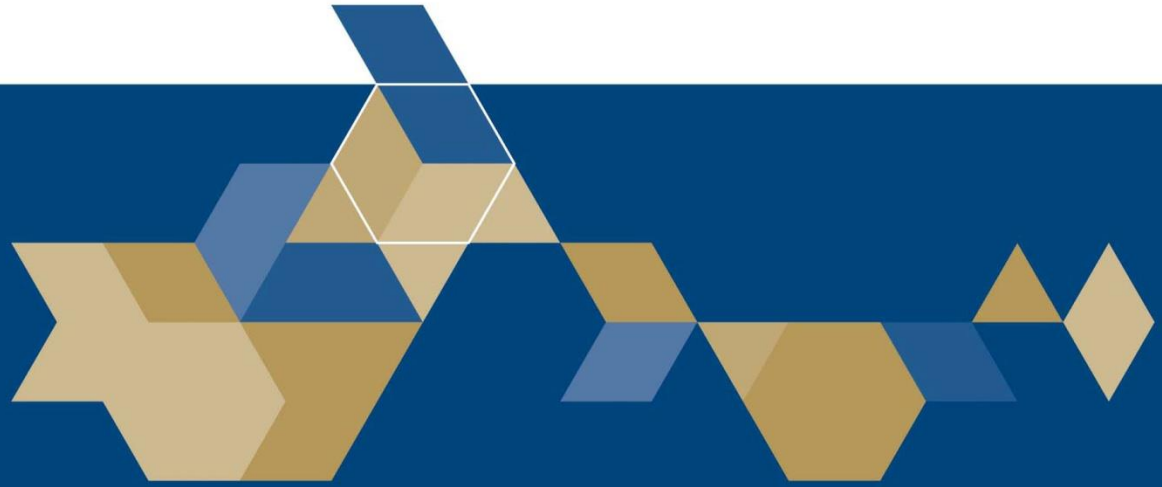


Passenger Building Design

Prof. Richard de Neufville

Istanbul Technical University

Air Transportation Management

M.Sc. Program

Airport Planning and Management

Module 18

January 2017

Design of Components of Airport Passenger Building

- Objective: To show how to integrate standards for sizing into design
- Topics
  - Procedure
  - Critical Loads = “hot spots”
  - Flows over time – not averages
  - Cumulative diagrams as design tool
  - Simulations provide detailed analysis
  - Practical Example: Paris/de Gaulle, Terminal 2 Passenger Building

Procedure

1. **Identify Critical Loads, “hot spots”**
    1. Actual peaks, not average flows
    2. Think through processes; “think like a passenger”
    3. Cumulative Diagrams
    4. “Think like a manager”
2. **Calculate Requirements**
    1. **Storage Areas:** Lines and Hold Spaces
    2. **Flows:** Passageways
3. **Integrate into Design**

Definition of Critical Loads (also known as “hot spots”)

Critical loads are those that define the capacity of a space or process

- **The essential problem is:**
  CONCENTRATION OF TRAFFIC
  in time and space
- **Concentration phenomenon**
  - **Creates bottlenecks – “hot spots”**
  - **These define capacity**

Concentration is Usual

- People naturally concentrate
  - In attractive places
  - At preferred, scheduled, or required times.
- Locational Examples
  - around check-in desks, gate areas
  - at mouth of baggage claim
  - at nearest of many facilities
- Temporal Examples
  - When a plane arrives, at immigration counters
  - When check-in counters open

