Final Report for
Contract Number: BC 354 RPWO #40
Evaluation of Changeable Message Signs (CMS) on I-4 at Exits 30A and 30B To Assign Ramp Traffic and at Princeton St. To Sign for Cultural Events

Prepared for

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Abstract

Florida Department of Transportation performed an experimental analysis of a series of changeable message signs functioning as freeway guide signs to assign traffic to Universal Theme Park via one of two eastbound exits based on traffic congestion at the first of the two exits. An examination of crashes along the entire route indicated a statistically significant increase in crashes at the first eastbound exit following the actuation of the system. Behavioral analysis scored from video tapes of driver behavior at the first eastbound exit, revealed that the reassignment of the theme park exit was associated with an increase in the percentage of motor vehicle conflicts such as the percentage of vehicles cutting across the exit gore and the percentage of motorists making unsafe lane changes in the immediate vicinity of the exit. A human factors analysis revealed that the method used for switching the designated or active theme park exit on the series of changeable message signs led to the presentation of conflicting messages to some motorists. The second experiment evaluated the use of a phased method of switching the designed theme park exit to eliminate the delivery of conflicting messages. The new method for switching the designated theme park exit was not associated with an increase in motorists cutting across the exit gore or unsafe lane changes. Based on the results obtained in the second experiment, it is recommended that the system used to assign the active exit based on traffic congestion be added to the MUTCD. A third experiment evaluated the use of a changeable message signs to provide information on cultural events in the Orlando area at a single exit. These signs were not associated with an increase in crashes. It is also recommended that this use for changeable message signs be added to the MUTCD.

The MUTCD provides standards for uniform and effective signing for high speed and high volume freeways (USDOT, 2001). The MUTCD specifies the following standard for changeable message signs: “Changeable message signs shall be capable of displaying several messages in a sequence. Such messages shall be changed manually, by remote control, or by automatic controls. Changeable message signs shall display pertinent traffic operational and guidance information only”. The standard does not address the use of such signs for assigning traffic between alternative exits based on traffic congestion.

In 1998 the Florida Department of Transportation was asked by FHWA to evaluate the safety impact of the use of changeable messages signs functioning as freeway guide signs on Interstate 4 (I-4) to assign traffic to Universal Theme park via exit 30A or 30B based on traffic congestion on exit 30A, and guide signs to inform motorists on interstate I-4 on current downtown cultural destinations. This evaluation was approved as an extension of an earlier Request to Experiment, using similar technology signs, to vary destinations at the I-4/US 192 interchange. Earlier evaluations examined the conspicuity, and motorist acceptance of these signs using survey methodology. These data indicated that most motorists surveyed noticed the signs and of those respondents who noticed the sign, a large percentages saw the attraction of their choice on the signs and selected the correct exit with the help of the signs.

Initial observations to determine if there were any negative safety effects were made immediately after each sign became operational. Staff at the Regional Traffic Management Center monitored these sites using cameras placed at sign and exit sites and did not observe changes in erratic maneuvers, sudden braking, etc., following the introduction of the signs. They also did not observe any change in vehicle speeds after the signs were implemented. Although, these casual observational methods would be adequate for discriminating a sudden extreme reduction in safety, relatively large changes would not be apparent without the use of more systematic data collection procedures. One reason why important decreases in safety might not be noted by causal observation techniques, is that serious conflicts and crashes normally occur at relatively low rates. Even if operational changes produced a four or five fold increase in these variables it might not be readily apparently to a person watching monitors while

carrying out other duties. For this reason, FHWA requested a safety evaluation of the changeable message signs assigning motorists to exit 30A or 30B and to inform motorists of current cultural destinations in Orlando. A second purpose of this study was to determine the efficacy of the CMS displays as guide signs to assign traffic based on ramp volumes.

This research was carried out in three separate experiments. The purpose of Experiment 1 was to: 1. Determine the efficacy of the CMS displays as guide signs: to assign traffic based on ramp volumes; and 2. to determine the safety impact of the CMS displays. Data analysis included the use of motor vehicle conflict data scored from video tapes, and crash data. Because the results of the first experiment revealed that the initial sign change protocol was associated with an increase in the number of conflicts and crashes, a second experiment was initiated. Experiment 2 evaluated the efficacy and safety of a second sign change protocol for exits 30A and 30B designed to eliminate conflicting messages. The third experiment examined the safety impact of the changeable message signs used to inform motorists of current cultural event destinations at the Princeton Street Orlando exits.

Experiment 1

Method

How the Changeable Message Signs Were Switched. The changeable message guide signs allowed controllers to route travelers by the most efficient route. When controllers saw traffic build up on the exit ramp for exit 30A (this exit is normally the most direct route to Universal Theme park) they introduced a 10 second dark phase during which neither exit 30A or 30B were designated as the appropriate exit for Universal Theme park. After the 10 second dark phase had elapsed exit 30B was designated as the new Universal Theme Park exit on all three signs. When traffic declined controllers used the same procedure in reverse to re-route traffic back to exit 30A. The sign change protocol is shown in Figures 1 and 2.

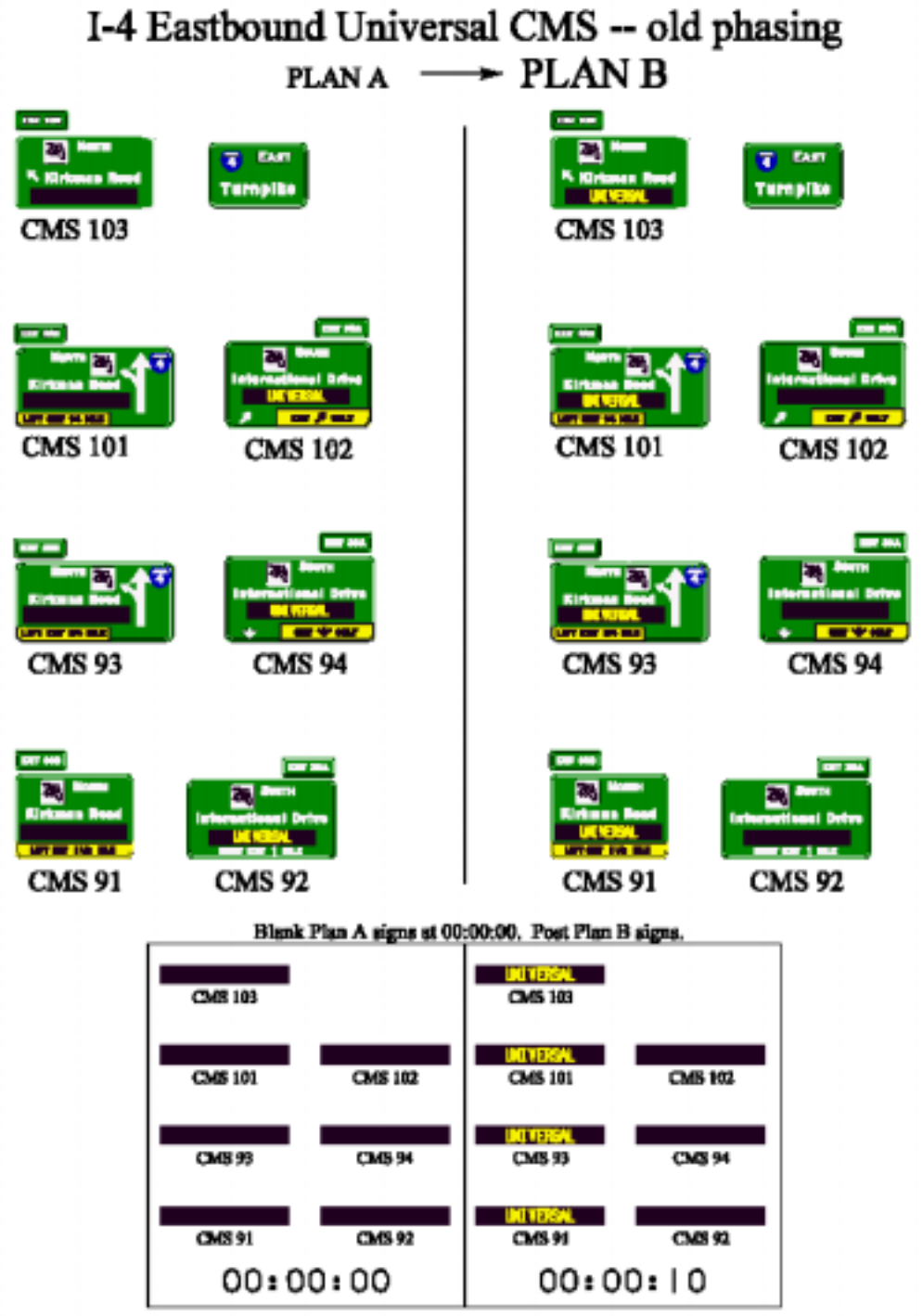


Figure 1. A diagram of the sign change protocol switching the Universal exit from International Drive to Kirkman Road.

