Traffic Engineering Studies Using a Driving Simulator – Year 2

FDOT BD-548-2

June/2005

Final Report

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Traffic Engineering Studies Using a Driving Simulator – Year 2	June 2005
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Harold Klee, Essam Radwan	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Center for Advanced Transportation Systems Simulation University of Central Florida P.O. Box 162450 Orlando, FL 32816-2450	11. Contract or Grant No. FDOT BD-548-2
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Research and Special Programs Administration 400 7th Street, SW Washington, DC 20590-0001	Final Report July 2003 – June 2005
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The primary objective of this project was to demonstrate the feasibility of using The University of Central Florida's interactive driving simulator to perform traffic engineering studies. Specifically, several scenarios involving the quality of service at a signalized intersection were investigated. This report describes the scenarios, the experiments conducted, the data collected, and some analysis of results. Findings and conclusions are directed more at the utility and practicality of using the driving simulator as a learning tool in helping to acquire a solid understanding of traffic operations. A follow-up study using the simulator is needed to explore geometric design alternatives and their effect on the quality of service.

17. Key Word	18. Distribution Statement
	No restrictions-this report is available to the public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

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

Executive Summary

The primary objective of this project was to demonstrate the feasibility of using The University of Central Florida's interactive driving simulator to perform traffic engineering studies. Scenarios involving the quality of service at a signalized intersection were investigated. Forty subjects, male and female ranging in age from the teens to the mid-fifties, drove the scenarios which involved three intersections. Each intersection was encountered in two separate scenarios.

One intersection had a misalignment of lanes without pavement striping in one scenario and with striping in the other. A second intersection had a short dropped lane on the downstream side in one scenario and a longer dropped lane in the other. The last intersection has a shared left turn and thru lane in one scenario and a dedicated left turn lane in the other.

Following the simulator session, a questionnaire was administered asking the subjects a series of questions about their experiences in real-world driving with similar conditions and their reactions to the conditions experienced while driving the simulator. Results are presented in graphical form. Findings and conclusions are directed more at the utility and practicality of using the driving simulator as a learning tool in helping to acquire a solid understanding of traffic operations.

Table of Contents

Introduction

The primary objective of this project was to demonstrate the feasibility of using The University of Central Florida's interactive driving simulator [1] to perform traffic engineering studies. Specifically, several scenarios involving the quality of service at a signalized intersection were investigated. This report describes the scenarios, the experiments conducted, the data collected, and some analysis of results. Findings and conclusions are directed more at the utility and practicality of using the driving simulator as a learning tool in helping to acquire a solid understanding of traffic operations. A follow-up study using the simulator is needed to explore geometric design alternatives and their effect on the quality of service.

Experimental Design

2.1 Intersection Descriptions

Signalized intersections with 3 types of characteristic features were identified for this study. They included

I1. A lane dropping on the downstream side of the intersection

I2. Misalignment of traffic lanes between the approach and downstream side

I3. Shared left turn and thru traffic lane or separate lanes for each approaching the intersection

The experimental phase consisted of two driving scenarios presented to all subjects following a brief orientation session to get acclimated to the driving simulator. Each scenario consisted of a drive through an urban section of the simulator's visual data base where each subject encountered a Type I1, I2 and I3 intersection.

I1. Lane Dropping

After crossing the intersection, the right most through lane was merged with the adjacent through lane. Due to traffic in the adjacent left lane, subjects was forced to cross the intersection in the right most through lane and then merge from 2 lanes into one. The length of the dropped lane was considerably shorter in one of the scenarios compared with the other. The two cases are referred to as I1-A and I1-B, where I1-A refers to the case where the dropped lane is shorter in length (Figure 1) and I1-B the other case shown in Figure 2.

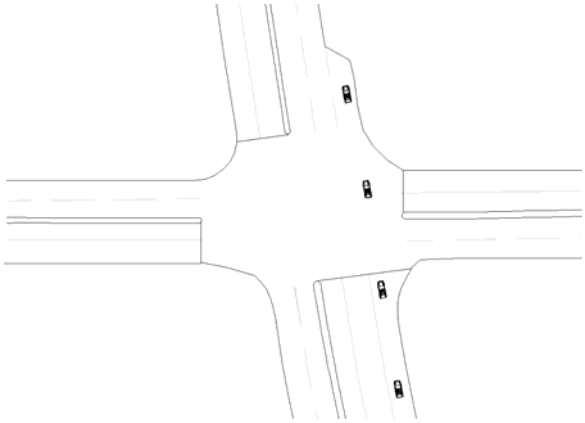


Figure 1 Intersection Case I1-A

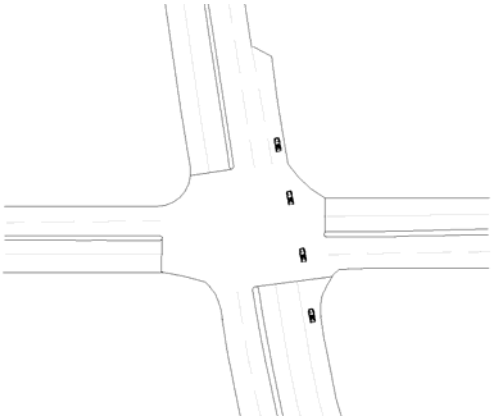


Figure 2 Intersection Case I1-B

I2. Non-alignment of Lanes

The second type of intersection present in both scenarios was one in which the lanes on either side of the intersection were misaligned. Drivers encountered this intersection in one of the scenarios without the aid of lane striping in the intersection. In contrast, the other scenario provided marking stripes within the intersection to guide the driver into the proper lane downstream of the intersection. The case of the misaligned intersection without lane striping is referred to as I2-A (Figure 3) while the case with striping present is denoted I2-B (Figure 4).

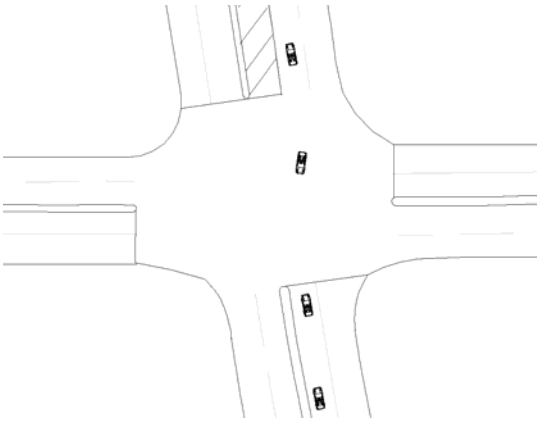


Figure 3 Intersection Case I2-A

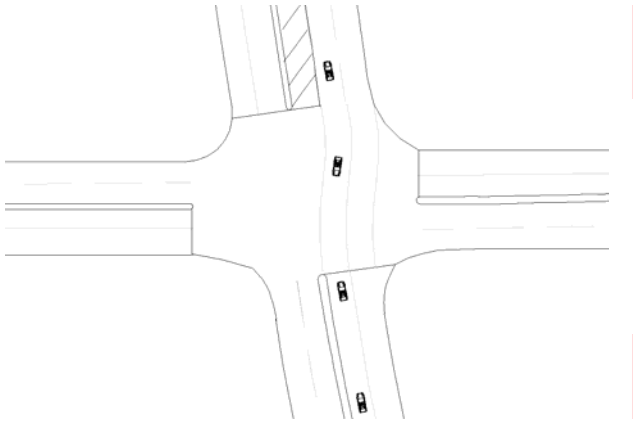


Figure 4 Intersection Case I2-B

I3. Shared Left and Thru Traffic Lanes

Subjects were instructed to drive straight thru the third type of intersection. Different configurations were present in each of the two scenarios. In one scenario, the driver was positioned in a shared left turn and thru lane with a left turning vehicle directly in front. Vehicles were placed in the adjacent lane to prevent drivers from changing lanes. In the other scenario, a dedicated left turn lane was added and the subject had unrestricted access through the intersection by driving in a thru lane. The former design, referred to as I3-A is shown in Figure 5 and the latter is designated I3-B (Figure 6).

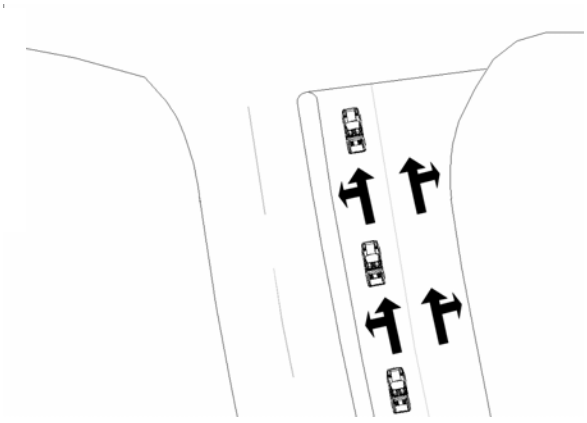


Figure 5 Intersection Case I3-A

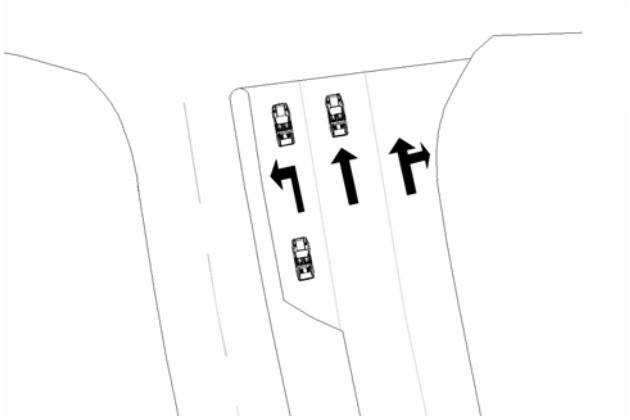


Figure 6 Intersection Case I3-B

The two scenarios are classified by the intersection cases present. Scenario 1 consisted of the following cases:

- Short lane drop after crossing the intersection (Case I1-A)
- Non alignment of lanes with striping(Case I2-B)
- Joint left turn and thru lane (Case I3-A)

Scenario 2 included 3 intersections with the following cases:

- Longer lane drop after crossing the intersection (Case I1-B)
- Non alignment of lanes and no striping (Case I2-A)
- Separate left turn and thru lanes (Case I3-B)

2.2 Composition of Subjects

A total of 40 subjects, 25 males and 15 females were recruited for the experiment. The age distribution of the subjects are shown in Table 1.

