Driver information load software was developed by NCHRP as a part of the project - “Additional Investigations on Driver information overload” [14]. The model calculates the information load based upon the four-factor multiple regression equation that includes the following:

- Sign Array Information Demand – Information demand based on a series of sign arrays.
- Maneuver Proximity – Takes into account the distance of a sign array from the maneuver point. Demand increases as the vehicle approaches a navigational choice point that requires a driving maneuver.
- Local Information Density – Based on information demand and distance from other sign arrays surrounding the target sign array.
- Roadway Demand – Based on geometric features of the roadway over the 11000 ft preceding the maneuver point such as number of lanes, exits, weaving sections, etc.

The model is confined to freeway and expressway signing. The focus of interest of the model is on the signing relevant to the navigation task. This includes guide signing, motorist services signing (logo signs), and recreational signing. The model assumes that the driver is not familiar with the particular site and is actively navigating to reach his/her destination with the help of signs which contain information relevant to that decision. The model also assumes that the driver is either old or inexperienced and that the driver is not impaired by alcohol, drugs, or excessive fatigue.

The primary objective of the model is to define the information load associated with given roadway signs within in its roadway context. The model calculates information load by determining the demand placed on the driver by roadway signs and by the driving task, and then summing these in an appropriate manner. The model breaks the driving task into two major categories, information search demand (ISD) and driving task demand (DTD). Together ISD and DTD draw the attention of the drivers. Driver

information load is determined by summing DTD and ISD. DTD further is function of two factors: a roadway baseline requirement and proximity to the navigational choice point which is termed “maneuver proximity”. The roadway baseline requirement is a general level of attentional demand requirement that is viewed as being more or less uniform over section of freeway which is determined by nature of roadway and its features. Though roadway baseline demand is treated as constant over section of freeway, the demand will increase as the vehicle approaches a navigational choice point that requires a driving maneuver. This increase is taken care of by the Maneuver Proximity factor of the model. The reason for an increase in load can be due to the perceptual and control demands required for monitoring traffic, determining the appropriate lane and speed, and making lane changes. Figure 5.1 explains the conceptual load diagram for DTD.

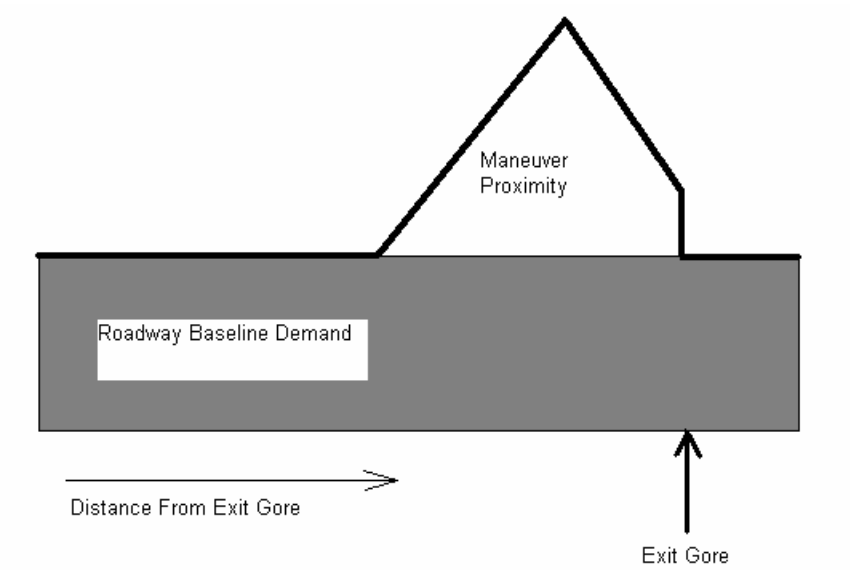

Figure 5.1 Conceptual Figure for DTD [12]

ISD is the demand imposed upon the driver in the effort to search the formal information sources provided on the roadway and process the information so as to support navigational decision making. Figure 5.2 shows the driver information load model components.

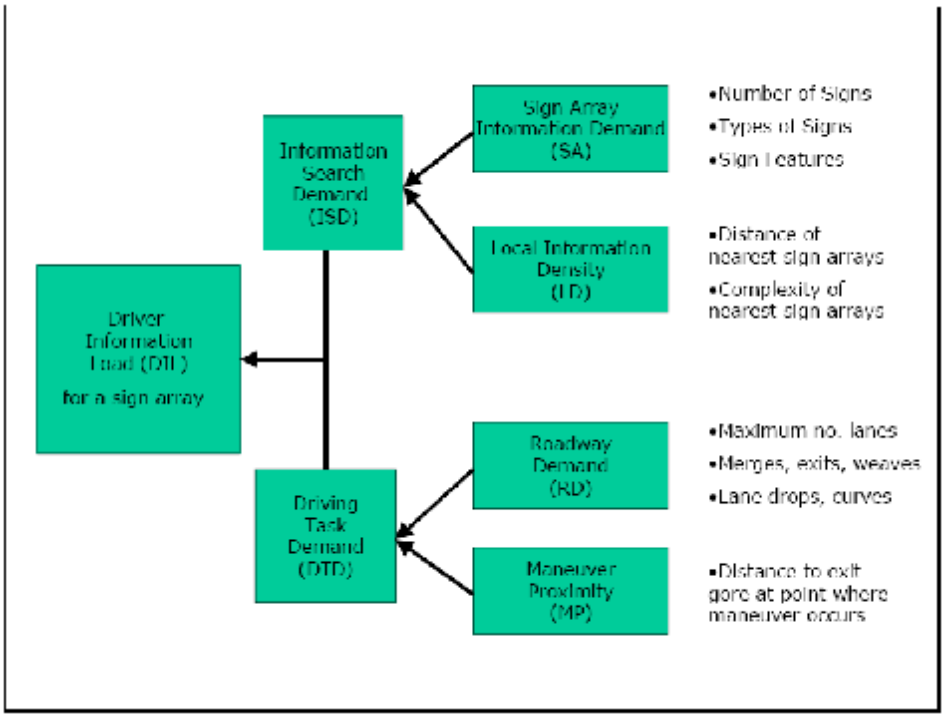

Figure 5.2 Driver information load Model Components [12]

The information load associated with a particular sign array is estimated by the multiple regression formula:

$$IL = 0.012SA + 0.062MP + 5.649RD + 0.082LD + 3.17$$

Where:

IL = Driver information load

SA = Sign Array Information Demand – Value of load imparted by each individual sign.

MP = Maneuver Proximity

LD = Local Information Density – Sign array information demand for the sign preceding and following the target sign.

RD = Roadway Demand – Takes into consideration number of lanes, merges, exits, weaving sections, lane drops and horizontal curves.

The regression equation shows that the roadway demand factor contributes the most towards the driver information load value. Though this model can be used to compare alternate signing systems, the contribution of sign information demand is low compared to other contributors.

