Objective: To show how standards for sizing can be integrated into design

Topics
  1. Procedure
  2. Practical Example: Paris/de Gaulle, Air France Passenger Building
## Procedure

1. **Estimate Critical Loads**; Identify “hot spots”
2. **Calculate Requirements**
   - Storage Areas
     - Lines
     - Hold Spaces
   - Flows
     - Corridors
     - Passageways
3. **Integrate into Design**

## Critical Loads (1)

The essential problem is:

**CONCENTRATION OF TRAFFIC**

in time and space

- People do not spread out evenly
- People normally cluster in attractive places:
  - around check-in desks, gate areas
  - at mouth of baggage claim
  - at nearest of many facilities
Critical Loads (2)

- **Concentration phenomenon**
  - Creates bottlenecks
  - These define capacity

- **Concentration phenomenon means:**
  - Capacity of a large facility cannot be found simply by applying standards to whole area

- **Failure to grasp this fact often causes significant design failures**

Example Hotspot
Estimation of Loads

Three important ideas:

1. Cumulative Arrival Diagram
2. Empirical Measurements necessary for each situation, site
3. Modulation by secondary activities

Calculation of Requirements

Recall from discussion of capacity:

- Storage Facilities
  - queues, hold rooms, ... Require tradeoff: Cost vs. LOS

- Flow Facilities
  - corridors, stairs, ... Capacity much greater than most designers imagine
Calculating Storage Facilities I

Two Phases:

• Exploration of Tradeoffs
  → Using cumulative arrival diagram

• Sizing of Space

Calculating Storage Facilities II

• Use of Cumulative Arrival Diagram
  → 1. Estimate, plot arrivals of Customers based on local measurements
  → 2. Superimpose departures of Customers generated by service rate of check-in, aerobridge, gate, ...
  → 3. Establish Maximum Customers Waiting as difference between arrivals and departures
  → 4. Explore Effect of Alternatives
Dwell Time Comparisons

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Percent of Passengers with dwell time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>under 1 hour</td>
</tr>
<tr>
<td>Domestic</td>
<td>46</td>
</tr>
<tr>
<td>International</td>
<td>29</td>
</tr>
</tbody>
</table>

Source: Confidential Survey at a Major International Airport in North America (1995)

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Percent of Passengers with dwell time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>under 1 hour</td>
</tr>
<tr>
<td>Transfer</td>
<td>47</td>
</tr>
<tr>
<td>Non-Transfer</td>
<td>42</td>
</tr>
</tbody>
</table>

Source: Confidential Survey at a Major International Airport in North America (1995)

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Percent of Passengers with dwell time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>under 1 hour</td>
</tr>
<tr>
<td>Business</td>
<td>46</td>
</tr>
<tr>
<td>Pleasure</td>
<td>41</td>
</tr>
</tbody>
</table>

Source: Confidential Survey at a Major International Airport in North America (1995)

Calculating Storage Facilities III

- Two kinds of calculations:
  1. Area = (Customers) (sq. m. per person) using appropriate space standards
  2. Queue Length = (Customers) (0.6 m. per person)

- Note: Queues generally project awkwardly
  ➔ Often block passage for other customers
Typical Cumulative Load Diagram (Paris 1980)

![Cumulative Load Diagram](image)

Typical Design Tradeoff for “Storage” Facilities

![Design Tradeoff Diagram](image)
Typical Basis for Modulating Cumulative Load Diagram

Typical Final Cumulative Load Diagram
Calculating Flow Facilities I

- **Note Carefully:**
  1. Implication of Flow crucial
  2. Flow \( \rightarrow \) more apparent space
  3. Big difference between Storage and Flow capacity

- **Example of Difference**
  - **Storage Capacity**
    - Space 3m wide, 30 m long \( \Rightarrow \) 90 sq.m area
    - Assume LOS = C \( \Rightarrow \) 1.9 sq. m per person
    - Storage capacity = 90 / 1.9 = 47 persons
  - **Flow Capacity**
    - Walking at 66m / minute
    - Apparent area = 3m (66 m/min) = 198 sq m / min
    - Flow Capacity = 198/1.9 = 94 persons / min = 5460 /hour!!!

Calculating Flow Facilities II

- **Procedure**
  1. Choose LOS, Level of Service
     \( \Rightarrow \) PMM, Persons per Meter width per Minute
  2. Calculate Effective Width Needed
     \( = \) Flow per minute / PMM
  3. Calculate Minimum Design Width
     \( = \) Effective Width + 1.5m.

  *Extra is for edge effects due to walls, counter flows, ...*
Example: Paris / de Gaulle
Air France Building

- Typical features before revision:
  - 1 hour flight turnaround at gate
  - 300 passengers per flight
  - 6 check-in counters per flight
  - 8 m. between counters and wall
  - 1.5 minute check-in time per passenger
  - 0.6 m. per passenger in line

Example Difficulties

- Counters insufficient
  Passengers per minute = 300 / 50 = 6
  Counters required = 6 (1.5 min) = 9 > 6

- Queue Space insufficient
  Assume half, 150 passengers wait
  Average queue = 150 / 6 = 25 ==> 25 (0.6 m.) = 15 > 8 m.
## Example: Paris / de Gaulle Air France Building

<table>
<thead>
<tr>
<th>Intercontinental (2A) after revision:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.30-2hr flight turnaround at gate</td>
</tr>
<tr>
<td>300 passengers per flight</td>
</tr>
<tr>
<td>6 check-in counters per flight</td>
</tr>
<tr>
<td>12 m. between counters and wall</td>
</tr>
<tr>
<td>2 minute check-in time per passenger</td>
</tr>
<tr>
<td>0.6 m. per passenger in line</td>
</tr>
</tbody>
</table>

| 4 Flights/gate per day               |

## Example: Paris / de Gaulle Air France Building

<table>
<thead>
<tr>
<th>European (2B) after revision:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45-1 hour flight turnaround at gate</td>
</tr>
<tr>
<td>100 passengers per flight</td>
</tr>
<tr>
<td>3 check-in counters per flight</td>
</tr>
<tr>
<td>12 m. between counters and wall</td>
</tr>
<tr>
<td>1.5 minute check-in time per passenger</td>
</tr>
<tr>
<td>0.6 m. per passenger in line</td>
</tr>
</tbody>
</table>

| 8 Flights/gate per day              |
Revision of Air France Passenger Building

Two main steps:

1. To create queue space ==> eliminate obstructions (telephones, ...) ; add counters
2. To guarantee service ==> Reduce Gate Use, using up to 2 hour turnaround

- Capacity drops: 10-- 8 to ~ 6 flights/day
- 50% more space needed to service load

- Very Expensive problem!!!