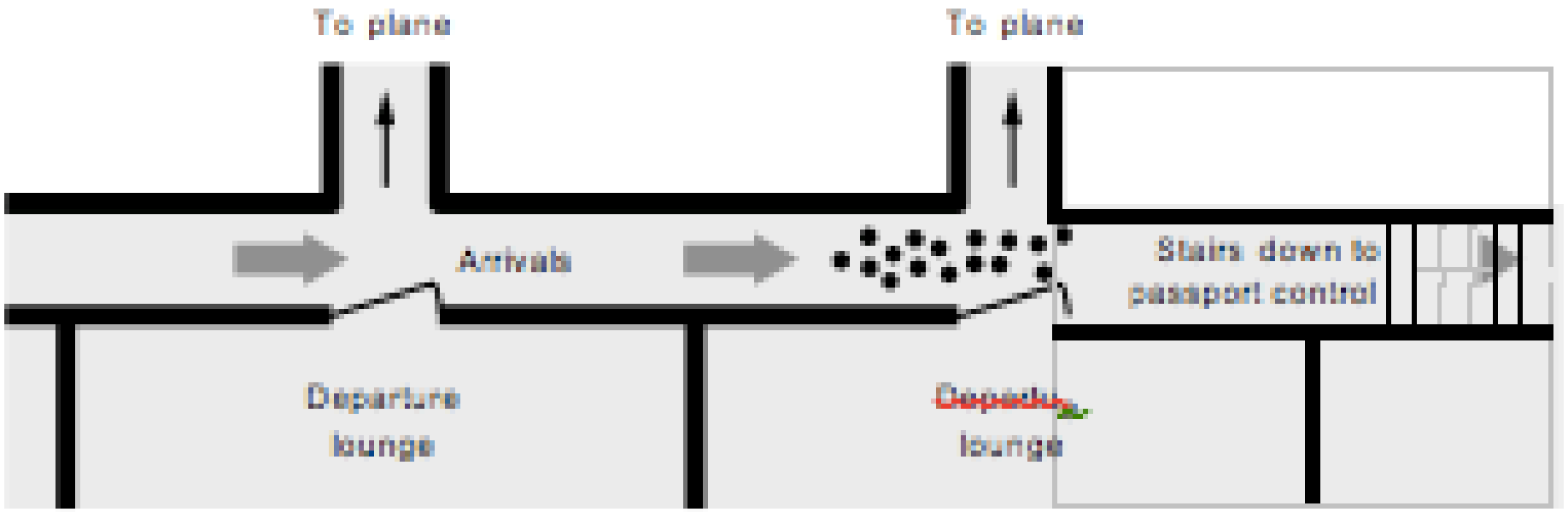
Result of Concentration

- **Concentration phenomenon means: Capacity of a facility cannot be found simply by applying standards to whole area**
- **Failure to grasp this fact often causes significant design failures**
- **We need to examine situations when and where “hot spots” occur**

Example Hot Spot:
Dallas / Fort Worth people mover

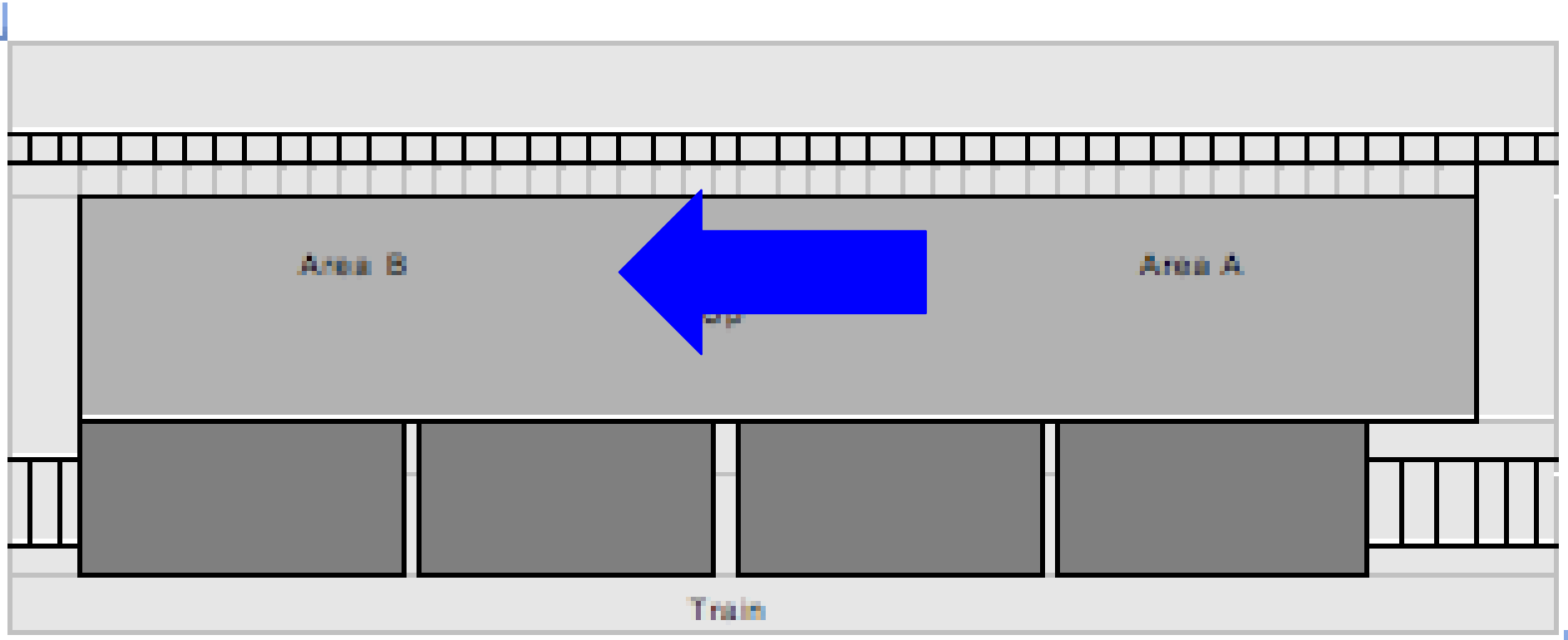
Example Hot Spot: Athens connections to aircraft