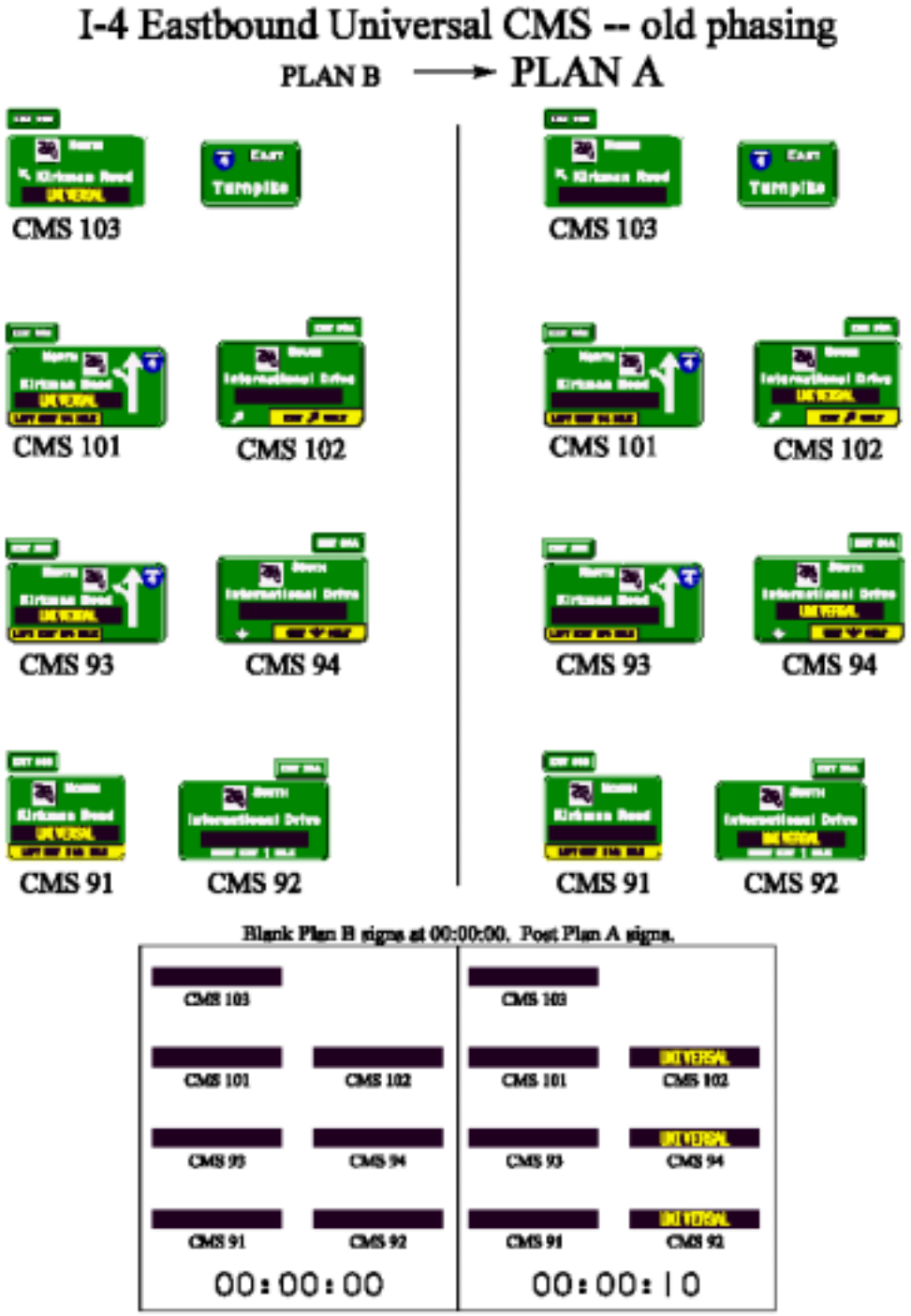


Figure 2. A diagram of the sign change protocol switching the Universal exit from Kirkman Road to International Drive.

Preliminary analysis. Video tape data collected along the system indicated that conflicts occurred specifically at the International Drive exit (30A), see Figure 3. This exit is the major choice point for tourists traveling to Universal Theme Park in an eastbound direction on I-4 because Exit 30A and the next exit at Kirkman Road (30B) both access Universal Theme Park. Confusion resulting from conflicting messages could lead to erratic behavior at exit 30A but not at exit 30B because travelers who did not take exit 30A no longer had a choice of exits. Changing the designated Universal Theme park exit included a 10 second dark phase period when neither exit was designated as the theme park exit. This procedure allowed persons to see one exit designated the correct exit for Universal Theme Park at one or both of the first series of signs and the other exit designated as the correct exit for Universal Theme Park on the last sign at exit 30A located adjacent to the start of the exit gore. This set up a conflict situation which might be expected to cause drivers to engage in erratic maneuvers to get into or out of the exit lane for 30A.

Participants and Setting. Motorists using I-4 served as participants in this study. Drivers' behavior was scored by observers from videotapes produced by the State's I-4 Surveillance and Motorist Information System staff. A high percentage of road users on I-4 in the Orlando area are tourists. Crash data were obtained from the Florida Department of Transportation crash database. Two exit signs were located in advance of exit 30A and 30B and a third exit sign was located at exit 30A adjacent to the start of the exit gore, and a fourth sign located 375 feet before the start of the exit gore for exit 30B. The first exit sign was located 1 mile prior to exit 30A. The second sign was located 3/4 mile prior to exit 30A. The third sign at exit 30A was located adjacent to the marked exit gore. The final sign for 30B was located at the start of the exit taper. The diagram for the series of signs is presented in Figure 3 and the exit diagram for exit 30A is presented in Figure 4.

Observational Measures. Observers scored video tapes for Gore Conflicts and Lane Change Conflicts at the exit to International Drive. Diversion of traffic was scored by counting the number of vehicles taking exit 30A (International Drive) or 30B (Kirkman Road) and calculating the percentage using 30A when it was the designated exit and when it was not the designated exit. Data were scored from videotapes, which showed four simultaneous views monitoring traffic on I-4. Figure 5 shows the view scored by