5.3 Driver information load Software

NCHRP developed the driver information load model computational tool using software and analytical capabilities. This software tool developed can be used to readily calculate the driver information load based on the model developed. This software makes the DIL model easy to use for analyzing information load associated with the given set of signs along a freeway segment. The model is user-friendly with input forms, drop down menu lists, and check boxes. Once the data are entered the analyses is performed automatically and the user can open the output module to see the results. The output is provided in both tabular and graphic format showing DIL rating at each sign location as well as the contributions of various component elements of the model to the overall information load. Figure 5.3 shows the sample graphical output of a DIL profile.

Distance from exit gore (or point of maneuver) is represented on the horizontal axis and information load on the vertical axis. Roadway demand remains constant for the section of freeway analyzed. Maneuver proximity increases as the exit gore approaches due to perceptual and control demands required monitoring traffic, finding gaps, determining appropriate lane and speed, etc. Local density is the information demand imparted due to other sign arrays surrounding the target sign array, i.e., two signs located nearby will impart more load on driver than signs located far apart. Total information demand is calculated by summing up all the factors according to the model. The model analyzes roadway sections, and a section ends at the point where a driver makes a navigational maneuver such as an exit. The road section may be defined as the section from exit gore point at one end to an upstream point which can be up to 11000 ft (approximately 2 miles) from gore thus including even the initial advance signing for an exit.

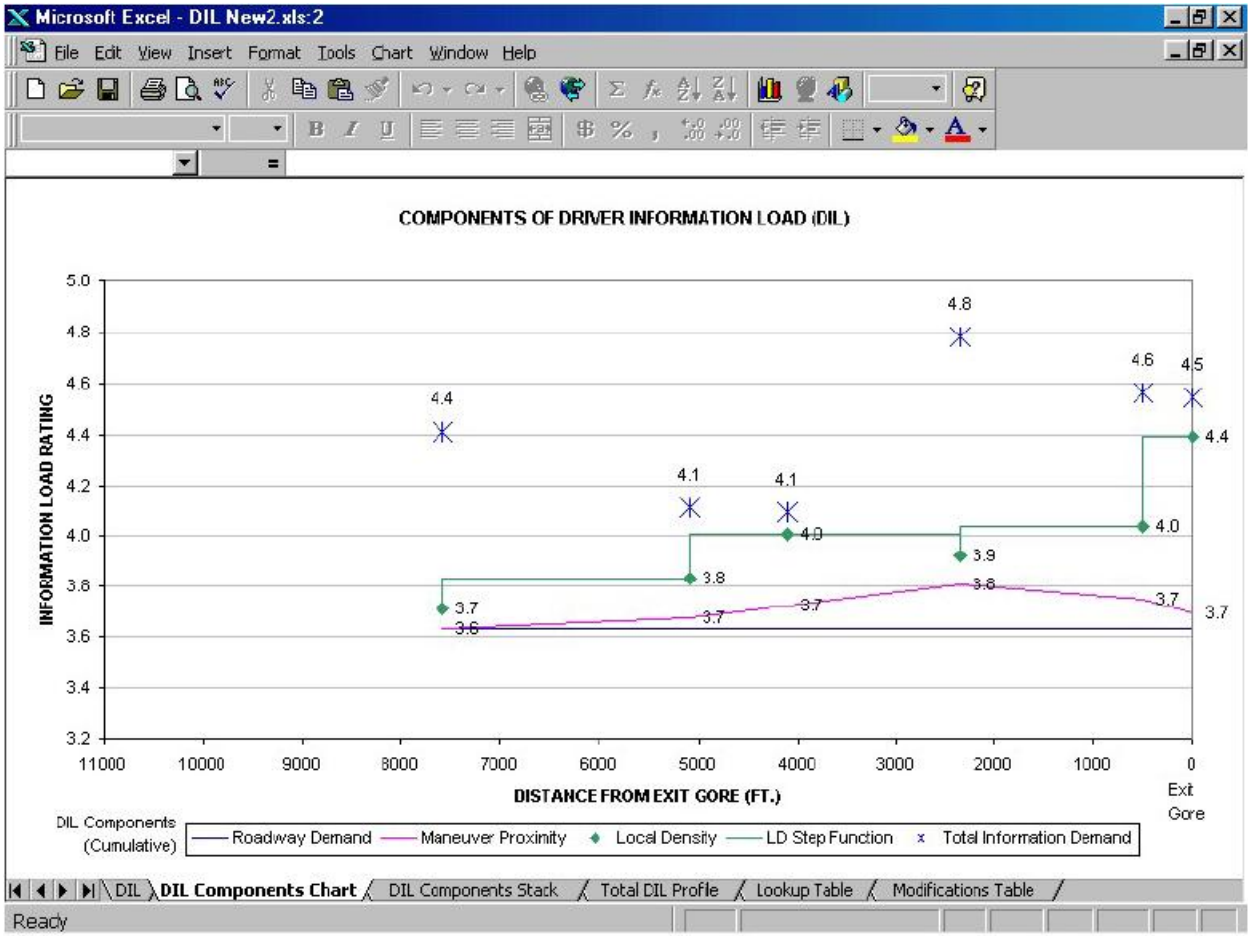

Figure 5.3 DIL Component Chart

5.4 Driver Information Load Profiles

Driver information load profiles were developed to compare the load imparted on driver by six-panel logo signs to nine-panel logo signs. Data pertaining to roadway characteristics and roadway sign characteristics were supplied as input to the software tool to develop driver information load profiles. A DIL profile an for array of signs which includes six-panel logo signs and necessary guide signs as shown in Figure 5.4 leading up to a subject interchange exit are taken as the base profile to compare to different scenarios such as nine-panel logo signs.