Conflicts between arriving and departing passengers



Example Hot Spot: Hong Kong

Travellers stack up at end of down staircase (to left of diagram)



How to find “hot spots”

What do you think?

1. Think like a customer moving through airport
2. Locational examples:
   - ✈ Where do you stand at bag carousel?
   - ✈ When faced with several choices, which queue do you join?
3. Temporal examples:
   - ✈ When do you arrive at airport?
   - ✈ Do you go from check-in directly to gate?

Need to examine Flows over Time

1. To find concentration, we need to look carefully at details of flows over time
2. Averages over hours or days not enough. 10 to 15 minute intervals may be good
3. We need to consider both sides
   - How fast people arrive at process (check-in, security, etc.)
   - How fast do they leave the process
   - Difference defines Wait Time, Queue Length

Tool: Cumulative Load Diagram

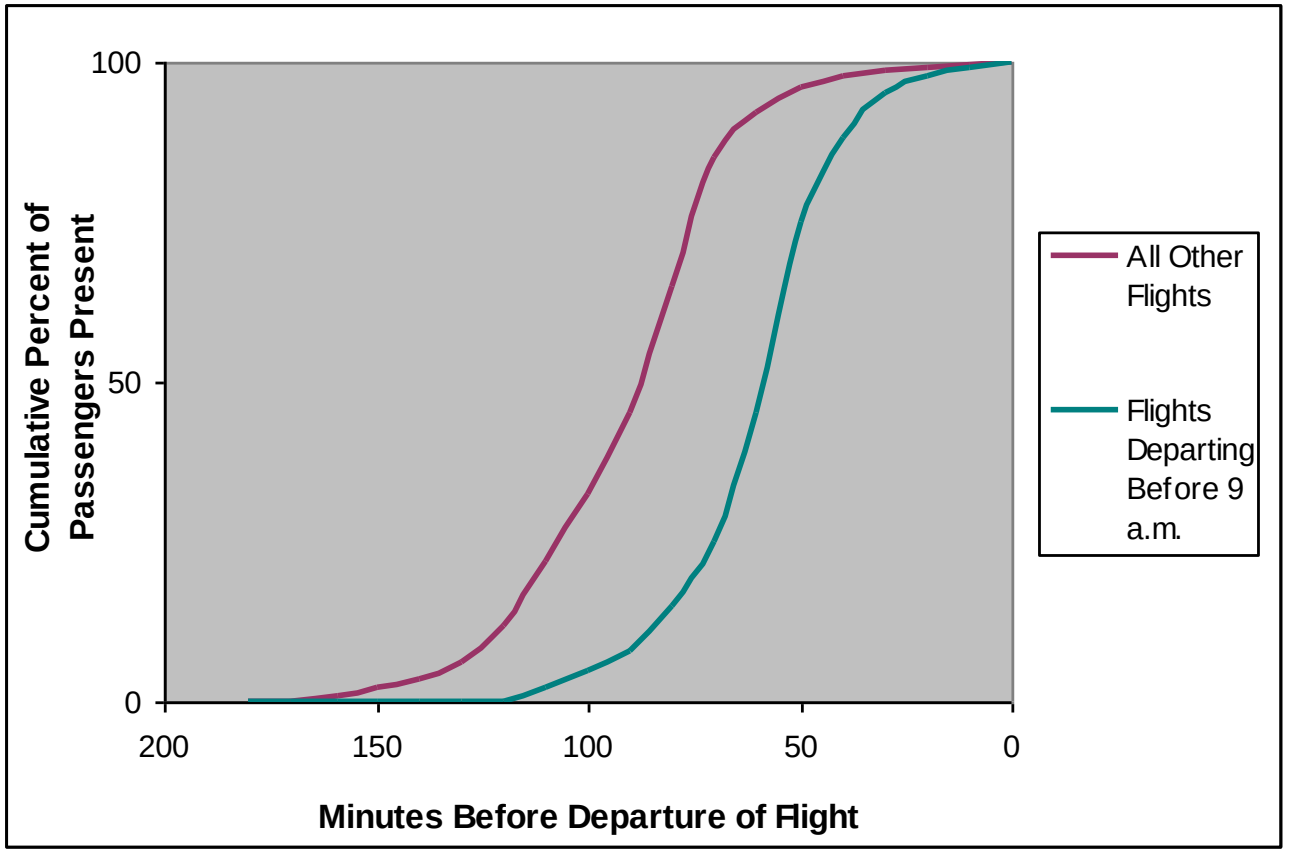
Estimation of Loads over Time

Four important ideas:

1. **Cumulative Load Diagram**
   - Plot Flows (vertical) against Time (x-axis)
   - Queue length = Horizontal distance between arrivals and exits from process
   - Wait Time = Vertical distance between them
2. **Empirical Measurements necessary for each situation, site**
3. **Modulation by secondary activities**
4. **Management Impact on performance**

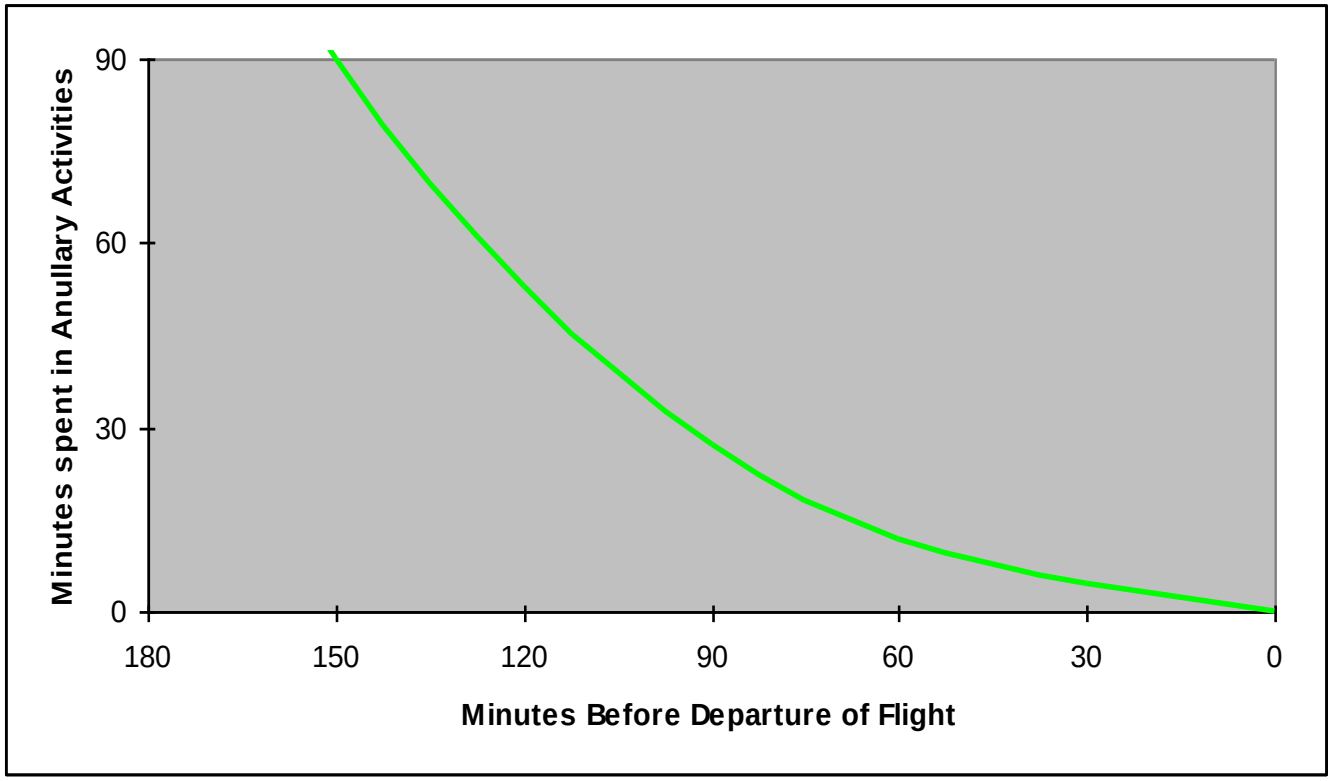
Some Cumulative LoadDiagrams (before and after 09.00)

Think like a passenger arriving before or after 09.00 What would you do?

