**Traffic Engineering**

**Pedestrian Flow Theory**

**Key differences between car traffic and pedestrian traffic**

**Aspect**  Dimensionality Direction Multiple Contact Interaction Rules

**Cars** Movement in one dimension Single direction flow No physical contact strongly affect interactions

**Pedestrians**  Movement in two dimensions directional flow Physical contact drives dynamics

Subconscious drives behavior

**Pedestrian Data collections**

Many traditional observation techniques are not suitable for pedestrian flow observation (inductive loops, pneumatic tubes)

**examples of ped data collection**

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**Pedestrian Flow Characteristics**

1. Flow

2. Density

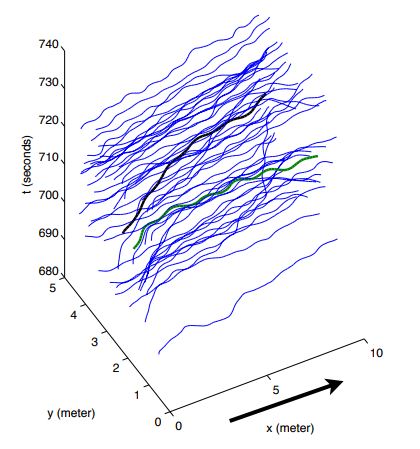
3. Speed

**Microscopic flow variables**

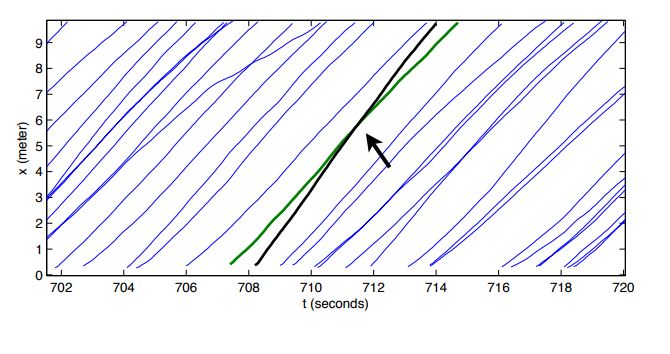
•Pedestrian trajectories describe position of a pedestrians as a function of t

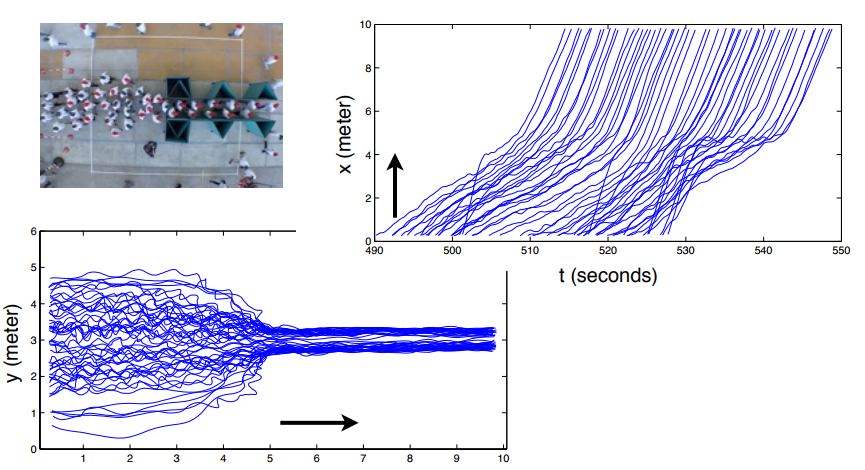
• Example taken from TUD pedestrian experiments

• Projection of 2D movement onto main direction of motion yields regular trajectories in which overtaking / passing etc can be identified.



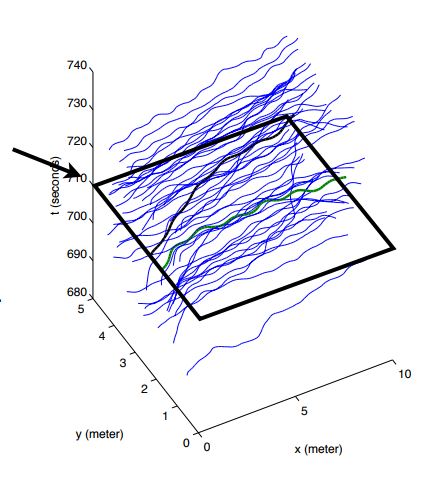
Passing maneuver in xt-plane

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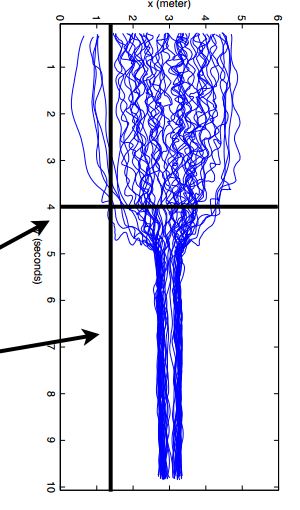
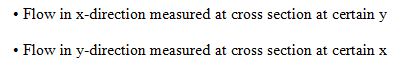
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**Density:**

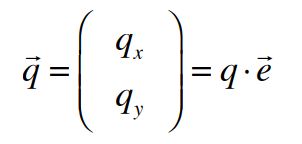
Is an instantaneous variable describing number of pedestrians in an area per unit area (P/m2).



