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INDIANA DEPARTMENT OF TRANSPORTATION
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Alternate Interchange Signing Study for Indiana Highways



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JOINT TRANSPORTATION RESEARCH PROGRAM

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16. Abstract <p>The main objectives of this research were to (1) understand signing issues from the perspective of drivers and (2) develop recommendations for improving interchange signing in Indiana to aid driver understanding and increase the safety and efficiency of highway traffic operations. An online survey with specific questions was designed and distributed through email, social media, online newspapers, and a survey company with the goal of better understanding driver thinking when approaching decision-making areas on the interstate. The analysis of the survey results revealed the following.</p> <ul style="list-style-type: none"> • Drivers usually do not know the interchange types as they approach an interchange on the freeway. • Drivers are most interested in which lanes they should be in when approaching an interchange, even in advance of typical signing locations. • Drivers do not like signs that require cognitive work since it will delay their driving decision by creating uncertainty. • Different drivers need different types of information from signs, such as cardinal direction, destination name, road name, and lane assignments. Therefore, a perfect sign for one driver may be confusing or information overload for another driver. • In some instances, a driver who is familiar with the area is confused by the signs because the sign information contradicts the driver's knowledge. 			
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EXECUTIVE SUMMARY

Introduction

INDOT is responsible for maintaining and constructing all interstate, US Routes, and State Routes in Indiana. Drivers on these highways rely on guide signing to make lane changes and routing decisions. Current highway interchange guide signing is designed based on established standards, but some drivers have expressed that signing is confusing, not intuitive, or not explanatory enough. The main objective of this research is (1) to understand signing issues from the perspective of the driver and (2) develop improvement recommendations for interchange sign design in Indiana that will aid driver understanding and improve the safety and efficiency of highway traffic operations.

To understand the potential disconnect between sign designers and drivers, the Transportation and Autonomous Systems Institute (TASI) at Indiana University-Purdue University Indianapolis (IUPUI) collaborated with INDOT to conduct a new research project entitled, *Alternate Interchange Signing Study for Indiana Highways*. This project will develop improvement recommendations for interchange signing in Indiana that will enhance the safety and efficiency of highway traffic operations.

Findings

The first step of the project was to design a survey with specific questions aimed at understanding signing locations that are not ideal from the driver perspective. Due to the Covid-19 pandemic, face-to-face promotion of the survey became impossible, making an online survey the only option. The survey was created on the server via an online tool called Qualtrics, and Institutional Review Board (IRB) approval was obtained.

The survey was distributed through email, social media, online newspapers, and a survey company. Email distribution received a response rate of around 2% and proved to be the most effective distribution option. The other distribution methods did not have much success. As a result, 84 valid survey responses were returned. It was determined that the low response rate was potentially due to the survey format since it required the participants to provide information in written format and not multiple choice. The survey also required the participants to identify specific signs at specific

locations using map tools. Although the number of valid survey responses did not turn out to be as high as we initially expected, they did cover all major Indiana cities and returned useful and actionable information for INDOT; therefore, the data collection is considered successful.

All survey cases were examined by three TASI researchers independently, including information about the surrounding area of the signs indicated in the survey. Some survey responses were interpreted and supplemented as the initial response was partial or unclear.

The survey results showed the following.

- Drivers usually do not know the interchange types as they approach an interchange on the freeway.
- Drivers are most interested in which lanes they should be in when approaching an interchange, even in advance of typical signing locations.
- Drivers do not like signs that require cognitive work since that can delay their driving decision by creating uncertainty.
- Different drivers need different types of information on signing, such as cardinal direction, destination name, road name and lane assignments. Therefore, a perfect sign for one driver may be confusing or information overload for another driver.
- In some instances, a driver who is familiar with the area is more confused by the signs due to the sign information contradicting the driver's knowledge pertaining to directionality and geometry of the junction.

For each customer signing issue identified in the survey results, suggested remedies pertaining to sign layout, location, or type were logged in the case information. The result was submitted to the Study Advisory Committee (SAC) for comments, and the SAC's comments were integrated with TASI's result in the report.

Implementation

INDOT has modified some sign layouts and locations during recent signing updates and will consider future actions for the suggested locations based on each survey case. INDOT will also apply lessons from this study to future interchange signing design by coordinating with project design teams, traffic engineering, and FHWA engineers, and reviewing interchange modification proposals and the design standards group.

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1. INTRODUCTION

1.1 Project Description

INDOT is responsible for constructing and maintaining all interstate, US Routes, and State Routes in the State of Indiana. Drivers on these highways rely on the signing to make lane change and routing decisions. Current highway interchange signing is designed based on established standards, but some drivers have expressed that signing is confusing, not intuitive, or not explanatory enough. This presents a dilemma since interchange signing is designed by engineers utilizing standards set by Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD). To understand this potential disconnection between sign designers and drivers, the Transportation and Autonomous Systems Institute (TASI) at Indiana University-Purdue University Indianapolis (IUPUI) in collaboration with INDOT proposed a new research project to the JTRP FY 2021 program entitled, *Alternate Interchange Signing Study for Indiana Highways*. This project was to develop recommendations for better design of interchange signing in Indiana to improve the safety and efficiency of highway traffic operations.

Many factors can impact the effectiveness of an interchange sign. Examples of these factors are (a) complexity of highway interchange (e.g., system interchanges tend to cause more confusion than service interchange), (b) uncommon interchange design (e.g., left side exit ramps and left side entrance ramps), (c) unintuitive interchange design (e.g., left exit for right turn direction or the opposite), (d) interchange types (e.g., roundabout, diverging diamond, single point diamond, etc.), (e) lane indicators, (f) sign locations and size (overhead, on the roadside, left or right of the road), and (g) lighting conditions (e.g., road direction concerning the sunrise and sunset directions, etc.).

1.2 Study Process

In this research, TASI proposed to work with the INDOT Traffic Engineering team on the following related tasks. Five separate and coherent research tasks have been carried out to achieve the research objectives.

These tasks and their execution plans include the following.

- Task 1: Investigate all interchange form signing on Indiana interstate highways and categorize the sign messages with respect to the interchange types. This involves working closely with INDOT engineers in road sign design and interchange design areas.
- Task 2: Identify the interchanges with unclear or inadequate signing from the perspective of drivers. This involves performing driver surveys with respect to the level of understanding (or confusion) of interchange signing and working with INDOT engineers to gather information about highway incidents around the highway interchanges.
- Task 3: Determine the causes that drivers consider "not clear" for all identified specific interchanges. The causes may be the geometry of the road, the number of lanes, too many signs, too few signs, the location of the signing, the message of the signing, etc.
- Task 4: Develop recommendation for improved interchange signing design based on the identified causes. Propose, review, and evaluate options to improve the performance of the alternative signing comparing to the original signing.
- Task 5: Prepare a report to document the findings and suggestions for making alternative signing considering the cost of changes. Generate additional sign design considerations for future sign design. Support the evaluation of new sign designs for new construction projects. Develop signing drawings for various alternative interchange forms to be included in the *Indiana Design Manual*.

To be specific, the proposed five tasks in 14 months were shown in Figure 1.1 for demonstrating a tentative project schedule based on tasks defined during the project period by quarters.

1.3 Report Structure

This report summarizes the research objectives, technical approaches to achieving these objectives, and detailed research methods and results. Each section in the report corresponds to a specific task proposed in the statement of work. Section 1 introduced the project description, research plan, and report structure. Section 2 described how to gather signing information at

Tasks	Quarters	1	2	3	4	5
Task 1. Investigate all alternative interchange form signing along Indiana interstate highways.	1					
Task 2. Identify the interchanges with unclear or inadequate signing from the perspective of the drivers.	2					
Task 3. Find the causes for the drivers to consider any specific signing as "not clear" for all identified interchanges.	2					
Task 4. Develop recommendations for improved interchange signing design.	3					
Task 5. Write project report and signing drawings for various alternative interchange forms.	2					

Figure 1.1 Project schedule by quarters based on tasks defined during the project period.

interchanges. Interchange general layout and signing information was gathered and recorded by using Google maps. In Section 3, interchanges were identified with the unclear or inadequate signing from drivers' perspective. The plan for collecting interchange sign problems, data collection survey design, web-based survey development, and survey data statistics were illustrated. Section 4 described the survey data analysis from the interpretation of the data, location distribution of the good survey data, highway entry and exit distribution, problem types and distribution, structured problem types, and the recommendations for improving the interchange signing design. Section 5 described the signing problems that appeared in various environments and sign combinations from the perspective of sign designers. Finally, summary of survey results was given in Section 6.

