An Operational Analysis of the I 64, I 65, I 71 Route Junction in Louisville

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In response to your memo of November 11, 1971, we agreed to conduct a preliminary study of the prevailing conditions at the Kennedy Bridge Route Junction in Louisville. The brief report, submitted herewith, may suffice as a basis for revisions needed there to relieve a severe, peak-hour bottleneck at Ramps 3 and 4.

All accident reports for calendar year 1971 were obtained and analyzed. Each loop and leg in the interchange was filmed; conflict movements at the juncture of Ramps 3 and 4 were filmed. These latter films show the collapse of Ramp 3 to a Level of Service F during peak hours. Skid tests were made throughout.

The film is a supplemental but necessary part of this report.

It was not our duty in this instance to present conclusions or recommendations. Originally, we had intended to monitor and film each bifurcation and merging site; however, the terminus of Ramp 3 commanded our full attention. All other points were deferred in order to bring the most obvious problem into more timely consideration.

Our report on "...Lane Drops," October 1971, may have some bearing on the problem at Louisville. The addition of a lane to carry Ramp 3 traffic forward, as has already been discussed and proposed by others, would surely allow Ramp 3 traffic to enter the weaving zone downstream. However, the existing 2-lane weaving zone would become a 3-lane weaving zone. Considering the short length, a 3-lane weaving situation would seem frightening. On the other hand, if lane assignments (destination) were made at the entrance to Ramp 4 (2 lanes), the leftward-bound traffic could proceed without further weaving. The center lane would necessarily branch rightward and leftward - that is to say, the 3-lane...
section would have to split into two 2-lane roadways ahead. Thus, the rightward-bound traffic off of Ramp 3 would merely merge into the center lane. No other weaving movements would seem necessary.

Respectfully submitted,

[Signature]

John H. Haven
Director of Research

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AN OPERATIONAL ANALYSIS OF THE I 64, I 65, I 71 ROUTE JUNCTION IN LOUISVILLE

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by

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INTRODUCTION

The Kennedy Interchange in Louisville is the most geometrically complicated of any in Kentucky; it is the junction of three interstate routes, I 64, I 65, and I 71. The many diverging, weaving, and merging movements demand a driver's attention. One merging situation collapses into an impasse during peak-hour traffic. This study is responsive to certain inquiries by the Department concerning safety and possible discovery of design deficiencies at this interchange. It was not intended to be an in-depth study but rather an exploratory identification of problems and their locations; more comprehensive studies, by others, would ensue if needed. The specific objectives were to discover conflicts and erratic movements and to locate and analyze high-frequency accident sites.

METHODS

All accident records were obtained for the entire interchange for calendar year 1971. Accidents were summarized, coded, and then plotted on aerial photographs of the interchange. Accident summaries are presented in APPENDIX A, and the collision diagrams in APPENDIX B. Coded information placed on the photograph included type of accident, severity, time and date, weather, and pavement conditions. To further define the pavement conditions, skid tests were conducted with a skid trailer, and the resulting friction measurements were noted on the aerial photographs.

The second phase involved photologging all loops and legs of the interchange. A 16-mm movie camera was mounted on a tripod in the front seat of an automobile, and the driver's view of the roadway was recorded while traveling at the speed of the traffic stream. In order to cover the entire interchange, fourteen separate filming excursions were made. All of these sections of film were spliced together and titled to comprise a twenty-minute film.

In the third phase, the highest accident-frequency location was monitored visually and with the camera during a peak-hour period. This location was the merging point of two lanes from I 65 northbound to I 71 - I 64 eastbound, and the single lane ramp from I 65 southbound leading to I 71 - I 64 eastbound. Data were collected on March 2, 1972, for 35 minutes between 4:00 and 5:00 p.m. A 16-mm Bolex movie camera with a zoom lens was positioned so that the merging of these lanes of traffic could be photographed. Visual monitoring of the location supplemented the filmed data. Included in this visual monitoring phase were traffic counts and observations of brake-light applications and erratic movements. Erratic movements were categorized as "crowded weave", "swerve", "slowed drastically", and "stopped". Erratic movement definitions are listed in APPENDIX C.

FINDINGS

Accident Summary

The accident statistics for the calendar year 1971 are presented in APPENDIX A. There were 134 accidents during the year. The summary indicated there was no predominant day or month in which accidents occurred. Most accidents occurred on Mondays and Fridays and in October and November. The erratic vehicle in the great majority of accidents was a passenger car, and the erratic driver was most frequently male and under thirty. The driver's residence in most cases was Jefferson County, but a large number of the drivers resided in Indiana.