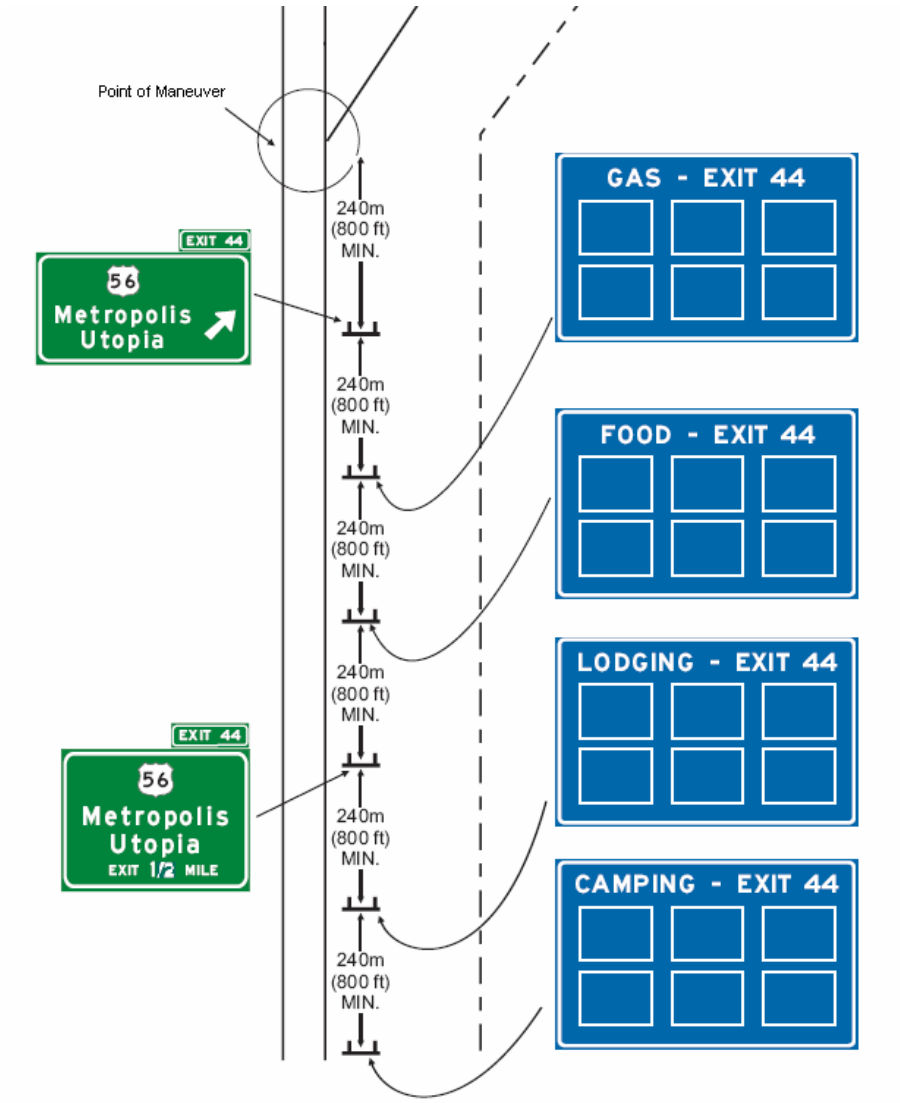

Figure 5.4 Six-panel Logo Sign and Guide Sign Locations [2]

A sign set with six signs (four logo signs and two guide signs) spaced appropriately according to the MUTCD, located along the section of freeway, was analyzed using the DIL software. The following paragraphs describe the procedure followed to develop a DIL profile for set of signs shown in Figure 5.4.

A three-lane highway of 11000 ft with one exit where the driver is assumed to make the maneuver was analyzed. Total numbers of sign arrays are six which include two guide signs (exit sign and advanced guide sign) and four logo signs (gas exit, food exit, lodging exit and camping exit) spaced at the minimum of 800 ft from each other.

The base profile was compared with information load profiles developed for:

- Case I – nine-panel gas and food signs, six-panel lodging and camping signs.
- Case II – nine-panel gas sign; six-panel food, lodging and camping signs.
- Case III – nine-panel food sign; six-panel gas, lodging and camping signs.

Information related to an individual sign is entered in the form shown in Figure 5.5. A sign type is assigned by choosing the category from the drop down list. This list is primarily based on the standard guide signs defined in the MUTCD. Based on the sign type and category selected, additional information appears on the form.

The sign's corresponding MUTCD reference is cited below the sign type box. Below the MUTCD reference is a table with the characteristics of the selected sign. The top row represents a typical complex sign of the selected sign type and the bottom row represents a typical uncomplicated sign of the selected sign type. The two rows have different sets of characteristics representing their varying levels of complexity. The complex ("upper") and simpler ("lower") versions of a sign type differ in terms of characteristics such as word length, number of destinations, and the presence of various features such as route markers or icons. Using the upper and lower complexity rating values shown in the table the base load rating for sign was determined. An average of upper and lower rating was used as the base rating for guide signs (base load rating = 23). The second upper complex rating ("upper 2") was used for six-panel logo signs as that rating exactly matches those signs (for six-panel logo signs, base load rating = 23).

The final section for the modification of the base rating for additional sign components i.e., for components of sign array which vary from predefined components. For example, in case of nine-panel logo signs, there are three additional panels on the logo sign. There is a selection box next to each item which can be checked or unchecked. In case of nine-panel logo signs, the box next to "Icons" was checked and three logos were added which results in increase of sign rating for information appropriately by adding it to the base rating. The rating for nine-panel logo signs became 32.

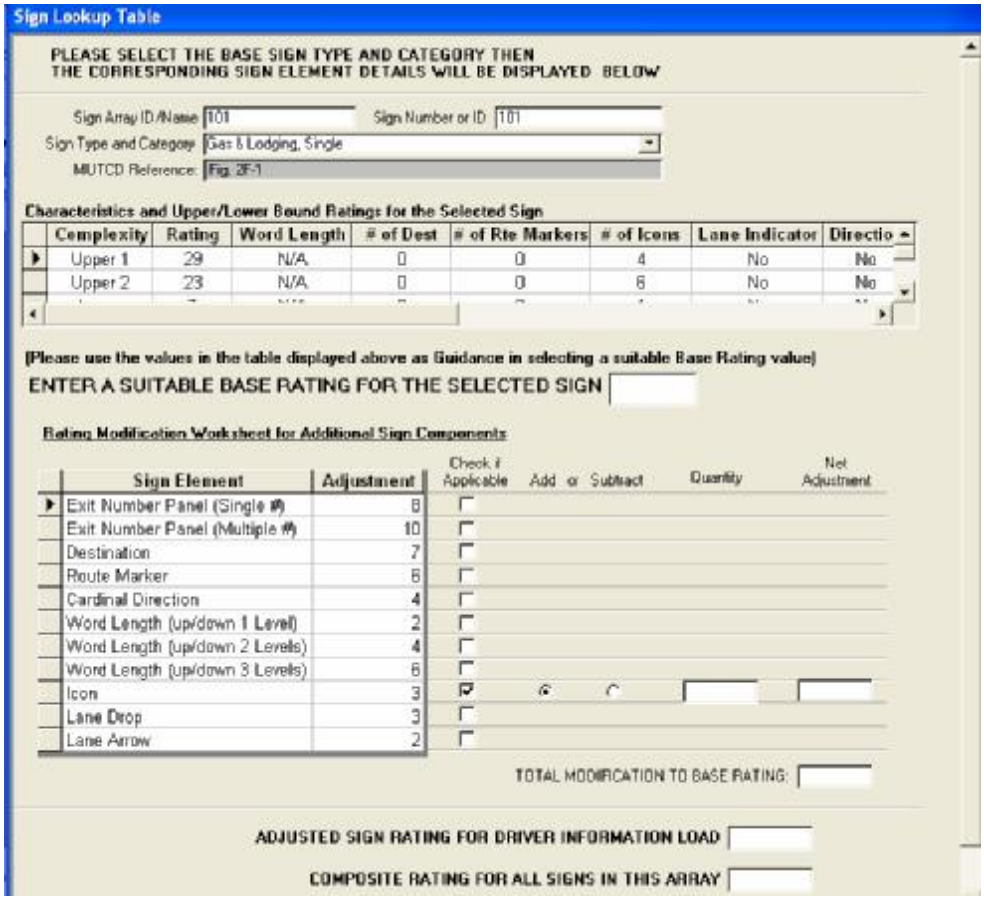

Figure 5.5 Individual Sign Data Input Form with Base Rating and Modifications – Sign Lookup Table

Table 5.1 Tabular Output for series of six-panel logo signs (Base Case)

Sign Array ID	Driver information load (DIL)	Distance from Exit Gore (ft)	Maneuver Proximity (MP)	Roadway Demand (RD)
Camping Exit	3.83	4800	0.06	3.38
Lodging Exit	3.87	4000	0.10	3.38
Advance Exit Sign	3.91	3200	0.14	3.38
Food Exit	3.95	2400	0.17	3.38
Gas Exit	3.99	1600	0.21	3.38
Exit Sign	3.92	800	0.14	3.38

Table 5.1 shows the driver information load output for the base profile (six-panel logo signs). The roadway demand remains constant through the freeway section and the maneuver proximity increases as the distance to the exit gore decreases, resulting in an increase in total DIL to the gas sign.