2. GATHER INTERCHANGE TYPE INFORMATION AND SIGNINGS

This project originated from the idea that driver experience and understanding related to interchange signing does not always match designer intent in placement, layout, and messaging of signs. An identified need of the study is to gain a better understanding of driver priorities related to signing design. The assumption is that the coordinated design of interchange type and interchange signing would improve drivers' satisfaction with signing. Therefore, the project team's first task was to understand the interchange types in Indiana and the number of interchanges in each type to better understand the different signing needs.

2.1 Find All Interchanges in Indiana

To identify all interchanges in Indiana, we referred to the INDOT's *Interchange Book* (INDOT n.d.) and found more than 300 interchanges. Using Google Street View, we recorded a web link for each interchange and stored them in an Excel file which is submitted to INDOT as supplemental information.

2.2 Determine the Type of Each Interchange

The next step was to determine the type of each interchange. Since there are many variations of interchange types, there is not a precisely defined standard naming convention for many interchanges. Based on input from INDOT, we determined the type of each highway interchange in Indiana. The result is submitted to INDOT as a supplemental information.

2.3 Find the Interchanges Signings of All Interstate Entries and Exits

The purpose of this subtask is to associate the problematic signs to the interchange type in the future. There are two types of signs related to the highway—one type includes signs to get on the highway and the

other type includes signs to guide the drivers to exit the highway. There are many signs related to each interchange. To distinguish which sign is which, we defined the signs in the following manner.

- For signs on the highway and indicating exit, the heading direction is used as the prefix, e.g., SB_exit (southbound exit), EB_exit (eastbound), NB_exit (northbound), WB_exit (westbound). If an exit is not in these directions, it is approximated to one of these four directions.
- For signs indicating the entrance to a highway, the sign location relative to the highway is used as the prefix, e.g., SS_entry (south side of the highway), ES_entry (east side of the highway), NS_entry (north side of the highway), WS_entry (west side of the highway). If an entry is not exactly on these side directions, it is approximated to one of these four sides.

Based on this definition, we found the location of each sign related to each interchange from Google Street View map. At each interchange, signs were identified and documented in an Excel file. A link for the image of each sign is embedded in the Excel file for each reference in the future. The Excel file was submitted to INDOT as a supplemental information.

3. IDENTIFY THE INTERCHANGES WITH UNCLEAR OR INADEQUATE SIGNING FROM THE PERSPECTIVE OF DRIVERS

This task is to compile and evaluate information from the perspective of surveyed Indiana drivers on misunderstood or undesirable highway signing. Current Indiana highway interchange signing is designed based on established standards, but some drivers have expressed that signing is confusing, not intuitive, or not explanatory enough. Thus, the project team sought to conduct a survey of drivers to identify unclear or confusing sign locations for entering and exiting interstate highways in Indiana. The specific subtasks include designing a survey and questionnaire to identify the unclear or inadequate signing from drivers' feedback and analyze the survey results. Section 3.1 introduces the overall process for collecting the unclear or inadequate road signs on highways in Indiana, including the survey design, IRB approval, online tools for designing a survey, survey implementation, text analysis, and problem summary. Section 3.2 explains how we designed the survey and what questions were included in the survey. The survey questions are listed in Appendix A. Section 3.3 provides more details about the development of survey using Qualtrics. The detailed process of survey implementation is given in Section 3.4. The procedure for text analysis of the collected data from the survey are illustrated in Section 3.5.

3.1 Overall Plan for Collecting Interchange Sign Problems

To collect appropriate data for driver perceived interchange sign problems on Indiana interstate highways, an overall survey plan for obtaining the data is shown in Figure 3.1. The survey with specific questions

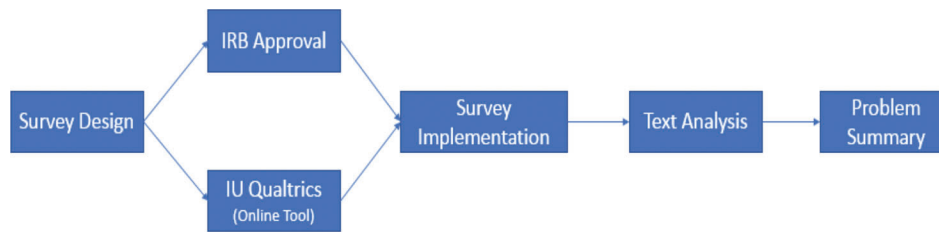


Figure 3.1 Overall plan of obtaining the interchange sign problems.

was first designed. Due to the Covid-19 pandemic, face-to-face promotion of survey became impossible, so an online survey was the only option. The survey was created via an online tool called Qualtrics on the server. Meanwhile, IRB approval was obtained to be able to conduct the survey. In the third stage, we advertised a survey and tried to attract the public's attention. The survey data were collected gradually. Then the text analysis process was conducted. Finally, a problem summary for pointing out problematic road signs on Indiana highways was concluded.

3.2 Data Collection Survey Design

Due to the Covid-19 pandemic, face-to-face promotion of survey became impossible, and an online survey was the only viable approach. To ensure that we can attract the people to take the survey, the survey questions were carefully designed, and the survey was kept as concise as possible. The survey questions are in four parts—survey disclaimer, demographic information, interchange signing related information, and contact information.

3.2.1 Survey Disclaimer

This part of the survey serves two purposes. First, it clearly describes the purpose of the survey, the eligibility of participants, relevant information to the participants, and states it got IRB approval, enabling the participants to decide if they still want to do the survey. The survey disclaimer ensures participants' legal protection and makes explicit promises according to the privacy policy and terms and conditions agreements. Second, it protects the research team from the potential for any legal actions.

In this study, we looked for anyone who experienced interchange signing issues in the State of Indiana. The participants need to (1) have highway driving experiences in Indiana and (2) be 18 years or older. We also promised to pay \$10 (later increased to \$20) for the completed valid survey.

3.2.2 Demographic Information

In general, the questions about drivers' demographic background are listed first. This information will allow us to understand the participants' specific background characteristics, such as their age, gender, number of

years driving, number of days driving on highways per week, highway driving miles per year before the Covid-19 pandemic. Age information may indicate the driving proficiency and reaction time of drivers. Young drivers may have faster reflexes and better vision than elderly drivers when seeing the road signs. Moreover, a driver with a more extended driving experience may better understand interchange signs and traffic conditions than a novice driver. In other words, drivers' perception of interchange signs will be influenced by their demographic background to some extent. Thus, it is essential to design such kinds of questions in the survey.

3.2.3 Interchange Signing Related Information

After answering the above two sets of questions, we ask the most critical questions for the interchange sign problems. To better describe the potential road sign issues, three different perspectives are listed as follows.

- The first question is the sign location, which is the basic information we need to collect for future analysis and evaluation. The location includes the road name, the direction the driver is heading, and where the driver intends to go. Once we know the specific locations of unclear interchange signs, we can double-check the subject's locations and see whether it is really an inadequate signing that may confuse most drivers or a problem for a small portion of drivers.
- The second question is the problem description. In order to get a deeper explanation and potentially a solution from the participant, we encourage the drivers to provide more details and describe how this unclear sign affects their driving decision. This question is also necessary since different people have varying understanding of the sign when approaching.
- The third question is about the image of the sign. It is not easy to clearly describe a specific sign's location, and there may be many signs at a location. In most cases, it would not be easy to understand problem description in words and check the validity without seeing a picture of the interchange sign. Some of the potential issues can only be observed through the photos. The Google Street View application is a convenient tool for participants to pinpoint the sign since they can search the intended sign in the location area. In some locations without the Google Street View, the self-taken photos are also accepted to show the sign.

3.2.4 Contact Information

The participant's email address was asked solely for sending the compensation of \$10–\$20 for each

completed survey. Therefore, we did not use the email for further communication. The Qualtrics survey pages are in Appendix A.

