Intersection Delay Relationships in Travel Models – Minimum Recommendations and Deployment Challenges

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24 Year Saga

- 1991: "Delay/Volume Relations for Travel Forecasting Based upon the 1985 Highway Capacity Manual" for FHWA by me
- 2015: "Traffic Assignment and Feedback Research to Support Improved Travel Forecasting" for FTA by Caliper

Lesson from Caliper/FTA Report

- Recap:
  - 5 very large MPO models
  - All models used VDFs, exclusively
  - Comparison of forecasted speeds (travel times) with HERE travel times
  - Speed estimates were not good.
  - Caliper recommendation: Need better calibrations of VDFs
- My recommendation: Ditch VDFs for node delays at urban intersections.

Correct Method Outlined in 1991 FHWA Report

- Delay at intersections should be calculated with operational analysis procedures in the HCM or similar.
- Must consider: turning, opposing and conflicting traffic.
- Restrictive conditions on VDFs required for Frank-Wolfe decomposition cannot be attained:
  - Non-monotonic
  - Non-continuous
  - Not closed form, cannot be integrated

Sample 1985 HCM Results

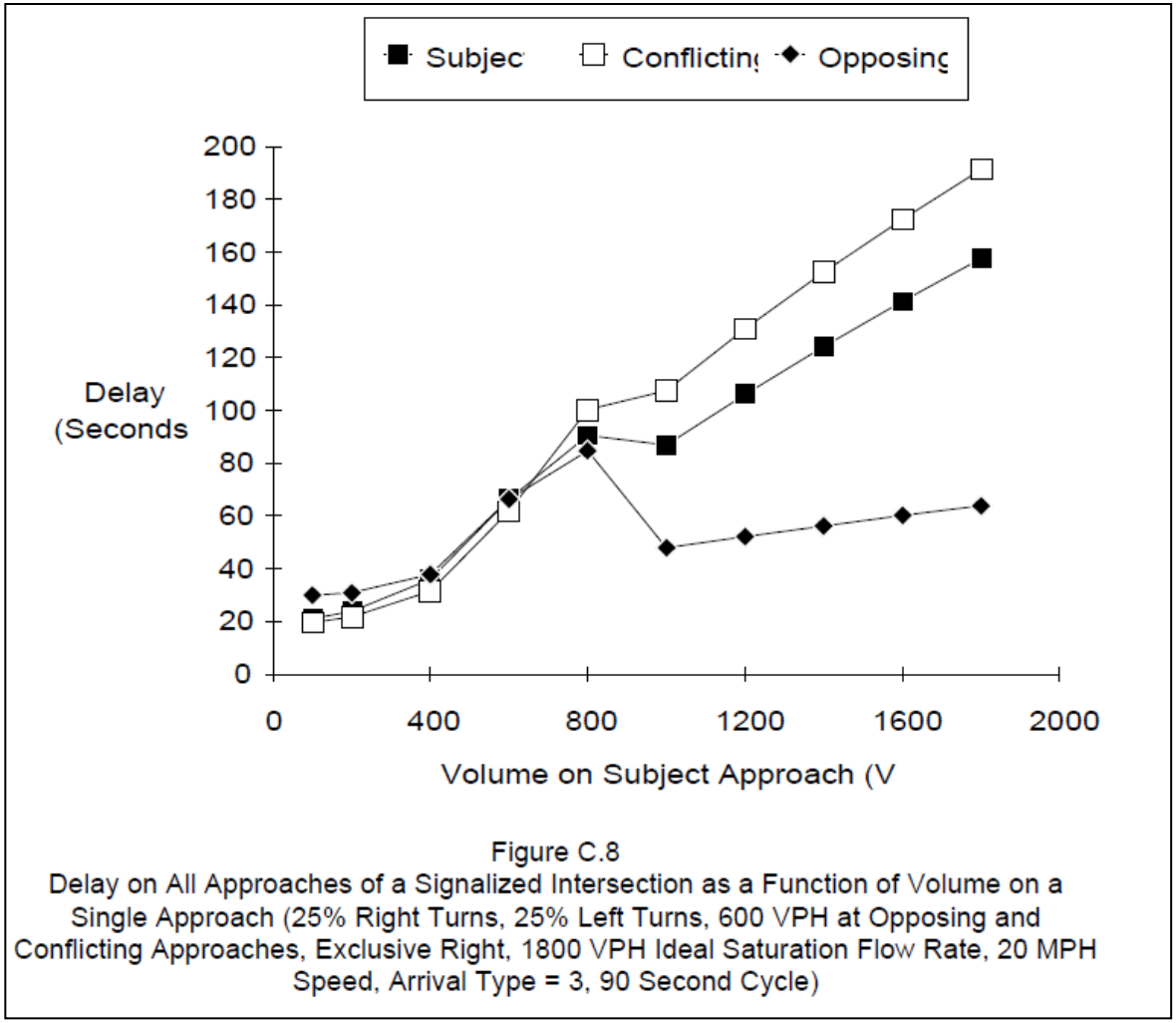


Figure C.8
Delay on All Approaches of a Signalized Intersection as a Function of Volume on a Single Approach (25% Right Turns, 25% Left Turns, 600 VPH at Opposing and Conflicting Approaches, Exclusive Right, 1800 VPH Ideal Saturation Flow Rate, 20 MPH Speed, Arrival Type = 3, 90 Second Cycle)

