Effect of Signs and Striping on Roundabout Safety: An Observational Before/After Study

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Abstract
This paper presents a case study of the impact that changes made to striping and signing at a two-lane roundabout located in Richfield, Minnesota had on driving behavior. After this roundabout was installed, it exhibited an abnormal amount of crashes. In response to the high number of crashes, local engineers experimented with changes in the roundabout’s signs and striping, as roundabout design regulations are relatively non-specific in contrast to those for standard signalized intersections. An observational study was conducted which reduced 156 hours of before and after video records of the roundabout into a database of all the violations committed by drivers during the recordings. Along with the observational data, crash report records were analyzed. The analysis demonstrated that improper turns and failing to properly yield accounted for the majority of collisions. The changes to signing and striping implemented in the approaches to the roundabout reinforced the message to drivers that they must select the correct lane while approaching the roundabout entrance. Although choosing the correct lane does not directly address yielding violations, it does reduce the occurrence of drivers conducting an improper turn, and to some extent reduces the need for a driver to change lanes within the roundabout. The implemented changes produced a reduction of 55% in normalized occurrences of improper turns, and a 59% reduction in normalized occurrences of drivers choosing the incorrect lane.
Introduction
Distinct from other forms of circular roadways, modern roundabouts require entering traffic to deflect into circular motion parallel to through traffic, and yield the right-of-way to traffic within the circulatory roadway. By deflecting entering traffic, roundabouts force vehicles to reduce their speed. Coupled with the presence of fewer conflict points, this makes the modern roundabout notably safer than a traditional signalized intersection (Retting et al, 2001). With benefits such as improved safety, minimized delays, and reduced vehicle emissions, roundabouts have become an increasingly popular design solution for intersections throughout the United States since the 1990s (Baranowski, 2009). Despite this increase in popularity and implementation, drivers throughout the country continue to misunderstand the rules of the roundabout, resulting in improper use and avoidable collisions.

In an attempt to minimize collisions associated with confused drivers, numerous engineering design solutions have been suggested and implemented. Before engineering practices and regulations are changed to accommodate the most successful design features, sufficient research must be conducted in order to determine which alternatives are effective, and which are not. Crash statistics are generally used as the basis of such research, but require several years of data preceding and following the changes made. In addition, it is difficult to control for all confounding factors when data are collected over very long periods, which makes the study of incremental improvements complicated. As an alternative to waiting for sufficient crash statistics, observational studies can be used to collect evidence of the changes in driving behavior and use crash surrogates to evaluate the impact of changes. This observational study attempts to evaluate the effect that a new sign and striping layout has on a roundabout that exhibits high crash rates. The evaluation is based on observations of all vehicles using the roundabout for sample periods before and after the changes in signs and striping.

This case study focuses on changes made to striping and signing at a two-lane roundabout located on East 66th Street & Portland Avenue South in Richfield, Minnesota. Prior to its reconstruction in 2008, it was a signalized intersection that was crash-prone and congested. Because of this, conversion into a roundabout was a practical solution (Richfield 2012). However, after its completion, this roundabout exhibited an abnormal amount of crashes. In response to this fact, local engineers from the City of Richfield and the Minnesota Department of Transportation (MnDOT) experimented with changes in the roundabout’s signs and striping.

The paper herein summarizes the before-after study that was initiated to analyze the effectiveness of physical changes implemented at the roundabout.
Design Regulations
As the roundabout is still a fairly new intersection design concept, relatively few standards exist pertaining to the signs and pavement markings. These standards, set forth by the Federal Highway Administration (FHWA) via the Manual on Uniform Traffic Control Devices (MUTCD) (FHWA, 2003 and FHWA, 2009), have exhibited significant changes in the past several years. In addition to these changes, there are oftentimes notable differences between the federal version of the MUTCD and state versions, such as MnDOT’s Minnesota MUTCD Manual (MN MUTCD) (MnDOT, 2011). Minnesota is one of eight states to use a state version of the MUTCD instead of the federal. However, in regards to roundabouts, any differences between the Federal MUTCD and the MN MUTCD are negligible.