Of the 134 accidents, 103 involved property damage. There were 42 nonfatal injuries and one fatal injury involved in the remainder of the accidents. The majority of accidents occurred during dry roadway conditions during daylight hours. Only six accidents occurred during darkness outside the lighted area of the interchange. Although the majority of accidents occurred during dry roadway conditions, a significant portion (34 percent) occurred during wet or wet roadway conditions.

A predominance of rear-end and multiple rear-end accidents (66) indicates a high degree of congestion. There were also several fixed-object accidents (32) and oblique or sideswipe accidents (28).

The contributing circumstances listed in most of the accident reports was a statement that the vehicle was not under proper control. Therefore, the majority of the accidents were placed in the "other" category of contributing circumstances. Other main items listed were failure to yield right of way and inattention of the driver. In a few cases, the driver was following too closely and (or) speeding.

HIGH ACCIDENT LOCATIONS

From the collision diagrams (APPENDIX B), the five highest accident locations were isolated. A brief summary of the number and type of accidents at each location follows. The locations are in the order of highest-to-lowest number of accidents.

1. The merge of the ramp from I 65 southbound to I 64 - I 71 eastbound with the ramp from I 65 northbound to I 64 - I 71 eastbound. There were 18 accidents at this location during the study period. Of these 18 accidents, 13 were rear-end type, and 3 were multiple rear-end collisions. There was also one oblique accident and one fixed-object-type accident. Of the 18 accidents, 17 involved property damage, and there was only one injury reported. Friction measurements on the ramp from I 65 southbound and from I 65 northbound were 34 and 40, respectively. These compare with a recommended minimum friction value of 37 as presented in National Cooperative Highway Research Program Report 37. This
2. I 65 southbound, just south of the Kennedy Bridge, at the ramp to Third Street and I 64 - 1 71 eastbound.

There were 14 accidents at this location during the study period. Of these, five were the rear-end type, four were sideswipes, and two were combination rear-end and sideswipe encounters (involving three vehicles). These accidents were generally spread throughout the day, but several occurred during the evening rush hour. Eleven of the accidents involved property damage; three caused injuries. Of the 14 accidents, 10 occurred during wet weather. It appears that pavement conditions might have played a significant role in these accidents. Friction measurements for the outer and inner lanes were 34 and 36, respectively. There are three southbound lanes crossing the Kennedy Bridge; the outside-lane traffic must turn right; the middle lane is optional with respect to I 65, south, or I 64 and 1 71, east. Traffic in the innermost lane must continue on I 65. Apparently, conflicts arise when unwary drivers desiring to enter Third Street find themselves in the innermost lane and when those trapped in the outermost lane desire to continue southward on I 65. A possible remedy might be to improve the advance signing (north of bridge) to emphasize lane assignments.

3. I 64, westbound, between Story Avenue and the I 71 overpass.

A total of 13 accidents occurred on this 0.2-mile section during the study period. Of these, six involved fixed objects, four were rear-end collisions, and three were sideswipes. Eight caused property damage, and five resulted in 11 personal injuries. Five occurred in wet weather; three of the six fixed-object accidents were during wet weather conditions. Three of the four rear-end accidents occurred during the morning rush hour when traffic was backed up on the expressway. Two of the three sideswipes involved vehicles which were merging into traffic from the Story Avenue ramp. The friction measurements in the outer and inner lanes were 31 and 33, respectively.

4. Ramp from I 64 westbound to I 65 southbound.

Nine accidents occurred on this 0.2-mile section of road during the study period. Six involved fixed objects, two were sideswipes, and one was a rear-end collision. Only two occurred during wet weather; they were sideswipes. Friction measurements in the outer and inner lanes were 40 and 44, respectively. The problem at this location is caused by the sharp curvature of this ramp, which points to congestion as the probable cause of accidents. Another possible contributing factor is the short acceleration lane of the ramp from I 65.

5. I 65, northbound, at the exit ramp to Third Street and I 64 - 1 71 eastbound.

Eight accidents occurred at this location during the study period. Three were rear-end collisions, three were sideswipes, and two involved fixed objects. Three of the accidents occurred during wet weather. The friction measurements in the outer and inner lanes were 33 and 39, respectively. The accidents did not occur at any particular time of the day. No pattern could be found from accident reports.