Gender	Age Distribution		
	Above 55	between 25 and 55	below 25
Males	2	15	8
Females	0	8	7

Table 1 Age Distribution of Volunteer Subjects

2.3 Data Logging and Survey

During the experimental phase, each subject drove both scenarios. They were divided into two groups. Subjects in Group A drove Scenario 1 first and then Scenario 2 while those in Group B drove Scenario 2 first followed by Scenario 1.

Data logging at 60 Hz for each scenario consisted of time-stamped values of *x*-position and *y*-position of the simulator vehicle, steering, accelerator and brake inputs by the driver, and vehicle speed. After the experiment a questionnaire soliciting opinions

and reactions about each intersection was administered. The survey is included in Appendix A.

Experimental Results

The experimental results are presented for each of the six intersection cases.

Case: I1-A (Dropped Lane – Short Length)

The intersection with a short dropped lane is shown in Figure 7. There are 2 full lanes for a distance of 133 ft followed by an additional 247 ft over which the right lane narrows from 12 ft to zero. The path followed by one of the drivers is indicated by the blue (right side of vehicle) and red (left side of vehicle) lines. A vehicle is considered to have merged from the dropped lane when the right side of the vehicle enters the left lane.

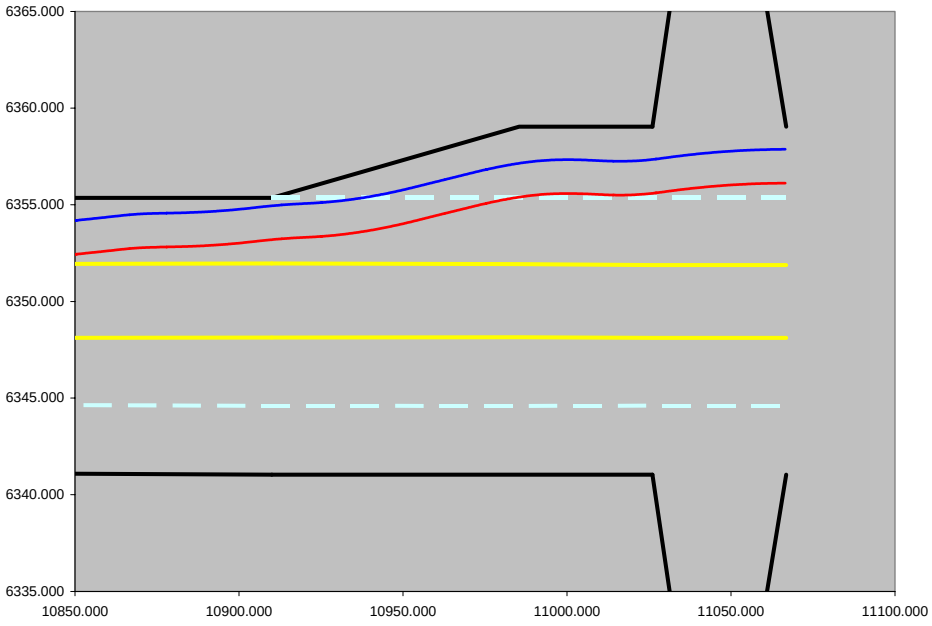


Figure 7 Intersection (I1-A) with Short Dropped Lane

The distance (measured from where the two lanes begin) to complete the merge was obtained from the logged data. A negative value indicates the merge was completed within the intersection. Results are shown in Tables 2a and 2b.

Female No.	Lane Change Distance (ft)
1	156.94
2	-5.55
3	281.88
4	300.15
5	232.12
6	214.44
7	259.15
8	172.52
9	301.85
10	156.94
11	267.44
12	178.75
13	221.62
14	232.48
15	95.02

Table 2a Merge Distance for Females at Intersection with Short Dropped Lane

Male No.	Lane Change Distance (ft)
1	191.68
2	256.88
3	290.37
4	173.83
5	278.79
6	144.51
7	215.62
8	178.39
9	246.65
10	157.93
11	76.75
12	189.84
13	131.85
14	237.47
15	275.74
16	252.95
17	254.85
18	221.10
19	213.62
20	319.53
21	169.14
22	270.76
23	339.47
24	-65.77
25	229.66

Table 2b Merge Distance for Males at Intersection with Short Dropped Lane

Case: I1-B (Dropped Lane – Longer Length)

The intersection with a longer dropped lane is shown in Figure 8. The full two lanes continue for a distance of 597 ft followed by the same 247 ft where the right lane narrows from 12 ft to zero. The path of one of the subjects is shown. Tables 3a and 3b summarize the results for female and male subjects.

A comparison of merging distances for case I1-A (short dropped lane) and case I1-B (longer dropped lane) is shown in Figure 9 for females and in Figure 10 for males. The average merge distances for each sex and the combined average is given in Table 4.

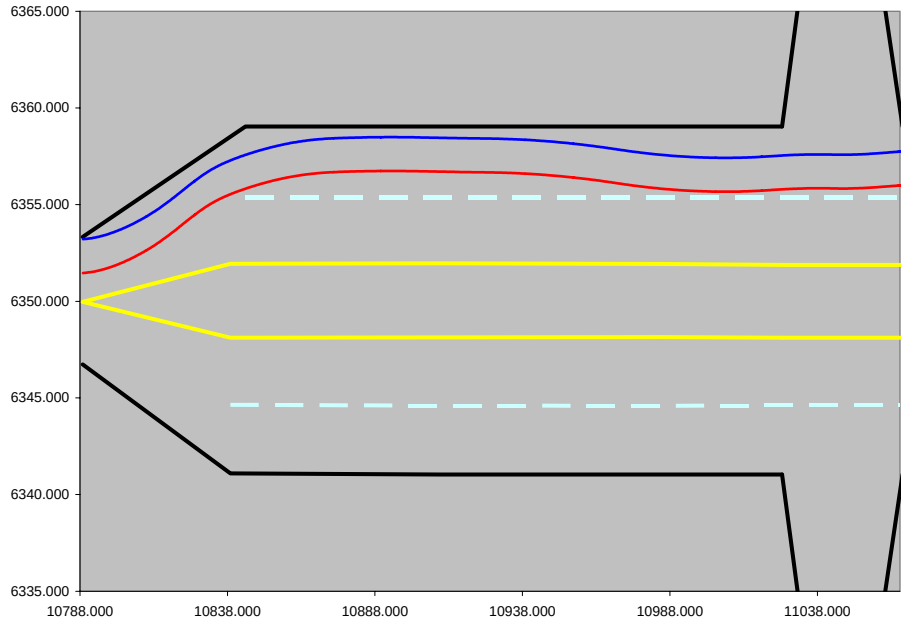


Figure 8 Intersection (I1-B) with Longer Dropped Lane

Female	Lane Change Distance (ft)
1	374.96
2	695.65
3	662.85
4	679.51
5	658.81
6	133.72
7	650.65
8	641.56
9	666.19
10	659.31
11	683.87
12	669.11
13	607.55
14	583.34
15	233.23

Table 3a Merge Distance for Females at Intersection with Short Dropped Lane

Male	Lane Change Distance (ft)
1	676.36
2	487.34
3	692.40
4	526.86
5	689.35
6	639.36
7	644.84
8	176.69
9	688.83
10	237.63
11	753.54
12	688.79
13	519.15
14	655.11
15	681.64
16	683.94
17	517.35
18	126.21
19	476.05
20	667.64
21	259.80
22	694.66
23	722.09
24	-39.17
25	664.78

Table 3b Merge Distance for Males at Intersection with Short Dropped Lane

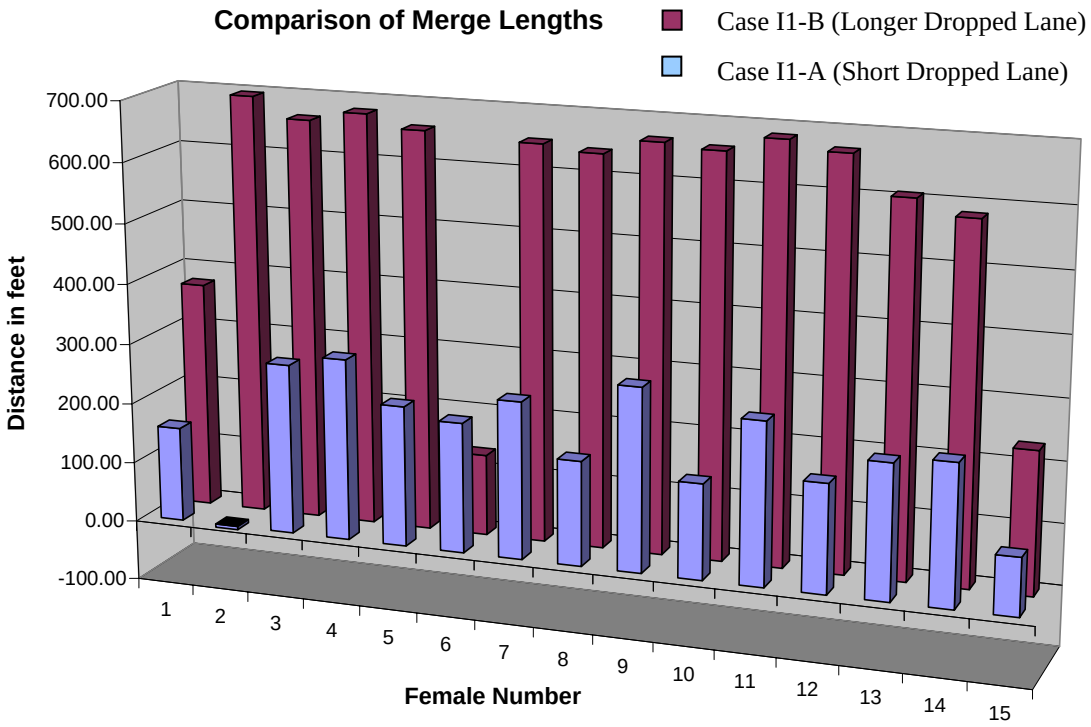


Figure 9 Comparison of Merge Distances (Females) with Short and Longer Dropped Lanes

