Transportation Design

Prof. Tapan Datta, Ph.D., P.E.

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The Transportation System

Traffic Engineering

defined as that phase of engineering which deals with the safe and efficient movement of people and goods on streets and highways.

Key Aspects of Traffic Engineering

- Person Movement or Vehicle Movement?
  - How many people may be moved in vehicles of different types on different types of facilities?
  - Goods movement
    - mostly by truck
    - vital to the local economy
    - must be incorporated into the plans for the transportation system

Key Aspects of Traffic Engineering

- Mix of Vehicles in Person Transportation
  - Private autos
  - Bus transit
    - Local
    - Express
  - Paratransit
    - Taxis
    - Jitneys
    - Limousines
  - Bicycles
  - People movers

Some Basic Statistics, 1986

- Over 158.5 million US drivers drove over 1.86 trillion vehicle-miles in over 172 million regulated vehicles
- 47,000 people were killed in highway accidents, with a rate of 2.57 deaths/100 million vehicle-miles of travel
- State and local highway user taxes generated over $40.6 billion

Transportation Engineering

Defined by Institute of Transportation Engineers (ITE) as "the application of technology and scientific principles to the planning, functional design, operations, and management of facilities for any mode of transportation in order to provide for the safe, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods."

Traffic Engineering

Defined by Institute of Transportation Engineers (ITE) as "that phase of transportation engineering which deals with the planning, geometric design and traffic operations of roads, streets and highways, their networks, terminals, abutting lands, and relationships with other modes of transportation."

Crisis in Serving the Growing Urban Traffic Demand

- Traffic demand is growing
- The amount of space that can be devoted to additional ROW is limited for financial, space, and social reasons
- Current technologies and use of ROW do not allow capacity improvements of the magnitude needed to meet the future demand

Urban Traffic Demand

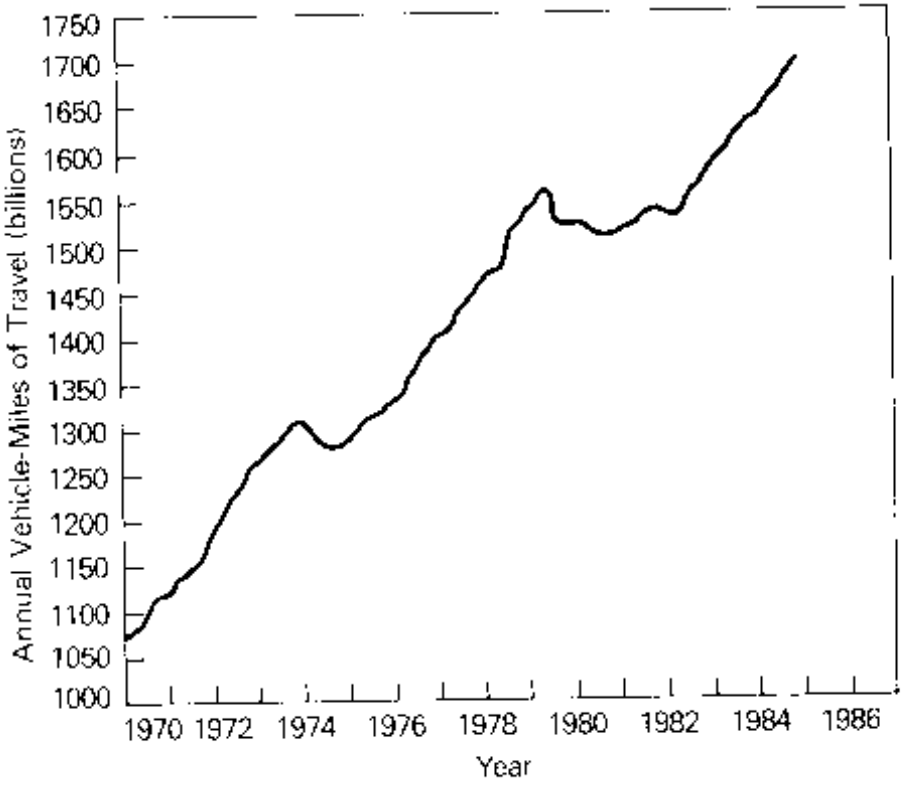


FIGURE 1-1 Recent trend of urban traffic demand.