During the design of the roundabout in Richfield, the 2003 MUTCD was in effect. No revisions were made to roundabout regulations until the 2009 MUTCD, in which roundabout pavement markings received their own chapter. The current version of the MUTCD is the 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012. The 2003 version contains limited amount of resources for roundabouts. Section 3B.24 (2003): Markings for Roundabout Intersections contains a single example each of road markings for one- and two-lane roundabouts, along with several options and guidelines. Options include the use of a yellow edge line around the inner edge, use of lane lines, and yield lines. Guidelines suggest that crosswalks be located 25 ft upstream from the yield line, line extensions not be used across exits, and the outer portion of the roundabout should contain a line that extends from the splitter island, where it remains solid, to across entrances, where it should be dotted. For illustration, please refer to Figure 1.a. Sections 2B.09 (2003) and 2B.10 (2003) discuss the only content related to regulatory signs in roundabouts, citing a standard that yield signs must be present at both the right and left sides of approaches in two-lane roundabouts. The aforementioned three sections are the only ones that pertain to roundabouts specifically.

The current version of the MUTCD manual contains significantly more content regarding roundabouts than its predecessor. Roundabout sign requirements appended in this edition include movement prohibition signs (Section 2B.18 (2009)), intersection lane control signs (Section 2B.19 (2012)), one way signs (Section 2B.20 (2009)), roundabout directional arrow signs (Section 2B.43 (2009)), circulation plaques (Section 2B.44 (2009)), and destination signs (Section 2D.38 (2009)). Refer to Figure 1 for a general presentation of the differences in sign requirements between 2003 (a) and 2009 (b).

In addition to the sign requirement content, the 2009 version of the MUTCD manual includes additional recommendations pertaining to lane-use arrows on approaches and markings within the circular roadway (Chapter 3C). Lane-use arrows deemed acceptable for approaches are demonstrated in Figure 2. They include normal arrows that would be located at a standard signalized intersection, as well as fish-hook arrows, which exhibit additional curvature that represents the radial direction of the circular roadway. Fish-hook arrows may be used with signs on the approach as well. An additional dot representing the central island for left turns and U-turns is an optional feature. Within the circular roadway, standard arrows must be used. Other markings within the circular roadway have also been addressed more specifically. It is now required that multi-lane approaches to roundabouts have lane lines (3C.02-1 (2009)), within the circulatory roadway continuous concentric lane lines may not be used (3C.02-4 (2009)), and exits cannot contain edge lines from the circulatory roadway (3C.03-3 (2009)), among other added recommendations and options for roundabout design.
Figure 1: MUTCD Example Signs & Markings for a Two Lane Roundabout
Roundabout and Violations
The roundabout studied is a two-lane roundabout in which for all approaches the inner lane may proceed straight or turn left, and the outer lane may proceed straight or turn right. The roundabout has an average daily volume of approximately 30,000 vehicles. Despite its straightforward configuration, 104 crashes relevant to our study have been recorded with the Richfield Police Department between September, 2008 and April, 2009. Additional crashes have been reported at the roundabout, including those caused by drunk driving, distracted driving, and environmental conditions, but are left out for the purposes of this study. This study is focusing on crashes that are the result of violations of the roundabout driving rules. Therefore, all relevant crashes can be categorized into one of the following three types: Yield Violations, Lane Change Violations, and Turn Violations. For consistency, these categorizations are used in the data reducing process as well, including sub classifications. In addition, Wrong Way and Stopping events are also noted and recorded during data reduction. Whether or not the offending driver exhibited an Incorrect Lane Choice is also recorded for each crash and each violation. Please refer to categorization definitions below.

Yielding Violation
A yielding violation denotes an instance in which, upon entering, a vehicle fails to yield to one or more vehicles already in the roundabout. It is required by law that the entering vehicle give the right of way to vehicles already within the circulatory roadway. For the purposes of this project, we differentiate between inner and outer lane events. The classifications of yielding violations specify whether the offending vehicle failed to yield to traffic in the inner lane (Figure 3.a), outer lane (Figure 3.b), or both lanes (Figure 3.c) of the roundabout, as demonstrated respectively below. The entry lane of the subject vehicle is separately recorded.
**Lane Change Violations**
For the purposes of this study a lane change within the circulatory roadway is considered to be a violation of roundabout driving rules. The regulations are not explicitly defined in the MUTCD, but are otherwise generally discouraged. There are several different cases in which vehicles commonly execute a lane change violation. Some of the observed cases are common as compared to others, and account for less than 10% of crashes. Each instance of a lane change is recorded with the classification of either being an entrance lane change (Figure 3.d), which denotes a lane change occurring in the first quadrant of a vehicle's path through the roundabout, or an exit lane change (Figure 3.e), which indicates that the lane change occurs at any point afterwards. There are also two special classifications: one in which a vehicle is simultaneously occupying or straddling both lanes (Figure 3.f), and the other in which a vehicle going straight through the roundabout cuts across both lanes to minimize the curvature of the turn (Figure 3.g). The latter is an issue in this particular roundabout. More recent roundabouts have increased the angle of the approaches, virtually eliminating such a behavior as well as minimizing wrong way cases.