3.3 Web-Based Survey Development

The Qualtrics was used to design the questionnaire online. IU Qualtrics was the CustomXM version of Qualtrics provided by Indiana University. This version can be only associated with a personal account and does not allow a group account.

3.3.1 IU Qualtrics

Qualtrics is a cloud-based survey tool that helps us build and distribute surveys, view reports, and tabulate and analyze responses. Qualtrics provides a programming environment that allows the user interface control and generates the survey results in various formats such as CSV, TSV, Excel, XML, SPSS, and extract user-submitted files.

3.3.2 Survey Page Design

- The survey contains five distinct parts—survey instructions, personal information, identify a location, explain why one feels that signing is confusing, and email address.
- There is an instruction for the survey on the first page, including what should be done and the compensation.
- The second page helps us get the driver's information to know the driving experience of the survey takers. The third page is called "Identify location," the survey takers need to mark the problematic signing on the map provided by the survey (Figure 3.2), then open the street view to find the picture of that signing, and finally copy the screen and upload the picture in next question. This series of actions can also be used to help us determine whether this response is valid or not. In this part, we use JavaScript to implement the question.
 - First, we save the code file to the library of the Qualtrics, then use the initializing function of JavaScript to run the file.
 - After that, we get an initialized map of Indiana.
 - When people drop a pin on this map, we will get the coordination of that pin, which will help us locate the problematic signing quickly.
- The fourth page has eight questions related to the problematic signing provided by survey participants. We ask survey participant the types of the signing problem—information-related, time-related, and location-related. Also, there is an "others" option in each multiple-choice if the predefined problem types cannot describe their situation.
- The last page requires survey participants to provide their email addresses for us to send the payment.

3.4 Advertisement Methods

Four methods for advertising surveys were initially proposed—emails, online forums, newspapers, and

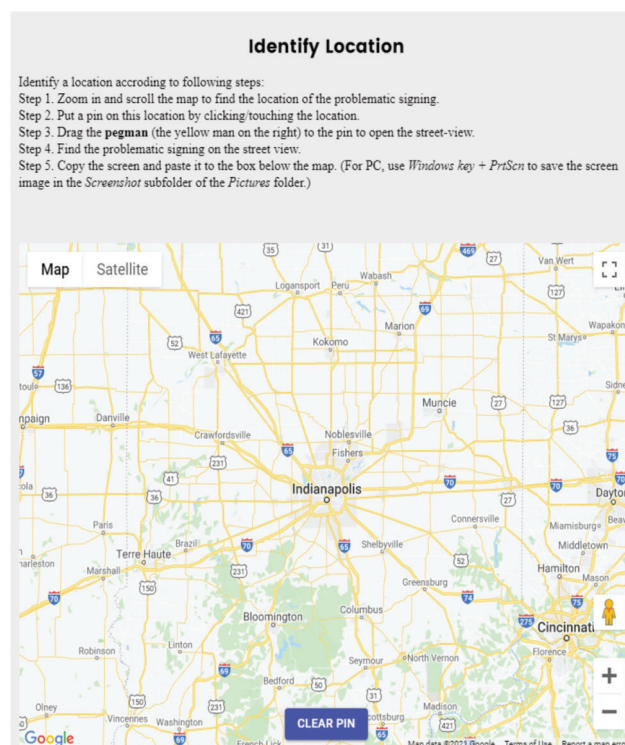


Figure 3.2 Identify location question (Google, n.d.a).

social media. Considering efficiency and convenience, email, newspapers, and social media were used to recruit the respondents. All advertisements received IRB approval. The advertisement for email notification, online newspaper, and social media are in Appendix B.

To get more inputs for our survey, we also worked with Dynata, a global online market research firm, to carry out a survey project using their sample pool. This survey project aimed to obtain 300 valid survey results in 1–2 weeks. TASI and Dynata teams worked together to make the survey advertisement and link it into the Dynata system. After the soft launch of the project, it was found that 98% of the respondents (59 out of 60) were not aware of any problematic interstate highway interchange signing in Indiana. Therefore, these respondents quit the survey and did not complete it. As a result, less than 2% of the respondents (1 out of 60) could successfully find and upload a confusing signing.

Low response rate across all forms of survey advertisement was a lesson in itself. Rather than constructing the survey to ask respondents to provide data, it is likely that better response would have been achieved by presenting signing situations from which the respondent could identify an issue in a multiple choice format.

Based on the feedback and responses we received, we found the following.

1. Among the three survey distribution methods, email distribution is the most effective way for the current study. Most of our survey respondents were recruited through email notification. The response rate was around 2%.
2. The advertisement through email and social media gets most responses within the first 2 days after it is placed.

3. Social media and online newspapers are not highly effective in recruiting respondents. For several social media groups with hundreds of members, we received single-digit responses. For the online newspaper, the report from the *Indiana Daily Students* showed that after running 17 days (from December 12, 2020, to December 29, 2020) on its website, our advertisement had shown 23,139 impressions and received 30 clicks with a 0.13% click-through rate. The rate is relatively higher than their regular click-through rates for the advertisement unit, which is around 0.06%–0.08% on average. The report from FortWayne.com indicated that between December 24, 2020, and January 3, 2021, our advertisement was seen 18,206 times and clicked 22 times, which is the average for an online advertisement (0.1% is average for their online advertisement). However, we did not receive many valid responses during the advertisement campaign period. It suggests that although people were attracted by the advertisement and clicked the survey link, they did not start or complete the survey.
4. We tried to obtain more survey data by working with the survey company. However, this approach did not work at all. Since it was difficult to find qualified respondents, the incidence rate of the survey is extremely low. It means that the cost of a valid case increases significantly, which was out of our budget.
5. Although the email notification is the most effective way to recruit the respondents, we still had some issues. The issue with the email approach was that most organizations did not allow the use of mass email for survey invitations. Fortunately, we had support from the IUPUI School of Engineering and Technology to email the advertisement to all faculty, staff, and students. Emails were also sent through personal networking, friends, and colleagues.
6. We observed that even when we got the participants to take the survey, many participants could not complete the survey due to the following reasons.
 - a. They could not find any problems with the interchange signs in Indiana. Many respondents stopped at the first page of the survey and did not move forward.
 - b. They may not have known how to use the Google Street View to identify the signing location.
 - c. They may not have known how to save the problematic signing image and how to upload the image. Some invalid cases do not include the problematic signing image.
7. Some participants were found to be robots. The data generated by the robot were easily noticeable since any questions that were not multiple choices were not answered.
8. For participants who completed the survey, we still had the following issues.
 - a. The participants did not provide a clear description of the problem with the signing, therefore, it takes time to understand what precisely the problem is.
 - b. The quality of the survey data needs to be improved. Some participants who took the survey just wanted to get the \$20 compensation but did not provide useful information.

TABLE 3.1
Survey results

Types of Survey Responses	Total
Robot response	250
Participants opened the survey but did not start to do it	160
Participants started the survey but did not finish it	432
Participants finished the survey but did not give complete information	182
Participants finished survey (paid)	128
<i>Total</i>	<i>919</i>

3.5 Survey Data Statistics

Due to the nature that this survey required participants' original active thinking and some knowledge of using the software tools to pinpoint the sign location, the total number of participants who finished the survey is much lower than we initially anticipated. It was even after we tried several ways to attract the participants. If it were not due to the no person contact restriction caused by the Covid-19 pandemic, we would use a face-to-face approach to help the participant fill the survey to eliminate the software usage difficulties. Table 3.1 Survey results summarizes the survey results.

4. SURVEY DATA ANALYSIS

This section analyzes all valid survey results. To better analyze the survey data, the team first tried to understand the survey data and determine if the survey provides a valid complaint about the referred sign. Since the survey data are mainly composed of one picture and text that describes the potential interchange signing problem, it is often hard to understand the reported issues. Therefore, Google Street View was used to find several signs before and after the sign indicated by the survey, if needed, to understand the issue. TASI clarified survey data by adding more corresponding Google Street View images, giving more information about the road and driving direction, and describing the problems more precisely. All the information is necessary for better explaining or describing the issues and proposing the suggested solutions.

