Responding to the Unexpected:
Traffic Research in the Wake of Bridge Collapse

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Planning for the Expected:
Traffic Research after Bridge Reopening
& Preliminary Results from Bridge Collapse

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Traffic Research Questions

• Natural Experimentation Site
  • Bridge Collapse / Reopening

• Theoretical Traffic Research Questions
  • Traveler behavioral responses
  • Traffic equilibration
  • Traffic management and optimization
  • Hysteresis
Research Projects (I)

• NSF: Small Grant for Exploratory Research: Understanding Travelers’ Behavioral Choices in the Wake of the Mississippi River Bridge Collapse (Liu, Levinson, and Harder)

• NSF: BRIDGE -- Behavioral Response to the I-35W Disruption: Gauging Equilibration (Liu, Levinson, and Harder)
Research Projects (II)

• Mn/DOT: Traffic Flow, Road User, and Business Impacts of the Collapse of the I-35W Bridge over the Mississippi River (Levinson and Liu)

• CTS/ITS Institute: Development of the Next Generation Metro-Wide Simulation Models for the Twin Cities’ Metropolitan Area (Liu, Hourdos, Michalopoulos)
Data Collection

• Massive amount of data was collected after the bridge collapse
  – Aggregated freeway and arterial data
  – Small scale traveler survey
  – Transit Ridership
  – Metro Transit Online Trip Planner

• Collaboration with local agencies is the key
Good News

• Twin Cities’ transportation network is resilient
  – Network Robustness
  – Traveler Adaptiveness

• Traffic restoration projects mitigate the traffic congestion greatly.
Freeway Traffic Volume

Weekdays from Jul. 23 to Aug. 31

Total Trips Entering Freeway System

- Morning Peak Trips (6-9am)
- Afternoon Peak Trips (4-7pm)

Bridge Collapse on Aug. 1 (Wed)
Peaks are starting earlier with some extra congestion on the shoulders of both the a.m. and p.m. for early August 2007.
Measuring Equilibration
Measuring Equilibration

RMSE

- July 4th
- Bridge Collapse
- State Fair Labor Day Start of School
- Thanksgiving

JunWeek2, JuniWeek4, JuiWeek2, JuiWeek4, AugWeek2, AugWeek4, SepWeek2, SepWeek4, OctWeek2, OctWeek4, NovWeek2, NovWeek4

2006
2007
Evening Congestion Impacts
2:00 to 7:00 p.m. – Relatively Unchanged

Week of July 23, 2007

Week of Sept. 10, 2007

Source: Mn/DOT
Travel Behavior Survey
Survey of Travel Behavioral Consequences of I-35W Bridge Collapse

Please complete the table, indicating the choice best describing your MORNING COMMUTE trip in the following time periods and draw your route(s) on the attached maps.

<table>
<thead>
<tr>
<th>Before I-35W Bridge Collapse</th>
<th>After Bridge Collapse August 2nd</th>
<th>Following Weeks</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Departure Time:</strong> (Typical time leaving home, to the nearest minute)</td>
<td>6:45 AM</td>
<td>6:20 AM</td>
<td>6:45 AM</td>
</tr>
<tr>
<td><strong>Arrival time:</strong> (Typical time arriving at work, to the nearest minute)</td>
<td>7:20 AM</td>
<td>7:15 AM</td>
<td>7:25 AM</td>
</tr>
<tr>
<td><strong>Travel Mode:</strong> (Please indicate the primary mode of travel)</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>a) Drive alone b) Car/vanpool c) Bus/Light rail d) Bicycle e) Walk f) Other ........... (Please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Route Choice</strong> (Please draw your routes on the attached maps. If you take bus or LR, please indicate the route and on and off stops.)</td>
<td>Please mark line(s) on the map 1</td>
<td>Please mark line(s) on the map 2</td>
<td>Please mark line(s) on the map 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If more than one, please indicate ALL of them.</td>
</tr>
<tr>
<td><strong>Travel Information Resources:</strong> (Which source(s) of information help you make travel decisions)</td>
<td>a, d,</td>
<td>a, d,</td>
<td>a, d,</td>
</tr>
<tr>
<td>a) Experience b) Call 511 c) Website d) TV e) Radio f) Co-workers g) Neighbors h) Family i) Others ........... (Please specify)</td>
<td>e, f,</td>
<td>e,</td>
<td>e</td>
</tr>
<tr>
<td><strong>Motivation for Changes in Travel Choices:</strong></td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>a) To reduce travel time b) Road or ramp closed c) Others ........... (Please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary Statistics