ERRATIC MOVEMENT STUDY AT THE HIGHEST ACCIDENT- FREQUENCY LOCATION

The merging of the ramp from I 65, southbound, to I 64 - 1 71, eastbound, with the ramp from I 65, northbound, to I 64 - 1 71, eastbound, was identified from the collision diagrams as being the highest accident frequency location in the Kennedy Interchange. Therefore, it was felt that this would be an appropriate location for both camera monitoring and an erratic movement study.

On March 2, between 4:00 - 5:00 p.m. (a peak hour), this site was monitored with a tripod-mounted 16 mm movie camera. Brakelight applications and volumes were recorded for both ramps. Erratic movements, classified as "crowded weave", "oversteer", "showed drastically", and "stopped", were recorded for the ramp from I 65, southbound, to I 64 - 1 71, eastbound. The periods of observation of erratic movements coincided with periods of filming. These periods were 4:10 to 4:25 p.m., 4:33 to 4:43 p.m., and 4:52 to 5:02 p.m. This 15-minute period and the two-10 minute periods coincided with the amount of time...
required to expose three, 100-foot rolls of film. An average of 13 percent of the vehicles issuing from I 65, southbound, into I 64 - I 71, eastbound, committed a "crowded weave", 2.5 percent committed a "swerve", 16 percent "slowed drastically", and 33 percent "stopped". These percentages indicate the magnitude of the problem at this location. It is important to note that the erratic movement classifications of "slowed drastically" and "stopped" were mutually exclusive of each other, as were "crowded weave" and "swerve". In other words, if a vehicle had "stopped" or committed a "crowded weave", it was never classified as having "slowed drastically" nor counted as having "swerved", and vice-versa. However, a vehicle which "slowed drastically" could also have been recorded as having committed a "crowded weave" or a "swerve", but not both. Erratic movements and brakelight applications are tabulated in APPENDIX C, as both numbers and rates. Volumes and erratic movement definitions may also be found in APPENDIX C. Each of the high accident sites is shown in Figures 1 through 5, respectively. An aerial view encompassing most of the study area and nearby environs is presented in APPENDIX D.
Figure 3. I 64 Westbound between Story Avenue and the I 71 Overpass.

Figure 4. Ramp from I 64 Westbound to I 65 Southbound.
ERRATIC MOVEMENT DEFINITIONS

CROWDED WEAVE -- A vehicle changes lanes directly in front of a following vehicle, causing the following vehicle to apply its brakes. This type of erratic movement always directly involves at least two vehicles.

SLOWED DRASTICALLY -- A very rapid deceleration, causing "dipping" of the front end or tire squealing.

COMPLETE STOP -- Vehicle comes to a complete stop.

Figure 5. I-65 Northbound at the Exit Ramp to Third Street and I-64 - I-71 Eastbound.
APPENDIX A

ACCIDENT SUMMARY
### SUMMARY OF ACCIDENTS

Kennedy Interchange
Calendar Year 1971

1. **Total Number of Accidents (1-1-71 through 12-1-71):** 134

2. **Day of Week**
   - **Monday:** 29
   - **Tuesday:** 17
   - **Wednesday:** 17
   - **Thursday:** 14
   - **Friday:** 26
   - **Saturday:** 14
   - **Sunday:** 17

3. **Month of Year**
   - **January:** 12
   - **February:** 3
   - **March:** 14
   - **April:** 7
   - **May:** 13
   - **June:** 6
   - **July:** 13
   - **August:** 5
   - **September:** 9
   - **October:** 21
   - **November:** 20
   - **December:** 11

4. **Type of Erratic Vehicle**
   - **Passenger Car:** 117
   - **Four-Tired Truck:** 1
   - **Truck (six or more tires):** 14
   - **Bus:** 1
   - **Motorcycle:** 1

5. **Sex of Erratic Driver**
   - **Male:** 102
   - **Female:** 28
   - **Unknown:** 4

6. **Age of Erratic Driver**
   - **16 - 20:** 19
   - **21 - 25:** 39
   - **26 - 30:** 18
   - **31 - 35:** 10
   - **36 - 40:** 7
   - **41 - 45:** 10
   - **46 - 50:** 12
   - **51 - 55:** 3
   - **56 - 60:** 5
   - **61 - 65:** 2
   - **Over 65:** 4
   - **Unknown:** 5