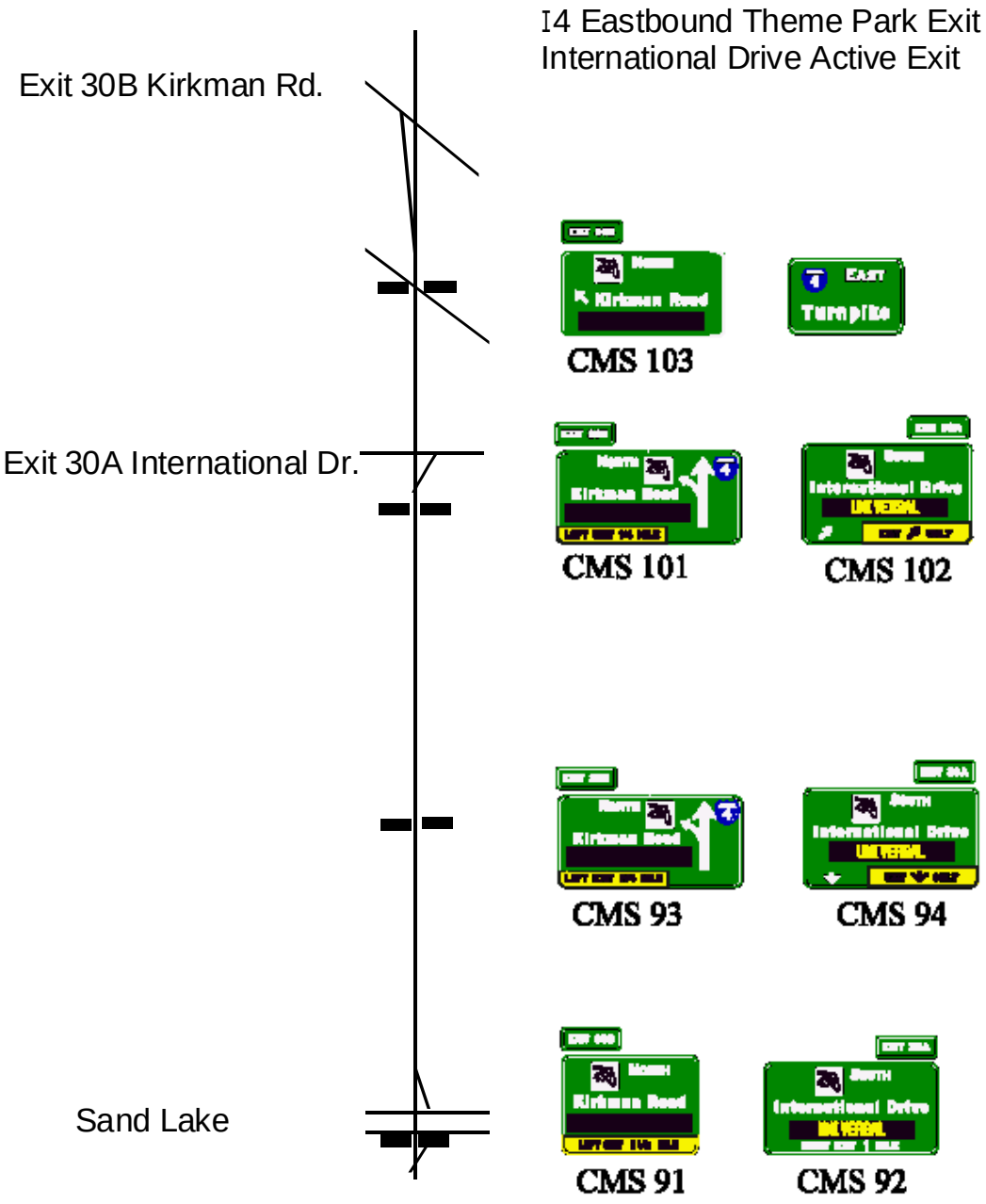
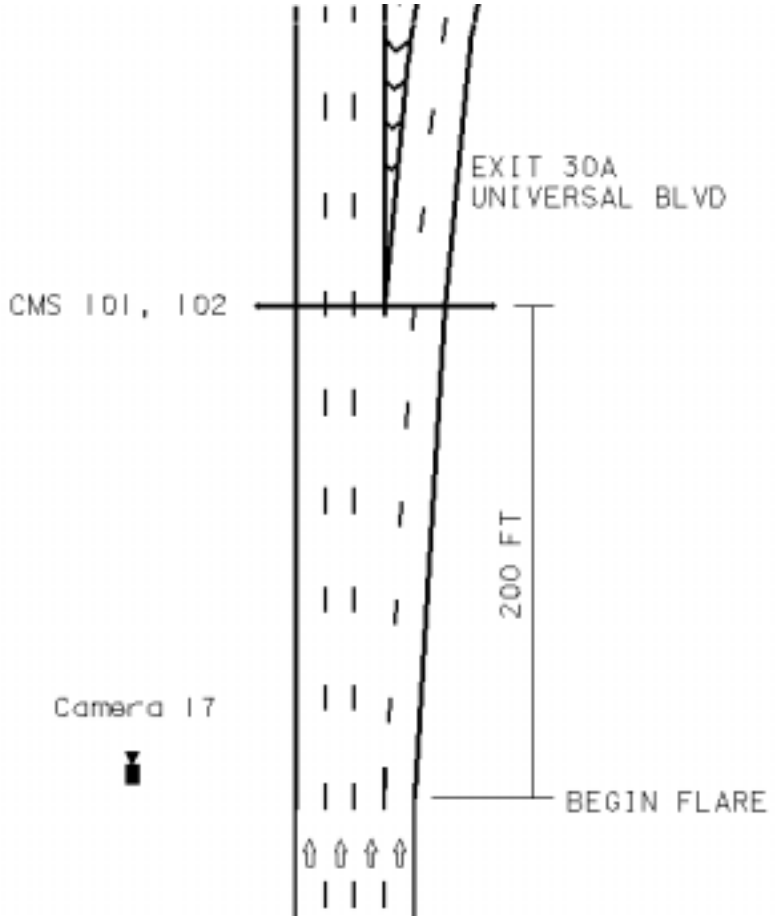


Figure 3. A diagram of the road showing the exits and the CMS.



Element Related to Eastbound Universal Signs	Roadway Section	Straight-Line Diagram Milepost	~Mile Marker
Sand Lake Road	75280	8.3	73.8
EB auxiliary lane extends from entrance ramp at Sand Lake Road			
Camera 16	75280	8.8	74.3
Universal CMS's 93, 94 (70' east of Camera 16)	75280	8.8	74.3
Camera 17	75280	9.3	74.8
Universal CMS's 101, 102	75280	9.3	74.8
Universal CMS 103 (on overpass)	75280	9.5	75.0

Figure 4. A diagram of the International Drive Exit.

the observers. Starting with the upper left frame and moving in a clockwise direction, the first frame show the two signs at near the Sand Lake exit one mile prior to exit 30A. This view allowed scorers to verify the sign change protocol and code the start of all sign changes. The second frame shows a side/rear view of exit 30A. The next frame shows the Kirkman road exit looking west. The final frame shows exit 30A looking west. This frame afforded the best view of gore conflicts at exit 30A.

Gore conflicts were defined as vehicles crossing the exit gore area to either enter exit 30A or to re-enter I-4 after entering exit 30A. This type of conflict is serious because vehicles entering or exiting a high speed roadway at an oblique angle can be expected to be at high risk of a crash with other vehicles. To be scored as a gore conflict the vehicle's tires had to intersect both sides of the gore. This type of conflict was easy to objectively score because one camera was located on a pole at the top of the interchange and could pan down the exit to clearly show the gore area. Examples of gore conflicts are shown in Figure 6. Gore conflicts could be scored as either toward or away from the designated or active exit shown on the exit signs at exit 30A. The active exit was defined as the exit designated as the exit for Universal Theme Park at this location.

A lane change conflict was scored whenever the driver cut across two or more lanes in one action or abruptly changing lanes in close proximity to another vehicle. This type of conflict could also involve a lane change toward or away from the exit designated for Universal Theme Park. This type of conflict was more difficult to score because separation between vehicles was not always easy to determine from the views provided by the video cameras.

Diversion of traffic was scored by counting the number of vehicles passing a landmark at each exit using a hand counter. The percentage of drivers taking the International Drive exit (30A) was then calculated for each data sample by dividing the number of vehicles taking this exit by the number of vehicles taking this exit plus the number of vehicles taking the Kirkman Road exit.

Crash Data. Crash data were obtained from the Florida Department of Transportation Data Base and entered into a spreadsheet to allow for statistical

Figure 5. The split screen used to score conflicts and the percentage of vehicles using the International Drive exit.

Figure 6. Examples of gore conflicts scored by the observers.

comparisons. These data included a crash number, a milepost designation, the annual daily traffic count for the period covering the crash, the time and date of the crash, vehicle(s) direction, harmful event, lighting, weather, contributing cause, number of injuries, and the lane where the crash occurred.

Experimental Design. An alternating treatments design was used to document the efficacy and safety impact of the changeable message guide signs. Baseline or steady state data were measured when all the guide signs specified exit 30A as the exit for Universal Theme park. These data allowed the researchers to calculate the baseline rate of gore conflicts, lane change conflicts and the percentage of vehicles using exit 30A before the signs were changed. Data were then calculated during the 10-second dark phase when none of the message signs were designated as the Universal Theme park exit. Next data were scored for the first minute after the exit signs were changed. A one minute interval was selected because after a minute had elapsed all vehicles present when the signs changed should have cleared the system beginning a new steady state condition with Kirkman Rd (exit 30B) as the new designated exit for Universal Theme Park Steady state data were then collected for 30B designated as the Universal Theme Park exit. Next data were scored during the new 10-second dark phase and during the first minute after 30A became the designated exit for Universal again. This procedure was repeated 175 times in order to obtain a large data base from which to evaluate sign transitions. All data were collected during busy times when traffic was heavy on exit 30A (typically morning hours or at times when special events were scheduled at Universal Theme park).

Inter-observer Agreement. Several observers independently scored the same video tapes and their spread sheets were compared in order to determine whether the definitions and training was adequate to allow them to objectively score gore conflicts, lane change conflicts, and driver counts. Inter-observer agreement was computed by dividing the number of times both observers agreed on the occurrence of each of the behavior by the number of times they agreed on the occurrence of each behavior plus the number of times they disagreed on the occurrence of each behavior. Inter-observer agreement on gore conflicts averaged 98% with a range of 91% to 100%. Inter-observer agreement on lane change conflicts averaged 63% with a range of 50% to 90 %. Inter-observer agreement on vehicle counts averaged 99.7% with a range of 98% to

100%.

Statistical Analysis. The un-pooled, two-sample t procedure was used throughout, which is highly robust, and virtually a distribution-free test with sample sizes on the order of 130.

Results

Observational Data. The percentage of drivers taking the International Drive exit before and after each block of 5 transitions is presented in Figure 7. These data show that a higher percentage of drivers use the International Drive exit when it was designated as the Universal Theme Park exit than when the Kirkman Road exit was designated as the Universal Theme Park exit. These data show that the sign is very effective at diverting traffic from one exit to the other.

