Roundabout Access for Visually Impaired Pedestrians:
Evaluation of a Yielding Vehicle Alerting System for Double-Lane Roundabouts

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Problem for Pedestrians with Visual Impairment at Double-Lane Roundabouts

- Drivers Don’t Yield
- Conditions for Detecting Gaps by Sound are not Good
- Crossable Gaps May be Infrequent
Approach: Two Studies

• Closed Course Evaluation of Pavement Treatment
  – Will pedestrians with severe visual impairment benefit from pavement treatment to alert them to the presence of stopped vehicles?

• Observations at operating Double-Lane Roundabout
  – Will pedestrians with severe visual impairment benefit from pavement treatment to alert them to the presence of stopped vehicles?
  – Can signage increase driver yields to pedestrians?
The Alerting System

- 1.5 inch PVC Pipe secured to roadway with asphalt tape
- Three strips
  - Parallel to upstream edge of crosswalk
  - 20 ft upstream of crosswalk
  - 24 ft upstream of crosswalk
- Each strip generates a distinct clack when a wheel passes over it
Nomenclature

• Both Lanes Blocked:
  – Two Vehicle Have Stopped, One Blocking Each of Two Exit Lanes

• Near Lane:
  – Right Lane

• Far Lane:
  – Left Lane
Closed Course Evaluation

- Seven Participants with Severe Visual Impairment
- Two conditions: Treatment (with) and Control (without)
- 18 Trials in Each Condition
  - Near Lane Yields First – 8 trials
  - Far Lane Yields First – 6 trials
  - Both lanes yield together – 4 trials
## Results – Detection of Both Lanes Blocked

<table>
<thead>
<tr>
<th>Participant</th>
<th>Hits Control</th>
<th>Hits Treatment</th>
<th>False Alarms Control</th>
<th>False Alarms Treatment</th>
<th>Misses Control</th>
<th>Misses Treatment</th>
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<tbody>
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<td>1</td>
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<td>87%</td>
<td>7%</td>
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<td>88%</td>
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</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>36%</strong></td>
<td><strong>57%</strong></td>
<td><strong>10%</strong></td>
<td><strong>13%</strong></td>
<td><strong>54%</strong></td>
<td><strong>31%</strong></td>
</tr>
</tbody>
</table>
Results – Correct Identifications by Lane

Lane Yield First: Far Treatment Near Far Control Near Lane

Proportion Correct Identifications

- Far Lane
- Near Lane
Closed Course Conclusion

- Most Participants Benefited without Need for Training
  - Detections Increase, Misses Decrease, False Alarms Unchanged
  - False Alarm Rate is Potential Problem
  - Performance After Training was Not Evaluated
Field Evaluation

• Evaluate Alerting System in Real World
• Observe Driver Response to Pedestrians with Visual Impairment
• Evaluate Effect of MUTCD R1-6 on Yielding Behavior
Treatment Condition

- Yield here to pedestrian
- State law: yield to within crosswalk

National Roundabout Conference 2005 DRAFT

11-03-04 15:46:27
Roundabout

- Inscribed Circle Diameter 159 ft
- Exit has Two 16 ft Lanes
- Red Brick Textured Crosswalk
- ~ 800 Vehicles per Hour
Procedure

• Control Condition:
  – Observations in Two Weeks Before Treatment Between 5 and 6:30 PM

• Treatment Condition:
  – Observations Between 3:30 and 5 PM
Trial

• Trial Ends When:
  – Participant Detects Both Lanes Block (whether correct or not)
  – Either Lane Blocked for 10 s or More and Traffic Backs Up
  – Participant Fails to Detect Both Lanes Blocked within 10 s
  – Good Samaritan Intervenes
  – Three Minutes Elapse without a Detection
### Results – Driver Behavior

<table>
<thead>
<tr>
<th>Driver Behavior</th>
<th>Control</th>
<th>Treatment</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Stopped</td>
<td>115</td>
<td>158</td>
<td>273</td>
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<tr>
<td>Continued without Stopping</td>
<td>881</td>
<td>790</td>
<td>1671</td>
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<tr>
<td><strong>Total</strong></td>
<td>996</td>
<td>948</td>
<td>1944</td>
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</table>

- **Mean Time of Stop**
  - Control Condition: 10.8 s
  - Treatment Condition: 4.7 s
# Results – Crossing Outcomes

<table>
<thead>
<tr>
<th>Participant</th>
<th>Control Hits</th>
<th>Treatment Hits</th>
<th>Control False Alarm</th>
<th>Treatment False Alarm</th>
<th>Control Time Out</th>
<th>Treatment Time Out</th>
<th>Control Miss</th>
<th>Treatment Miss</th>
<th>Control Good Sam</th>
<th>Treatment Good Sam</th>
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<td><strong>21%</strong></td>
<td><strong>10%</strong></td>
<td><strong>25%</strong></td>
</tr>
</tbody>
</table>
Most Vehicles Stopped without Triggering Alert (near lane)
Far Lane Stops – Distance to Crosswalk

Control

Treatment

Distance from Crosswalk (m)

Frequency

Graph showing frequency of far lane stops at different distances to the crosswalk, comparing Control and Treatment groups.
If Participants Could Immediately Detect Both Lanes Blocked, How Long Would They Need to Wait?

<table>
<thead>
<tr>
<th></th>
<th>Time (min:sec)</th>
<th># Passing Veh.</th>
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<tbody>
<tr>
<td>Max</td>
<td>4:05</td>
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<tr>
<td>Min</td>
<td>0:00</td>
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<tr>
<td>Average</td>
<td>1:03</td>
<td>8.9</td>
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<tr>
<td>15th %ile</td>
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<td>0.0</td>
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<tr>
<td>85th %ile</td>
<td>2:05</td>
<td>19.1</td>
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<tr>
<td>Number of Trials</td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

- Record Time from Beginning of Trial Until both Lanes are Blocked
  - Exclude Trials Where Good Samaritan Interfered
  - Exclude Trials that End in Timeout
Conclusions

• The Alerting System Can Improve Detection If It is Triggered
  – This was True Without Training
• The Alerting System Did Not Eliminate False Alarms
• Drivers Often Stop Far from the Crosswalk
• In Street MUTCD R1-6 May Increase Stopping, but Not Patience
Recommendations

- Examine Effect of Crosswalk Setback on Where Drivers Stop and Where Pedestrians Cross
- Evaluate Alerting System for Single-Lane Roundabouts Where False Alarms are Less Likely to be a Problem
For Further Information
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