**Turn Violations**
Turning violations are one of the causes of the most severe crashes and are the subject of greater scrutiny in this project. Turning violations indicate that the turning maneuver a vehicle makes is not allowed in the lane in which the vehicle proceeds through the roundabout. For the two-lane roundabout investigated in this study, the turning violation classifications include turning right from the inner lane of the roundabout (Figure 3.h), turning left from the outer lane (Figure 3.i), and turning more than 270 degrees from the outer lane (Figure 3.j).

**Wrong Way Violations**
Instances of vehicles driving the wrong way in the roundabout were recorded. Wrong way violations pertain to clockwise vehicular procession through the roundabout, with classifications comprising entering the roundabout against the direction of traffic (Figure 3.k), and utilizing the entrance lanes to exit the roundabout (Figure 3.l).

**Stop Violations**
A stopping violation denotes an instance in which, after entering the roundabout, a vehicle comes to a stop or otherwise impedes traffic without proper justification. Proper justification may include yielding to pedestrians, avoiding collisions with other vehicles, pulling over for emergency vehicles, etc. Two classifications of stopping violations were created based on trends from previous observation: stopping to yield to vehicles entering the roundabout unnecessarily (Figure 3.m), and stopping for other general and unjustified purposes (Figure 3.n).

**Incorrect Entrance Lane Choice**
In addition to the aforementioned violations, the correctness of the entrance lane depending on the destination is recorded. In most cases the selection of the wrong entrance lane also involves a lane change and/or turn violation later on in the path of the vehicle. The entrance lane selection is independently noted to assist in the more refined data mining and comparison of the “after” conditions. Figures 3.h, 3.i, and 3.d are common examples of incorrect lane choices.
Figure 3: Categories of Violations
Before the marking changes were made to the roundabout, a total of 90 relevant crashes were reported over the course of 35 months. Of these crashes, 39 were caused by yielding violations, 7 by lane changes, 44 by turning violations, and none from wrong way or stopping events. Associations with the aforementioned definitions were accomplished through scrutiny of the actual crash reports provided to the research team by the City of Richfield. Specific numbers are as follows:

- **Yielding violations:** 39
  - Failing to yield to the inner lane (Figure 3.a): 25
  - Failing to yield to the outer lane (Figure 3.b): 14
  - Failing to yield to both lanes (Figure 3.c): 0

- **Lane changes:** 7
  - Lane change at entrance (Figure 3.d): 3
  - Lane change at exit (Figure 3.e): 2
  - Straddling both lanes (Figure 3.f): 1
  - Cutting straight across (Figure 3.g): 1

- **Turn violations:** 44
  - Right turn from the inner lane (Figure 3.h): 6
  - Left turn from the outer lane (Figure 3.i): 38

After the changes were implemented, with 9 months of records, a total of 14 relevant crashes occurred. Of these crashes, 12 resulted from yielding violations and 2 from turning violations. Specific categorizations are as follows:

- **Yielding violations:** 12
  - Failing to yield to the inner lane (Figure 3.a): 6
  - Failing to yield to the outer lane (Figure 3.b): 6