SOURCE: *Status of the Nation's Highways: Condition and Performance,* Report of the Secretary of Transportation to the U.S. Congress, June 1985.

Safety Programs and the DWI Problems

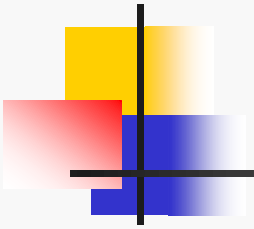
- Since mid-1980s, emphasis given to *programmatic efforts* to implement existing safety procedures
- States have passed seat-belt laws in greater numbers than before
- States have responded to federal requirement of drinking age be raised to 21
- Passed strict laws on driving while intoxicated (DWI) and to aggressively enforce them

Highway Funding

- The Interstate System and the Highway Trust Fund
- The Highway Act and the UMTA Act

Basic Parameters of Traffic

- Flow (q)
- Density (K)
- Speed (V)



Definitions of Flow, Density & Speed

- **Flow** is defined as the number of vehicles traversing a point of roadway per unit time. *Unit: vehicles per hour.*
- **Density** is the number of vehicles occupying a given length of lane or roadway averaged over time. *Unit: vehicles per mile.*
- **Speed** is defined as the distance traversed by a vehicle per unit time. *Unit: miles per hour.*

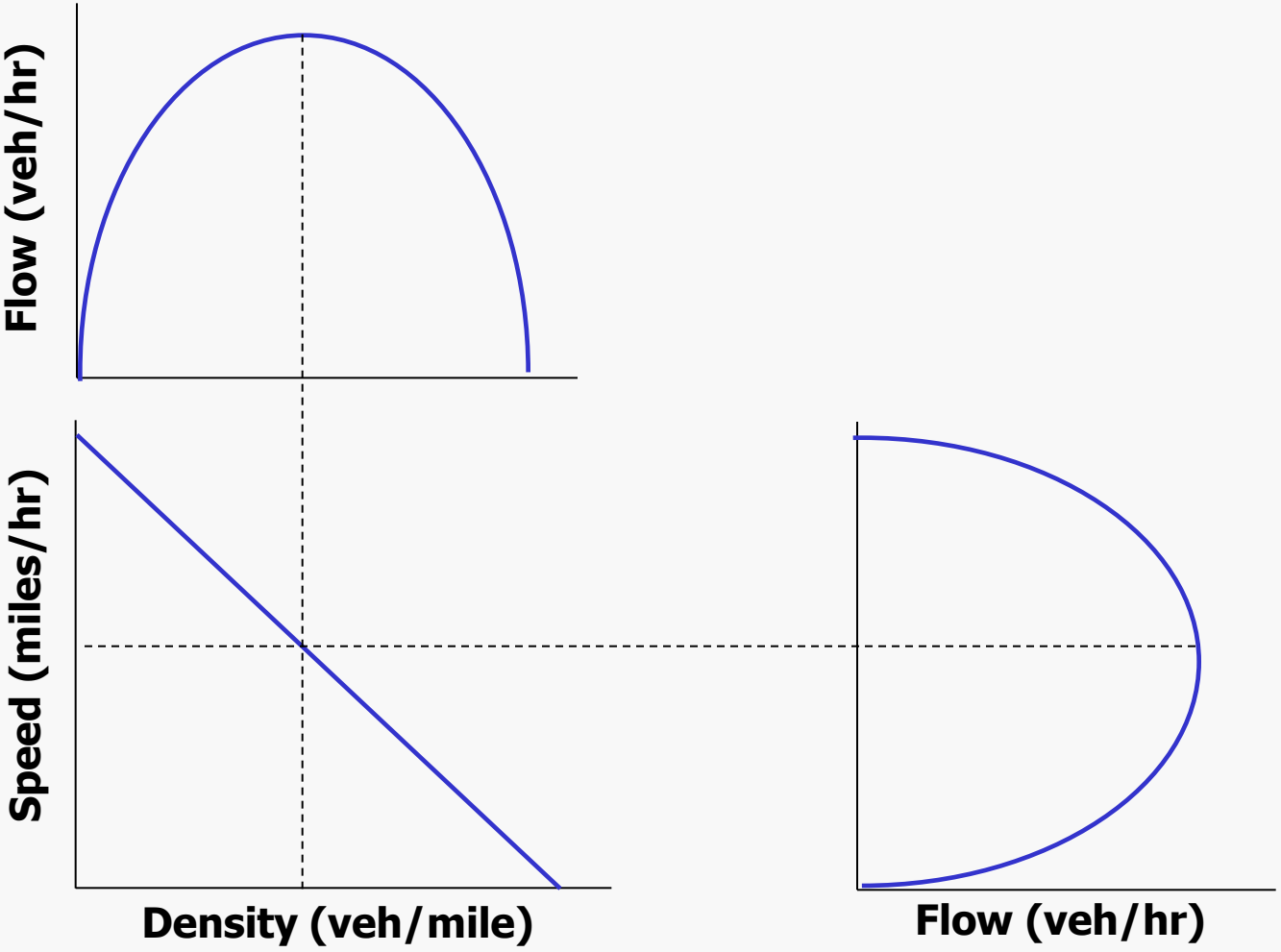
q-K-V Relationship

Flow (veh/hr)

= Density (veh/mile) x Speed (miles/hr)

Therefore, $q = K \times V$

q-K-V Curves

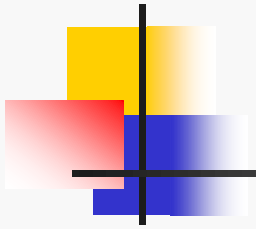


Travel Demand Models

Questions asked:

- How many trips? Trip Generation
- Where from and where to? Trip Distribution
- Which mode? Mode Choice
- Which route? Traffic Assignment

Traffic Problems



- Grid lock – capacity problem
- Pot holes – road maintenance problem
- Construction barrels – foreign object on road
- Poor drivers – driver behavior