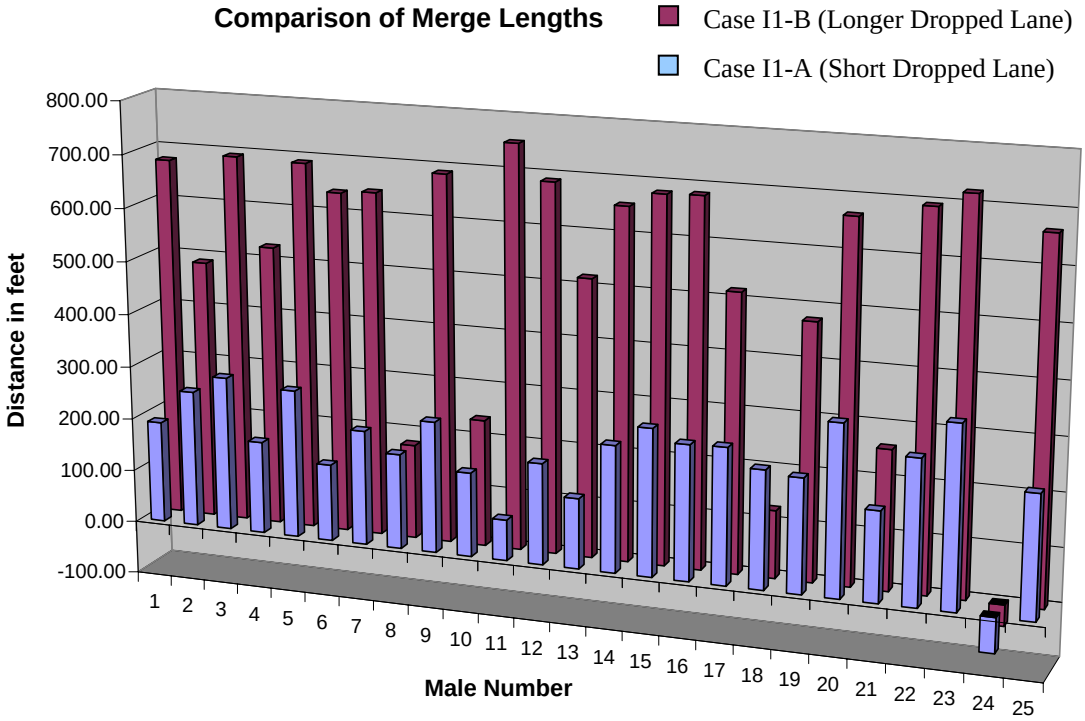


Figure 9 Comparison of Merge Distances (Males) with Short and Longer Dropped Lanes

Intersection Case	Female	Male	Combined
I1-A (short dropped lane)	204 ft	210 ft	208 ft
I1-B (longer dropped lane)	573 ft	541 ft	553 ft

Table 4 Results of Merging Distances for Intersection with Dropped Lane

Several pictures of the intersection for both cases are shown in Figures 10-13. Note, the simulator vehicle is the light blue car in Figures 12 and 13.

Figure 10 Approaching Intersection With Short Dropped Lane

Figure 11 Approaching End of Short Dropped Lane

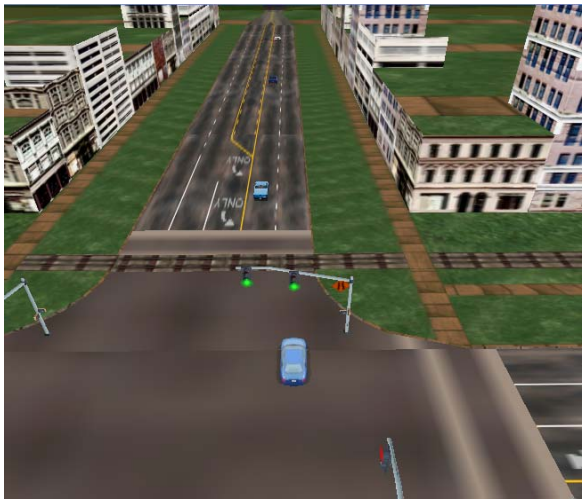


Figure 12 View of Simulator Vehicle Approaching Intersection Followed by Longer Dropped Lane

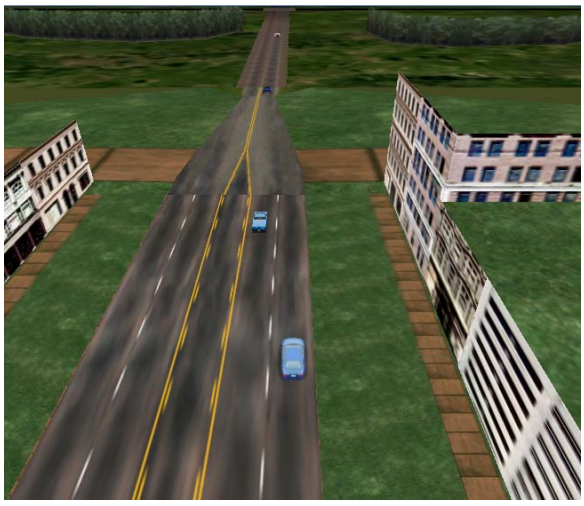


Figure 13 View of Simulator Vehicle in Longer Dropped Lane

Case: I2-A (Non Alignment of Lanes and No Markings on the Ground)

Four out of 15 females and 4 of 25 males were able to stay entirely in the same lane on either side of the intersection and stay within the imaginary lane boundaries while crossing the intersection. The path followed by one such driver is shown in Figure 14.

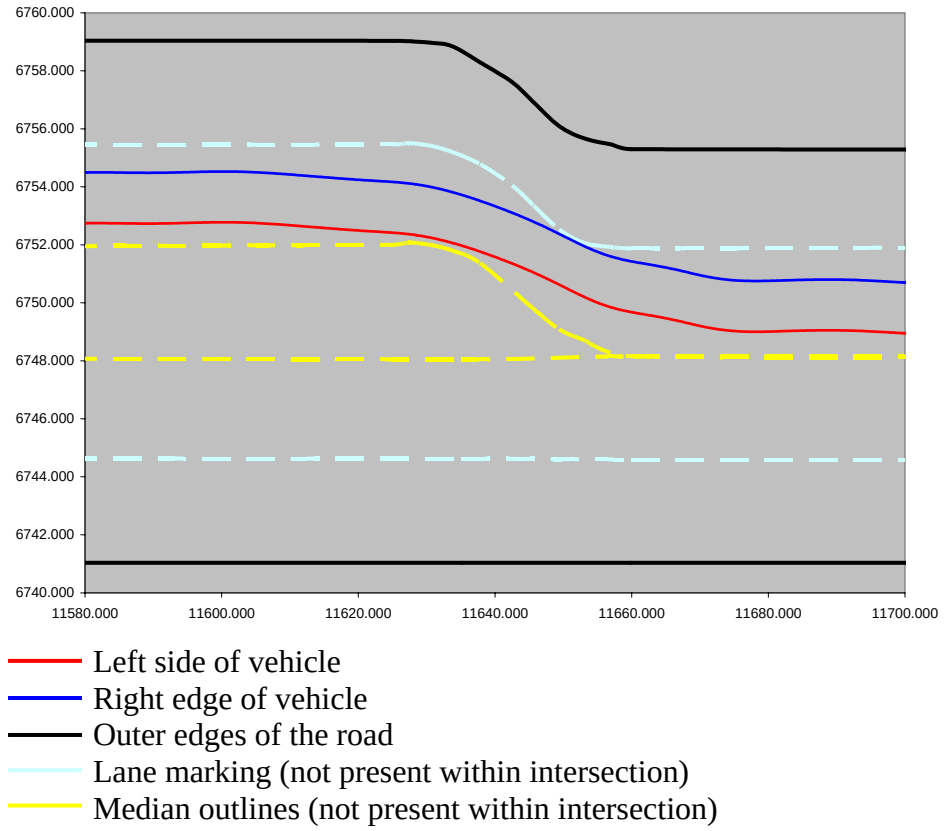


Figure 14 Path of Subject Who Maintained Proper Positioning at all Times

A second group of 9 females and 19 males deviated slightly from the path described previously, i.e. went outside the actual or virtual lane marking at some point. One of the paths is shown in Figure 15.

