

# Traffic Statistics 101

Measuring and Describing the Use of  
Our Roadways



# Achieving Quality Data

- Effective program management
  - The management feedback loop
    - Determine desired results
    - Measure actual results
    - Perform corrective actions
  - The key is measurement (or observation)
  - No other process (e.g., expert judgment) provides feedback
  - And then there's the focus thing



# Why Must We Measure?

- We have to look in the horse's mouth.
- The only valid data are measurements (or observations).
- If you can't measure it, forget it!
  - The management process requires it.
    - Data collection management.
    - Planning management.
    - Executive management.
- No, you don't know unless you measure it.
  - “Expert estimates” are neither.



# Truth in Data

- We just did this slide
- Truth in data is a necessary (but not sufficient) condition for effective management
- AASHTO requirements:
  - Disclosure of practice
  - Estimate of data variability
  - (Also) do not impute data



# Two views of roadway use

- The operations view
  - What is the state of my roadway system NOW?
- The planning view
  - What is the long-range requirement for roadway capacity?
- These are different views.
- What works for one doesn't directly work for the other.
- This presentation is about the planning view.



# The process

- It begins with the roadway system.
- Then a sampling plan for describing the system.
- Then the measurement thing.
- Then the description of the measurements (statistics).
- Finally, the generalizations from the statistics (roadway system estimates).



# Little roads , big roads ...

- Ways of describing roads
  - Functional classification
    - How are the roads used?
  - Factor groups
    - What are the traffic characteristics of the roads?
      - What's the seasonal variation?
      - Does it vary by day of week?
      - What's the annual growth rate?
      - Big trucks, little cars, miniscule motorcycles—what's the mix?



# The proper measurement of traffic

- A permanent traffic recorder every hundred feet or so
- Measuring all vehicle attributes (count, type, speed, headway, gap, travel time, delay, number and weight of passengers, type of commodity, *etc.*)
- With no equipment failure
- Which would cost a couple of years' GNP



# OK , so what do we do?

- Make longer chunks of roadway
  - The *traffic section*.
  - A piece of roadway with constant traffic.
  - Be sure these completely contain HPMS sample sections
- Don't measure all the chunks all the time
  - A few permanent sites for estimating factors.
  - Short time counts elsewhere.
  - How often, how long?



# The TMG sampling plan

- The *Traffic Monitoring Guide* recommends:
  - For traffic volume estimation:
    - A continuous (ATR) element
    - HPMS (coverage) element
    - Special needs element
  - Vehicle class and weight samples are subsets of the volume sample



# The AASHTO Guideline

- Provides recommended procedures for common traffic monitoring practices.
- Including definitions of statistics.
- Designed to meet the requirements of the TMG.
- While minimizing the need for estimating missing data.



# Traffic measurement

- We do it with equipment (mostly).
  - Manual counts are expensive and unreliable.
  - But we have to do them in some conditions.
- What can we measure?
  - Traffic volume: number of vehicles per unit of time.
  - Vehicle classification: what types of vehicles.
  - Weight: usually axles and total of moving vehicles.
  - Speed: speed bins per unit of time.
  - Others: lane occupancy, headway, gap ...



# How do we measure traffic?

- Volume: loops, road tubes.
- Vehicle classification: loops + piezoelectric (“piezo”), road tubes.
- Speed: paired loops, road tubes.
- Weight: load cells, bending plates, piezo, capacitance mats, ...
- New technologies: video, microwave, fiber optic.



# Status of traffic measurement

- Fraught with technical problems
  - Sensor accuracy under all conditions.
  - Sensor reliability.
  - Transforming sensor vectors to vehicles
    - Pattern variability problems.
    - Algorithm problems.
- But we can do OK.
- And it's all we got.



# How do we know if we measured?

- Quality control checks.
- Basic ones are described in *AASHTO Guidelines*.
- Problem: can't distinguish bad sensors from weird traffic in many cases.
- “Fatal” errors is therefore relative.
- Requires knowledge of conditions (weather, events, *etc.*).



# Now for the description

- What are the descriptive statistics used for traffic counts?
  - Permanent sites.
  - Groups of permanent sites (factors).
  - Short-term counts.
- How do we estimate roadway statistics?



## Permanent sites: monthly statistics

- MADW: monthly average days of the week = the arithmetic average for each day of the week.
- MADT: monthly average daily traffic = the average of the seven MADWs.
  - Not used for AADT.
  - Used for reporting and factor calculations.
- MAWDT: monthly average weekday traffic: usually, the Monday-Thursday average.
- MAWET: monthly average weekend traffic: average of Saturday and Sunday.



# Permanent sites: annual statistics

- Annual averages
  - AADW: annual average days of the week = the average of the 12 MADWs.
  - AADT: annual average daily traffic = the average of the seven AADWs.
  - AAWDT: annual average weekday traffic = the average of Monday - Thursday.
  - AAWET: annual average weekend traffic = the average of Saturday and Sunday.



# What about holidays?

- Traditionally, they have been included.
- Do you want actual or typical?
- (Same holds for road closures).
- Normally, for AADT and factor calculations, these should be excluded.



# What about variability?

- Truth in data requires an estimate of variability.
- But the AASHTO definitions make that extremely difficult.
- TMG approach: standard deviation of annualized average days.



# Factor calculations

- Seasonal factors.
- Day-of-week factors.
- Axle adjustment.
- Growth.



# Seasonal factors

- These are really monthly factors
- Monthly adjustment factor =  $AADT / MADT$
- Which is inversely proportional to traffic volume.
- Might want to calculate a *monthly traffic ratio*, which is  $MADT / AADT$ , for reporting



# Day-of-week factors

- In the “two-step method” (per TMG), the daily factors are =  $MADT / MADW$ .
- Could also do  $AADT / MADW$  and eliminate the seasonal factor.
- These are optional in TMG.
- More useful in urban, recreational, other areas where there is a distinct pattern.



# Axle adjustment

- The number of vehicles per axle.
- Which is calculated by multiplying the average number of axles per vehicle class times the number of vehicles of each class, then dividing by the total number of vehicles.
- From permanent vehicle classifiers.
- Right.



# Growth factors

- *Normally* calculated as the three-year average algebraic growth at ATR sites.
- Can also use linear regression (particularly if short-term counts are used).
- Or even exponential or polynomial regression.
- Use the simplest method that works.
- Where “works” means keeping error to reasonable limits.



# Short-term count statistics

- AADT estimation methods
  - TMG:  $\text{count} \times \text{day-of-week factor} \times \text{monthly factor} \times \text{axle adjustment factor} (\times \text{growth factor}) / 2$
  - Partial days don't work very well.
  - Hallenbeck method: factor each *hour*, compute average hour across the entire count, add these to get AADT estimate.



# Road system estimation

- The “best available data” approach: if there’s a count, use it. Otherwise, apply the growth factor to the existing value.
- Network-based approaches: use the upstream and downstream known values to interpolate the unknown value.



# Road system statistics

- Vehicle distance traveled (VDT) can be calculated as the sum of individual section VDTs (times HPMS expansion, if used for HPMS).
- Section VDT = AADT x length.
- This statistic is useful for “biographical” reports (by district, by county, *etc*).



# Other issues

- Data retention (of “base data”).
- Use of traffic operations data for planning
  - Data considerations.
  - Organizational considerations.



# Summary

- The starting point is truth in data.
- Planning vs. ops.
- Describing the roadway system.
- The sampling plan.
- Traffic measurement.
- Traffic statistics.
- Roadway traffic estimation.