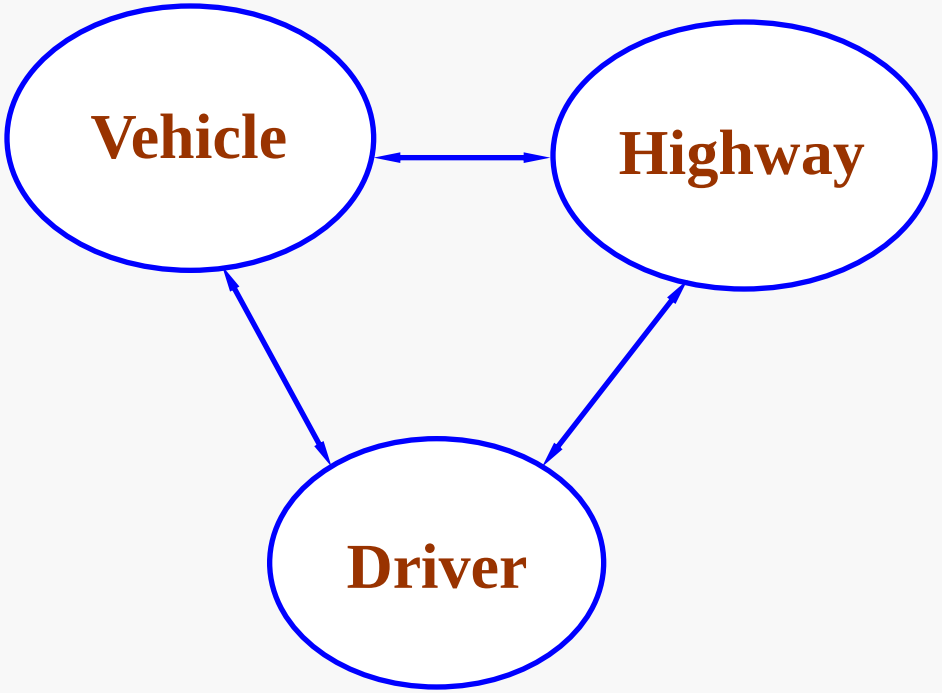
Traffic Problems

- Roadway drainage – drainage system problem
- Gawkers – inattentive drivers
- Roadway geometry problem – deficiency in geometric design
- Environmental problem

Traffic Crash Problem

- Traffic crashes
  - Fatalities – persons killed
  - Injuries – having injuries of various severities
  - Property damages – only a damage to the vehicle without injury

Elements of Traffic Engineering



Congestion Problem

- Data needs
  - Highway geometry
    - Number of lanes
    - Lane width - ideal 12 ft.
    - Grade, Alignment
    - Type of pavement, Shoulders
    - Side slope
    - Medians

Congestion Problem

- Traffic control devices
  - Signs
  - Signals
  - Pavement markings
  - Markers and delineators

Congestion Problem

- Demographic information
  - Driver ages
  - Road user ages

Congestion Problem

- Operational data
  - Volume study
    - by mechanical counters
    - by electronic counters
    - manual counting (short counts)

Counting periods: generally 7am - 7pm

Peak periods: 7am - 9am, 12noon - 1pm and 4pm - 6pm.

Best days: Tuesday, Wednesday and Thursday.

A Few Terms Explained

PIEV = Perception + Intellection + Emotion + Volition

See → *Understand* → *Act* → *Execute*

Perception: The recognition or realization that a cue or stimulus exists that requires a response

Intellection: Identification of the cue or stimulus

A Few Terms Explained

Emotion: The determination of the appropriate response to the cue or stimulus

Volition: The physical response that results from the decision

PIEV for a normal person is assumed as 2.5 sec.

A Few Terms Explained

DHV = Design Hourly Volume

In other words, Design Volume

Calculated as the 30th Highest Hourly Volume of the year (abbreviated as 30 HV).

(Figure II-20 of AASHTO Green Book P-55)