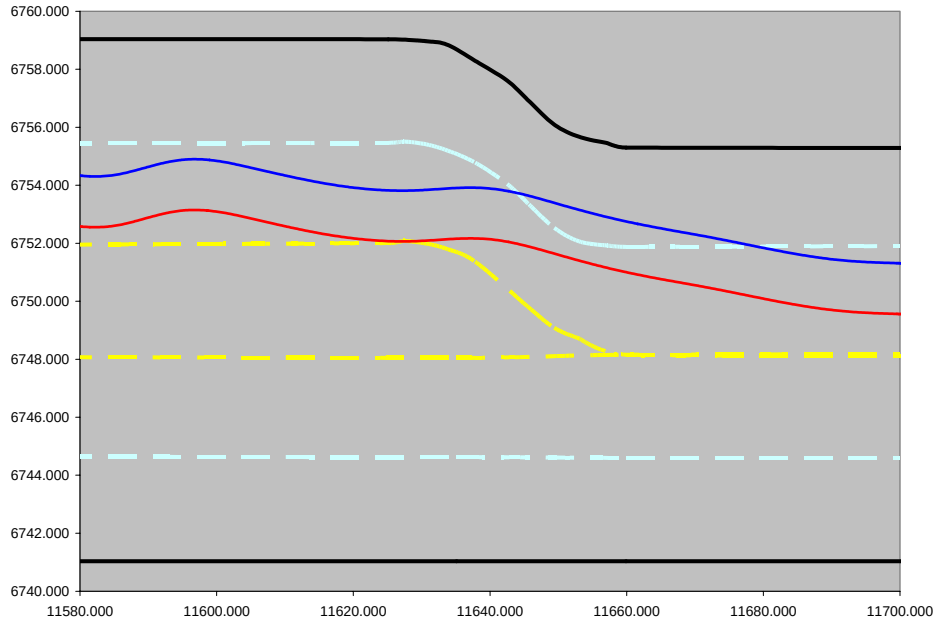


Figure 15 Path of Driver Who Deviated Slightly Outside Approach Lane

The remaining drivers (2 females and 2 males) had the most difficulty with the lane misalignment. Each of these drivers wound up in a different lane after crossing the intersection. Figure 16 illustrates the path of one such driver who began in the right lane and unintentionally steered the simulator vehicle into the left lane on the downstream side of the intersection.

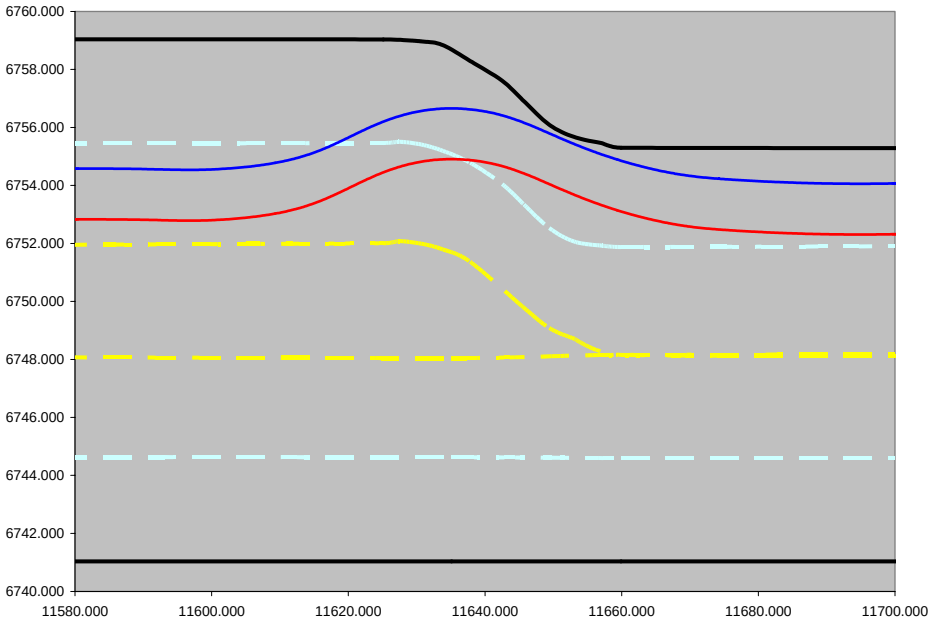


Figure 16 Vehicle Path of Driver Switching Lanes Across Intersection

Case: I2-B (Non Alignment of lanes with markings on the ground)

The results for this case are summarized in Table 5.

	Female	Male
Within Lane at all times	5	15
Slight Deviation from Lane	6	8
Switched Lanes	4	2

Table 5 Results for Intersection with Misaligned Lanes and Lane Striping Present

Figures 17-20 are photos of the intersection without lane striping (case I2-A). Figure 20 shows the simulator vehicle driver veering into the median after crossing the intersection. Figures 21-23 are pictures of the same intersection (case I2-B) with markings to help drivers maintain the correct lane. Again, the simulator vehicle is a light blue passenger car in all of the figures in which it appears.

Figure 17 Approaching Intersection With Lane Misalignment and No Striping

Figure 18 Overhead View of Simulator Vehicle Approaching Intersection with Lane Misalignment and No Striping

Figure 19 Overhead View of Simulator Vehicle in Intersection with Lane Misalignment and No Striping

Figure 20 Overhead View of Simulator Vehicle Exiting Intersection with Lane Misalignment and No Striping

Figure 21 Overhead View of Simulator Vehicle Upstream from Intersection with Lane Misalignment and Striping Present

Figure 22 Approaching Intersection With Lane Misalignment and Striping Present

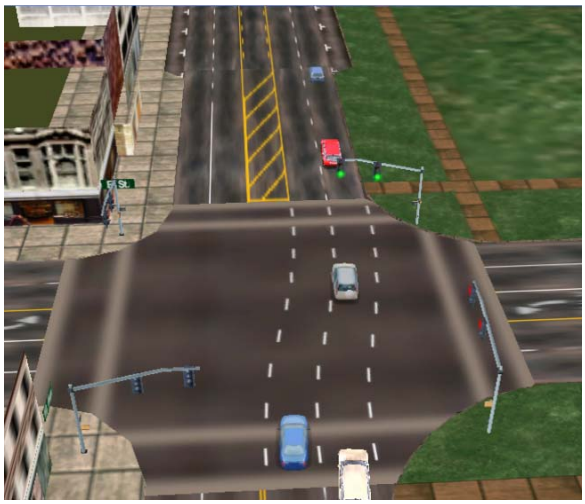


Figure 23 Overhead View of Simulator Vehicle Within Intersection with Lane Misalignment and Striping Present

Case I3-A (Joint Left and Thru Lane)

Case I3-A refers to the presence of a joint left turn and thru lane at the intersection. Figure 24 shows the simulator vehicle stopped at a red light behind a lead vehicle in a joint left turn and thru lane. In Figure 25 the traffic signal is green and the

lead vehicle is waiting for an acceptable gap before turning left. The simulator vehicle is stuck behind the lead car. Note the simulator vehicle is blocked from switching lanes due to the heavy traffic in the adjacent lane.

Figure 24 Simulator Vehicle Stopped at Red Light in a Joint Left and Thru Lane

Figure 25 Simulator Vehicle Waiting for Left Turning Vehicle to Clear Before Proceeding Thru Intersection

Scenario 1 was created to have the lead vehicle turn left during the amber phase as shown in Figure 26. The subjects in the simulator vehicle were confronted with two choices:

1. Remain stopped at the intersection and wait for the next green phase
2. Run the red light and proceed thru the intersection

Nine males and 5 females ran the red light. One male and 3 females tried to pull out around the left turning vehicle and proceed thru the intersection. Seven males and 3 females blew the horn in the simulator vehicle waiting for the car ahead to turn left.

Figure 26 Lead Vehicle Turning Left During Amber Phase

Case I3-B (Separate Left Turn Lane)

A dedicated left turn lane is present in this case. Figure 27 shows the simulator vehicle approaching the intersection in the thru lane. Figure 28 is the view from a camera inside the simulator.

Figure 27 Simulator Vehicle Approaching Intersection in Thru Lane

Figure 28 View Approaching Intersection

Figures 29 shows two views of the simulator vehicle stopped at the intersection waiting for the light to turn green.

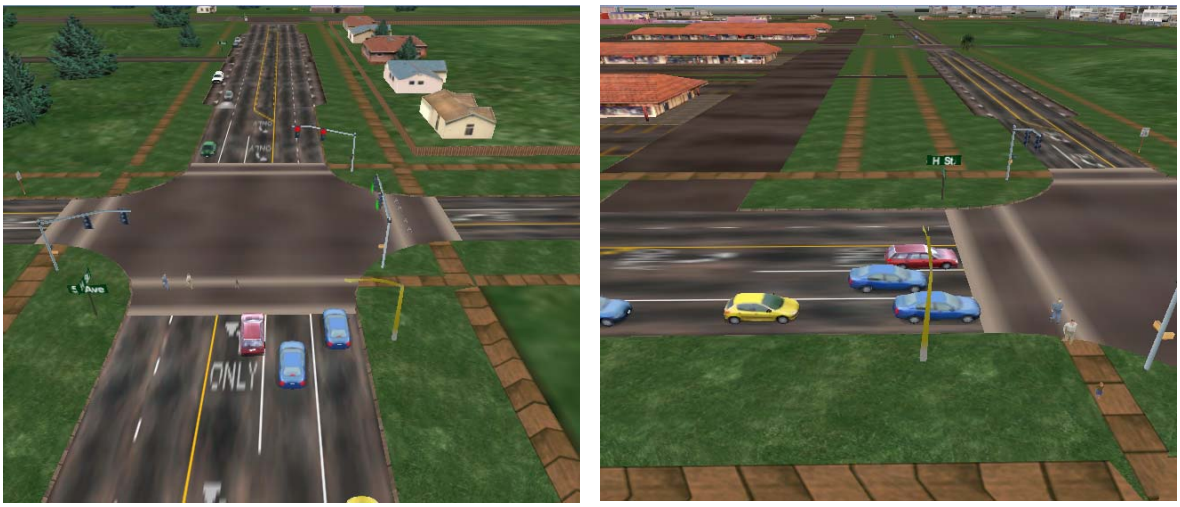


Figure 29 Views of Simulator Vehicle Stopped at Red Light in Thru Lane

Survey

This section presents results of the survey questionnaire administered to all the subject drivers after completing both scenarios. The Survey is found in Appendix A.