Figure 5.6 shows the output in graphical format. The information load profile shows that there are no unusual things happening with a series of six-panel logo signs. The information load increases consistently without any sudden peaks or drops up to a distance of 1600 ft upstream of the gore point, where the driver must choose the right lane, an appropriate speed, and perform the maneuver. The maximum load occurs at the position where the “Gas Exit” logo sign is present. The output on its own does not lead to any conclusion unless the profile is compared with other profiles.

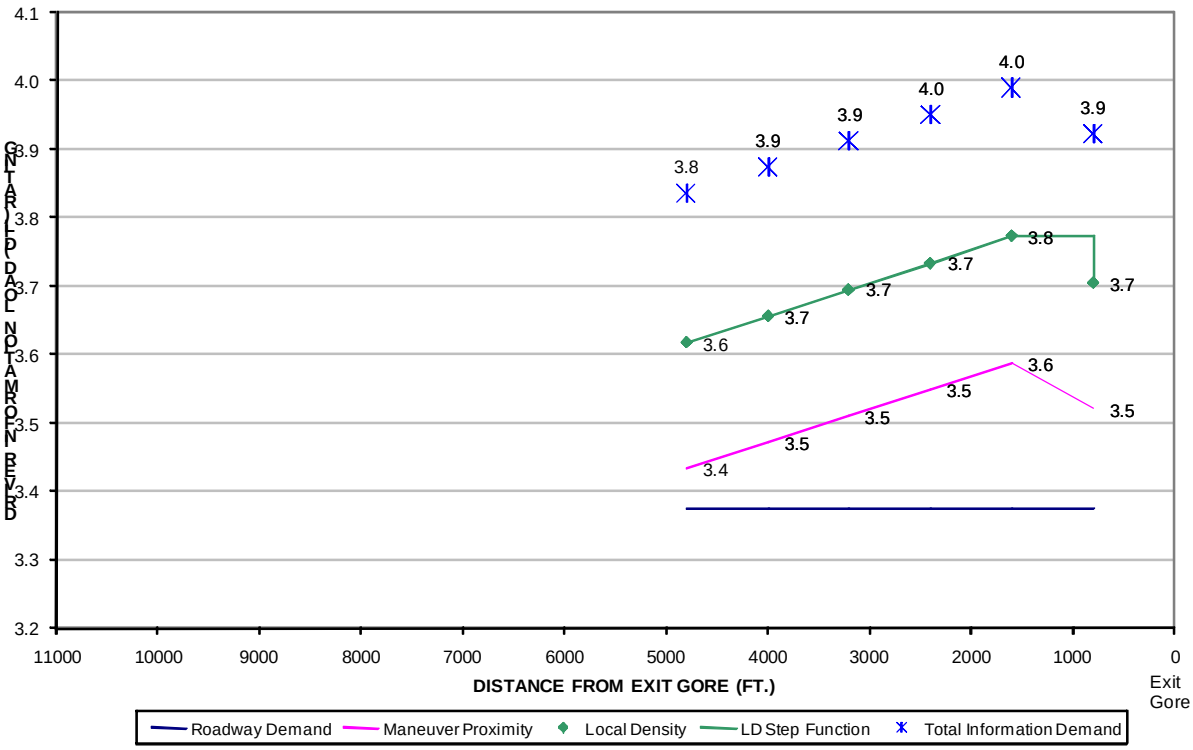

Figure 5.6 Components of DIL for Six-panel Logo Signs (Base Case).

Figure 5.7 shows the array of signs for Case I (nine-panel logo signs for gas and food, six-panel logo signs for lodging and camping, and necessary guide signs leading up to a interchange exit).

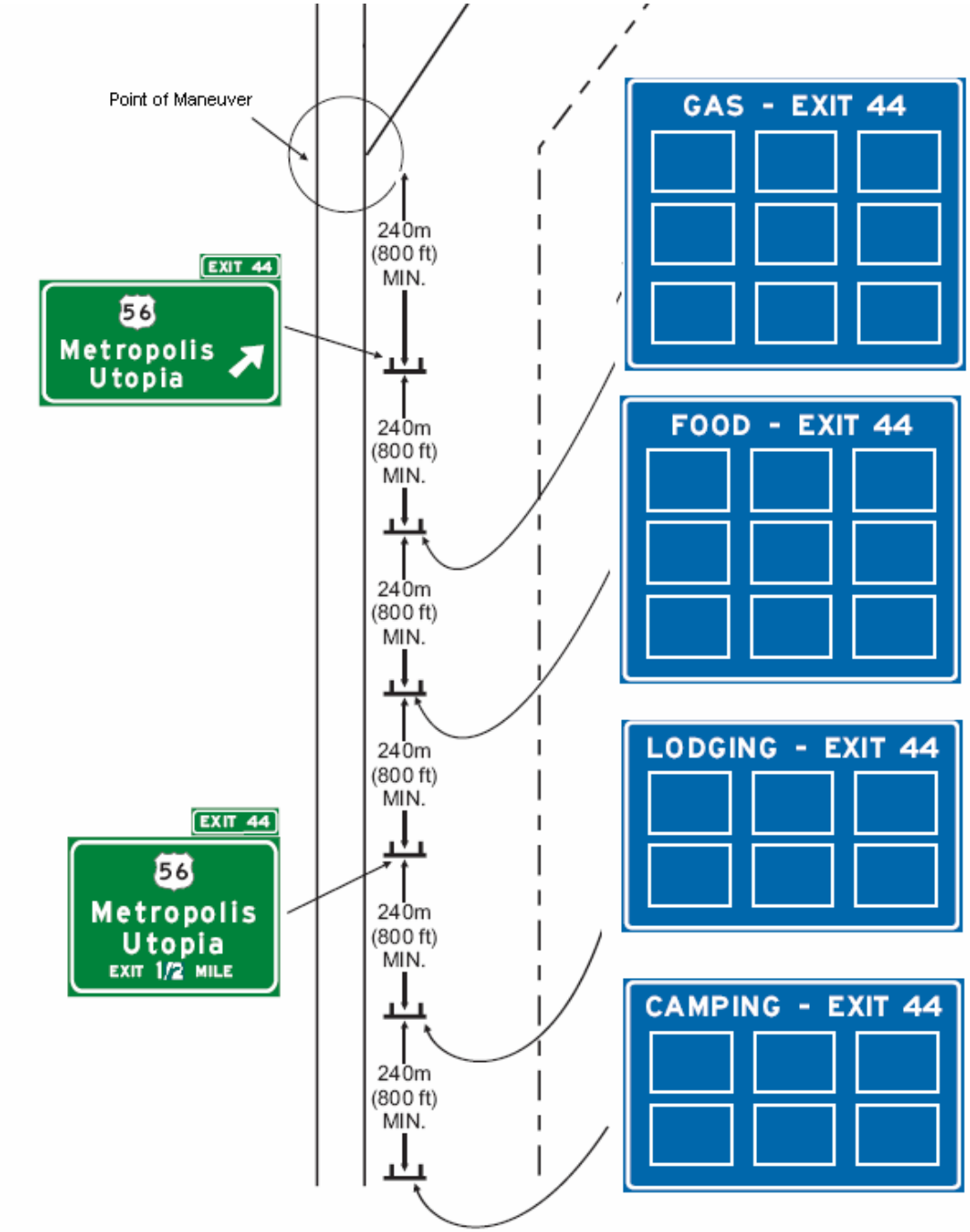

Figure 5.7 Case I Logo Sign and Guide Sign Locations.