- Total 141 respondents (including 89 car drivers and 52 non-auto travelers):
  - 77 travelers claim they are affected by the bridge collapse.
  - 58 have changed their departure times and 56 are using different routes.
  - Only 5 respondents changed their mode of travel and 7 reported higher frequency of working at home.
Departure Time Changes

- Before Bridge Collapse
- Aug. 2
- A Week after Aug. 1
- Mid of Sept.
Existing Models for Day-to-day Traffic Equilibration

Experiences

Perception Filter

Pre-Trip Information

Pre-trip Travel Time Perception
New Model for Day-to-day Traffic Equilibration after Network Disruption

Experiences

Pre-Trip Information

Prediction Processor

Travel Time / Flow Prediction

Previous Day's Experienced Time

Correction Processor

Previous Day's Prediction

Pre-trip Travel Time Perception
MnDOT Traffic Restoration Projects

A  TH 280  $372,000 COMPLETED AUG 13
Add second lane to northbound on ramp to I-35W/TH 36

B  I-35W at 4th Ave.  $112,000 COMPLETED AUG 30
Convert to a two lane exit/entrance

C  TH 100  $92,000 COMPLETED AUG 18
Second lane northbound to eastbound I-694

D  TH 280  $50,000 UNDER CONSTRUCTION
Add cameras, traffic detection sensors and dynamic message signs

E  TH 65  $70,000 UNDER CONSTRUCTION
Add cameras and traffic detection sensors

F  TH 47  $70,000 UNDER CONSTRUCTION
Add cameras and traffic detection sensors

G  I-94  $1,162,000 COMPLETED AUG 20
Fourth lane eastbound and westbound
TH 280 to I-35W

H  TH 280  $300,000 COMPLETED AUG 22
Construct southbound one way frontage road at Broadway Avenue

I  TH 100 southbound  $30,000 BEING STUDIED
Add auxiliary lane Duluth to TH 55

J  TH 280  $680,000 COMPLETED AUG 20
Convert to diamond interchange with two temporary signals at ramps at Hennepin/Larpenteur

K  Washington Ave.  $75,000 COMPLETED SEPT
Improvements to Washington Ave and ramps to I-35W

L  TH 280  $200,000 COMPLETED AUG 19
Add continuous lighting

M  TH 280  $170,000 COMPLETED AUG 2
Convert 280 to a freeway

N  I-694  $168,000 COMPLETED SEPT
Construct 4th lane on eastbound I-694 at Hwy 47

O  I-694  $10,000 COMPLETED AUG 5
Convert Shoulder to bus only lanes

P  I-35W  $1,500,000 BEING STUDIED
Add half diamond interchange to and from the north at Hennepin Ave
Baseline Model
Baseline Model

I-35W Bridge Location

Detector Station Location

Graph showing data points from 7/23/2007 to 8/27/2007.
Baseline Model

Bridge Collapse on August 1

Assigned Link Volumes

Observed Link Volumes

$R^2 = 0.9325$
Testing Scenarios

• Scenario 1: (Base Scenario)
  – Follow MnDOT traffic restoration projects

• Scenario 2:
  – Open the additional lane on I-94 one week earlier, other projects same as the base one
Freeway Total Travel Time

Scenario 2 v.s. Scenario 1

The additional lane on I94 was actually opened on Aug 20, 2007.

The additional lane on I94 is assumed opening one week earlier on Aug 13, 2007. Congestion could be reduced earlier.
Scenario 2 v.s. Scenario 1
In Total Travel Time

The additional lane on I94 is assumed opening one week earlier on Aug 13, 2007

Transportation system performance may be improved, compared with reality

The additional lane on I94 was actually opened on Aug 20, 2007
Submitted Research Papers

- Xie, F. and D. Levinson (2008) *Evaluating the Effects of I-35W Bridge Collapse on Road-Users in the Twin Cities Metropolitan Region* (under review)
Thank You

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