Part I – Questions Related to Lane Dropping

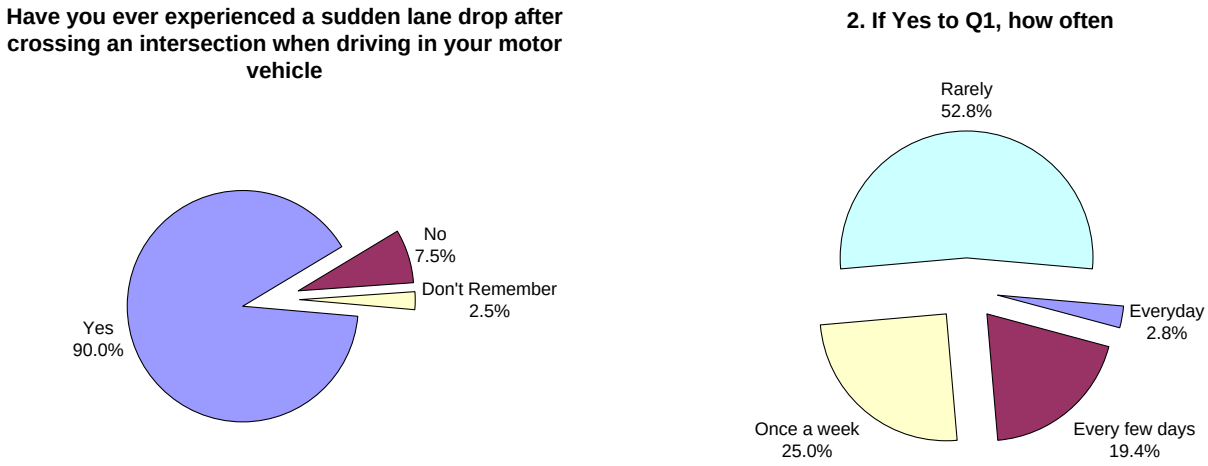
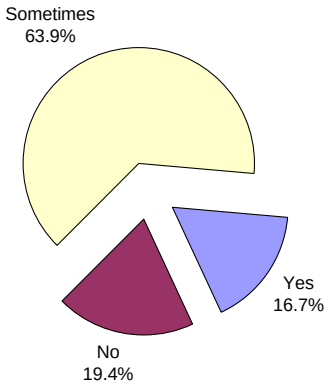
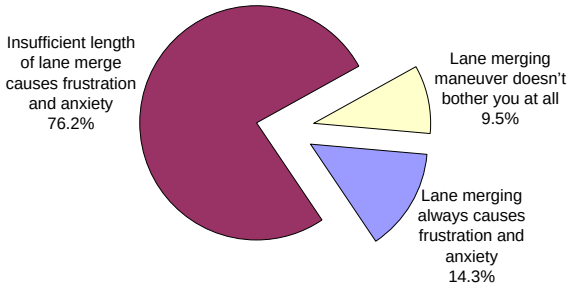


Figure 30 Results of Survey Questions 1 and 2

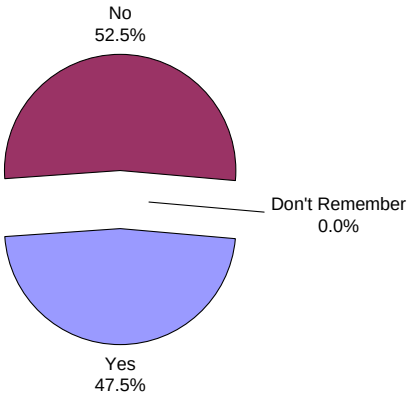
3. If Yes to Q1, was the length of the merge lane sufficient to merge safely?



4. Check which is applicable:



5. In the driving simulator, did your experience of a lane drop cause frustration and anxiety?



6. If Yes to Q5, please rate your frustration level.

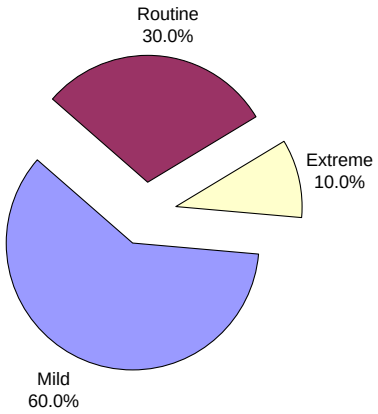
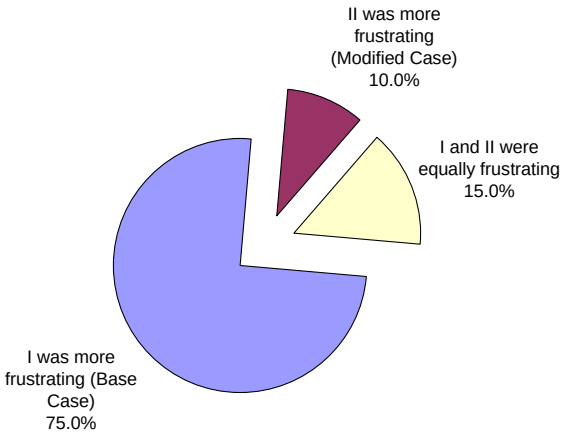


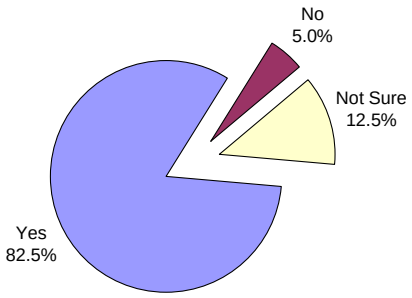
Figure 31 Results of Survey Questions 3-6

In Q7 and Q8 below, designs I and II refer to cases I1-A (short dropped lane) and I1-B (longer dropped lane), respectively.

7. If Yes to Q5, for the two designs I and II below,



8. Do you think design II is better than I and will improve the conditions for merging?



9. If Yes to Q8, please rate the potential improvement

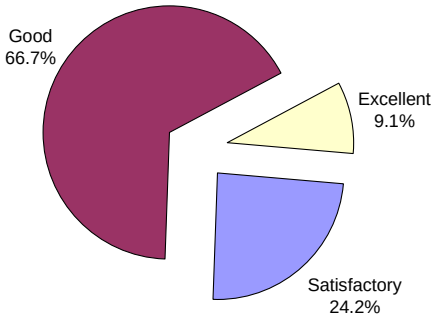
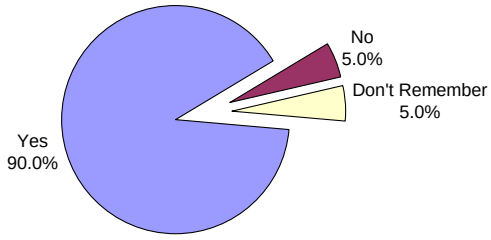


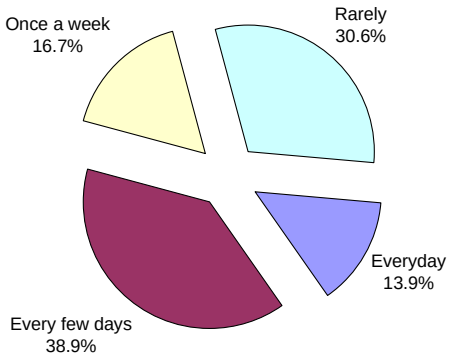
Figure 32 Results of Survey Questions 7-9

Part II – Questions Related to Lane Misalignment

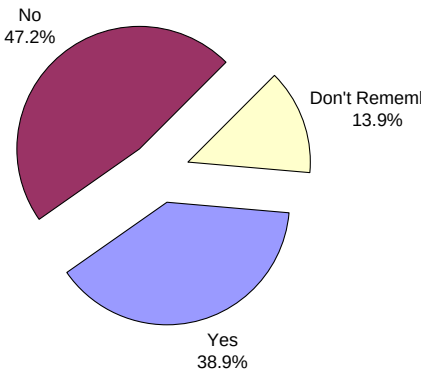
10. Have you ever experienced a non alignment of lanes on either side of an intersection while driving a motor vehicle?



11. If Yes to Q10, how often



12. If Yes to Q10, was there a pavement marking in intersection to guide you to the other side?



13. In the driving simulator did your experience of a non alignment of lanes at an intersection cause frustration and anxiety?

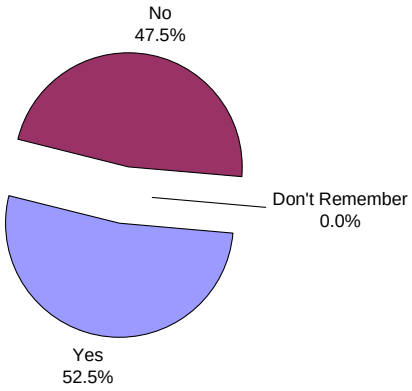
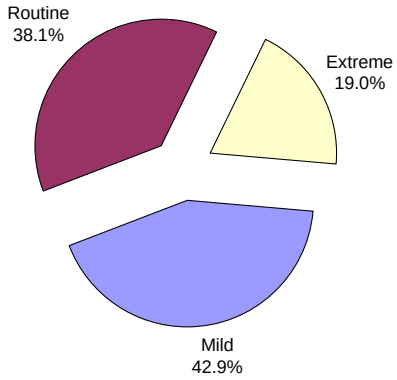


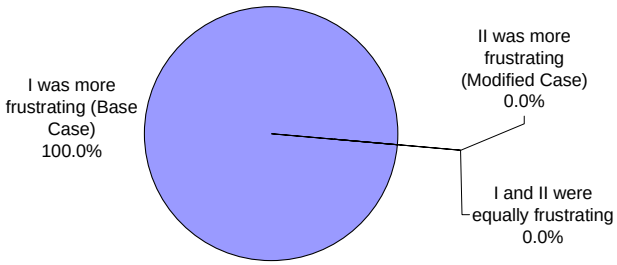
Figure 33 Results of Survey Questions 10-13

In Q15 and Q16 below, designs Ⅰ and Ⅱ refer to cases I2-A (lane misalignment with no markings in intersection) and I1-B (lane misalignment with markings in intersection), respectively.