Each survey response was carefully studied by two members of our team independently. The result was combined and checked by a third team member independently, and the suggested changes were proposed. TASI's study results were submitted to INDOT SAC for their comments. SAC also provided their comments and included sign change suggestions for each case included in this report. As a result, out of 128 completed surveys, there are 84 considered valid (with correct and helpful information).

4.1 Location Distribution of Good Survey Data

A map was produced to visually represent statewide coverage of the survey results. The distribution map for the valid problematic highway interchange signing locations has been created on Google Map using the GPS locations of the valid reported cases (see Figure 4.1). The locations of the specific number of valid cases are shown in Table 4.1. Most locations are around Indianapolis, and a few of them are in other major cities in Indiana. It makes sense that most of the reported cases were located around the greater Indianapolis area since it has many highway interchanges and many uncommon interchanges in a densely populated area. Some cases are for the same signs; therefore, the survey results include 72 unique signs. The cases referred to the same sign are grouped in a parentheses.

4.2 Highway Entry and Exit Sign Distribution

By analyzing the 84 valid responses, several problematic categories can be identified since many cases have a common problem. Before we list all the categories of

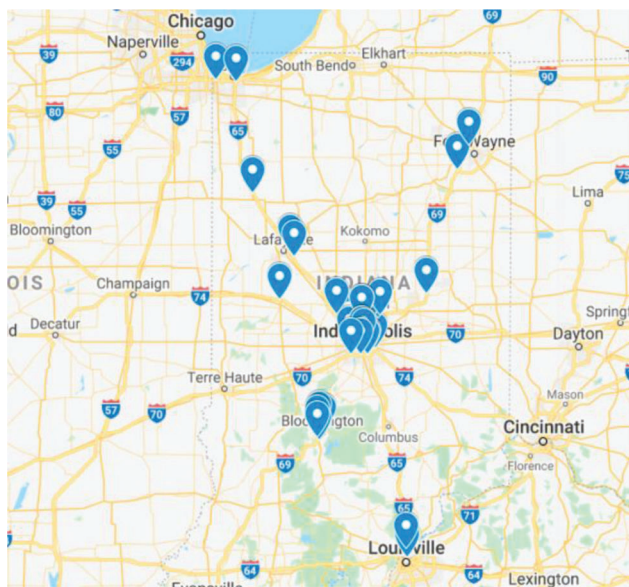


Figure 4.1 Distribution map for problematic highway interchange signing locations (Google, n.d.b).

TABLE 4.1
Locations of a specific number of valid cases

Location	Case Number	Sum
Indianapolis	1, (4, 25, 36B, 63, 85, 94, 137), 5, 9, 10A, 10B, 12, 13, 26, 28, 29, 31A, 35, 37, 40, 62, (64, 104), 65, 66, 70, 71, (72, 126), 73, 74, 75, (87A, 114, 125), 88, 89, 90, 95, 96, 100, 101, 102, 103, 105, 107, 111, 113, 115, 116, (117, 128, 132), 118, 121, 123, 127, 130, 131, 133, 135, 136, 138–141	66
Bloomington	34, 77, 78, 82, 99	5
Louisville	80	1
Fort Wayne	39, 41, 134, 146	4
Lafayette	83, 84	2
Others	6, 30, 68, 79, 115, 124	6
<i>Total</i>		<i>84</i>

confusing highway interchange signing, based on the feedback from the survey, were introduced and defined as follows.

- H2H: highway to highway.
- H2S: highway to local street.
- S2H: street to highway.

Table 4.2 shows the distribution of highway entry and exit signs for all TASI confirmed valid cases. From the table, we can see that the H2S signs were reported most, and the other two types have the similar reported number.

4.3 Problem Types and Distribution

This section focuses on finding the reasons drivers consider identified signs to be “not clear.” Meanwhile, several types of problems on the interchange signing have also been extracted and described in Table 4.3. Some cases may belong to several problem types. According to the table, the top four problem types are types 2, 6, 3, and 5.

4.4 Road Geometry Types and Distribution

The number and distribution of the problematic signs according to the road geometry and the number of lanes is shown in Table 4.4. Most signing issues are reported on straight roads with 3 or 4 lanes. This means that the signing problems are more noticeable on roads with a higher number of lanes. It does not mean that the signs on 5 or 6 lane roads are fewer, but the interchanges with 5 or 6 lanes are fewer in Indiana.

4.5 Recommendations for Improving Interchange Signing Designs

TASI and the INDOT SAC provided possible changes for the signs indicated in all valid survey cases. Since the problem of the sign is related to a specific road environment, the suggested changes are unique to each case. Therefore, the suggested changes are associated with each case. However, the principles of each suggested change can likely be applied to other similar locations as well.

TABLE 4.2
Highway entry and exit distribution

Type of Environment	Descriptions	Case Number	Sum
H2S	Highway to street	1, (4, 25, 36B, 63, 85, 94, 137), 5, 6, 10A, 10B, 26, 29, 31A, 40, 41, 62, (64, 104), 65, 66, 68, 71, 73, 74, 78, 79, 82, 83, 95, 99, 100, 102, 103, 105, 113, 115, 123, 127, 133, 134, 138, 139, 141	44
H2H	Highway to highway	9, 13, 28, 35, 36B, 37, 70, 75, 80, 89, 96, 101, 107, 111, 116, 118, 121, 124, 130, 131, 140,	21
S2H	Street to highway	12, 30, 34, 39, (72, 126), 77, 84, (87A, 114, 125), 88, 90, (117, 128, 132), 135, 136, 146	19
Total			84

TABLE 4.3
Problem types and distribution in good cases

Problem Types	Descriptions	Case Number	Sum
1	Sign is located too far from the actual split	1	1
2	Information is not complete on the sign	5, 12, 71, 79, 82, 84, 90, 96, 100, 103, 107, 115, (117, 128, 132), 123, 134, 136, 138	19
3	Information appears too late to change lanes/ to exit/enter	(4, 25, 36B, 63, 85, 94, 137), 6, 35, 40, 70, 73, 77, 95	14
4	Placing two individually correct signs causes confusion	68	1
5	The location of the sign is inappropriate	10A, 10B, 37, 83, 88, 99, 101, 113, 118, 127, 135, 139, 140	13
6	Incorrect/confusing/misleading information on the sign	28, 34, (64, 104), 65, 74, 75, (87A, 114, 125), 89, 102, 116, 121, 124, 131, 146	17
7	Too much information (signs) and little time to respond	9, 13, 30, 31A, 39, 41, (72, 126), 78, 111, 130	11
8	Damaged sign	26	1
9	Confusing sign sequence	29	1
10	No sign or unclear sign for the road exit	105, 133, 141	3
11	Inconsistency of information in the signing sequence	62	1
12	Road sign is counterintuitive	66, 80	2
Total			84

TABLE 4.4
Number of lanes and road geometry distribution

Type of Environment	Descriptions	Case Number	Sum
1-S	1 lane on straight road	30, 79, 136	3
2-S	2 lanes on straight road	6, 34, 66, 82, 127, 131, 135	7
3-S	3 lanes on straight road	(4, 25, 36B, 63, 85, 94, 137), 10A, 10B, 26, (72, 126), 73, 83, 84, (87A, 114, 125), 88, 115, (117, 128, 132), 121, 133, 134, 140,	27
4-S	4 lanes on straight road	12, 28, 31, 35, 39, 40, 41, 74, 78, 80, 89, 90, 96, 99, 100, 103, 113, 123, 130, 139	20
5-S	5 lanes on straight road	1, 13, 62, (64, 104), 65, 71, 102, 107, 111, 118	11
6-S	6 lanes on straight road	9, 29	2
1-C	1 lane on curved road	70	1
2-C	2 lanes on curved road	77, 105	2
3-C	3 lanes on curved road	5, 138, 141	3
4-C	4 lanes on curved road	68, 75, 95, 101, 116, 124	6
5-C	5 lanes on curved road	37, 146	2
Total			84

5. SIGN DESIGN AND LAYOUT RECOMMENDATIONS

This project aims to find the current signing problems from the perspective of drivers and avoid those issues in future road and sign design. This section describes the signing problems that appeared in various environments and sign combinations from the perspective of sign designers. If the future road and sign design situations are like one or more of the types listed, adjustments can be made to avoid the previous signing problem. There are 19 types of environment or situations that potentially need more careful signing design. They are discussed in detail in following subsections. The examples of environments in each subsection are identified with the survey case number and can be found in volume 2 of the report.