Figure 5.8 shows the driver information load profiles for Case I. Figure 5.9 shows that information load increases when the driver encounters nine-panel logo signs on a freeway.

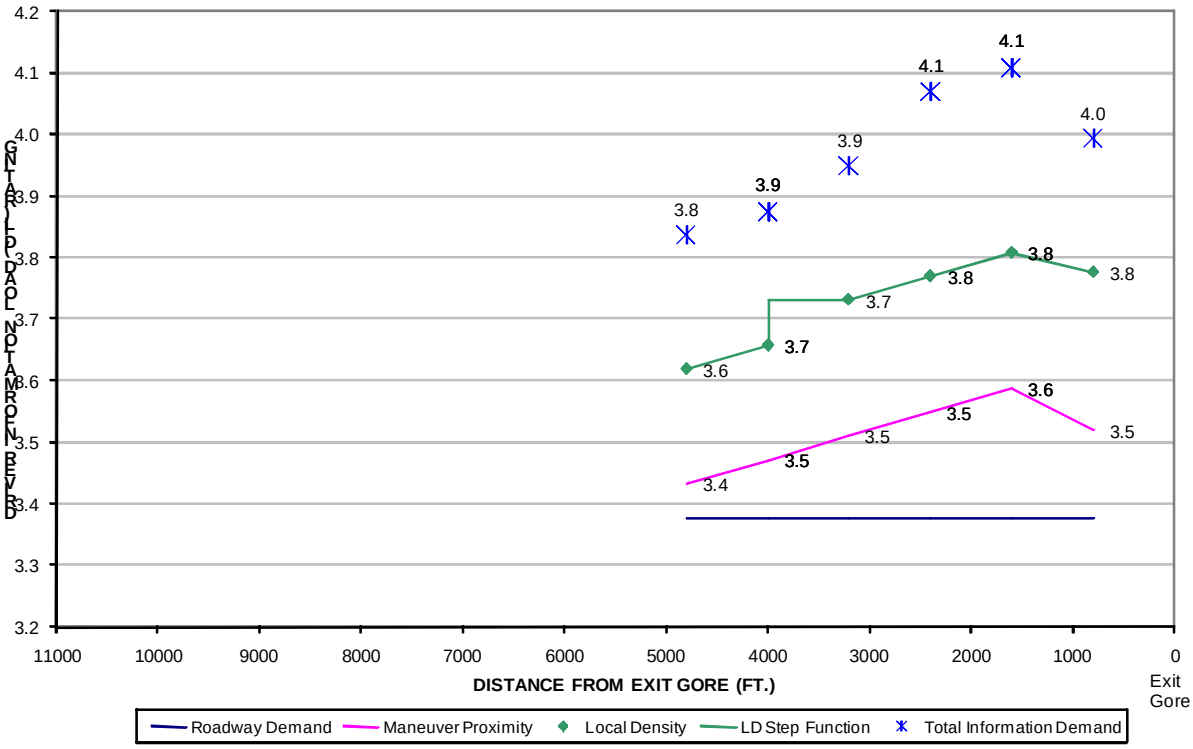

Figure 5.8 Components of DIL for Roadway Sign Set in Figure 5.7 (For Case I)

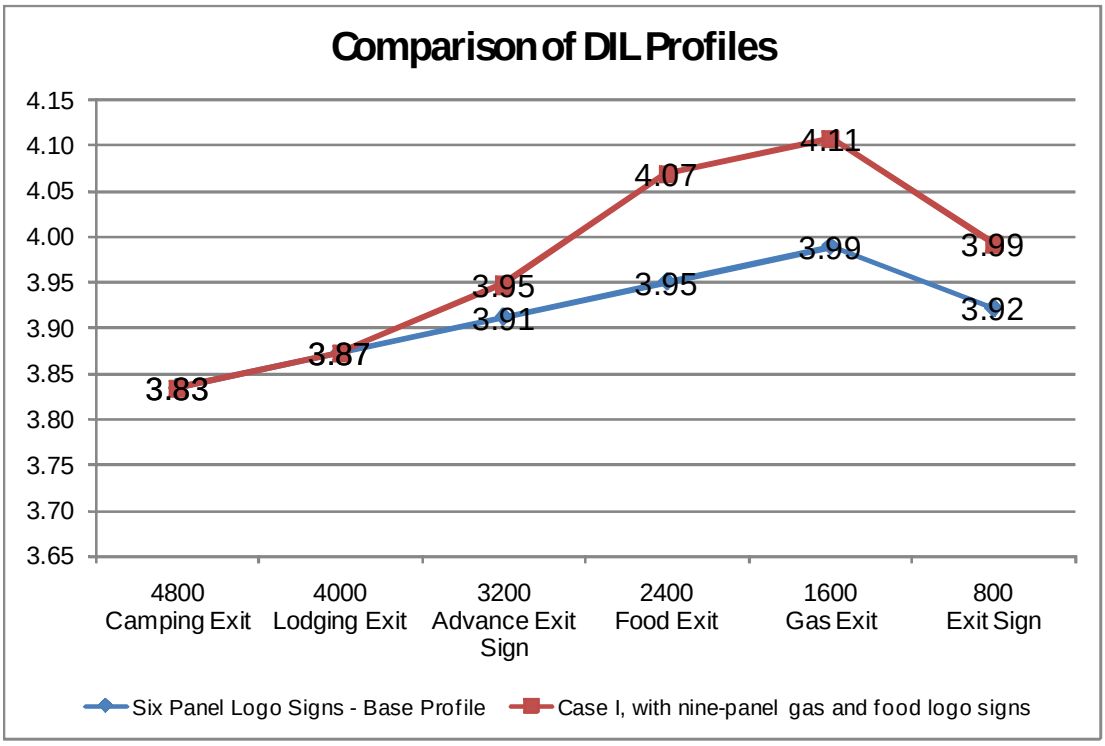

Figure 5.9 Comparison of DIL profile for Case I with Base Profile

The driver information load remains the same at the camping and lodging logo signs as they have six-panels in both cases. As the distance to the gore point decreases the rate of increase in information load is greater in Case I compared to base case. The information load rating at the food and gas signs is higher for nine-panel logo signs compared to six-panel logo signs and this also effects due to an increase in the “local density” factor. Hence it can be concluded that nine-panel logo signs not only increase the information load at the signs with nine-panels but also have an effect on information demand for the signs preceding and following the target sign

Though there is an increase in driver information load for nine-panel logo signs, the amount of increase is quite small. The maximum value of the increase in DIL for a sign set along a free-way with nine-panel logo signs is 0.12, i.e., an increase of 3%. The increase in information load in other areas preceding and following nine-panel logo signs is less than 2%.