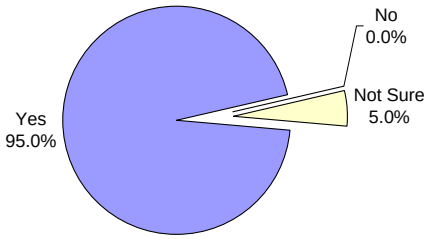
14. If Yes to Q13, please rate your frustration level.



15. If Yes to Q13, for the two designs I and II below,



16. Do you think design II is better than I and will improve conditions for traveling through the intersection?



17. If Yes to Q16, please rate the potential improvement

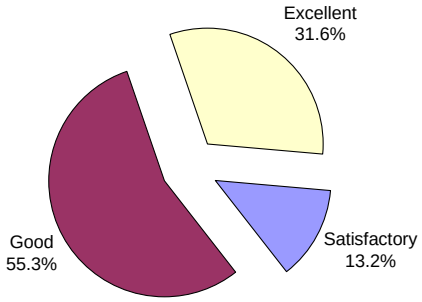
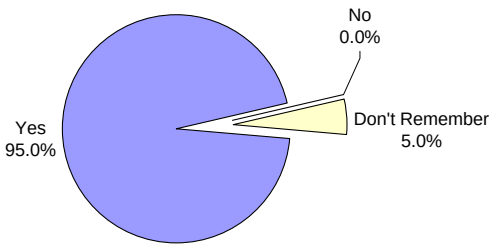


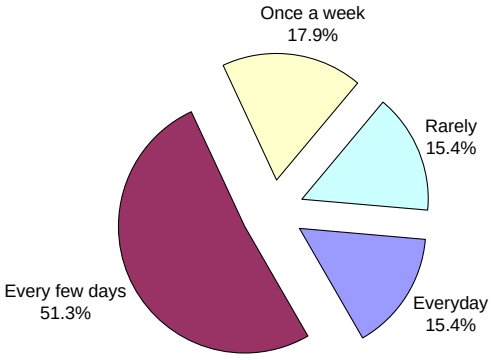
Figure 34 Results of Survey Questions 14-17

Part III – Questions Related to a Joint Left Turn and Thru Lane

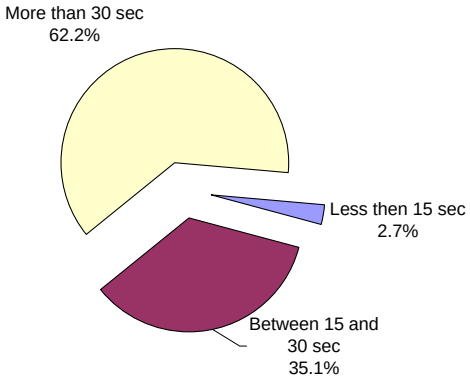
18. Have you ever been stuck behind a left turning vehicle in a joint left and thru lane when driving a motor vehicle?



19. If Yes to Q18, how often



20. If Yes to Q18, what was the longest amount of time you were forced to wait behind the left turning vehicle before going thru the intersection?



21. Have you ever been stuck behind a left turning vehicle for more than one cycle of the signal (time period between one red light to another red light)

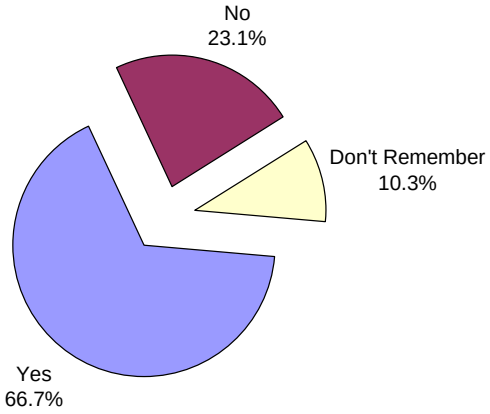
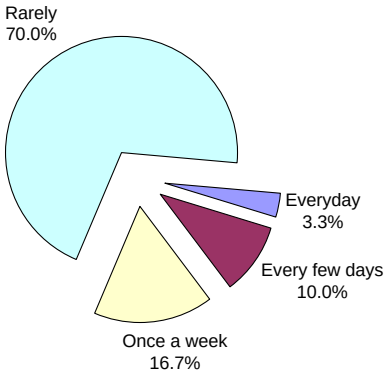


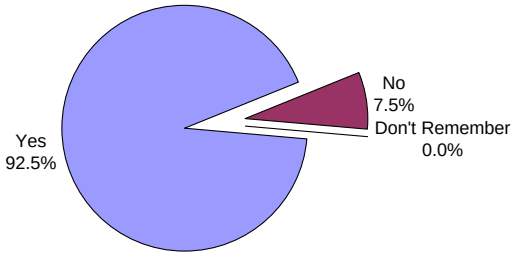
Figure 35 Results of Survey Questions 18-21

In Q25 and Q26 below, designs I and II refer to cases I3-A (joint left turn and thru lane at intersection) and I3-B (separate left turn at intersection), respectively.

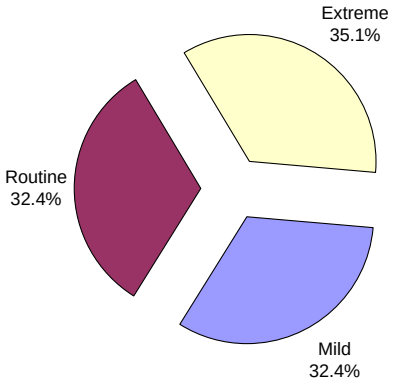
22. If Yes to Q21, how often do you experience this situation



23. In the driving simulator, did getting stuck behind a left turning vehicle cause frustration and anxiety?



24. If Yes to Q23, please rate your frustration level



25. If Yes to Q23, for the two designs I and II below

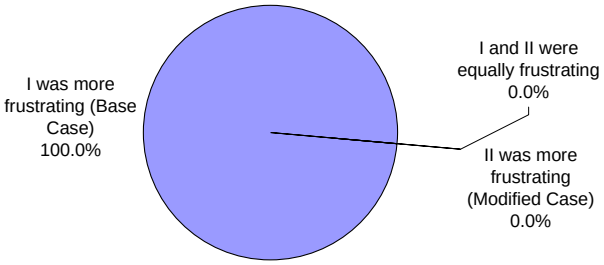


Figure 36 Results of Survey Questions 22-25

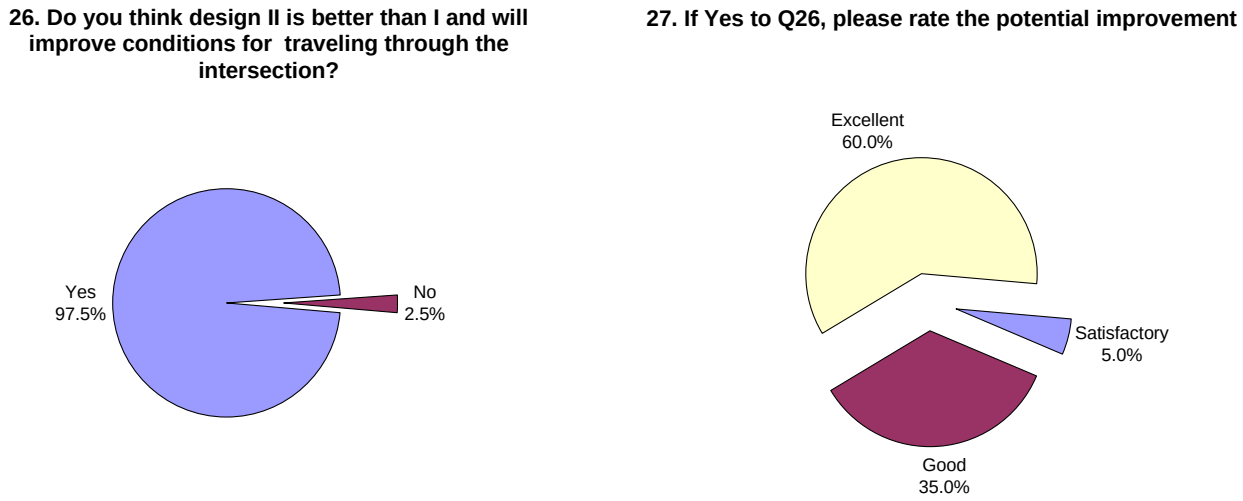


Figure 37 Results of Survey Questions 26-27

Answers to the questions by respondents are tabulated in Appendix A.

Conclusions

The primary objective of this project was to demonstrate the feasibility of using The University of Central Florida's interactive driving simulator to perform traffic engineering studies. A similar project [2] was completed last year demonstrating how the driving simulator could be used to acquire gap acceptance data for comparison with published AASHTO data. The current project described herein demonstrates the utility of having a high fidelity driving simulator to evaluate how driver's respond to alternative geometric designs at intersections. It can serve as a valuable asset in testing new designs prior to implementation or simply optimize one or more features relative to an existing geometric design. For example, further testing could shed light on what the minimum

length should be for the dropped lane to minimize driver's anxiety when confronted with a dropped lane after an intersection.