Relationship of Highest Hourly Volume and ADT on Rural Arterials

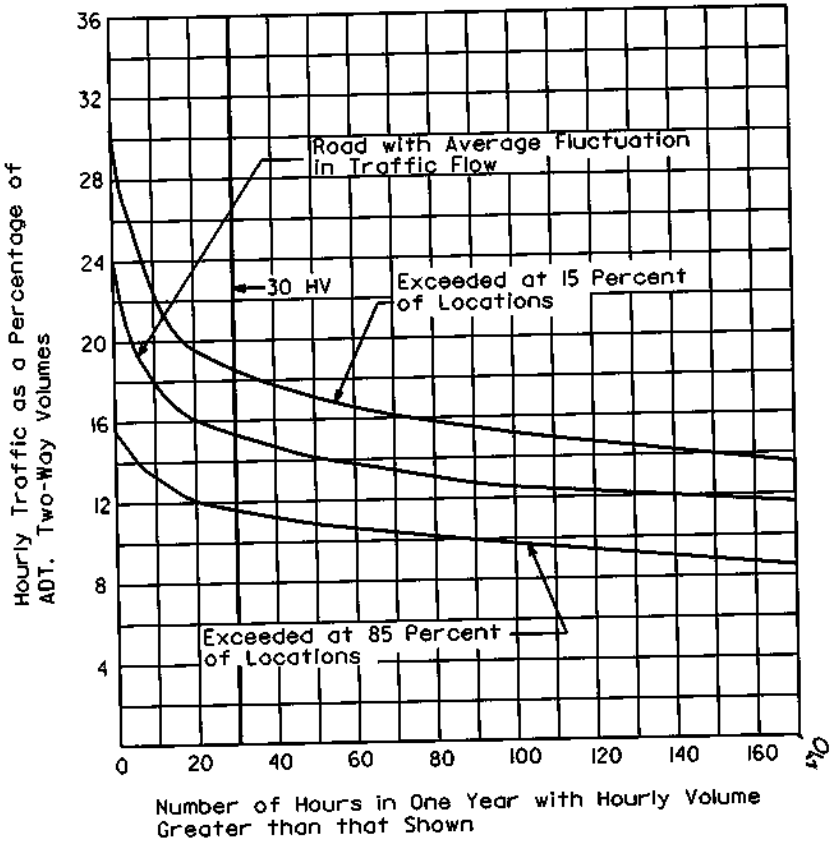


Figure II-20. Relation between peak-hour and average daily traffic volumes on rural arterials.

A Few Terms Explained

- The curve steepens quickly to the left of the point showing 30th highest hour, indicating much higher volumes if we include only a few more of the hourly volumes.
- The curve flattens to the right, indicating many hours in which the volume is not much less than 30 HV.

A Few Terms Explained

AADT = Average Annual Daily Traffic

It is the average 24-hour traffic volume at a given location over a full 365-day year - that is, total number of vehicles passing the site in a year divided by 365

Travel Time

By travelling several times in a car from A to B, a person notes down the time taken in each run and then comes up with a statistical average of Travel Time.

Delay

Delay = Actual travel time - Expected travel time

- Stopped time delay
- Travel time delay

Calculation of Delay

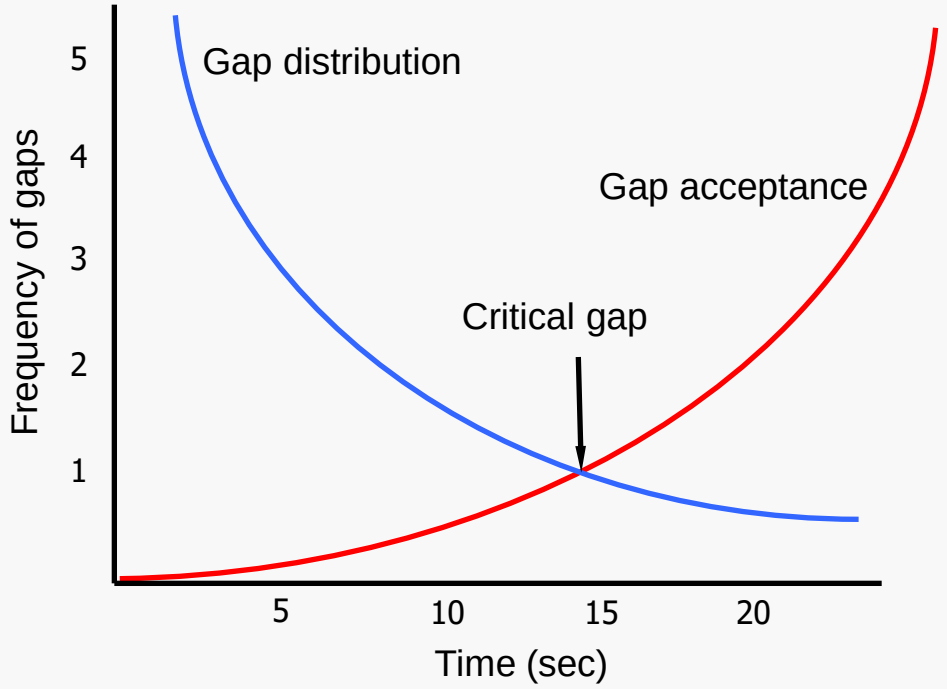
- Travel time delay
  - Actual travel time data collected by traveling in a car through the stretch of the road under study.
  - Expected travel time calculated from the distance and average speed.
  - Travel time delay calculated from the difference between actual travel time and expected travel time.
- Stopped time data for the vehicular speed of 0 to 5 mph.