It is not always necessary to have nine-panel logo signs for gas and food signs. Depending on the number of businesses and services offered by the business, it may be possible that either the gas or food sign may have nine-panels or all others could be six-panel logo signs. Driver information load profiles were therefore also developed for Case II and Case III as shown in the Figure 5.10 and 5.11.

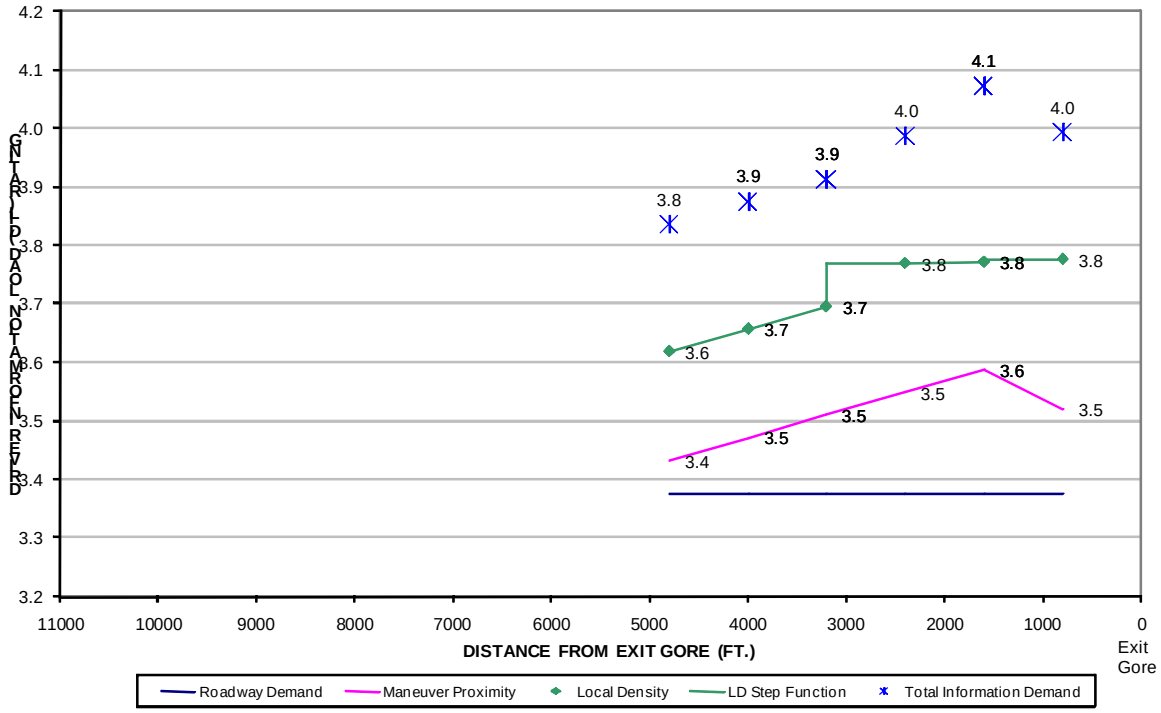

Figure 5.10 Components of DIL for Case II – Nine-panel Gas Logo Sign

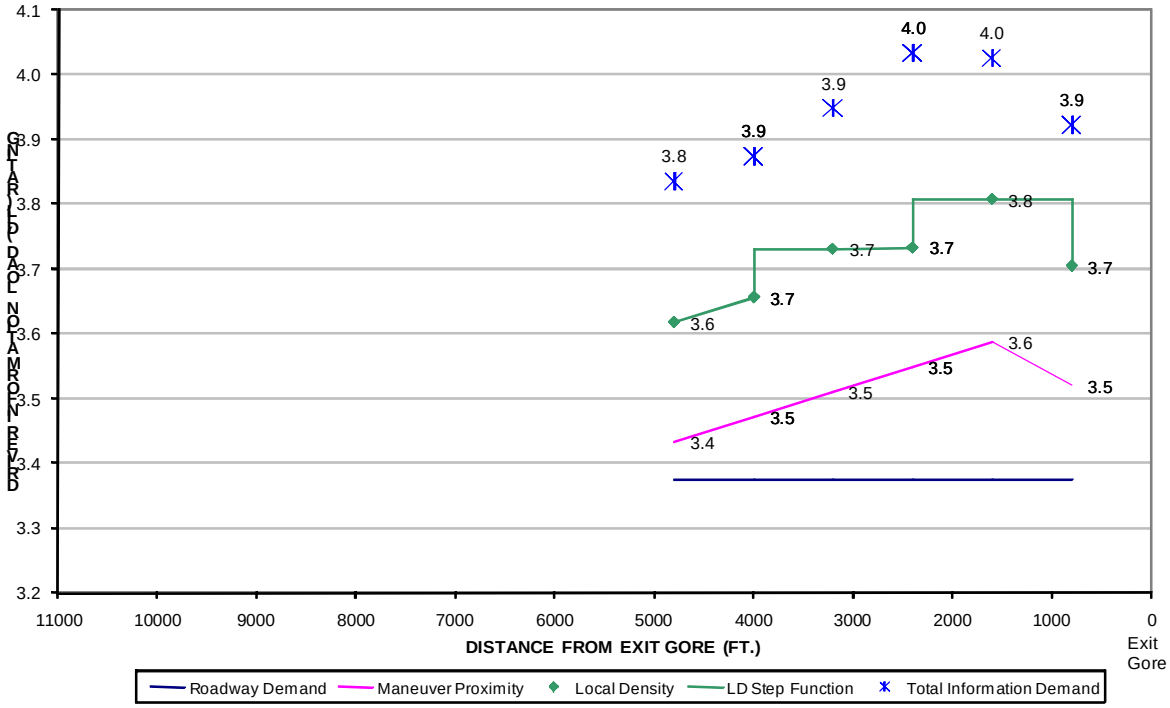

Figure 5.11 Components of DIL for Case III – Nine-panel Food Logo Sign

Table 5.2 Comparison Table for Base Case and Case II, Base Case and Case III

Sign Array ID	Distance from Exit Gore (ft)	Driver information load (DIL)			Difference b/w Case II and Base Case	Difference b/w Case III and Base Case
		Base Case (All Six-panel Signs)	Case II (Gas Sign with nine-panels)	Case III (Food Sign with nine-panels)		
Camping Exit	4800	3.83	3.83	3.83	0.00	0.00
Lodging Exit	4000	3.87	3.87	3.87	0.00	0.00
Advance Exit Sign	3200	3.91	3.91	3.95	0.00	0.04
Food Exit	2400	3.95	3.99	4.03	0.04	0.08
Gas Exit	1600	3.99	4.07	4.02	0.08	0.04
Exit Sign	800	3.92	3.99	3.92	0.07	0.00

Table 5.2 shows the difference in driver information load values between base case and for cases II and III (with a single nine-panel logo sign in each case). For Case II and III, the maximum increase in DIL value occurs at the point of the nine-panel logo sign. The maximum amount of increase in DIL value at point of nine-panel logo sign is 0.08, i.e., an approximate increase of 2%. The overall increase in DIL values was more for the case of the nine-panel gas sign than for the nine-panel food sign. This is because of proximity of the gas sign to exit point. Having a nine-panel logo sign nearer to exit point adds more information load on the driver as the driver has to deal with maneuver related tasks.