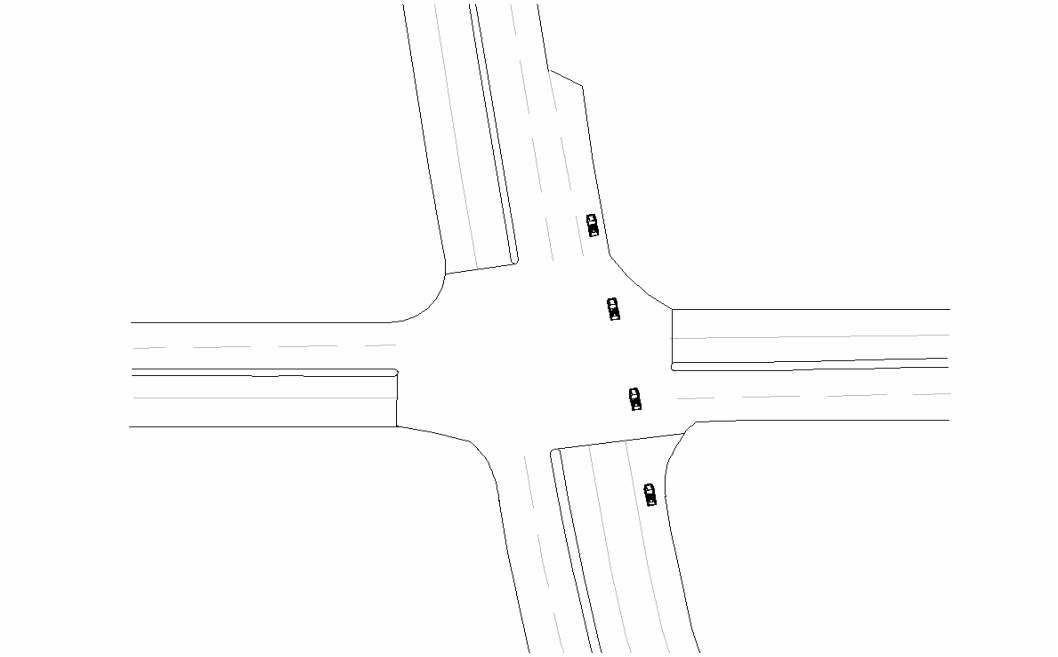
References

1. Klee, H. The University of Central Florida Driving Simulator", Modeling and Simulation Magazine", Vol. 2, Number 2, April-June 2003.
2. Klee, H., Radwan E., "Final Report - Assessment of the Use of a Driving Simulator for Traffic Engineering and Human factors Studies", FDOT Contract No. BC096/RPWO#18, Feb 04.

Appendix A

Survey for "Quality of Service"

1. Lane drop after crossing the intersection



1. Have you ever experienced a sudden lane drop after crossing an intersection when driving in your motor vehicle?

   a) ___ Yes b) ___ No c) ___ Don't remember

2. If Yes to Q1, how often

   a) ___ Every day b) ___ Every few days c) ___ Once a week
   d) ___ Rarely

3. If Yes to Q1, was the length of the merge lane sufficient to merge safely?

   a) ___ Yes b) ___ No c) ___ Sometimes

4. Check which is applicable:

   a) ___ Lane merging always causes frustration and anxiety.

b) ___ Insufficient length of lane merge causes frustration and anxiety.

c) ___ Lane merging maneuver doesn't bother you at all.

5. In the driving simulator, did your experience of a lane drop cause frustration and anxiety?

   a) ___ Yes b) ___ No c) ___ Don't remember

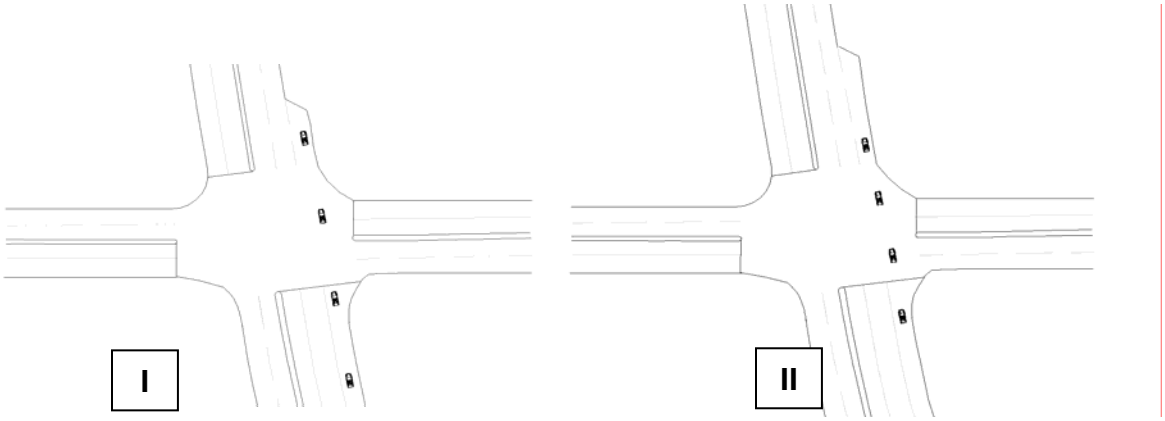
6. If Yes to Q5, please rate your frustration level.

   a) ___ Mild b) ___ Routine ___ c) Extreme

7. If Yes to Q5, for the two designs **I** and **II** below,

   a) ___ **I** was more frustrating b) ___ **II** was more frustrating

   c) ___ **I** and **II** were equally frustrating



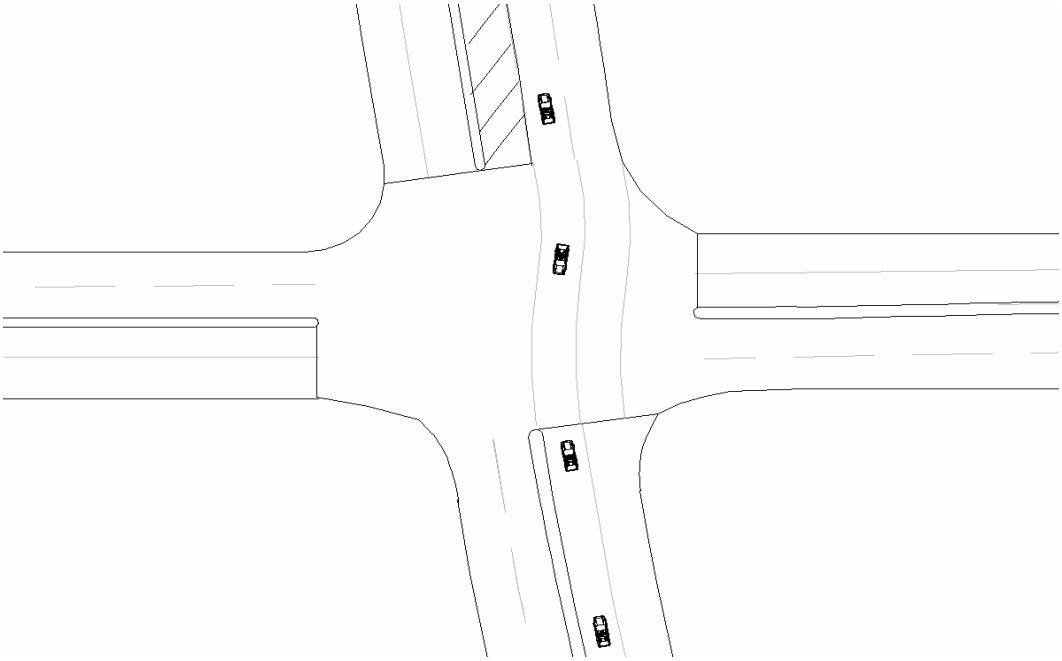
8. Do you think design **II** is better than **I** and will improve the conditions for merging?

   a)___ Yes b) ___ No c) ___ Not sure

9. If Yes to Q8, please rate the potential improvement

   a) ___ Satisfactory b) ___ Good c) ___ Excellent

2. Non alignment of lanes



10. Have you ever experienced a non alignment of lanes on either side of an intersection while driving a motor vehicle?

    a) ___ Yes b) ___ No c) ___ Don't remember

11. If Yes to Q10, how often

    a) ___ Every day b) ___ Every few days c) ___ Once a week

    d) ___ Rarely

12. If Yes to Q10, was there a pavement marking in the intersection to guide you to the other side?

    a) ___ Yes b) ___ No c) ___ Don't remember

13. In the driving simulator did your experience of a non alignment of lanes at an intersection cause frustration and anxiety?

    a) ___ Yes b) ___ No c) ___ Don't remember

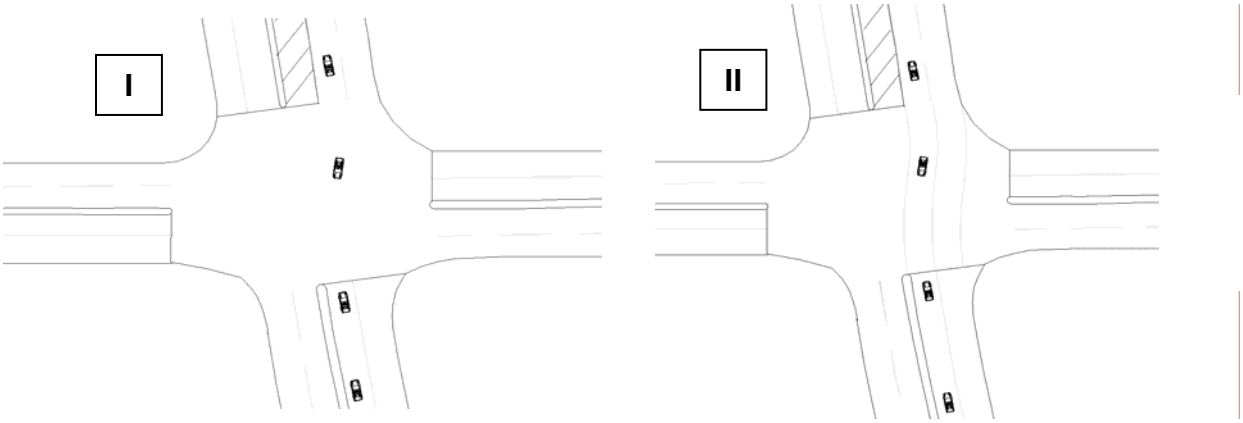
14. If Yes to Q13, please rate your frustration level.