- **Turn violations:** 2
  - Left turn from the outer lane (Figure 3.i): 2

Recognizing the high count of avoidable crashes, the city of Richfield took steps to improve the roundabout’s safety. During early August 2011, various changes were made to the signing and striping of the roundabout. Turn arrows on the approaches to the roundabout, in the roundabout, and on lane designation signs were all replaced. They were changed from the “fish-hook” style of marking to the standard style, including a dot to represent the roundabout island. Additional turn arrows and lane designation signs have been placed at approximately 450 feet upstream of the yield line on all legs of the roundabout. The solid lane line was extended from the original 50 feet from the yield line to a current 250 feet. This particular element is in contrast to the examples provided in the MUTCD. In addition, pavement marking changes were made within the roundabout. Specifically, striping width increased from 4 inches to 6 inches, stripes through the middle of the roundabout are now 3 feet long with a 1 foot gap, while within the circulatory roadway, 4 inch by 4 inch “cat track” striping was included to guide turning curvature while entering the roundabout, and concentric-spiral striping replaced all previously solid striping. Changes in signage include improving line-of-sight visibility for one-way signs, median signs, and large street signs by lowering them by 3 feet, 2 feet, and 3 feet, respectively. All signs were mounted on street poles and “Roundabout Ahead” warning signs were moved to 500 feet from the roundabout. To address the high occurrence of drivers committing yielding violations, the size of yield signs increased from 30 inches to 36 inches. For a visual reference, please see Figure 4 for aerial views before (a) and after (b) the changes.

In addition to the engineering changes to the roundabout, the city of Richfield took steps to increase the public’s understanding of proper roundabout driving procedures. Motorists were educated through
Figure 4: Aerial Photos of Roundabout Before and After Implemented Changes
various media in order to provide the knowledge required to properly traverse the roundabout. The local media, including local cable television programming, newspapers, informational online resources, pamphlets, and city council meetings, was used as means to spread roundabout awareness. The information these resources provided include general guidelines on how to traverse the roundabout for drivers, bikers, and pedestrians. Driver specific guidelines include the following: yield to all traffic already in the roundabout, choose the proper lane before entering as lane changes within are prohibited, and obey one-way signs at all times. Also provided were visual representations of the correct lane choices for all possible maneuvers (i.e. straight through, left turn, right turn, U-turn) a commuter may make inside the roundabout.

In addition to the increased education efforts, there was an increase in traffic enforcement at the intersection by the Richfield Police Department. Officers aggressively enforced traffic violations in the roundabout between August 11th and September 12th, 2011, including 24.25 hours spent watching for violations. This increased enforcement resulted in 66 vehicle stops, 53 traffic related citations, and 15 traffic related warnings. Among the citations and warnings pertinent to our study, there were 37 yielding violations, 23 turn violations, 2 stopping violations, 2 lane changes, and 2 wrong way violations. In addition to issuing citations and/or warnings, officers verbally explained proper roundabout procedures and provided stopped motorists with informative roundabout pamphlets.

Research Methodology
To collect observation data, video was first recorded by deploying a trailer to the roundabout, which was equipped with an extendable mast containing cameras pointed at the intersection (Figure 5). While recording the “before” video, four cameras comprised the view of the entire intersection, with each camera pointed at the splitter island of an approach (Figure 6). The “before” video was originally recorded for a different study, focusing on the yielding behavior of drivers at roundabout pedestrian crossings (Hourdos et al, 2012). The format of the “after” video instead was changed to better facilitate the needs of this study, and differs from the “before” video by transitioning from four separate cameras to a single panoramic lens camera (Figure 7). In addition to the main panoramic lens camera, two regular surveillance cameras recorded video from the north and west approaches to the roundabout. This video was used to extract volume information for the observation periods.

The collected video records cover two periods of six days each before and after the changes. Specifically the “before” observations were made on six days in August 2010 (8th, 11th, 24th, 25th, 26th, and 27th) while the “after” observations were made in October (8th, 28th, 31st) and November (1st, 2nd, 3rd) of 2011. Once the video was obtained, a preliminary analysis was performed to create the violation categorizations outlined in the previous section of this paper. The next step was to train observers to properly watch the video and record all observed violations. Detailed training materials were developed along with a regime to test the trainees in order to validate their ability to extract all the necessary data correctly. The goal was to maximize the uniformity of the observations specifically on the more subjective violations like failure-to-yield. In addition to the training material, utilities and enhancements to open-source software were developed to accelerate the video reduction process.

Each hour of video was analyzed once for each approach of entering traffic, resulting in four viewings per hour of video. This allowed for every vehicle to be watched from the time it entered until the time it exit to detect the occurrence of a driving violation. If a violation occurred, it was then classified and recorded in a database. The collected information pertained to the time, vehicle entrance lane, vehicle type, and violation categorization.
In order to normalize the data with traffic volumes, a video analysis with a machine vision sensor provided 15 minute volumes. Care was given to minimize double counting vehicles during their trip through the roundabout. The device was used to collect traffic volume data for all observed roundabout video for both the before and after video. With the volume data available, normalized comparisons could be made.