On average 70.1% of motorists used the International Drive exit when it was specified at the Universal Theme Park exit while only 47.3 percent used this exit when the Kirkman Road Exit was specified at the Universal Theme Park exit. This difference is highly statistically significant, t=20.48, P=0.0000.

The rate of gore conflicts in conflicts per minute toward the exit designated as the Universal Theme Park exit during the steady state or baseline condition, during the dark phase, and during the first minute after the new exits appeared on the signs is presented in presented in Figure 8. Because there is no designated Universal exit during the dark phase these data included conflicts toward exit 30A and conflicts toward 30B. Thus these conflicts are divided by 2 in order to make a fair comparison with the other conflict sets.

These data show that steady state conflicts toward the exit designated as the Universal Theme Park exit averaged 0.118 and gore conflicts toward the exit which was not designated the Universal Theme Park exit averaged 0.081. Conflicts during the dark phase/2 averaged 0.070. Gore conflicts toward the exit designated as the Universal exit increased during the minute following the change to 0.358. This

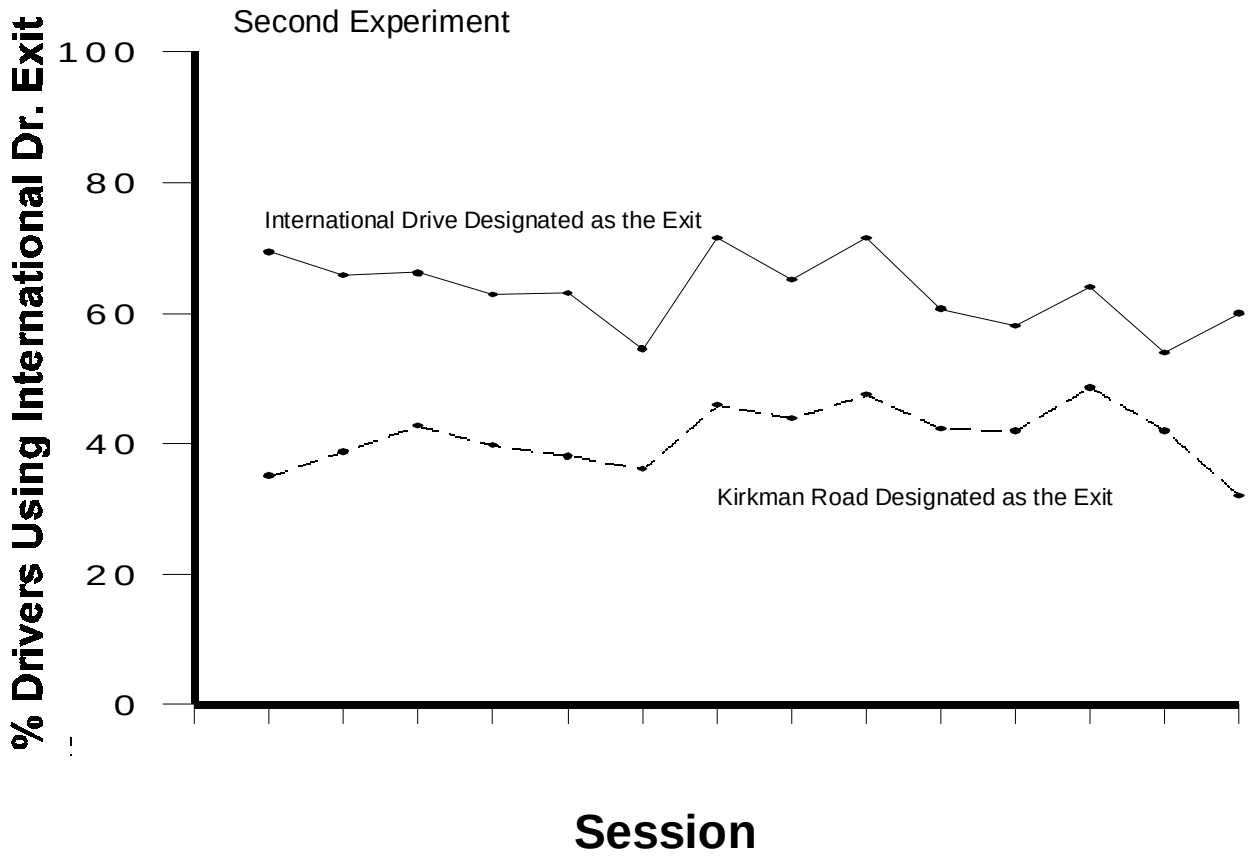


Figure 7. The percentage of drivers taking the International Drive exit before and after each block of 5 transitions

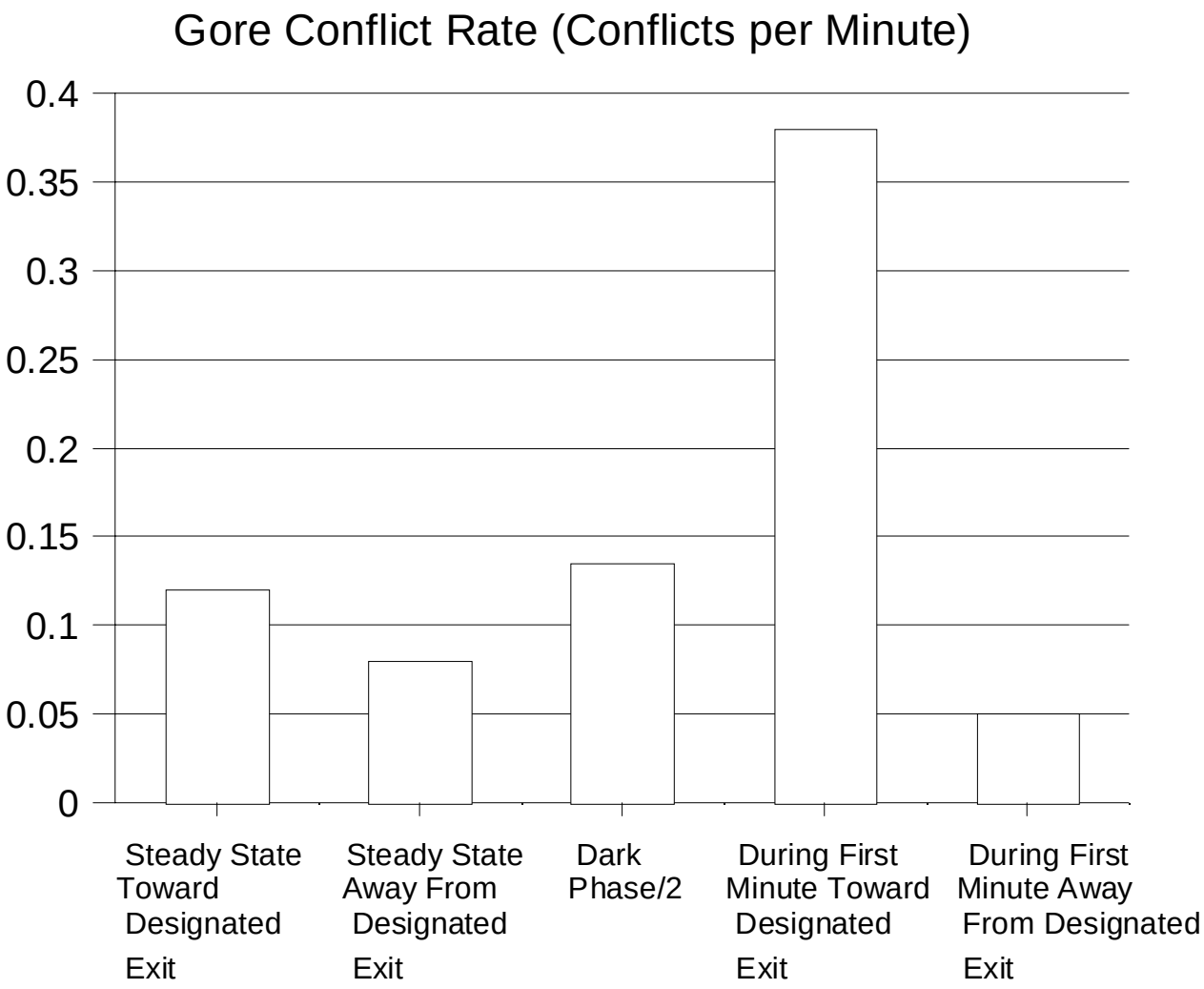


Figure 8. The rate of gore conflicts either toward or away from the designated exit during the steady state or baseline condition, the dark phase, and the first minute after the newly designated exit appeared on the signs

represents a three-fold increase in gore conflicts. The difference between gore conflicts toward the designated exit between the steady state and one first minute after the change is highly significant, t = -4.21.10, P = 0.0000. The difference between gore conflicts away from the designated Universal exit, and the difference in gore conflicts between the steady state and dark phase were not statistically significant.