    a) ___ Mild b) ___ Routine ___ c) Extreme

15. If Yes to Q13, for the two designs **I** and **II** below,

a) ___ **I** was more frustrating b) ___ **II** was more frustrating

c) ___ **I** and **II** were equally frustrating



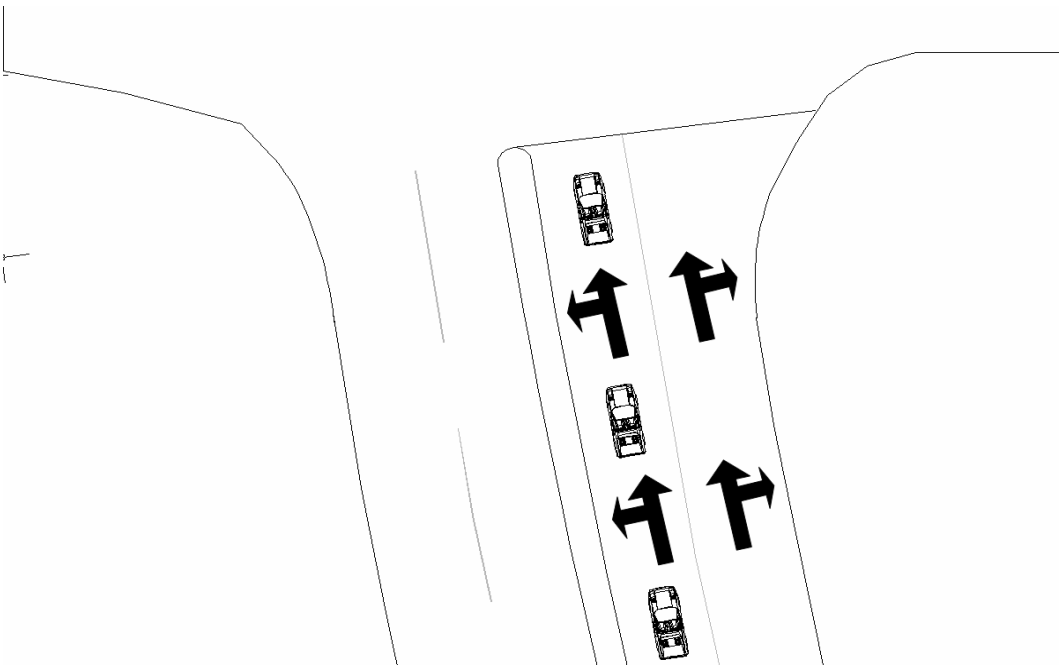
16. Do you think design **II** is better than **I** and will improve conditions for traveling through the intersection?

a)___ Yes b) ___ No c) ___ Not sure

17. If Yes to Q16, please rate the potential improvement

a) ___ Satisfactory b) ___ Good c) ___ Excellent

3. Effect of joint left and thru lane



18. Have you ever been stuck behind a left turning vehicle in a joint left and thru lane when driving a motor vehicle?

    a) ___ Yes b) ___ No c) ___ Don't remember

19. If Yes to Q18, how often

    a) ___ Every day b) ___ Every few days c) ___ Once a week

    d) ___ Rarely

20. If Yes to Q18, what was the longest amount of time you were forced to wait behind the left turning vehicle before going thru the intersection?

    a) ___ Less then 15 sec b) ___ Between 15 and 30 sec

    c) ___ More than 30 sec

21. Have you ever been stuck behind a left turning vehicle for more than one cycle of the signal (time period between one red light to another red light)

    a) ___ Yes b) ___No c) ___ Don't remember

22. If Yes to Q21, how often do you experience this situation

a) ___ Everyday b) ___ Couple of days c) ___ Once a week

d) ___ Rarely

23. In the driving simulator, did getting stuck behind a left turning vehicle cause frustration and anxiety?

a) ___ Yes b) ___ No c) ___ Don't remember

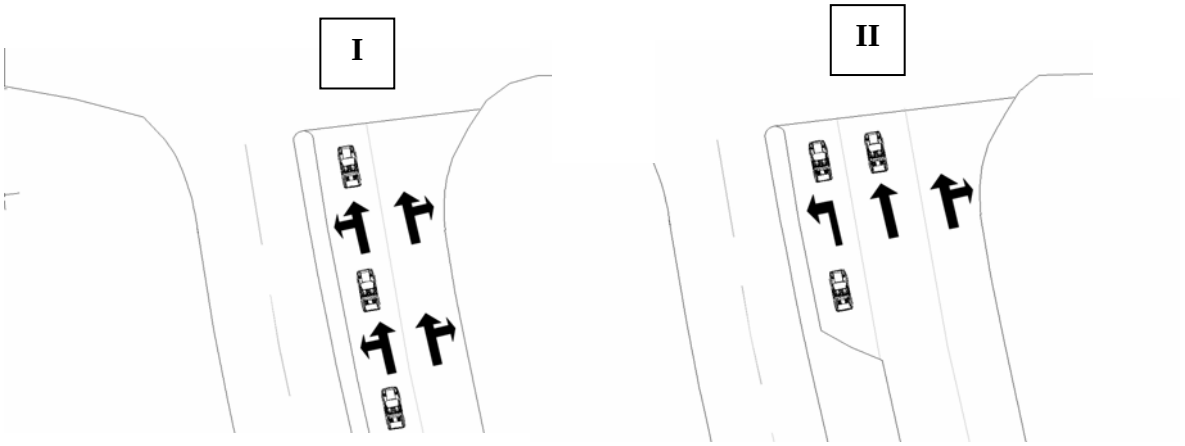
24. If Yes to Q23, please rate your frustration level.

a) ___ Mild b) ___ Routine ___ c) Extreme

25. If Yes to Q23, for the two designs **I** and **II** below

a) ___ **I** was more frustrating b) ___ **II** was more frustrating

c) ___ **I** and **II** were equally frustrating



26. Do you think design **II** is better than **I** and will improve conditions for traveling through the intersection?

a) ___ Yes b) ___ No

27. If Yes to Q26, please rate the potential improvement

a) ___ Satisfactory b) ___ Good c) ___ Excellent

Numerical Results of Survey Questionnaire

	M	F	Tot	%		M	F	Tot	%		M	F	Tot	%
Q1					**Q12**					**Q23**				
a	21	15	36	90.0	a	11	3	14	38.9	a	24	13	37	92.5
b	3		3	7.5	b	8	9	17	47.2	b	1	2	3	7.5
c	1		1	2.5	c	4	1	5	13.9	c				0.0
Q2					**Q13**					**Q24**				
a	1		1	2.8	a	14	7	21	52.5	a	9	3	12	32.4
b	3	4	7	19.4	b	11	8	19	47.5	b	7	5	12	32.4
c	8	1	9	25.0	c				0.0	c	8	5	13	35.1
d	9	10	19	52.8	**Q14**					**Q25**				
Q3					a	6	3	9	42.9	a	24	13	37	100.0
a	2	4	6	16.7	b	5	3	8	38.1	b				0.0
b	5	2	7	19.4	c	3	1	4	19.0	c				0.0
c	14	9	23	63.9	**Q15**					**Q26**				
Q4					a	15	7	22	100.0	a	25	14	39	97.5
a	3	3	6	14.3	b				0.0	b		1	1	2.5
b	21	11	32	76.2	c				0.0	**Q27**				
c	2	2	4	9.5	**Q16**					a	1	1	2	5.0
Q5					a	23	15	38	95.0	b	8	6	14	35.0
a	13	6	19	47.5	b				0.0	c	16	8	24	60.0
b	12	9	21	52.5	c	2		2	5.0					
c				0.0	**Q17**									
Q6					a	4	1	5	13.2					
a	11	1	12	60.0	b	11	10	21	55.3					
b	3	3	6	30.0	c	8	4	12	31.6					
c		2	2	10.0	**Q18**									
Q7					a	24	14	38	95.0					
a	11	4	15	75.0	b				0.0					
b	1	1	2	10.0	c	1	1	2	5.0					
c	2	1	3	15.0	**Q19**									
Q8					a	4	2	6	15.4					
a	21	12	33	82.5	b	14	6	20	51.3					
b	1	1	2	5.0	c	2	5	7	17.9					
c	3	2	5	12.5	d	4	2	6	15.4					
Q9					**Q20**									
a	7	1	8	24.2	a		1	1	2.7					
b	11	11	22	66.7	b	9	4	13	35.1					
c	3		3	9.1	c	15	8	23	62.2					
Q10					**Q21**									
a	23	13	36	90.0	a	17	9	26	66.7					
b	1	1	2	5.0	b	5	4	9	23.1					
c	1	1	2	5.0	c	2	2	4	10.3					
Q11					**Q22**									
a	3	2	5	13.9	a		1	1	3.3					
b	10	4	14	38.9	b	2	1	3	10.0					
c	2	4	6	16.7	c	5		5	16.7					
d	8	3	11	30.6	d	13	8	21	70.0					