5.1 Type 1: Two Roads are Parallel for a Long Distance

Problem Description

In this situation, the drivers are confused about which road they are driving on. This has the potential to cause quick lane changes or missing exits and is really an issue of route confirmation. Often a driver has passed the decision point and in the correct place but then sees a sign for their route on a parallel highway section or collector-distributor, causing a moment of confusion as to whether they made the correct choice.

Number of Cases: 3

The Root of the Problem

The issue was caused by both the road design and signing design.

Solution Approach

Since two roads are in parallel, the driver is confused which road they are driving on. The sign layout can be adjusted to remind the driver on which road the car is traveling. In these instances, providing simple route confirmation signing on the primary route could confirm the driver that they made the correct decision. In other words, supplying additional countermeasures to indicate the destination on each lane would reinforce the drivers' intentions.

5.2 Type 2: Exits on the Left Side of the Road

Problem Description

Exits on the left side of the road are not common in Indiana. They often cause quick lane changes and missing exits.

Number of Cases: 5

The Root of the Problem

The issue is due to the interchange design, the sign location and sign message.

Solution Approach

Since drivers do not expect the exit on the left side, the signing should try to make sure drivers see the left exit lane in addition to all other information on the sign. It would be beneficial to provide advance notice to the driver that the downstream exit occurs on the left. In this way, the driver can begin to plan ahead and not be caught by surprise or feel that they do not have enough time to make the lane changes to the exit. In addition, adding supplemental signing or pavement markings could notify the driver of the left exit lane.

5.3 Type 3: Left Exit to the Right Direction and Right Exit to the Left Direction

Problem Description

A left exit to the right direction and a right exit to the left direction is an issue in many locations and can cause driver confusion if the route direction and exit direction are opposite. This may not be a problem for a driver who is not familiar with the area, but the presence of the route shield and cardinal direction may not be enough if the driver has a good sense of direction. Opposite route direction and exit direction may cause second guessing for drivers with a strong direction sense who are familiar with the area.

Number of Cases: 2

The Root of the Problem

The issue was caused by both the interchange design and signing design.

Solution Approach

Intuitive design should be considered when designing new interchanges or interchange modifications. For this issue, some additional information on the sign would be beneficial. In many cases, the sign simply shows the direction and the route shield, but a destination would aid driver understanding of direction in these cases. In the case of I-65 southbound at I-865, Indianapolis could be added to one sign to aid directional understanding.

5.4 Type 4: The Short Distance Between a Road and a Highway Entry/Exit

Problem Description

The short distance between the ramp entrance and exit with multiple lanes in the weaving area sometimes requires a quick change of several lanes, which is especially difficult in heavy traffic. Short distance and wide cross section weaving areas are a significant challenge for drivers.

Number of Cases: 3

The Root of the Problem

The issue was caused by both the road design and signing design.

Solution Approach

Provide drivers the lane assignment information as early as possible and avoiding the distraction of other signs could be the approach to solve this type of problem. This also raises the issue of, if it is hard to sign, then a better geometric solution likely exists. In any event though, providing drivers who are entering the cross section plenty of advance notice that they will need to make multiple lane changes is critical. The challenge will be placement and content of such signing. The implementation of enhanced pavement markings to confirm lane assignments can be considered as well.

5.5 Type 5: A Large Sign and a Small Sign at the Exact Same Location

Problem Description

In this situation, the driver is busy reading a large sign so that the small sign may be overlooked. In areas with both major diverge highway signing and local exit signing, the secondary signing gets lost in the clutter of signs.

Number of Cases: 1

The Root of the Problem

The issue appears to be that different groups of people put up signs at different time but do not coordinate the sign locations.

Solution Approach

In these circumstances, coordinating the sign design among different agency groups or installations at different times is the solution. The careful consideration of placement is critically important. Separating the local exit signing from the major diverge route signing and placing at intermediate interval would allow the driver to consider the separate information and make the correct decision.

5.6 Type 6: A Sign for an Exit or Split is Located Before the End of the Rightmost Lane

Problem Description

This is a situation where a sign is placed noting an exit coming up but before the exit, the right lane also ends in a mainline lane drop. Drivers then change lanes to the right-most lane and need to switch back when the lane drop occurs, causing unnecessary lane changes.

Number of Cases: 5

The Root of the Problem

This issue is due to the sign design and sign location.

Solution Approach

This is the critical messaging of lane assignment. In this study, drivers showed in many responses the desire to have more or better lane assignment information,

often in advance of typical standard sign locations. Lane drops need to be carefully considered on the interstate to reduce confusion. Additional signing and pavement markings may be necessary to better indicate to the driver in those situations that the right lane is not to be used for the exit.

5.7 Type 7: Sign At or After Reaching a Curved Road

Problem Description

The sign arrow is perceived to indicate one particular lane at a far distance, but it actually indicates another lane when arriving at the sign. This situation often makes the driver change to a wrong lane and eventually change back to the correct lane. This is a continual issue with horizontal curvature for lane assignment signing.

Number of Cases: 2

The Root of the Problem

This issue is due to the sign design and sign location.

Solution Approach

The wrong lane perception needs to be cancelled out by adding countermeasures or changing sign locations. This issue could be accounted for by either adjusting sign placement or adjusting the spacing interval between signs in cases of horizontal curvature that causes lane assignment confusion. The sign placement within a horizontal curve should be minimized or eliminated entirely. If signs are placed closer together, then it is unlikely that an arrow would appear to be over a lane that it is not. In some cases of more severe horizontal curvature, supplemental pavement marking signing should be required that could confirm the route assignment for the driver. An OAPL guide sign may be necessary.

5.8 Type 8: Missing Essential Direction Information

Problem Description

The needed information for geographical directions, location directions, and lanes is missing. This is yet another of the calls from drivers for more lane assignment information in advance of the decision area. The example of missing information happens to be at an intersection, but the issue can be seen in interstate signing as well.

Number of Cases: 3

The Root of the Problem

This issue is due to non-ideal sign location.

Solution Approach

Improve the sign design and installation. This issue can be solved by providing advanced lane assignment route direction signing, as necessary, for drivers to simplify the decision-making process.

5.9 Type 9: Many Individual Road Signs at a Complex Intersection

Problem Description

Many individual signs at a complex intersection cause the driver to use much cognitive processing to decide which way to go.

Number of Cases: 3

The Root of the Problem

This is an issue with both road design issue and sign design.

Solution Approach

One signboard with road name and geometric shape information can be used, so the drivers can quickly capture the information and make lane decisions.

5.10 Type 10: Multiple Signs and Lane Markings are Inconsistent with Driver Expectations

Problem Description

Drivers are confused which road they should choose, potentially causing quick lane changes or missed exits. This is a typical instance of the driver wanting information prior to where it is being shown. Although the information is correct, they are stressed by the feeling that they need the information sooner than provided. Another related issue is that advance signing is provided for lane assignments at a prior intersection but then drivers want more information prior to the next provided location near the following intersection at the decision point. This is common in congested areas near interchanges.

Number of Cases: 2

The Root of the Problem

This is an issue with the sign design and location.

Solution Approach

Coordinated efforts among state and local agencies could improve the situation. This could likely be solved by ensuring early and often lane assignment signing in areas of dense traffic and numerous decision-making points. Drivers will feel less stress if they have the correct information when they want that information.

5.11 Type 11: Several Close Consecutive Exits to Different Roads

Problem Description

Information of many roads is shown on the same signing board, but it doesn't show which road will be reached first. Drivers may have no idea about the exit for each road on the signing board.

Number of Cases: 3

The Root of the Problem

This is an issue with signing design information.

Solution Approach

Using a single sign that lists the number of miles to reach each road, providing drivers with the order roads appear in and their relationship to each other, can be a solution. However, be careful not to create signs that require a lot of cognitive effort for a motorist to understand at high speeds. When a sign is too busy with road names, motorists will tend to slow down to try to understand the sign, which creates mainline slowdowns.