The rate of lane change conflicts at the International Drive Exit is shown in Figure 9. Lane change conflicts toward the new designated Universal exit occurred at a higher rate during the minute following the assignment of the new exit. However, it should be noted that the percentage of inter-observer agreement for this type of conflict was quite low and observers commented that it was very difficult to judge gap size from the camera views available.

Crash Data. The number of crashes per month between January 1995 and December 1999 at the International Drive exit are presented in the top frame of Figure 10. The crash rate averaged 0.16 per month prior to the introduction of the changeable message guide signs. Following the introduction of the new signs the crash rate increased to 0.80 crashes per month. This represents a 5 fold increase in crash frequency. This increase in crash frequency is highly significant (t = -4.10, P = 0.0007) and validates the large increase in the frequency of gore conflicts associated with changing the exit designated as the Universal Theme Park exit on the changeable message signs. Crash data over the same period in the east bound direction for the Kirkman Road and Sandlake Road exits, which did not have a conflicting message on their exit guide signs, did not show a significant change in frequency. These data are presented in the middle and bottom frame of Figure 9 respectively. The mean number of crashes per month at Kirkman averaged .605 for the period before the changeable message signs were installed and .267 after the sign was installed. At Sandlake crashes averaged .535 before the signs were installed and .267 after the signs were installed.

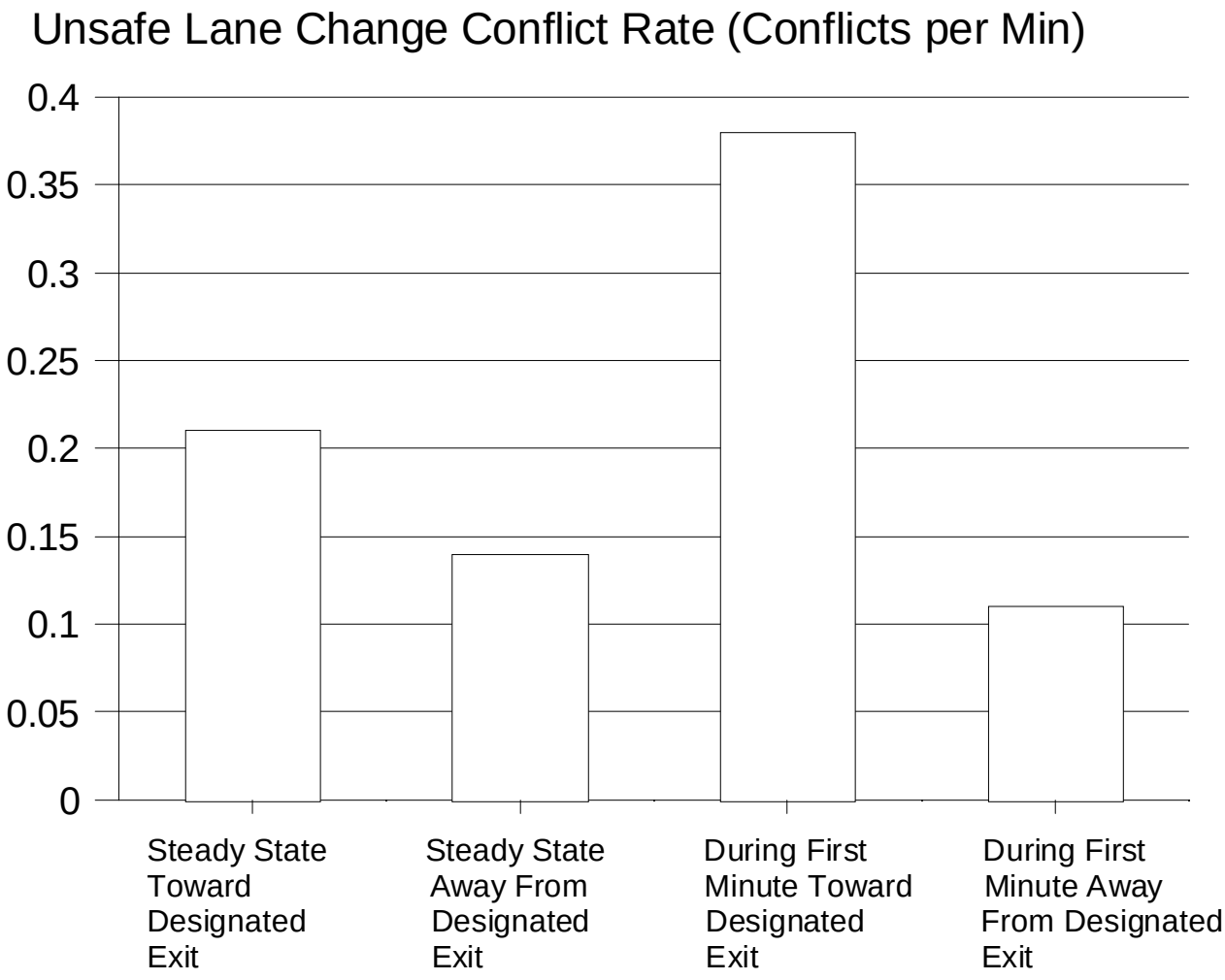


Figure 9. The rate of lane change conflicts directed toward or away from the designated International Drive Exit during the steady state or baseline condition, and during the first minute after the new exit appeared on the signs.

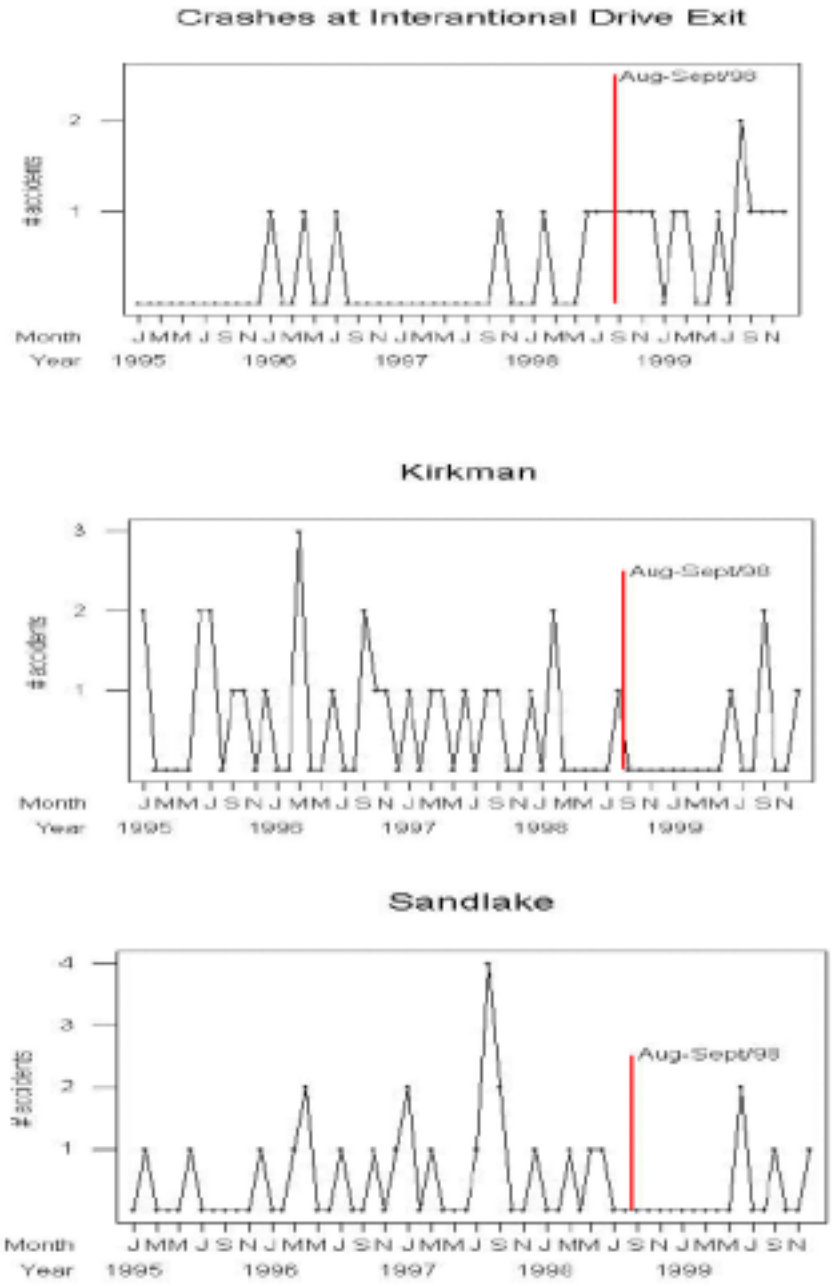


Figure 10. The number of crashes per month between January 1995 and December 1999 at the International Drive exit, the Kirkman Rd. exit and Sandlake Rd. exit.