QRS II's Signalized Implementation, 2010 HCM

- Two lane groups, L + TR.
- 4 phase plans, up to 2 phases per approach.
- d1 and d2 terms for delay (d3 is unnecessary because of DTA queuing.)
- Three options for timing:
  - Adaptive (medium to long range)
  - Fixed (short range)
  - Actuated (short range)

Other Node Delay, Briefly

- Some-way stops
- All-way stops
  - M/G/1 queuing model
  - Predates HCM but results are very similar
- Roundabouts
  - Based on SIDRA gap acceptance theory
  - Predates HCM but results are likely better, given stronger theory for circulating traffic
- Ramp Meters
  - No conflicting or opposing traffic

Implications for Sensitivity

- Cedar Rapids Experiment (MS Thesis at UWM, Craig Holan)
  - Network originally developed with node delays, but a second network was calibrated with VDFs only.
  - Node delays v. VDF under growth scenarios
  - Compare emissions changes
- Changes with node delays were about **twice** those seen with VDFs.

The Inadvertant Parkersburg + Huntington Experiments

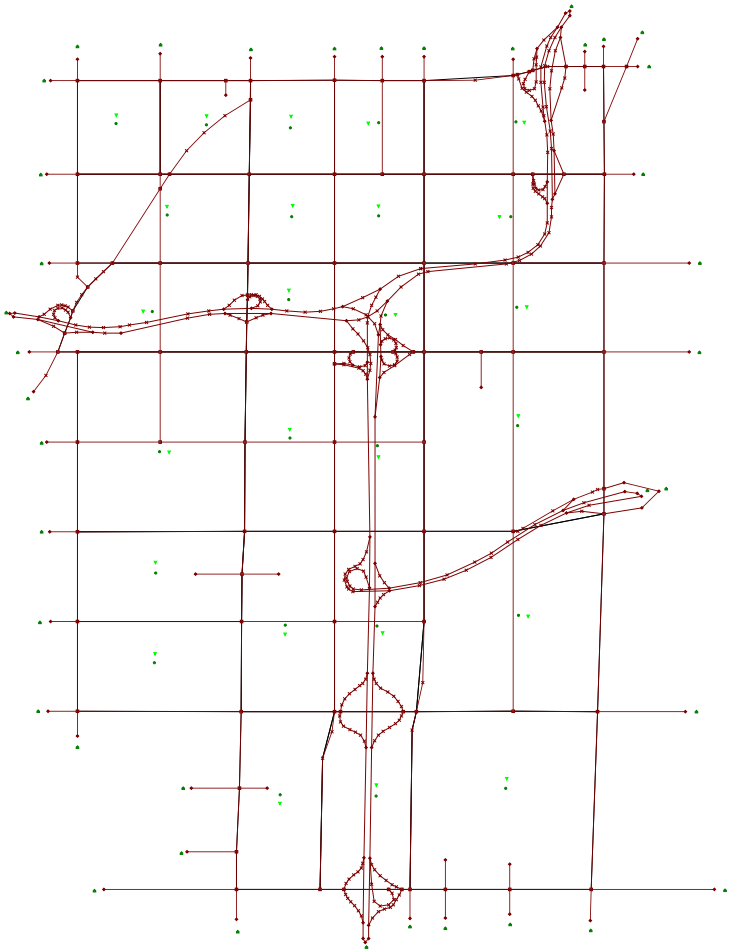
- Comparison of Two Models
  - Ohio DOT – QRS II with node delays, DTA
  - Consultant – TransCAD with VDFs
- WWW: Parkersburg
- KYOVA: Huntington