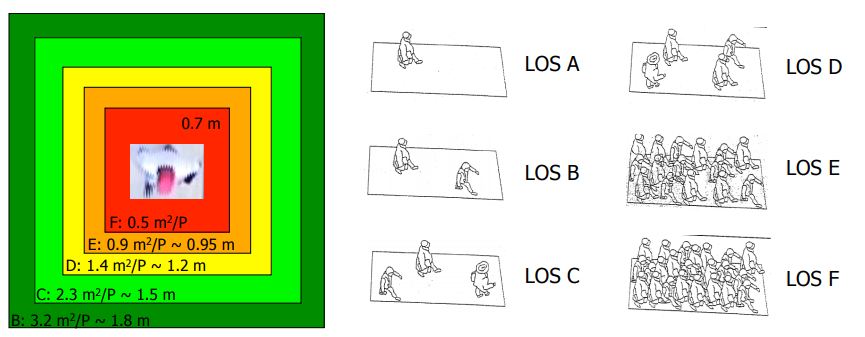
**Flow**: can be defined in relation to a cross section (a line in two-dimensional space).

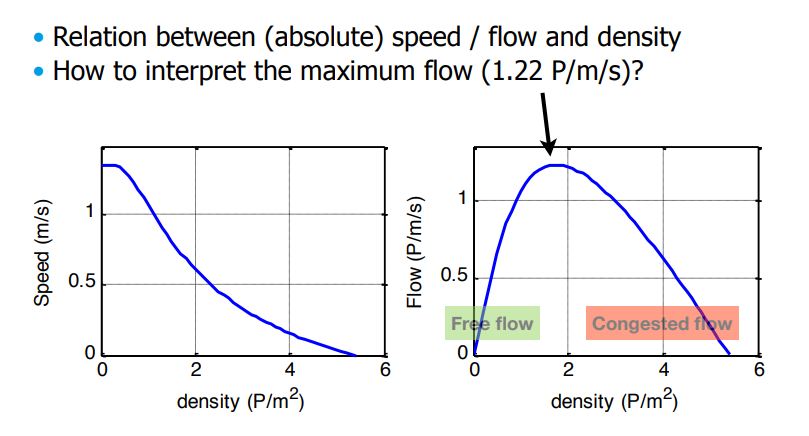


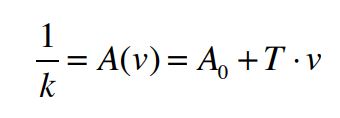
• Flow at a location (x,y) thus has direction

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**Service Levels Identification**

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**Factors affecting the FD**

• Flow composition

- Age, gender,

- Walking purpose (e.g. leisure, commuting, shopping)

• Walking infrastructure

- Surface inclination

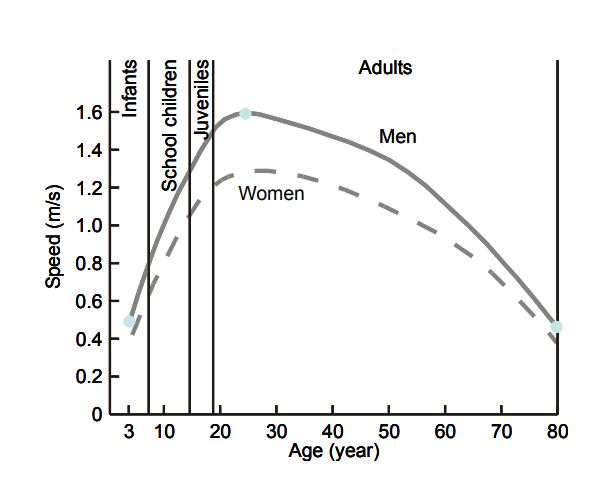
- Stairs

• Environment

- Temperature,

- weather conditions.

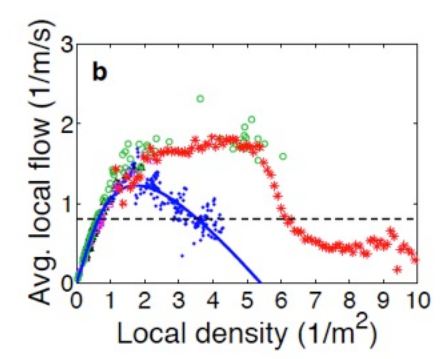
**Impact of gender and age**

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**Fundamental diagram Hajj**

Measured flow-density relation at Jamarat bridge

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**Pedestrian crowds**

Existence of new ‘turbulent’ traffic state:

• Dynamics of flow are governed by physical interactions.

• Density is extremely high (8-10 P/m2).

• Pedestrians move uncontrolled in multiple directions.

• Pressure on pedestrians can be very high, situation is very dangerous.