Discussion.

The results of Experiment 1 show that the introduction of the changeable message signs was associated with a significant increase in crash frequency at the International Drive exit. This increase is consistent with a human factors analysis of the method used for changing the signs, which involved a 10 second dark phase prior to switching all three signs to designate a different exit for Universal Theme Park. This method ensured that some drivers received conflicting exit instructions at the 30A exit sign. Because exit 30A was a right exit and exit 30B was a left exit, it followed that impulsive drivers could respond to this message by making a sudden lane change which would involve crossing the exit gore at an oblique angle. The method used to change the exit designated for Universal Theme Park is likely responsible for the increase in crash frequency. One way to eliminate the possibility of drivers receiving conflicting messages is to change the guide signs in a staged manner and to increase the dark phase on the exit at International Drive to allow for all motorists who saw the sign showing the old exit on one or both of the previous two guide signs to have already passed the third guide sign located at this exit before the new exit sign was illuminated. The purpose of Experiment 2 was to evaluate such a system.

Experiment 2

Method

How the Changeable Message Signs Were Switched. In Experiment 2 the changeable message guide signs were changed using the phased sign change method illustrated in Figure 11 and 12. The first guide sign at the Sand Lake Exit was immediately switched from the old exit to the new exit and the second two guide signs were placed in the dark phase. After 20 seconds the new exit appeared on the second sign. After 1 minute had elapsed the sign at the International Driver exit indicated the new exit.

Figure 11. A diagram of the phased sign change protocol employed in Experiment 2 for switching the Universal exit from International Drive to Kirkman Road.

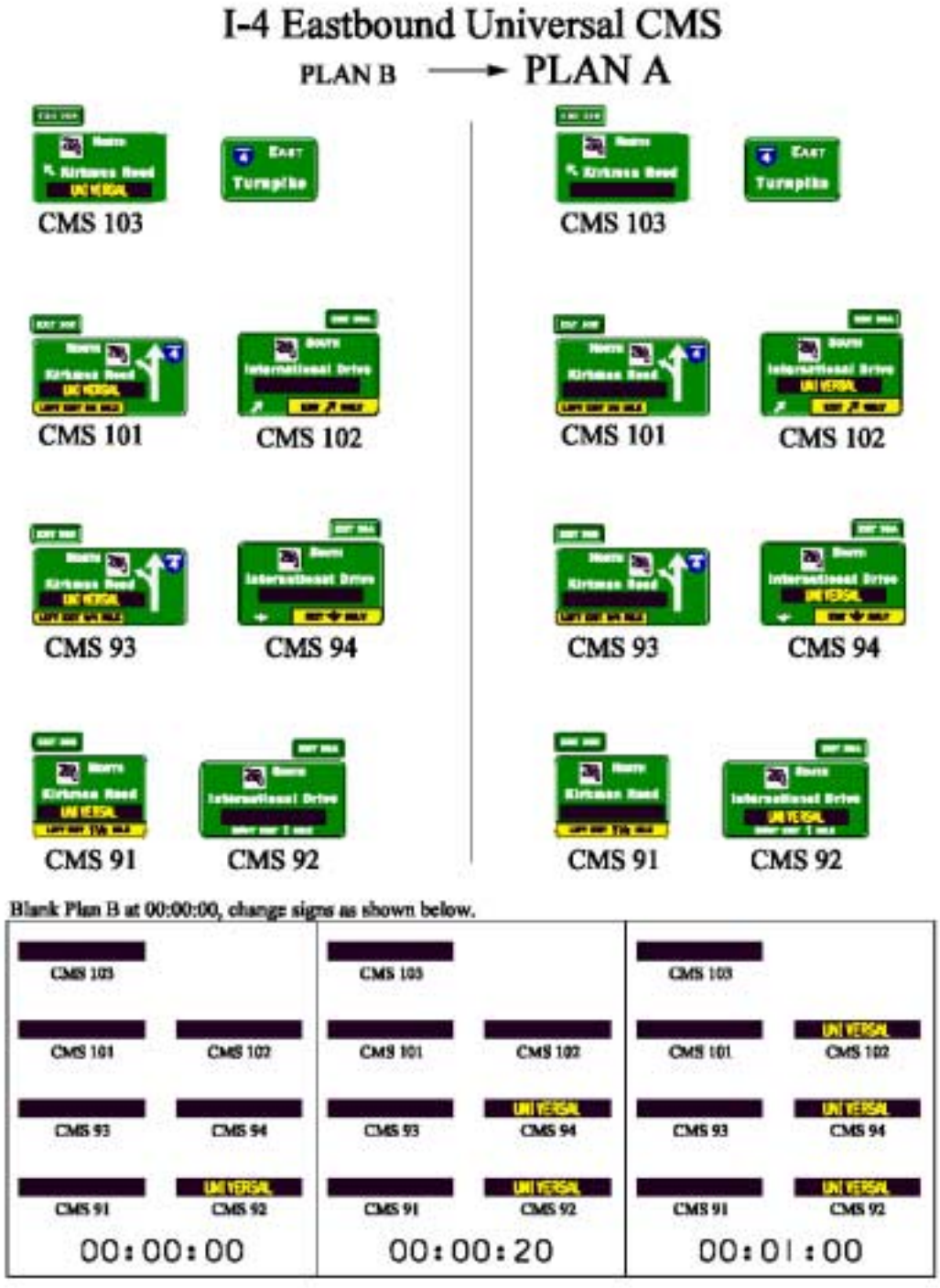


Figure 12. A diagram of the phased sign change protocol employed in Experiment 2 for switching the Universal exit from Kirkman Road to International Drive.

Participants and Setting. Participants and setting were the same as described for experiment 1.

Observational Measures. Observers scored video tapes for Gore Conflicts and Lane Change Conflicts, and redirection of traffic at the exit to International Drive exit in the same way as described in Experiment 1.

Crash Data. Crash data were obtained from the Florida Department of Transportation Data Base and entered into a spread sheet to allow for statistical analysis. These data included a crash number, a milepost designation, the annual daily traffic count for that period covering the crash, the time and date of the crash, vehicle(s) direction, harmful event, lighting, weather, contributing cause, number of injuries, and the lane where crash occurred.

Experimental Design. The experimental design used in this experiment was identical to the design used in the previous experiment.

Inter-observer Agreement. Several observers independently scored the same video tapes and their spread sheets were compared in order to determine whether the definitions and training was adequate to allow them to objective score gore conflicts, lane change conflicts, and driver counts. Inter-observer agreement was computed by dividing the number of times both observers agreed on the occurrence of each behavior by the number of times they agreed on the occurrence of each behavior plus the number of times they disagreed on the occurrence of each behavior. Inter-observer agreement on gore conflicts averaged 100%. Inter-observer agreement on lane change conflicts averaged 65% with a range of 48% to 83%. Inter-observer agreement on vehicle counts averaged 100%.

Statistical Analysis. The un-pooled, two-sample t procedure was used throughout, which is highly robust, and virtually a distribution-free test with sample sizes on the order of 130.

Results

Observational Data. The percentage of drivers taking the International Drive exit and the percentage of drivers taking the Kirkman Road exit before and after each block of 5 transitions is presented in Figure 13. These data replicate the results of Experiment 1, showing a higher percentage of drivers use the International Drive exit when it is designated as the Universal Theme Park exit than when the Kirkman Road exit is designated as the Universal Theme Park exit. These data show that the sign is effective at diverting traffic from one exit to the other.

On average 63.6% of motorists used the International Drive exit when it was specified at the Universal Theme Park exit while only 41.9 % used this exit when the Kirkman Road Exit was specified at the Universal Theme Park exit. This difference is highly statistically significant, t=14.1, P=0.0000.

The rate of gore conflicts in conflicts per minute which were toward and away from the exit designated on the International Drive exit sign is shown for the steady state or baseline condition, during the dark phase, and during the first minute after the new exits appeared on the signs is presented in presented in Figure 14. These data show that gore conflicts did not vary much between the steady state, dark phase, and during the first minute after new exit was designated on the changeable message sign at the International Drive exit.

Gore conflicts toward and away from the exit designated for Universal Theme Park were not significantly different between these three conditions. Gore conflicts toward the designated exit averaged .117 during the steady state condition and .150 toward the designated exit during the one minute period following the designation of the new exit on the International Drive sign (t=–0.80, P = 0.42). Gore conflicts toward the inactive exit averaged 0.083 during the steady state condition and 0.120 per minute following the designation of the new exit (t = -1.00, P = 0.32). The statistical analysis also indicated no difference in gore conflicts between the steady state and dark phase conditions.