Figure 5: Instrumented extendable mast trailer in the roundabout

Figure 6: Screenshots of “before” roundabout video
Results
The video from which the data was reduced takes place from 07:00-21:00 and 07:00-19:00 for the six analyzed days of 2010 and 2011, respectively, resulting in a total of 156 hours of video having been reduced. Variable environmental conditions among these days have negligible differences, although construction many blocks away from north approach accounts for the difference in traffic volumes between 2010 and 2011. Table 1 presents two sets of data: observed violation counts and the corresponding traffic volume during the observation periods. The normalized violation occurrence rate is the observed count divided by the traffic volume. The normalized rate of occurrence is the percent difference between the violation occurrence rates for 2010 and 2011. In addition, the significance of the difference between the before and after rates for each type of violation was determined, with the corresponding z-statistic and two-tailed p-value included in Table 1. With the exception of failing to yield to traffic in both lanes each type of violation exhibits a significant difference with 95% confidence.

All types of observed violations exhibited decreases in their normalized frequencies. Notably, yielding and turning violations were reduced. The relationship between the 2010 and 2011 normalized rates of yielding violations is not necessarily a straightforward statistic considering that isolating the individual effects of the engineering, education, and enforcement measures is impractical given the data available. Due to the increased traffic counts in 2011, a vehicle that would have failed to yield regardless of the situation is more likely to encounter a vehicle and commit a yielding violation than in 2010. The reverse can also be argued. Nonetheless, 1.03% of vehicles entering the roundabout in 2010 committed a yielding violation, whereas in 2011 only 0.78% did, resulting in a 25% reduction, with a more notable drop in failing to yield to the outer lane than the inner lane. Turning violations were committed by 1.22% of
vehicles in 2010 and 0.55% in 2011, boasting an occurrence reduction of 55%. The most common turning
violation, making a left turn from the outer lane, was the primary contribution to the overall reduction and
exhibits the most significant reduction in both count and rate of occurrence of all the violation types. This
observation is statistically linked with the decrease of the “Incorrect Lane Choice” for the intended
destination, which decreased by 59%.

Conclusions
This paper describes the results from a straightforward, almost naïve, before and after study of the effect
of changes in signs and striping on a two–lane roundabout in Richfield, Minnesota. The subject
roundabout was designed with the best standards and guidelines available in 2005. For the 35 months
following its construction, the roundabout exhibited an abnormally high crash rate for its type and
demand. After observing driving behavior in this and other roundabouts, in addition to new guidelines
proposed in the 2009 MUTCD, city and state engineers produced a set of proposed changes attempting to
improve the roundabout’s safety.

This study is an attempt to produce a low cost and expedient evaluation of the effect of the planned
changes. Instead of performing a traditional before/after study based on crash records, the research team
capitalized on prior, unrelated, research conducted by the Minnesota Traffic Observatory which pertained
to roundabouts: an observational study on the effect of the changes in driving violations performed within
the roundabout. The earlier research had produced several hundred hours of video records of all the
activity around the roundabout. Repeating the same data collection exercise after the changes were
implemented allowed the research team to identify and count all violations performed by vehicles using
the roundabout before and after the changes. Although the value of the exercise would have been greatly
increased if data collection was also performed on a control site, the project budget and timeline made
that impossible. Regardless, the produced results display such large differences in the rates of certain
violations before and after the changes that the positive effect of the changes can be safely illustrated.

