CE351
Transportation Systems: Planning and Design

TOPIC:
Level of Service in Highways
Outline

1. Definitions
2. Level of Service (LOS)
   - Traditional concept
   - New concepts (under research)
LEVEL OF SERVICE CONCEPT

• Highway Capacity and Level of Service Analysis

• Seek to measure Highway Performance (Congestion). Needed for:
  – Highway construction
  – Congestion relief
I-5 Average Daily Traffic

Interstate 5 - Oregon to Canada
Traffic Volume Comparison - 1990 and 2000

Annual Average Daily Traffic

Mileposts and Urban Areas

- 2000
- 1990
- Urban Area

from the WSDOT 2001 Annual Traffic Report
LEVEL OF SERVICE CONCEPT

COMPLEX ISSUE

• Wide variation of highway conditions:

• Different roadway types (Freeway, multilane, etc.)
• Number of lanes and width of lanes
• Vehicle mix (cars vs. trucks)
• Shoulder widths
• Temporal variation in traffic flow over the day and over the peak hour
LEVEL OF SERVICE CONCEPT

• The level of service provides a qualitative ranking of the traffic operational conditions experienced by users of a facility.

• Highway Capacity Manual defines the LOS categories for freeways and multilane highways as using the letters A, B, C, D, E, and F.
Definitions – Level of Service (LOS)

• Chief measure of “quality of service”
  – Describes operational conditions within a traffic stream.
  – Does not include safety
  – Different measures for different facilities

• Freeway & Multilane Highway LOS
  – Based on traffic density

• Two lane-two way highway
  – Based on % passing distance
Levels of Service

• LOS A
  – Free-flow operation
  – Individual users are virtually unaffected by the presence of others in the traffic stream.

• LOS B
  – Reasonably free flow
  – Ability to maneuver is only slightly restricted
  – Effects of minor incidents still easily absorbed

From Highway Capacity Manual, 2000
Levels of Service

• LOS C
  - Speeds at or near FFS
  - Freedom to maneuver is noticeably restricted
  - Queues may form behind any significant blockage.

• LOS D
  - Speeds decline slightly with increasing flows
  - Density increases more quickly
  - Freedom to maneuver is more noticeably limited
  - Minor incidents create queuing

From Highway Capacity Manual, 2000
Levels of Service

- **LOS E**
  - Operation near or at capacity
  - No usable gaps in the traffic stream
  - Operations extremely volatile
  - Any disruption causes queuing

- **LOS F**
  - Breakdown in flow
  - Queues form behind breakdown points
  - Demand > capacity

From *Highway Capacity Manual*, 2000
Is this the best way to measure LOS?

- Why do people use highways?
- How can we measure LOS in a more meaningful way for travelers?
- Car drivers?
- Trucks? Distribution and Delivery?
- ACTIVE RESEARCH TOPICS
One alternative way of measuring LOS

Travel Time Reliability
Traffic Congestion

• Large numbers of people trying to reach their destination
• Peak hours
• Expected congestion
  – Recurrent
  – Plan for it
• Unexpected congestion
  – Nonrecurrent
  – Late for work or childcare pickup
  – Late shipments, disrupt just-in-time delivery
Reliability Defined

• Consistency or dependability in travel times
• Measured from day to day or across different times of day
• Tend to remember the few bad days
How Traffic Conditions Have Been Communicated

Segment of Northbound I-5 in 2005

Annual Average
What Travelers Experience...

Actual Travel Times Vary Day to Day

Segment of Northbound I-5 in 2005
What Travelers Experience...

95th Percentile Travel Time

Segment of Northbound I-5 in 2005
What Travelers Experience...

What Travelers Remember...

Segment of Northbound I-5 in 2005
Measurements

- **95th Percentile Travel Times**
  - Late one day per month
- **Buffer Index**
  - Extra time (cushion) to ensure on-time arrival 95% of the time

Average travel time = 20 min
Buffer index = 40%
Buffer time = 20 min × 0.40 = 8 minutes

- **Planning Time Index**
  - Total time to ensure on-time arrival

Free flow travel time = 15 min
Planning time index = 1.60
Planning time = 15 min × 1.60 = 24 min
Measurements

- Reliability Indices

Link Reliability (travel time) \[ r_t = \frac{\bar{t}}{z\sqrt{\text{var}(t)}} \]

Link Reliability (speed) \[ r_v = \frac{\bar{v}}{z\sqrt{\text{var}(v)}} \]

Path Reliability \[ r_p = \frac{\sum \bar{t}_i}{z\sqrt{\sum \text{var} t_i + 2 \sum \text{cov} t_i t_j}} \]

\[ \text{cov}_{ij} = E(t_i t_j) - t_i t_j \]

Reliable Time of Arrival \[ RTA = ETA \pm z\sqrt{\text{var}(T_p)} \]
Estimated Monthly Travel Time I-5 N September 2006
Reliability

• This is a topic currently studied at PSU
• Passenger side:
  ITS LAB
  http://portal.its.pdx.edu

Also reliability affecting freight
• Intercity-long haul
• Urban distribution
  research projects underway