Airport Planning and Terminal Design

presented by

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Major Terminal Design Considerations

- Passenger Terminal Configuration
- Major Design Considerations
- Passenger Terminal Concepts
Terminal Configuration

- Centralised processing building connected by people mover system to satellites

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Denver International Airport

- Satellite Buildings
- People Mover System
- Terminal Building
Heathrow Airport Alternatives

Terminal Configurations

Centralised passenger processing terminal building with finger piers
Passenger Terminal Concepts

Basic Planning Criteria in Development of Passenger Terminals

- Easy orientation
- Simplicity
- Minimise walking distances
- Minimise level changes
- Minimise pax cross-flows
- Compatibility of facilities with aircraft characteristics
- Built-in flexibility to accommodate future changes in dynamic industry
- Traffic peaking characteristics
- Transfer volume and connecting times
Passenger Terminal Concepts

1. Pier/Finger
2. Linear
3. Transporter
4. Satellite
5. Compact Module Unit Terminal

Passenger Terminal Concepts

1. Pier/Finger

Nashville  P  Baltimore - Washington
### Passenger Terminal Concepts

#### 1. Pier/Finger

**Advantages**
- Centralized resources, economies of scale (human, facilities, amenities)
- Facilitates pax management
- Economical to build
- Efficient use of land

**Disadvantages**
- Long walking distances
- Kerbside congestion
- Limited expansion capability
- Reduced aircraft circulation & manoeuvrability
- Limited compatibility of future aircraft design development

#### 2. Linear

![Diagram of Linear Passenger Terminal Concepts](image-url)
### 2. Linear

**Advantages**
- Shortest walking distances
- Clear orientation
- Simple construction
- Adequate kerb length
- Shorter close-out times
- Lower baggage systems costs (conveying/sorting) using decentralized system

**Disadvantages**
- Duplication of terminal facilities/amenities
- Longer minimum connecting time
- Longer walking distances for transfer pax
- Special logistics for handling of transfer bags
- Less flexibility in terminal and apron for future changes in operations eg aircraft design, airlines

### 3. Transporter

![Passenger Terminal Concepts Diagram]

- Dulles International

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*Strategic Airport Management Programme*

9-13 April 2007
## Passenger Terminal Concepts

### 3. Transporter

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy compatibility of terminal/apron geometry and future aircraft design development</td>
<td>Higher instances of pax delays</td>
</tr>
<tr>
<td>Ease of aircraft manoeuvrability</td>
<td>Early closed-out times</td>
</tr>
<tr>
<td>Ease of expansion capability for aircraft stands</td>
<td>High capital, maintenance &amp; operating costs</td>
</tr>
<tr>
<td>Simple and smaller central terminal</td>
<td>Susceptible to industrial disputes with vehicle drivers</td>
</tr>
<tr>
<td>Cost savings</td>
<td>Increased vehicular movements on airside with aircraft</td>
</tr>
<tr>
<td></td>
<td>Kerbside congestion</td>
</tr>
<tr>
<td></td>
<td>Increased minimum connecting times</td>
</tr>
</tbody>
</table>

### Passenger Terminal Concepts

### 4. Satellite

![Satellite Diagram]

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9
Passenger Terminal Concepts

4. Satellite

**Advantages**
- Centralized resources (human, facilities and amenities)
- Facilitates pax management
- Additional satellites can be designed to accommodate future aircraft design developments

**Disadvantages**
- Requires high technology, underground transportation system
- High capital, maintenance & operating cost
- Kerbside congestion
- Limited expansion capability at main terminal
- Increases minimum connecting times
- Early closed-out times

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Passenger Terminal Concepts

5. Compact Module Unit Terminal

Diagram of compact module unit terminal with P marking passenger areas.
Passenger Terminal Concepts

5. Compact Module Unit Terminal

**Advantages**
- Short walking distances
- Late closed-out times
- Longer kerb length than conventional central terminal
- Capital investment is commensurate with demand
- Simple pax & baggage transportation/sorting systems within each module
- Low baggage mishandling potential

**Disadvantages**
- Multi-compact module units require pax and bag transfer systems between terminals
- Duplication of facilities, higher operating costs

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Changi Airport Terminal Concept

**Hybrid Concept**

- Provide large passengers processing capacity
- Permit centralization of facilities and amenities
- Manpower saving in the centralization system
- Facilitate flow and orientation of passengers
- Reasonable check-in and close-out times
- Higher level of service
**Changi Airport – Terminal 3**

**Major Considerations**

*Key for Management to first define its objectives*

- **Type of airport operations:** hub, point-to-point, low cost, charters, general aviation
- **Demographics of pax:** international/domestic, business/tourists
- **Level of service**
- Establish key design criteria/parameters = design brief: simplicity, clarity, efficiency, minimum change in level, comfort, ambience, architectural statement/icon, state-of-the-art technology, low operating costs
- Prioritise design criteria/parameters
Major Considerations

What factors contribute towards a good terminal building design?