6. **Accident Involvement Rate by Residence of Erratic Driver**
   - **In County Where Accident Occurred:** 71
   - **In Other County in State:** 11
   - **Out of State:** 50
   - **Unknown:** 2
### 7. Seriousness of Injury Among Car Occupants

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Visible signs of injury, as bleeding, distorted member, or had to be carried from the scene of the accident.</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>Other visible injury, as bruises, abrasions, swelling, limping, etc.</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>No visible injury but complaint of pain or momentary unconsciousness.</td>
<td>15</td>
</tr>
<tr>
<td>O</td>
<td>No indication of injury.</td>
<td>103</td>
</tr>
<tr>
<td>K</td>
<td>Fatal</td>
<td>1</td>
</tr>
</tbody>
</table>

### 8. Road Surface Condition

- Dry: 88
- Wet: 35
- Snowy or Icy: 11

### 9. Light Condition

- Daylight: 89
- Darkness: 6
- Dawn or Dusk: 3
- Highway Lighted: 36

### 10. Weather Conditions

- Clear: 74
- Raining: 23
- Snowing: 9
- Fog: 0
- Unknown: 0
- Cloudy: 28

### 11. Type of Accident

- Rear End: 55
- Right Angle: 1
- Oblique or Sideswipe: 28
- Fixed Object: 32
- Single Vehicle: 7
- Head On: 0
- Multiple Rear End: 11
- Other: 0

### 12. Contributing Circumstances

- Drinking: 0
- Speeding: 10
- Failed to Yield Right of Way: 23
- Ran Stop Sign: 0
- Disregard Traffic Signal: 0
- Followed Too Closely: 13
- Improper Passing: 0
- Improper Turn: 0
- Inattentive: 37
- Failed to Signal: 0
- Other: 57
- Backing on Ramp: 1
COLLISION DIAGRAM LEGEND

Path of moving motor vehicles

Pedestrian path

Fatal injury

Non-fatal injury

Rear-end collision

Collision with parked vehicle

Collision with fixed object

Overturned

Out of control

Sideswipe

Time:  A = AM  P = PM

Pavement Conditions:  D = Dry  I = Icy  W = Wet

Weather Conditions:  C = Clear  CL = Cloudy
                     R = Rain  F = Fog
                     S = Snow
COLLISION DIAGRAMS
APPENDIX C

ERRATIC MOVEMENTS, BRAKELIGHT APPLICATIONS, AND LANE VOLUMES AT THE MERGE OF RAMP FROM I 65 SOUTHBOUND TO I 641 71 EASTBOUND WITH RAMP FROM I 65 NORTHBOUND TO I 641 71 EASTBOUND
### TABLE C.1. NUMBERS OF ERRATIC MOVEMENTS, BRAKELIGHT APPLICATIONS, AND LANE VOLUMES.

<table>
<thead>
<tr>
<th>TIME</th>
<th>ERRATIC MOVEMENTS</th>
<th>BRAKELIGHT APPLICATIONS</th>
<th>VOLUMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CROWDED WEAVE</td>
<td>SWERVE</td>
<td>SLOWED DRASTICALLY</td>
</tr>
<tr>
<td>4:10-4:25</td>
<td>13</td>
<td>7</td>
<td>34</td>
</tr>
<tr>
<td>4:33-4:43</td>
<td>30</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>4:52-5:02</td>
<td>40</td>
<td>5</td>
<td>50</td>
</tr>
</tbody>
</table>

* Hourly volumes extrapolated from the short-term volumes shown.

### TABLE C.2. 1) ERRATIC MOVEMENTS EXPRESSED AS A PERCENTAGE OF THE RAMP A VOLUME.

2) BRAKELIGHT APPLICATIONS EXPRESSED AS A PERCENTAGE OF THE RESPECTIVE LANE VOLUMES.

<table>
<thead>
<tr>
<th>TIME</th>
<th>ERRATIC MOVEMENTS</th>
<th>BRAKELIGHT APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CROWDED WEAVE</td>
<td>SWERVE</td>
</tr>
<tr>
<td>4:10-4:25</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4:33-4:43</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>4:52-5:02</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>AVERAGES</td>
<td>13</td>
<td>2.5</td>
</tr>
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APPENDIX D

AERIAL VIEW OF THE I 64, I 65, I 71 ROUTE JUNCTION AND SURROUNDING AREA