Gap Study

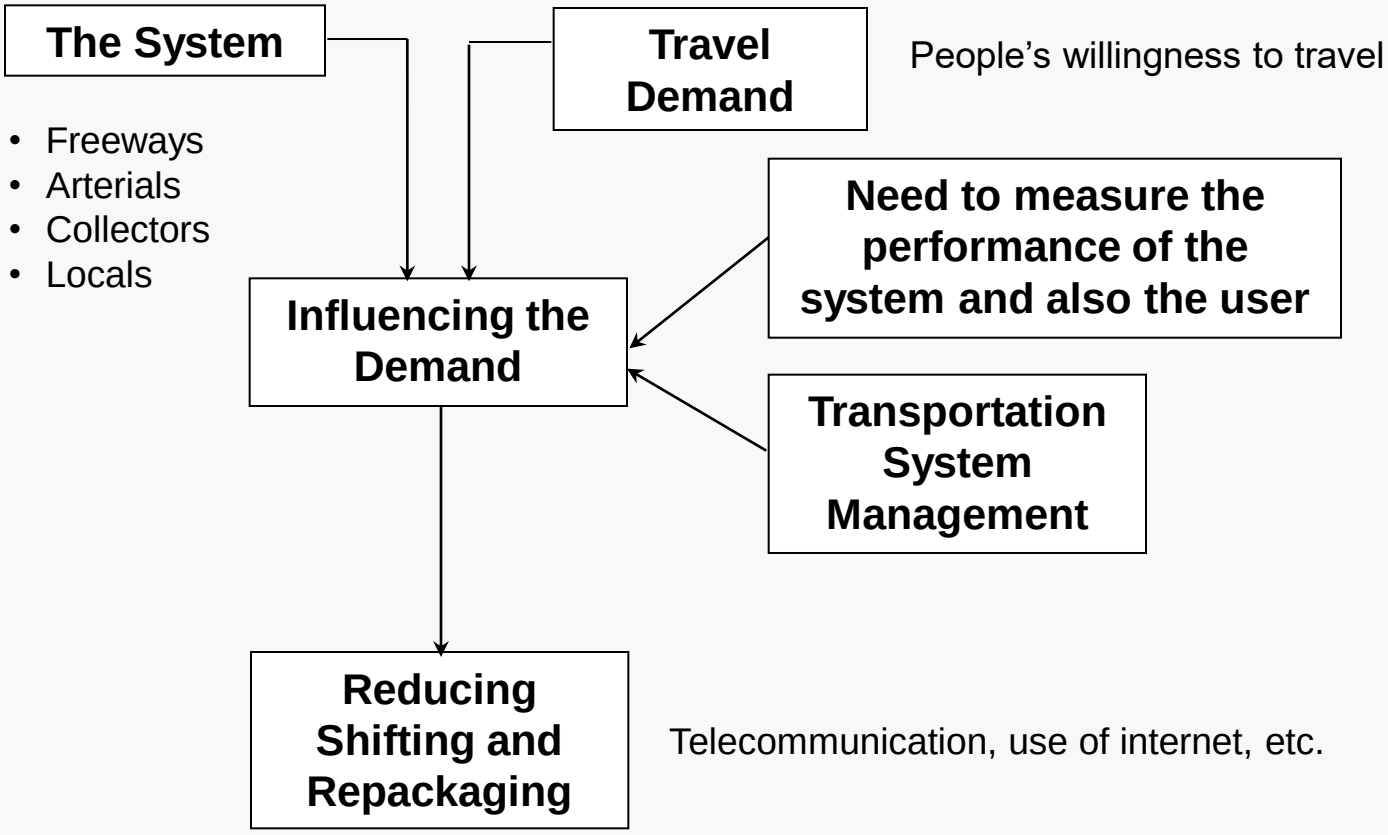
Gap is the time elapsed between the movement of two consecutive vehicles one following another.