5.4.1 Nine-panel Logo Sign Equivalent

To provide perspective the author developed an equivalent standard sign sequence that would have similar information demand to sequences with nine-panel logo signs. A double exit interchange sign has a base rating equal to the rating of a nine-panel logo sign, so the author selected it.

A sign set with double-exit logo signs replacing the nine-panel gas and food logo signs in Case I is shown in Figure 5.12. Figure 5.13 shows the DIL profile for this set.

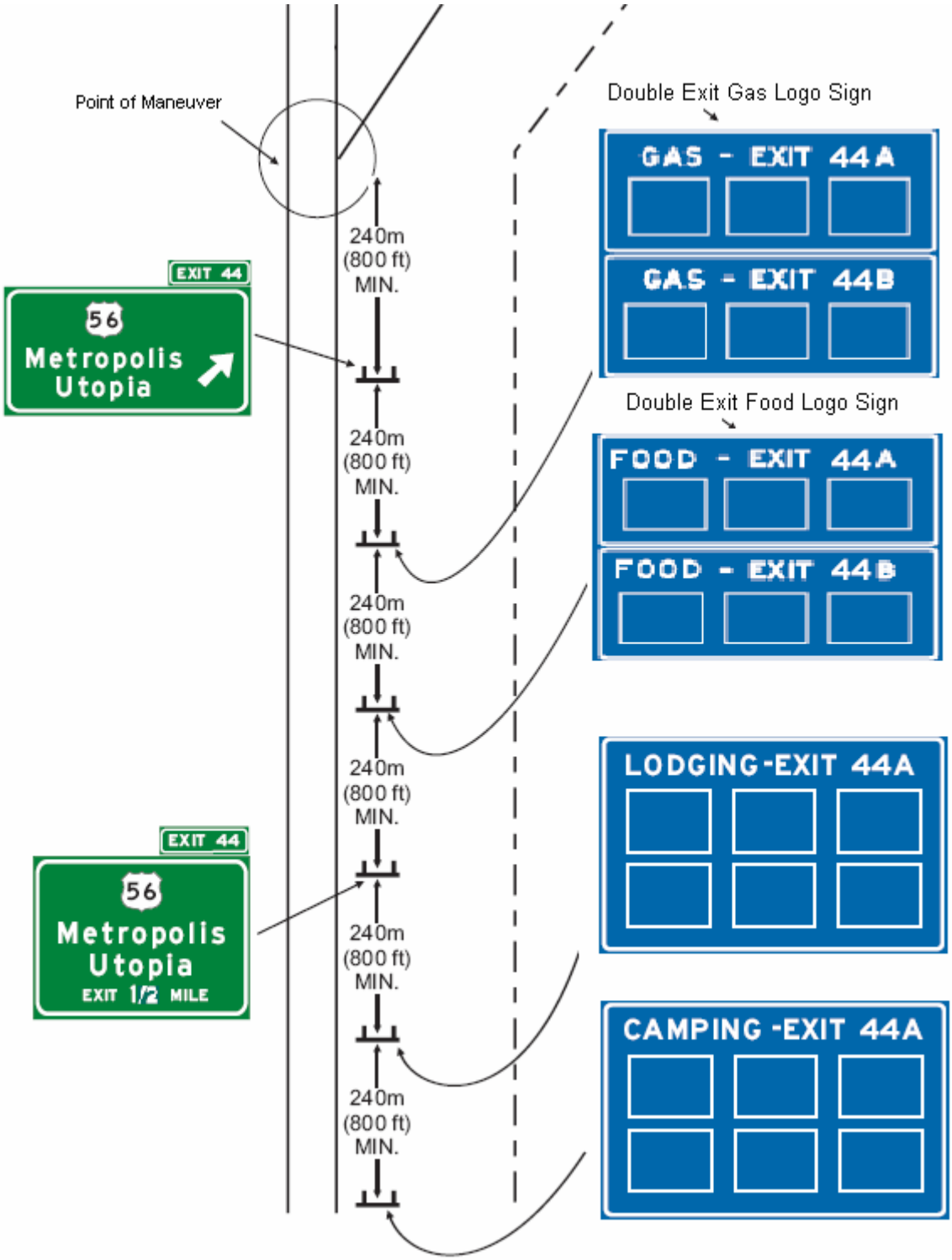

Figure 5.12 Freeway segment with Double Exit Interchange Logo Signs for Gas and Food Services

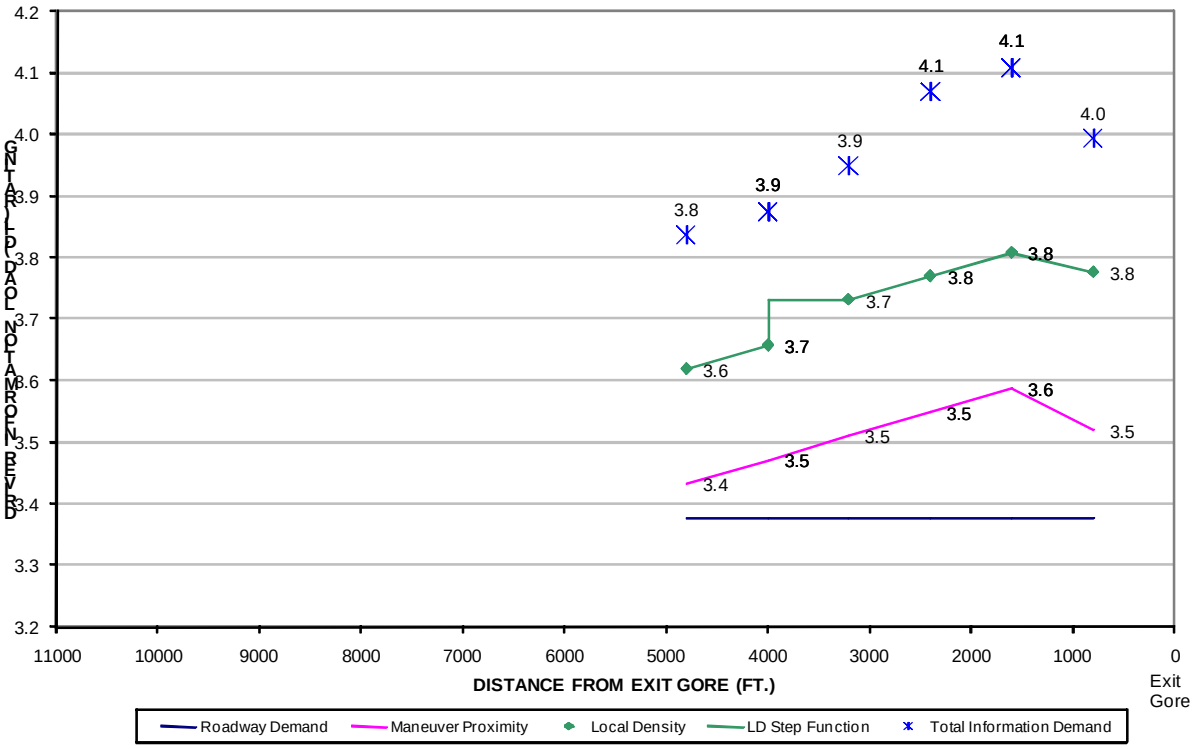

Figure 5.13 DIL Component chart for set of signs in Figure 5.19

Figure 5.13 shows that there is absolutely no difference between information loads for the sign set in Figure 5.19 and the loads for Case I. It can be concluded that nine-panel food or gas logo signs would impart equal amounts of information load on a driver as a six-panel double exit logo signs.

