Design of Components of Airport Passenger Buildings

Dr. Richard de Neufville

Professor of Engineering Systems and Civil and Environmental Engineering
Massachusetts Institute of Technology

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

### Domestic Passengers Spend less Time at the Airport than International

<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)

### Transfer Passengers Spend less Time at the Airport than Non-Transfer

<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)

### Business Passengers Spend less Time at the Airport than Pleasure

<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. $\text{Area} = (\text{Customers}) \times (\text{sq. m. per person})$
     using appropriate space standards
  2. $\text{Queue Length} = (\text{Customers}) \times (0.6 \text{ m. per person})$

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

![Diagram showing cumulative load over time for different flight departures.]

Typical Design Tradeoff for “Storage” Facilities

![Diagram showing cumulative passengers served over time with key indicators such as service completed and speed of service.]

Airport Systems Planning & Design / RdN
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 => more apparent space
  → 3. Big difference between Storage and Flow capacity

• Example of Difference
  → Storage Capacity
    • Space 3m wide, 30 m long => 90 sq.m area
    • Assume LOS = C => 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
      => 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. 1 hour flight turnaround at gate
  2. 300 passengers per flight
  3. 6 check-in counters per flight
  4. 8 m. between counters and wall
  5. 1.5 minute check-in time per passenger
  6. 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

• Intercontinental (2A) after revision:
  → 1.30-2hr flight turnaround at gate
  → 300 passengers per flight
  → 6 check-in counters per flight
  → 12 m. between counters and wall
  → 2 minute check-in time per passenger
  → 0.6 m. per passenger in line

• 4 Flights/gate per day

---

Example: Paris / de Gaulle
Air France Building

• European (2B) after revision:
  → 0.45-1 hour flight turnaround at gate
  → 100 passengers per flight
  → 3 check-in counters per flight
  → 12 m. between counters and wall
  → 1.5 minute check-in time per passenger
  → 0.6 m. per passenger in line

• 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!!!