	QRSII-based (2005) model	TransCad-based (2010) model
WWW	○ Volume RMS Error ○ **29%** (w/1,217 counts) ○ Arterial travel time error ○ ***9.5%***	○ Volume RMS Error ○ **35%** (w/727 counts) ○ Arterial travel time error ○ ***18%***
KYOVA	○ Volume RMS Error ○ **35%** (w/1,426 counts) ○ Arterial travel time error ○ ***13%***	○ Volume RMS Error ○ **42%** (w/456 counts) ○ Arterial travel time error ○ ***25%***

Validation Accuracy

Volume Range, ADT	Ohio Minimum Standard	Best Practical Experience
0-499	200%	166%
500-1499	100%	80%
1500-2499	62%	48%
2500-3499	54%	47%
3500-4499	48%	32%
4500-5499	45%	27%
5500-6999	42%	25%
7000-8499	39%	23%
8500-9999	36%	18%
10000-12499	34%	19%
12500-14999	31%	16%
15000-17499	30%	14%
17500-19999	28%	11%
20000-24999	26%	10%

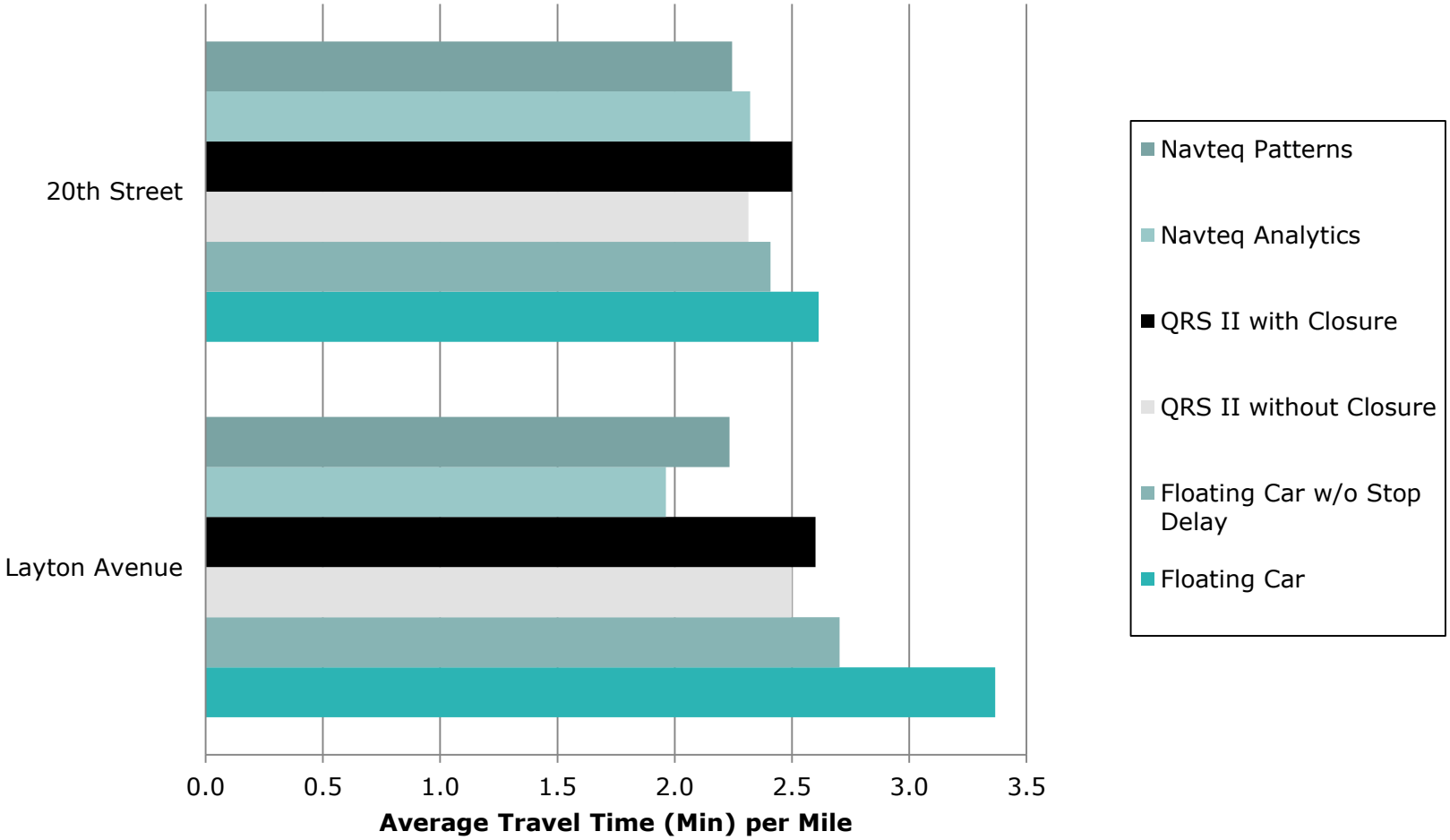
Travel Time Comparisons, Milwaukee Mitchell Window



Forecast of Arterial Travel Times Following Closures

- Prior to Closure: Estimate OD table from traffic counts (static 1 hour); obtain NAVTEQ travel time data
- Apply closures to network; assign OD table; observe delays
- Perform floating car runs of most arterials (8 samples per trajectory)
- Compare sets of travel times