- Passenger Flow
- Walking Distance
- Level of service for passengers
- Performance standards
- Traffic peaking characteristics
- Future growth
- Sophisticated and costly airport systems
- Ease of wayfinding
- Processing times
- Retail

Passenger Flow

Minimise level changes
Segregation of screened pax

TYPICAL PIER SECTION

... DEPARTURES FLOW
... ARRIVALS FLOW
Passenger Flow

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Passenger Flow

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Passenger Flow

Walking Distance

A major quantifiable factor that takes into account the psychology of users and proportions of buildings relative to human scale
### Walking Distance

#### Aided and Unaided walking distances

- **IATA**: < 300m unaided
- **AdP**: < 300m unaided; < 900m with travellators
- **BAA**: < 250m unaided; < 650m with moving sidewalks
Capacity is a function of Level Of Service

- A facility can operate at varying degrees of congestion and delay depending on level of service intended

Established design norms:
IATA’s Level of Service (LOS) Framework consisting of six categories, i.e. from LOS “A” to “F”

- **LOS “A”**: Excellent LOS, free flow, no delays and excellent level of comfort
- **LOS “C”**: Unacceptable LOS, cross flow, system breakdown and long delays and unacceptable level of comfort

Unacceptable LOS, cross flow, system breakdown and long delays and unacceptable level of comfort
IATA Level of Service Space Standards for Airport Passenger Terminals

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-in queue area</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Wait/circulate</td>
<td>2.7</td>
<td>2.3</td>
<td>1.9</td>
<td>1.5</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Hold room</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
<td>-</td>
</tr>
<tr>
<td>Bag claim area</td>
<td>2.0</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>(excluding claim device)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government inspection</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>
Performance Standards

Translate expectations of service standards into quantifiable measures, differs from airport to airport

- Processing speed
  - check-in process
  - immigration/customs clearance
  - pax and baggage security screening
  - baggage delivery
- Functionality standards
  - Minimum connecting time
- Availability
  - Key operating systems eg flight monitor, escalators, trolleys etc

Traffic Peaking Characteristics

- Pax Traffic
  - “Peaky” Pattern
  - “Flat” Pattern

| Time (Hour) |
|------------|---|---|---|---|---|---|---|---|
|             | 03 | 06 | 09 | 12 | 15 | 18 | 21 | 24 |
| Pax Traffic | 2  | 2  | 2  | 2  | 2  | 2  | 2  | 2  |
| Traffic Peaking Characteristics | Flat Pattern | Peaky Pattern | Peaky Pattern | Flat Pattern | Flat Pattern | Peaky Pattern | Flat Pattern | Flat Pattern |
Future Growth - Expandability

- Over or premature investment?
- Support modular expansion?
- Flexibility and constraints?
- Lead time needed to add capacity?
- Disruptions to existing operations?
Operating Costs - Maintenance

People mover system

Baggage handling and sorting system

Ease of Wayfinding

- Complex or convoluted paths?
- No clear line of sight to facilities?
- Poor accessibility to commercial areas?
- Multiple decision points?
- Back-tracking?
Ease of Wayfinding

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Ease of Wayfinding

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Facilitating Processes

- Centralised or decentralised?
- Required number of units for each facility?
- Accommodating changes in processing methodology?
- Use of technology vs resources?
- Reliability and redundancy?

Retail

- Airside or landside?
- Prime location vs operational needs?
- Increase dwell time vs efficiency?
- Creativity vs clarity?
Is there a practical limit to how large a terminal building can be?
Optimal Geometry

- Centralised terminal with finger piers
Establishing Optimal Size

Optimal Number of Piers = \( \sqrt{\text{Gates}} \)
[Reference: Bandara & Wirasinghe 1992]

For 6 piers,
Number of Gates = 32 to 42

Use of Planning Norms

20 to 25 million pax a year
Check walking distances for departing passenger travelling to the nearest and furthest gate.

Check walking distances for departing passenger travelling from kerbside to the furthest check-in island.

Check walking distances for transfer passenger travelling between the furthest gates.
### Table 1: Unaided Walking Distances

<table>
<thead>
<tr>
<th></th>
<th>20 mppa</th>
<th>22 mppa</th>
<th>25 mppa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerbside to furthest check-in island</td>
<td>195 m</td>
<td>205 m</td>
<td>235 m</td>
</tr>
<tr>
<td>Furthest check-in island to nearest gate</td>
<td>265 m</td>
<td>275 m</td>
<td>300 m</td>
</tr>
</tbody>
</table>

### Table 2: Aided Walking Distances

<table>
<thead>
<tr>
<th></th>
<th>20 mppa</th>
<th>22 mppa</th>
<th>25 mppa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furthest check-in island to furthest gate</td>
<td>495 m</td>
<td>515 m</td>
<td>550 m</td>
</tr>
<tr>
<td>Furthest gate to gate distance</td>
<td>790 m</td>
<td>840 m</td>
<td>1,000 m</td>
</tr>
</tbody>
</table>

### Optimal Terminal Size

Based on current technology, it appears that a centralised passenger terminal building with six finger piers handling 25 million passengers per is the optimum size.