Because a disproportionate percentage of the gore conflicts occurred during the

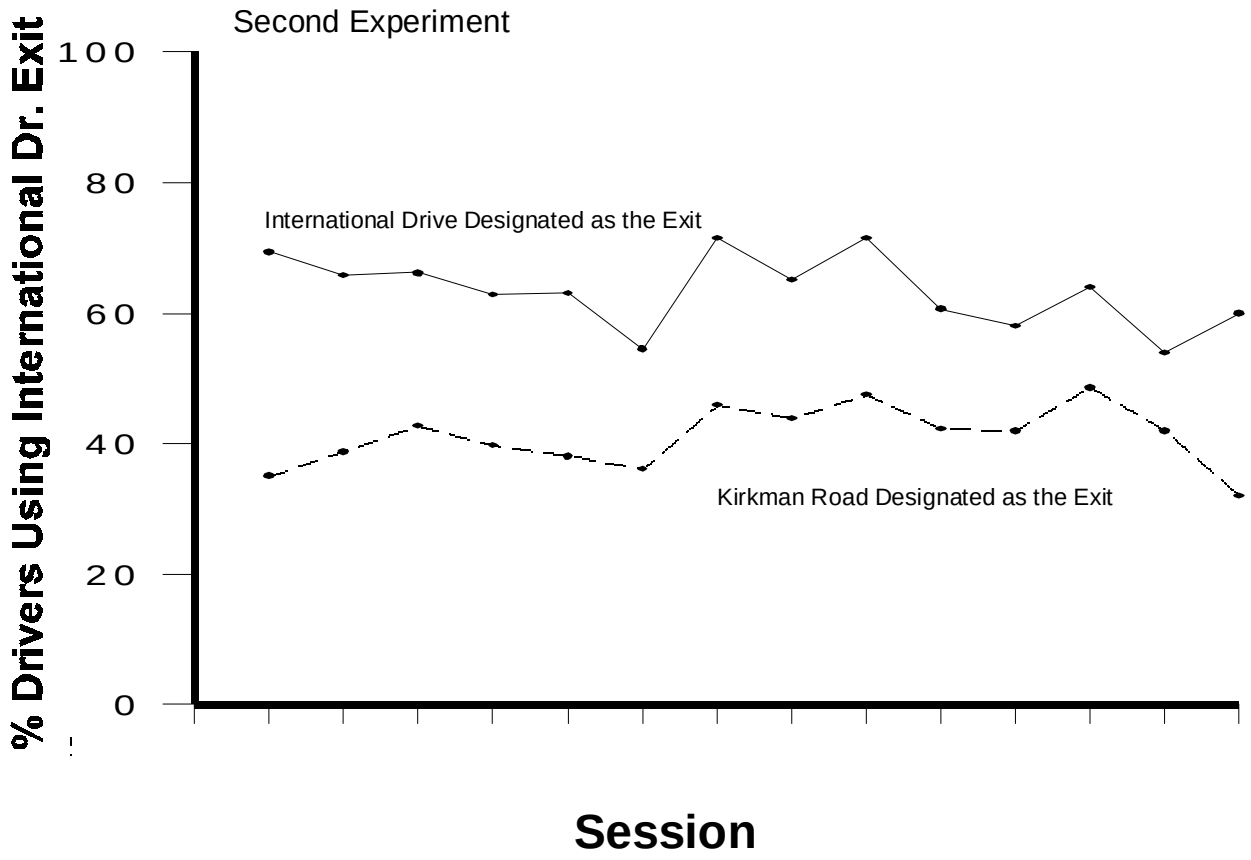


Figure 13. The percentage of drivers taking the International Drive exit before and after each block of 5 transitions using the staged sign change procedure.

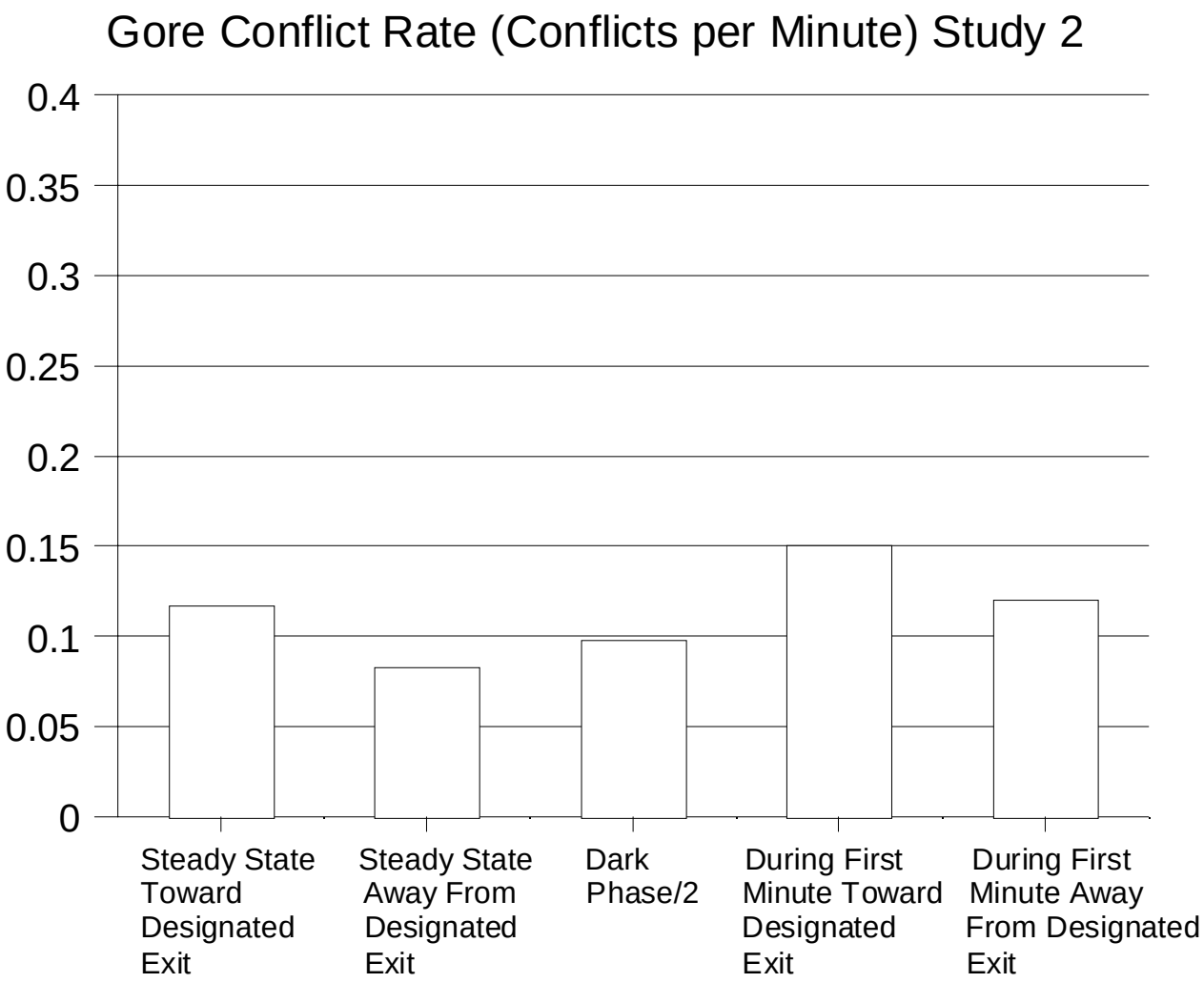


Figure 14. The rate of gore conflicts either toward or away from the designated exit during the steady state or baseline condition, the dark phase, and the first minute after the new exits appeared on the signs during the second study. Note the dark phase for the International Drive exit was longer during this condition

first 10 seconds of the minute after the new exit was designated the data were re-analyzed for the remainder 50 seconds of the minute. These data revealed even closer results between the steady state and after change conditions. The after gore conflict mean was reduced to 0.132 and toward the designated exit and .122 away from the designated exit. These results were also not significant with ($t = -0.36$, $P = 0.72$ toward the active exit and $t = -0.105$, $P = .29$ toward the inactive exit). The rate of lane change conflicts at the International Drive Exit was also not significantly different.

Discussion.

The results of Experiment 2 demonstrated that the introduction of the new procedure for switching the changeable message signs eliminated the increase in conflicts associated with changing the designated exit. Therefore, this procedure appears to be a safe way to change the signs in order to divert motorists in response to increased traffic at the International Drive exit. This procedure has been in place for too short a period to validate conflict data with crash data. However, it is unlikely the procedure would result in an increase in crashes if motorists do not engage in unsafe driving behaviors.

Experiment 3.

Method

Experiment 3 examined the impact of the two signs to inform motorists of current cultural destinations on the Princeton Street exit signs. This analysis examined crashes that occurred between the eastbound sign and the eastbound Princeton Street exit, and the west bound Princeton street sign and the westbound Princeton Street exit.