6. Conclusions and Recommendations

6.1 Summary and conclusions

The objective of this project was to determine whether logo signs with nine-panels cause negative impacts on drivers from a human factors point of view. The research conducted provided interesting and useful information on the human factors performance of various types of logo signs. Among the highlights were:

- The review of unconventional logo sign safety indicated that they do not have any negative impact on driver safety and effectiveness of logo signs.
- The most-frequently used logo sign is for gasoline, followed by the sign for food. Most of drivers scan logo signs.
- On average, six-panel signs led to higher correct response percentages than nine-panel and mixed-use signs.
- On average, mixed-use signs had slightly higher correct response percentages than nine-panel signs, although there were plenty of cases in which nine-panel signs performed better.
- The time during which the image with the sign was exposed mattered a great deal. The sign type performing worst with a 2.5-second exposure time still had a far higher correct response percentage than the sign type performing best with a 1.0-second exposure.
- Logo position on a sign made just a very small difference in correct response rate, with rates only about 3% higher for a logo in row 1 or 2 than a logo in row 3.
- Respondents made many more errors when the logo they were searching for was not on the sign than when it was on the sign. This was especially true for nine-panel signs.

- The unfamiliar food logo tested provided a far higher correct response percentage than the familiar food logo tested. For the unfamiliar food logo, the correct response percentage was almost as high for the nine-panel and mixed-use signs as for the six-panel signs.
- Gasoline logo signs led to the lowest correct response percentages, with mixed-use signs and nine-panel signs faring particularly poorly. Nine-panel signs did not do as well for food logos, and for lodging logos all three sign types tested fared about the same on average.
- Nine-panel signs performed relatively better with younger respondents, middle aged respondents and relatively worse with older respondents. Correct response rate for younger and middle aged drivers did not vary statistically by sign type.
- The maximum driver information load occurs at a point where the gas logo sign is present, for both six and nine-panel logo signs.
- Driver information load values for nine-panel logo signs are higher than the values for six-panel signs by a maximum value of 4%. In most of the cases examined, DIL values for six and nine-panel signs were very close with a difference of less than or equal to 2%.
- Having a nine-panel logo sign nearer to exit point adds more information load on the driver. Hence a nine-panel-gas sign would have more information demand than a nine-panel food sign.
- Information demand from a nine-panel logo sign is exactly equal to information demand from six-panel double-exit logo sign. In either case, the variation from the information load with six-panel logo signs is not very high.
- DIL profiles looked consistent for both six and nine-panel signs without any abrupt peaks or drops in information loads along the stretch of freeway.

That six-panel and mixed-use signs would perform better than nine-panel signs was not a surprise and was not really the issue in this study. The real issue was the margin of the difference. The results from laboratory experiment showed that the comprehension levels for nine-panel logo signs are low only at shorter exposure times; however, as the

exposure time increased the correct response rate for nine-panel signs improved. Driver information load profiles suggested that the information load imparted by nine-panel logo signs is only slightly higher (maximum 4%) than six-panel signs. It can be concluded that the margin of difference between six and nine-panel logo signs decreases along increase in exposure times. From the information demand point of view, the margin of difference between six-panel and nine-panel logo signs is not substantial.

When the number of qualifying businesses of a single type around an interchange builds up past six, the NCDOT and other agencies can respond with the following choices:

- Nine-panel logo signs,
- Mixed-use logo signs, which in many cases will increase the number of signs on an interchange approach, or
- Stay with conventional six-panel logo signs, which in many cases will lead to more billboards and tower advertising signs.

This experiment did not test the extra signs, extra billboards, or extra tower advertising that will be introduced in many cases by the options other than nine-panel logo signs. In this way, this experiment was weighted against nine-panel signs, and the results must be framed in this light.

Considering the above, it is the conclusion of this study that nine-panel logo signs performed well from a human factors point of view for the conditions tested in the study. Their correct response percentages were usually competitive with, and sometimes surpassed, the mixed-use signs, and were not far behind those of the six-panel signs. Indeed, many scenarios involving nine-panel signs outperformed many scenarios involving six-panel signs (i.e., nine-panel signs with 2.5-second image exposure outperformed six-panel signs with 1.0-second exposure, nine-panel lodging signs outperformed six-panel gas signs, etc.). At a single point on the roadway, a nine-panel

sign will likely distract some drivers away from the more important driving tasks longer than a six-panel or mixed-use sign. However, DIL profiles showed that the information load demand for nine-panel logo sign is only slightly higher than six-panel sign; hence the difference may not be substantial enough to cause a safety concern. Since the six-panel or mixed-use cases will also likely add other distracting elements to other points on the highway environment that were not tested here, drivers and their passengers are likely to be as safe with the nine-panel sign.

6.2 Recommendations

Based on the study results and the conclusion provided above, highway agencies can allow the use of nine-panel logo signs. However, judicious use of nine-panel logo signs is recommended. Agencies should strive to provide nine-panel signs only where drivers have more time to scan them safely, such as where traffic volumes are lower, roadway geometries are not as challenging, and other signs are not providing additional distractions. Agencies might also consider limiting the use of nine-panel signs to food and lodging to minimize the information load increase at a point near to exit gore where drivers need to pay more attention towards maneuvering, since gasoline logo signs performed worse in the laboratory experiment, and since the survey indicated that individual gasoline logos might not be of as much interest anyway. It is also recommended that the agencies make use of NCHRP driver information load software to make the decisions, taking into consideration the existing highway conditions.

6.3 Further Research

The human factors experiment conducted during this project was really just the “tip of the iceberg” in understanding how logo signs and advertising affect drivers, and indeed in providing drivers with an optimum information system. A before and after collision analyses may provide more insight into the safety aspects of nine-panel logo signs. An obvious follow-up study would be in looking at the effects of the extra billboards and tower advertising signs that seem inevitable if the number of logos is restricted and also the effect of increased ramp signs. As driver simulator technology advances, perhaps

these types of studies can be done on simulators with the promise of plausible results. Further downstream, one can imagine calls for more than nine logos on a sign someday, perhaps by reducing the logo size, and studies of this option may be productive. A study of the logo signing on interchange ramps should be done as the signs on the ramps are smaller, provide more messages, and appear in a high stress driving environment, so changes like more signs or more logos may have nontrivial effects on safety.

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