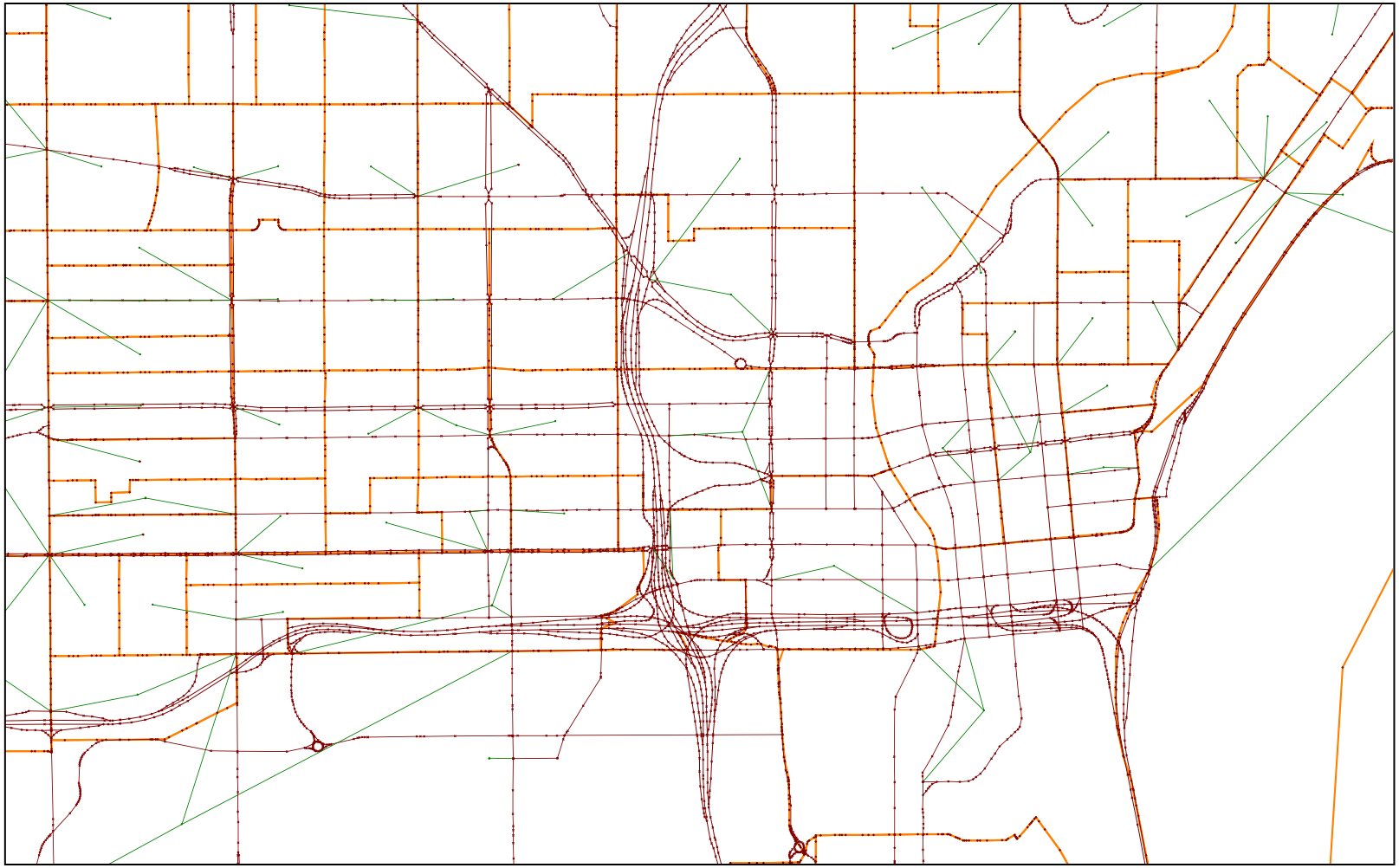
Floating Car Runs, Sample Results (Youngblom/Virk)