5.12 Type 12: Separate Signs at One Intersection, Each with Partial Information

Problem Description

Using separate signs at one intersection, each with partial information (e.g., one has geometry information and the other has name information), is problematic since it requires drivers to use their cognitive skills to link the information quickly and may result in missing the exits. In complex signing situations, drivers struggle to identify the correct information quickly enough prior to their decision point if the information is combined with too many other items.

Number of Cases: 2

The Root of the Problem

This is the issue with sign design simplicity.

Solution Approach

Using a single sign to reduce the cognitive load of the drivers can be an approach. During signing design, it is necessary to consider the best way to group information, so that the driver can quickly identify the route they want and where they need to be in advance of the decision point.

5.13 Type 13: Unclear Which Lane Goes to Which Road at Split Road Exits

Problem Description

Although the lane to each exit is indicated, the other information on the sign makes things unclear. This primarily pertains to secondary diverges that follow directly after a major diverge. Oftentimes drivers are unsure which lane they need to be in for the secondary decision, but little space remains to make a different decision once they pass the first diverge.

Number of Cases: 4

The Root of the Problem

This is an issue with sign design, spacing, and layout.



Figure 5.1 The cities on the roadside sign for the right exit are different from the cities on the overhead sign for the same right exit (Google, 2018).

Solution Approach

Making information consistent and reducing the cognitive load of the drivers are solutions to this problem. This issue leads to the idea of ensuring that a design can be properly signed prior to moving forward with the layout. Beyond this, advance lane assignment signing such as overhead arrow per lane, will greatly aid the driver with the information they need to be confident in their decision making.

5.14 Type 14: Inconsistent Information on Adjacent Signs

Problem Description

Inconsistent information in the two adjacent signs causes confusion. If a driver wants to go to Yorktown and sees the roadside sign, the driver will hesitate to exit when seeing the overhead sign (see Figure 5.1).

Number of Cases: 2

The Root of the Problem

This is an issue with sign design and messaging.

Solution Approach

The sign design across different groups or installations at different times need to be coordinated. Signing consistency is critical for drivers. The signing needs to be as informative yet simple as possible for the driver finding their destination.

5.15 Type 15: Confusing Temporary Sign

Problem Description

The temporary signs do not provide complete/sufficient information so the driver may not understand the sign.

Number of Cases: 5

The Root of the Problem

The problem is related to the sign design and sign location.

Solution Approach

The sign design and location need to be improved even in temporary applications.

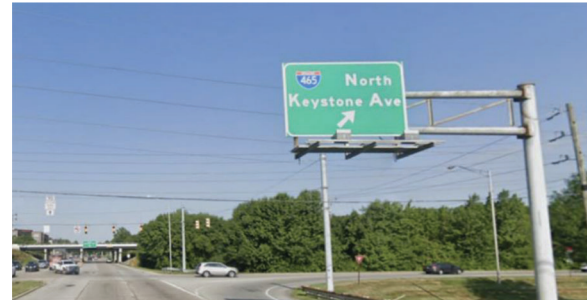


Figure 5.2 Road sign may be interpreted as 465 North and Keystone Ave or 465 and North Keystone Ave (Google, 2019a).

5.16 Type 16: The Layout of the Sign Information May Cause Different Interpretations

Problem Description

The different interpretations of the sign may cause confusion to some drivers.

Number of Cases: 4

The information layout of the following sign may be interpreted as 465 North and Keystone Ave, or 465 and North Keystone Ave (see Figure 5.2).

The Root of the Problem

This is an issue of sign design.

Solution Approach

The sign layout design needs to be improved to clearly indicate the ramp destination to the driver. This is also an issue of intuitive design. Due to the small dimensions of the sign and tight bunching of the message, many drivers will associate all text as being together rather than line by line.

5.17 Type 17: The Location of a Correct Sign May Cause Wrong Interpretation

Problem Description

In this situation, the placement of the sign does not meet driver expectation.

Number of Cases: 2

In this example, the road sign “Purdue Univ. Exit 175” provides the correct information but was placed at

a location close to the Exit 172. The driver may exit the highway I-65 at the Exit 172 but think it is Exit 175 (see Figure 5.3).

The Root of the Problem

The issue is incomplete information on the sign.

Solution Approach

It needs to be ensured that location is a major point of emphasis in sign installation. Considering the location that where the driver needs the information and ensure that the message is not lost by other distraction/signing on the road. The subject case shown above could be remedied by showing “Use Exit 175” since the sign placement is intended to alert traffic that Exit 172 is not the ideal path to campus.

5.18 Type 18: The Road Indicated on the Exit Sign is Not the First Road After the Exit

Problem Description

The road indicated on the exit sign is not the first road that a driver arrives at upon exiting the interstate. When a driver exited from this exit, the first major road the driver sees is another road. The result might be the driver thinking that they took the wrong exit (see Figure 5.4).



Figure 5.3 The close proximity of the Exit 175 sign to Exit 172 can confuse drivers about which exit they are taking (Google, 2019c).



(a) Example sign



(b) Better designed sign

Figure 5.4 (a) The road name listed on the exit sign is not the first road that a driver arrives at upon exiting the interstate. (b) The exit sign includes the first road a driver will arrive at after exiting (Google, 2019b).

Number of Cases: 1

The Root of the Problem

This is an issue of sign design and messaging.

Solution Approach

The sign design needs to be improved to ensure the message accurately represents what the driver will see upon exiting. In cases of interchanges with multiple intersecting roads, it is critical to note those options on the interstate signing.

5.19 Type 19: The Sign is Designed Correctly but Can Be Improved

Problem Description

The most valuable information needed by highway drivers are lane assignments for their destinations. It is desirable that the number of required lane changes is minimized, and necessary lane changes are notified early so the drivers will not miss the exits. Even if some signs are designed correctly, they can be improved based on the driver's desires.

Number of Cases: 3

5.19.1 Improvement 1

A sequence of signs may require drivers to change multiple lanes in a short distance when the number of lanes changes.

Examples in Survey Cases

The sign is perfectly correct and indicates the lanes for each road and exits at the present location. However, shortly after the current sign, the number of lanes increases so the lane indicator for each road immediately needs to be updated.

Solution Approach

The sign design and placement should consider the lane number increases directly downstream so the lane arrows on the sign are still correct after the increase of number of lanes.

5.19.2 Improvement 2

When there are multiple lanes and different route decisions, lane assignment arrows are necessary to ensure that the drivers are on the lanes to their desired roads.

5.19.3 Improvement 3

When there are multiple lanes and some lanes lead to different destinations, the destination information, if possible, can be added on the sign to ensure that the drivers are on the lanes to their desired destinations.

5.19.4 Improvement 4

When there are multiple lanes and some lanes are curved, ensure the drivers associate the lanes to their desired destinations. The lane shape can be added on the sign to help the driver link the lane to the general direction.

6. SUMMARY OF THE STUDY RESULTS

The intent of this project is to support the effort of INDOT to find the effectiveness of interchange signing in Indiana from the perspective of drivers and to gain an improved understanding of driver opinions. The idea is that the coordinated design of interchange type and interchange signing would improve drivers' satisfaction with highway guide sign design. Experienced transportation professionals use well founded knowledge and guidance, such as the MUTCD, to design highway signing but due to the experience, have a natural biased thinking or understanding of what is satisfactory. However, most drivers do not have the same training and thus, interpret signing from an entirely unique perspective and understanding. A goal of the study is to gain a better understanding of driver priorities related to signing design and adapt those priorities to the way we think about highway signing. In order to ascertain the information on driver opinion of interstate interchange signing, a survey was created and distributed. The survey posed specific questions requesting the driver to provide information about signs that they have found to be confusing, poorly located, not intuitive, not having enough information or otherwise not ideal.

The research project provided INDOT with a fair amount of insight into the mind of a driver. The results show that drivers are generally not aware of the interchange type but are most interested in which lanes they should be aligned when approaching an interchange. Additionally, it was found that drivers want lane alignment information in many cases well in advance of typical signing locations. These two findings have the potential to have the greatest impact to interstate sign design in Indiana going forward, at least for complex signing situations. Instances of doing just what the guidance shows will need to be considered closely as a starting point rather than a satisfactory end

point. This may result in additionally signing locations or simply changed locations from standard practice depending on the circumstances.