Participants and Setting. Motorists using I-4 between January 1995 and December of 1999 served as participants in this study. Crash data were obtained from

the Florida Department of Transportation crash data base. The Westbound Cultural Attraction sign was located 3167 feet in advance of the Princeton St. exit lane taper and 3723 feet in advance of the start of the Princeton Street exit gore. The Eastbound Cultural Attraction sign was located 901 feet in advance of the Eastbound Princeton St. exit lane taper and 1380 feet in advance of the start of the Eastbound exit gore. Only one message at a time was displayed on these signs. The message on the signs was changed at midnight on a daily basis following a 5-minute period when the sign was blank.

Experimental Design. A before/ after design was employed in this study. Crash data were compared before and after the Orlando cultural information guide signs were introduced.

Crash Analysis. Crash data were entered into a spreadsheet to allow for statistical analysis. These data included a crash number, a milepost designation, the annual daily traffic count for that period covering the crash, the time and date of the crash, vehicle(s) direction, harmful event, lighting, weather, contributing cause, number of injuries, and the lane where crash occurred.

Statistical Analysis. The un-pooled, two-sample t procedure was used throughout, which is highly robust, and virtually a distribution-free test with sample sizes on the order of 130.

Results

The number of crashes between the location where the motorist could first see the cultural information sign and the subsequent exit pooled for both directions is presented in the top frame of Figure 15. These data show that the introduction of the cultural signs was not associated with a significant change in crash frequency at these exits. The crash frequency per month was 1.96 before the cultural signs were introduced and 1.30 after the cultural signs were introduced ($t = 1.65$, $P = .11$).

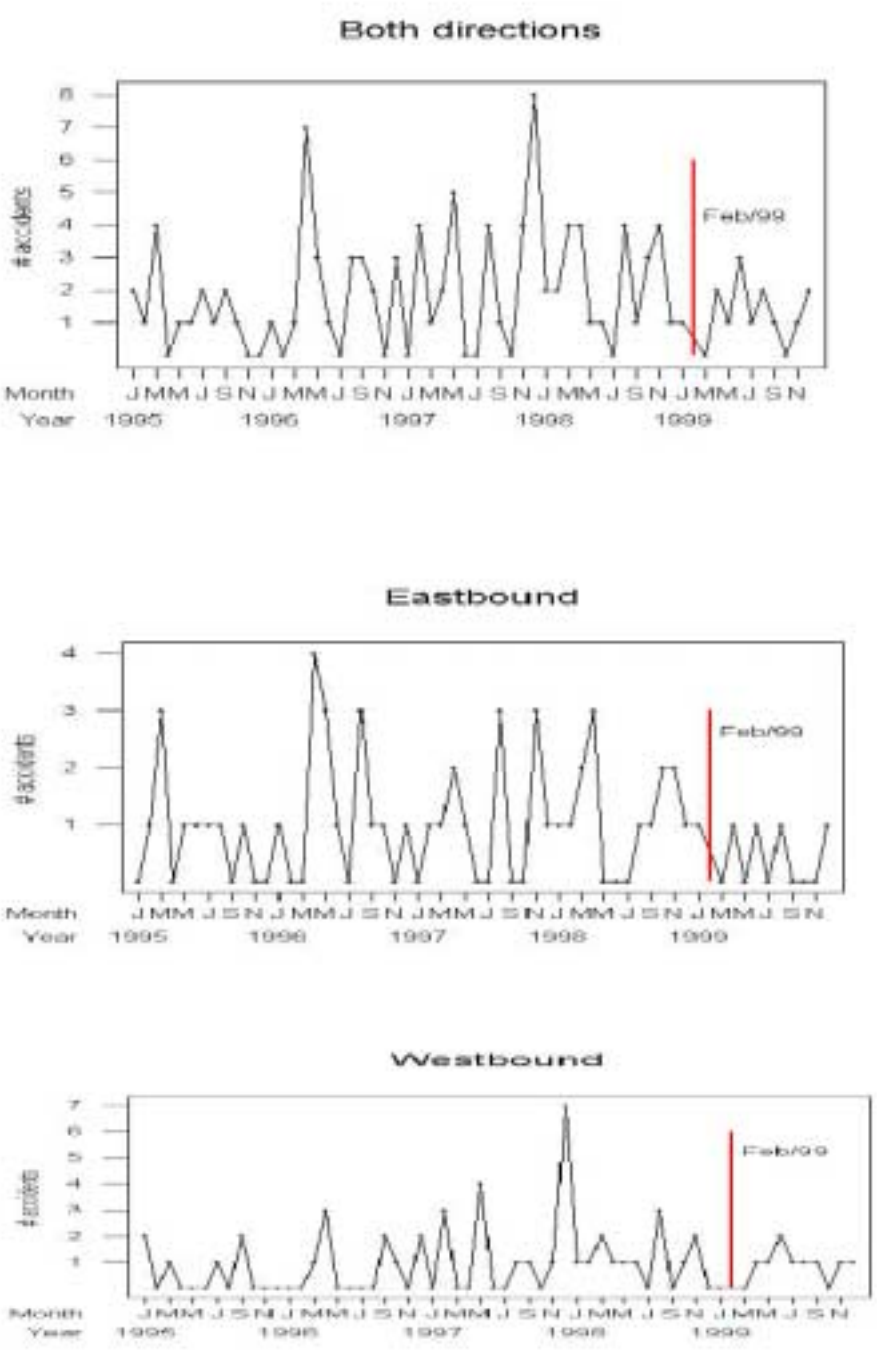


Figure 15. The number of crashes per month between January 1995 and December 1999 at the Princeton Street exit.

The data in the middle and bottom frame of Figure 14 show a graph of the number of crashes in two month blocks between the point where the motorist traveling in the east

bound direction or motorist traveling in the West bound could first see their respective sign and the location of the Princeton Street exit. There are no significant changes in crash frequency between these points. Eastbound crashes averaged 1.04 per month before the cultural signs were introduced and 0.40 after the cultural signs were introduced. This represents a significant decline in crash frequency ($t = 2.88$, $P = .008$). Westbound crashes averaged 0.92 crashes per month before the signs were introduced and 0.90 after the signs were introduced ($t = 0.07$, $P = .94$).

Discussion

These data show that changing the cultural sign did not lead to an increase in crashes. One reason why the introduction of these signs were not associated with crashes may have been that they were not located in close proximity to the respective exits specified on the sign.

General Discussion

The results of the first experiment indicated that the method used to switch the changeable message signs between exit 30A and 30B based on traffic flows led to an increase in gore and lane change conflicts that were associated with an increase in the frequency of crashes. The method used to change the signs involved presenting some drivers with a conflicting message on the exit to take to reach Universal Theme Park. Because the message conflicting with preceding messages and was presented on a sign located at the start of the exit gore; and 2 involved a conflict between a left and a right exit; there was an increase in gore intrusions, and sudden lane changes.

In the second experiment the method used to switch the signs was altered to prevent the delivery of conflicting messages when the theme park exit was switched. This change was not associated with an increase in conflicts at the exit. In both experiments changing the designated exit for Universal Theme Park was associated with a diversion of traffic to the newly designated exit. Based on the results of the second experiment, it is recommended that the signs be retained to manage traffic using the new method for switching exits.

The final experiment determined that the use of Changeable message guide signs

to indicate cultural attractions at the Princeton Street exit was not associated with an increase in crashes. Because these signs have been shown to be helpful to motorist, it is also recommended that these signs be retained.

Recommendations on the Use of CMS as Guide Signs

CMS as Guide Signs. The crash data at the Princeton Street exits show that CMS can safely be used as guide signs even when they are changed on a daily basis. Crashes did not increase in either the East bound or West bound direction. However, it should be noted that In this study only one event or attraction was featured on the sign. It is unclear whether similar data would be obtained if the signs flipped between two or more attractions or activities at the same exit. Further research is needed to address this question. Data from earlier studies using CMS as guide signs to attractions in the Orlando area also indicated these signs could be effective in guiding drivers to their destination.

CMS Used to Redistribute Tourist Traffic. These data show that CMS can be effective in redistributing tourist traffic from one exit to another. However, when CMS are used to redistribute traffic headed to a specific destination care has to be taken that conflicting messages are not presented to drivers.
The delivery of a conflicting message increases the probability of erratic driving behavior and can increase crashes.

Therefore, when changing the designated exit on CMS guide signs, *A phased sign change protocol shall be used in order to prevent the occurrence of different messages being presented to the driver by different signs. This can be achieved by immediately switching the first guide sign from the old exit to the new exit, switching subsequent signs to blank, and ensuring that subsequent guide signs remain blank until sufficient time has elapsed to allow traffic that passed the first sign when it displayed the original message to pass each subsequent sign*.

References

Manual of Uniform Traffic Control Devices. (2001). U.S. Department of Transportation. Washington, D.C.

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