Prior to the design of the changes to signs and striping, it became evident that one major factor
contributing to the high crash rate was the difficulty drivers exhibited when selecting the correct entrance
lane for their intended destination. This inability resulted in confusion while entering, producing lane
changes within the circulatory roadway and a significantly large number of left turns from the outer lane.
As noted in the paper, crashes resulting from left turns from the outer lane accounted for 42% of the
recorded crashes. The changes implemented in the approaches to the roundabout, such as the extension of
the solid line from the original 50 feet from the yield line to 250 feet, reinforced the message to the
drivers that they must select the correct lane before approaching the roundabout entrance. Although other
changes focused on yielding violations and correct lane keeping inside the roundabout, the violation type
exhibiting the most notable reduction was the improper left turn from the outer lane. It is important to
note that although numerous details have been added and clarified on the MUTCD guidelines for
roundabout markings, there is no specific guideline on the length of the solid line between lanes at the
entrances while most of the figures show the line turn to dashed shortly upstream of the pedestrian
crossing. Although further research is needed, we believe this is an area where improvements in the
guidelines are possible. The research team is actively continuing observations at the subject roundabout
looking for the stability of the reported changes over time.
Table 1: Summary and comparison of observational data for 2010 and 2011

<table>
<thead>
<tr>
<th></th>
<th>Count Before - 2010 (84 hours)</th>
<th>Count After - 2011 (72 hours)</th>
<th>Normalized % change</th>
<th>P-value</th>
<th>Z-statistic</th>
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<tbody>
<tr>
<td><strong>Total Traffic Volume</strong></td>
<td>107,510</td>
<td>137,379</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Violations</strong></td>
<td>5909 5.50%</td>
<td>4916 3.58%</td>
<td>-34.89%</td>
<td>&lt; 0.01</td>
<td>22.9</td>
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<tr>
<td><strong>Yielding</strong></td>
<td>1111 1.03%</td>
<td>1065 0.78%</td>
<td>-24.98%</td>
<td>&lt; 0.01</td>
<td>6.76</td>
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<tr>
<td><strong>Inner</strong></td>
<td>716 0.67%</td>
<td>771 0.56%</td>
<td>-15.73%</td>
<td>&lt; 0.01</td>
<td>3.31</td>
</tr>
<tr>
<td><strong>Outer</strong></td>
<td>337 0.31%</td>
<td>218 0.16%</td>
<td>-49.38%</td>
<td>&lt; 0.01</td>
<td>7.99</td>
</tr>
<tr>
<td><strong>Both</strong></td>
<td>58 0.05%</td>
<td>76 0.06%</td>
<td>2.54%</td>
<td>0.89</td>
<td>-0.144</td>
</tr>
<tr>
<td><strong>Lane Change</strong></td>
<td>3476 3.23%</td>
<td>3094 2.25%</td>
<td>-30.34%</td>
<td>&lt; 0.01</td>
<td>14.9</td>
</tr>
<tr>
<td><strong>Entrance</strong></td>
<td>1510 1.40%</td>
<td>1407 1.02%</td>
<td>-27.08%</td>
<td>&lt; 0.01</td>
<td>8.61</td>
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<tr>
<td><strong>Exit</strong></td>
<td>1966 1.83%</td>
<td>1687 1.23%</td>
<td>-32.85%</td>
<td>&lt; 0.01</td>
<td>12.2</td>
</tr>
<tr>
<td><strong>Turn Violation</strong></td>
<td>1307 1.22%</td>
<td>749 0.55%</td>
<td>-55.15%</td>
<td>&lt; 0.01</td>
<td>18.0</td>
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<tr>
<td>Right from inner</td>
<td>86 0.08%</td>
<td>77 0.06%</td>
<td>-29.93%</td>
<td>0.023</td>
<td>2.28</td>
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<tr>
<td>Left from outer</td>
<td>1181 1.10%</td>
<td>664 0.48%</td>
<td>-56.00%</td>
<td>&lt; 0.01</td>
<td>17.5</td>
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<tr>
<td>More than 270° from outer</td>
<td>40 0.04%</td>
<td>8 0.01%</td>
<td>-84.35%</td>
<td>&lt; 0.01</td>
<td>5.51</td>
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<tr>
<td><strong>Wrong Way</strong></td>
<td>15 0.01%</td>
<td>8 0.01%</td>
<td>-58.26%</td>
<td>0.039</td>
<td>2.06</td>
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<tr>
<td>Enter</td>
<td>12 0.01%</td>
<td>8 0.01%</td>
<td>-47.83%</td>
<td>0.15</td>
<td>1.45</td>
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<tr>
<td>Exit</td>
<td>3 0.00%</td>
<td>0 0.00%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Incorrect Lane Choice</strong></td>
<td>2208 2.05%</td>
<td>1151 0.84%</td>
<td>-59.21%</td>
<td>&lt; 0.01</td>
<td>25.7</td>
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References