In addition, the survey also found that drivers have difficulty with signs that require increased cognitive work. The more information that is placed on a sign, the longer it takes a driver to absorb the information and make a decision, potentially impacting driver behavior. Rather, there seems to be a preference for separating information as much as possible to enable drivers to make fewer decisions at a time.

Furthermore, different drivers need different types of information on the signing, such as, destination name and road name in addition to typical route and direction. Therefore, a perfect sign for one driver may be confusing for another. As a result, and relative to the prior item as well, the sign designers will need to consider the perfect balance of information presented depending on the site attributes. In some instances, a driver familiar with the area is more confused by the signs due to the sign information contradicting the driver's knowledge. This can often apply to wayfinding signing or route travel-over signing.

A variety of other driver perceived signing issues were identified in the survey. Some of the cases have given INDOT insight into the understanding of drivers and resulted in the need to change thinking under certain circumstances. Other cases have highlighted that drivers do not always understand perfectly accurate and correctly placed signing. This finding points to the need for increased public coordination and education ahead of major projects to ensure complex situations are better understood. That said, many situations will still be unfamiliar to out of town drivers, so designs will have to balance the need for information with the issue of overloading the driver. All cases in the survey have been interpreted and provided a suggested remedy by the project team.

Looking forward, INDOT has modified some of the signing locations identified in this study during the recent projects or in development construction projects and will also consider the potential future actions for the suggested locations based on each survey case. INDOT will also apply lesson learned from this study for future interchange signing design related to driver perspective issues that were raised with this study. This will be executed by coordination with project design teams, Traffic Engineering and FHWA engineers laying out and reviewing interchange modification proposals and the design standards group as necessary to improve driver understanding.

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APPENDICES

Appendix A. Survey Questionnaire

Appendix B. Advertising

APPENDIX A. SURVEY QUESTIONNAIRE

Interchange sign study survey

Dear survey participant,

Please help our research team at IUPUI complete this survey to **identify unclear or confusing signings** before you enter or exit interstate highways in Indiana. Your input will help the Indiana Department of Transportation to improve current and new highway signings. The survey may take about 30 minutes.


In order to participate in the survey, you need to:

1. Have highway driving experiences in the state of Indiana;
2. Be 18 years and older.

All surveys will be reviewed by the research team to ensure that answers are valid. The research team reserves the right to determine the quality check results.

For questions about your rights as a research participant or to discuss problems, complaints or concerns about a research study, or to obtain information, or offer input, please contact the IU Human Subjects Office at 800-696-2949 or at irb@iu.edu. Please reference IRB study 2009905793.

By clicking the “Continue” button below, you agree with the terms described above.

Powered by Qualtrics 

Personal Information

1. What is your age

2. What is your gender?

3. How many years have you had your driver license?

4. How many miles do you drive on interstate highway per year (before COVID-19)?

5. How many days do you drive on interstate highway per week?

Previous

Next

Identify the location of confusing traffic sign

We would like you to identify an unclear or confusing signing before you enter or exit the interstate highways in Indiana. A picture of a traffic sign is essential for the research team to understand which sign makes you confused. The following provides you a step-by-step procedure to identify the location of the problematic signing.

Identify a location according to following steps:

Step 1. Zoom in and scroll the map to find the location of the problematic signing.

Step 2. Drop a pin on this location by clicking/touching the location. (A red inverted-drop-shaped icon will appear on the map).

Step 3. Drag the **pegman** (the yellow man on the right side) to the pin to open the street-view.

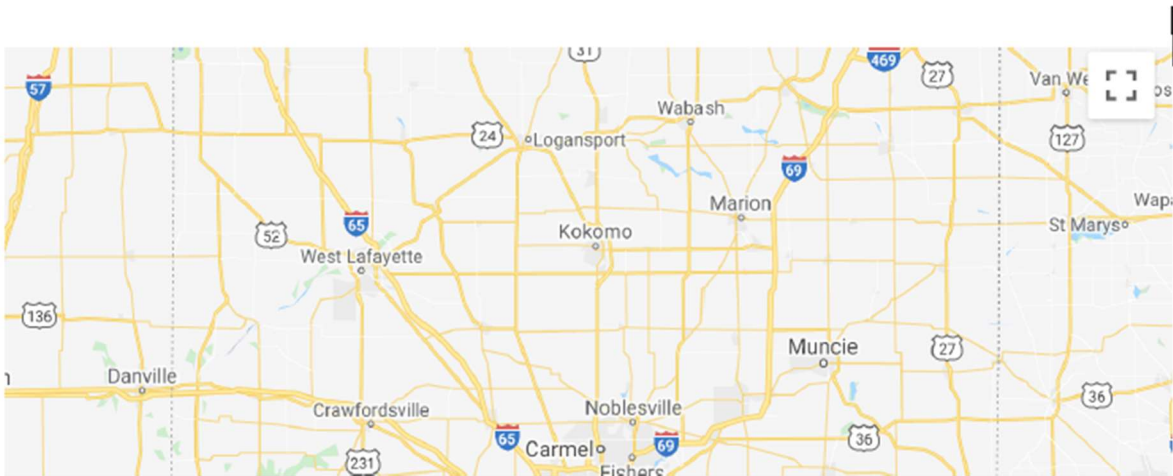
Step 4. Find the problematic signing on the street view.

Step 5. Take the screenshot by using *Windows key + PrtScn* button to save the image of the signing. (The image will automatically be saved in the subfolder called "Screenshots" in the "Pictures" folder.)

You can also use other methods to save the signing image.

Step 6. Upload the image (e.g. JPEG, JPG, or PNG file) saved in Step 5 to the box at the next page.

Note: No PII data will be included within the screenshot.



(Source: Google, n.d.b)

Drop files or click here to upload

You can upload one more picture if there is another signing in this interchange.

Drop files or click here to upload

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Explain why do you feel that signing is confusing?

1. When you see the problematic signing, on which road and direction you are driving ?

2. How often do you drive through this road?

☐ Rarely

☐ Several times a year

☐ Often

☐ Very often

3. What information are you looking for from the signing? (identify the road, direction, or destination)

4. Information-related question (select all that apply)

☐ Not seeing the signing I look for

☐ Not enough needed information on the signing

☐ Information on the signing is not clear

☐ Information on the signing is wrong (e.g., turn right but exit left)

☐ Others (please explain below)

5. Time-related question (select all that apply)

- ☐ The texts on the signings are too small to read and take actions
- ☐ The signings appear too late to take actions (time-wise)
- ☐ The signings appear too early to remember actions (time-wise)
- ☐ Too many signings show up and no time to read and make decisions
- ☐ Others (please explain below)

6. Location-related question (select all that apply)

- ☐ Cannot find the signing for the road I want to go
- ☐ The location of the signing is confusing
- ☐ The location of the signing does not match with the corresponding lanes
- ☐ Signings show different information seen from different distances
- ☐ Others (please explain below)

7. Please give more explanation if above choices do not describe your situation.

8. If a series of signings approaching this interchange cause confusion, please describe it, or you can upload several pictures in the previous page.