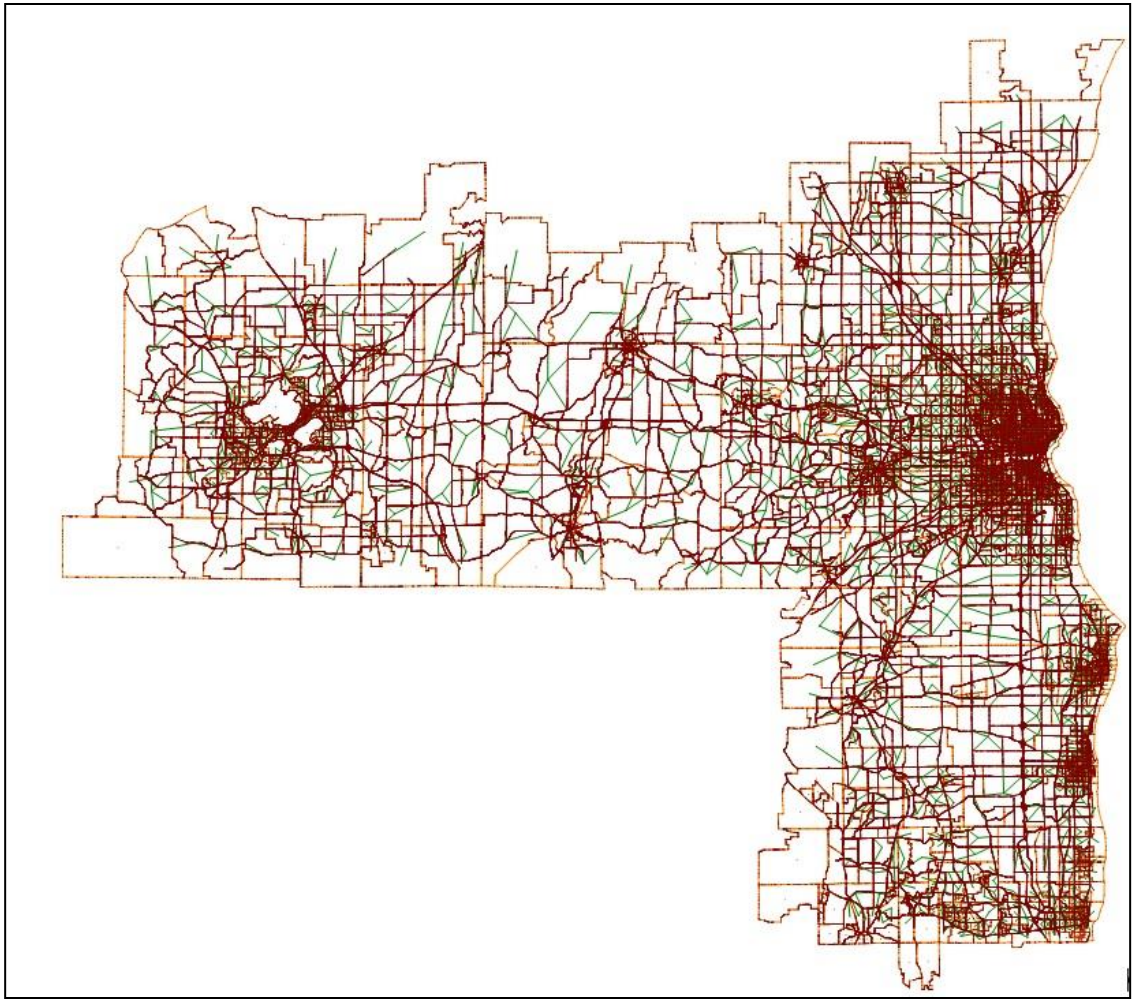
RADIUS: Very General Overview

- RADIUS 39 and RADIUS 94 are dynamic traffic assignments of traffic for short-term estimation of freeway work zone traffic volumes considering the possibility of diversion.
- Two large regions:
  - I-39 corridor from South Beloit to Madison
  - I-94 corridor from Northern IL to Madison
- Platform is Quick Response System II (QRS II) and General Network Editor

I-94 Network Detail



I-94 Whole Network



Models Differ by Time Period

- Four models for each area:
  - Weekday AM (6 am to 10 am)
  - Weekday PM (Mon-Thurs, 3 pm to 7 pm)
  - Friday PM (3 pm to 7 pm)
  - Sunday PM (3 pm to 7 pm)

Intersections Features

- Every Signal
  - Adaptive (adjusted for traffic flows as forecast, per HCM signal timing method using flow ratios, and then uses 2010 HCM fixed time procedures)
  - Actuated (uses the 2010 delay actuated procedures with local signal timing parameters)
  - Fixed-timed available, but not used so far
- Every Roundabout
- Many Stop Signs
  - HCM some-way or all-way procedures within 2 miles of a freeway
- Budget: ½ student-hour per intersection

Assignment Details

- OD Table Creation
  - NCHRP Report 365, Trip Generation, Trip Distribution and TOD (static)
  - Static refinement with 6500 counts.
  - Dyamic refinement with 6500 counts stations in 4 one-hour intervals.
  - 31,000,000 OD pairs statistically estimated for each time period.
- Left Turn Penalties
- MSA

Conclusion

- IMHO, ignoring node delays is no longer an option.