Unit of gap is second.

Gap Distribution and Gap Acceptance Curves



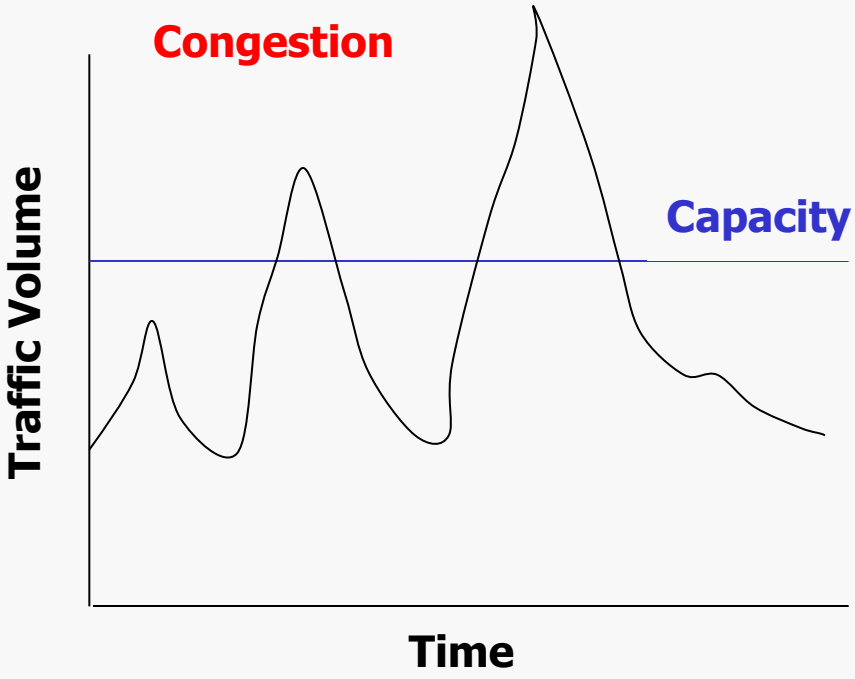
Transportation System



Basis of Design

- Not for maximum volume, rather for optimum volume.
- Shifting of demand is used to adjust the peak congestion
  - staggered work hours
  - flexible time

Traffic Volume w.r.t. Time



Obtaining Optimum Volume

- Reducing demand
  - shorter work week
  - shorter trip length
  - more work at home
- Repackaging demand
  - increased auto occupancy
  - transit usage - bus, rail, etc.
  - paratransit usage - taxi

Measuring the Performance

- Volume
  - Demand volume, discharge volume
- Speed
  - Average travel speed, spot speed, space mean speed
- Delay
  - Total delay, travel time delay, stopped time delay
- Trip time
  - Average travel time

Measuring the Performance

- Volume/Capacity Ratio
  - Ratio of traffic demand to highway capacity
- Vehicle occupancy
  - Number of persons occupying a vehicle

Components of Traffic System

- Road users
  - Drivers
  - Passengers
  - Pedestrians
  - Bicyclists

Components of Traffic System

- Vehicles
  - Passenger car
  - Single-unit truck
  - Single-unit bus
  - Articulated bus
  - Semi-trailer
  - Motor home
  - others

Components of Traffic System

- Highways
  - serving two different purposes
    - Movement
    - Mobility and land access.

Drivers

- PIEV Time - 2.5 sec for a normal person
- Glare - blinds the eyes of drivers; therefore, design should minimize glare.
- Night driving
  - ambient light
  - head light