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Identify 2nd Location (Optional)

Identify a location according to following steps:

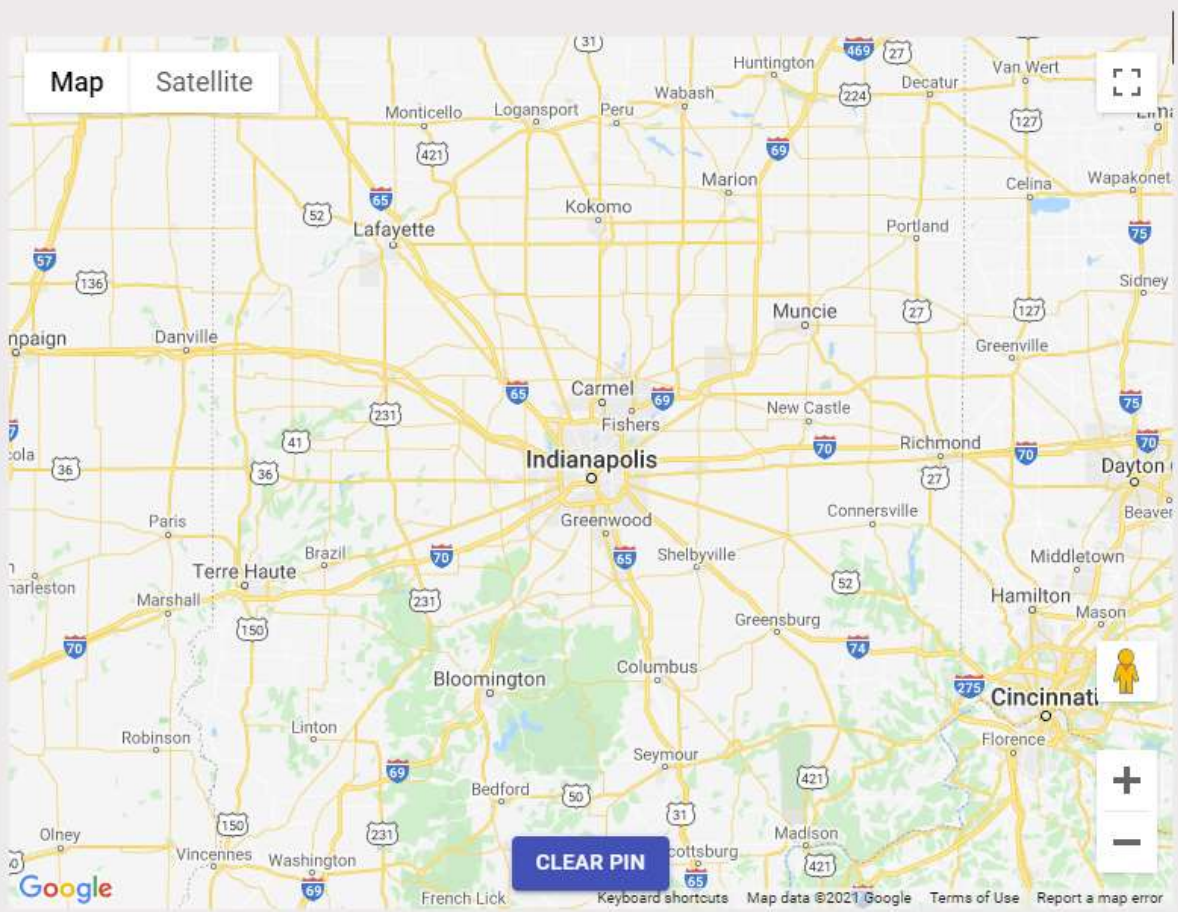
Step 1. Zoom in and scroll the map to find the location of the problematic signing.

Step 2. Put a pin on this location by clicking/touching the location.

Step 3. Drag the **pegman** (the yellow man on the right) to the pin to open the street-view.

Step 4. Find the problematic signing on the street view.

Step 5. Copy the screen and paste it to the box below the map. (For PC, use *Windows key + PrtScn* to save the screen image in the *Screenshot* subfolder of the *Pictures* folder.)



(Source: Google, n.d.b)

Drop files or click here to upload

You can upload one more picture if there is another signing in this interchange.

Drop files or click here to upload

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Explain why do you feel that signing is confusing?

1. When you see the problematic signing, on which road and direction you are driving ?

2. How often do you drive through this road?

☐ Rarely

☐ Several times a year

☐ Often

☐ Very often

3. What information are you looking for from the signing? (identify the road, direction, or destination)

4. Information-related question (select all that apply)

☐ Not seeing the signing I look for

☐ Not enough needed information on the signing

☐ Information on the signing is not clear

☐ Information on the signing is wrong (e.g., turn right but exit left)

☐ Others (please explain below)

5. Time-related (select all that apply)

- ☐ The texts on the signings are too small to read and take actions
- ☐ The signings appear too late to take actions (time-wise)
- ☐ The signings appear too early to remember actions (distance-wise)
- ☐ Too many signings show up and no time to read and make decisions
- ☐ Others (please explain below)

6. Location-related question (select all that apply)

- ☐ Cannot find the signing for the road I want to go
- ☐ The location of the signing is confusing
- ☐ The location of the signing does not match with the corresponding lanes
- ☐ Signings show different information seen from different distances
- ☐ Others (please explain below)

7. Please give more explanation if above choices do not describe your situation.

8. If a series of signings approaching this interchange cause confusion, please describe it, or you can upload several pictures in the previous page.

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Provide your email address

Please provide your valid e-mail address to receive a \$20 gift card if you give one of the first 400 valid submissions.

Enter your e-mail:

Enter your e-mail again:

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Submit

APPENDIX B. ADVERTISING

B.1 Email

The following is the advertisement designed for email notification.

Survey Participants Needed

Study Background:

Current Indiana highway interchange signing is designed based on established standards, but some drivers have expressed that signing is confusing, not intuitive, or perhaps not explanatory enough. Please help our research team at IUPUI to complete a survey to identify unclear or confusing signings for entering and exiting interstate highways in Indiana. Your input will help the Indiana Department of Transportation to improve current and new highway signings.

Who we are looking for:

We are looking for anyone who feels some interchange signing issues in the state of Indiana. To participant, you need to (1) have highway driving experiences in Indiana; and (2) are 18 years and older.

What you need to do:

This survey is anonymous. You need to provide some basic demographic information, and report one or two problematic highway interchange signing issues by providing (1) the location of the signing in Google map (the GPS coordinates), (2) the image of the sign (screen capture or self-taken photo), and (3) the descriptions of the problem. The whole survey takes about 30 minutes.

What you can get:

All the replies will be manually reviewed by the research team to ensure valid, complete, and reasonable answers are provided. The first 400 participants who passed our quality check will receive \$10 Amazon.com gift card electronically. You have to provide a valid e-mail address to receive the compensation.

How to participate:

If you are interested in the survey, please access the following link:

https://iu.co1.qualtrics.com/jfe/form/SV_9oxRFIW0sK14HJP

Note: This survey cannot be taken on Internet Explorer. You should use other commonly used web browsers.

Who to contact:

For additional questions, please contact jtrpsign@iupui.edu.

We increased the payment to \$20 in later advertisements to attract more survey participants. However, the improvement is not apparent.

B.2 Online Newspaper

The survey was advertised in the following six local newspapers.

- *The Exponent*: A multimedia news agency serving Purdue students, faculty, staff, and the greater West Lafayette community.
- *Indiana Daily Student*: An independent, student-run newspaper that has been published for the community of Indiana University in Bloomington.
- *The Journal Gazette*: A member of the Fort Wayne Newspapers family of websites, the most visited news website in Northeast Indiana.
- *The Horizon*: A student-produced news organization of Indiana University Southeast, published daily online.
- *The Observer*: A student newspaper in the University of Notre Dame, Saint Mary's College, and Holy Cross College.
- *The Indiana Statesman*: A campus newspaper serving the Indiana State University and its surrounding community.

The size and costs and advertisement duration for newspaper advertisement are shown in Table B.1. The online advertisement is in the form of a static image or an animated image. Some newspapers design their own advertisement, so we had several versions. Four examples of designed Ads are shown in Figure B.1. One newspaper's AD design is copyrighted, and it was not allowed to be used by other newspapers. However, other newspapers allow us to use their AD designs on other newspapers.

Table B.1 Newspaper advertisement

Newspaper	Size (pixels)	Price/Month	Advertised Period
Purdue– <i>The Exponent</i>	300×250	\$772	1 month
IU– <i>Indiana Daily Student</i>	300×250	\$300 with 30,000 impressions	4 weeks
Fort Wayne– <i>The Journal Gazette</i>	300×250	\$400 with 40,000 impressions	4 weeks
IU Southeast– <i>The Horizon</i>	900×100	\$120	4 weeks
Notre Dame– <i>The Observer</i>	300×250	\$228.5 with 35,000 page views	4 weeks
Indiana State University– <i>The Indiana Statesman</i>	300×250	\$125	1 month



Figure B.1 Four advertisement designs for newspapers.

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1 — evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at <http://docs.lib.purdue.edu/jtrp>.

Further information about JTRP and its current research program is available at <http://www.purdue.edu/jtrp>.

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