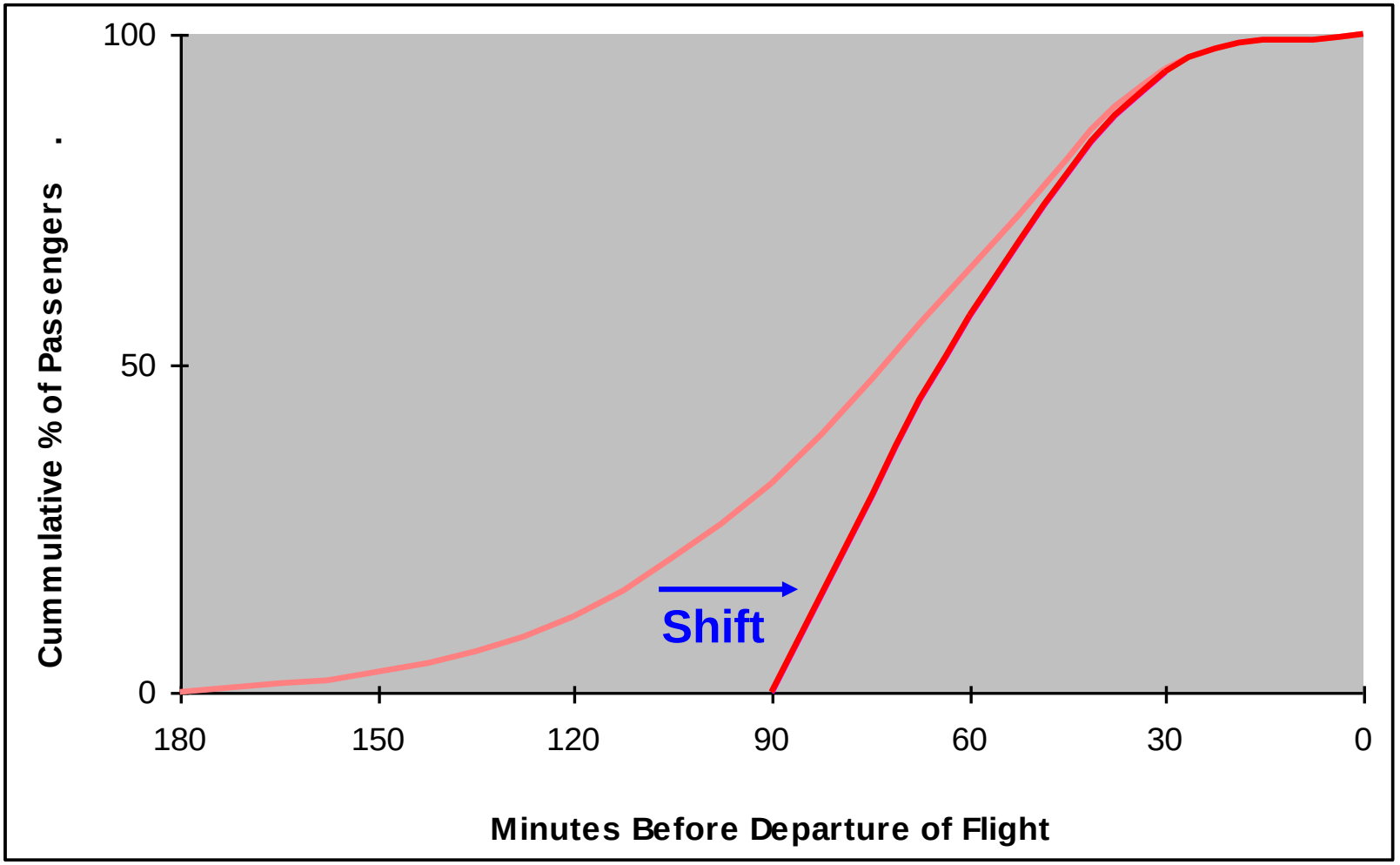


Conceptual Basis for Modulating Cumulative Load Diagram

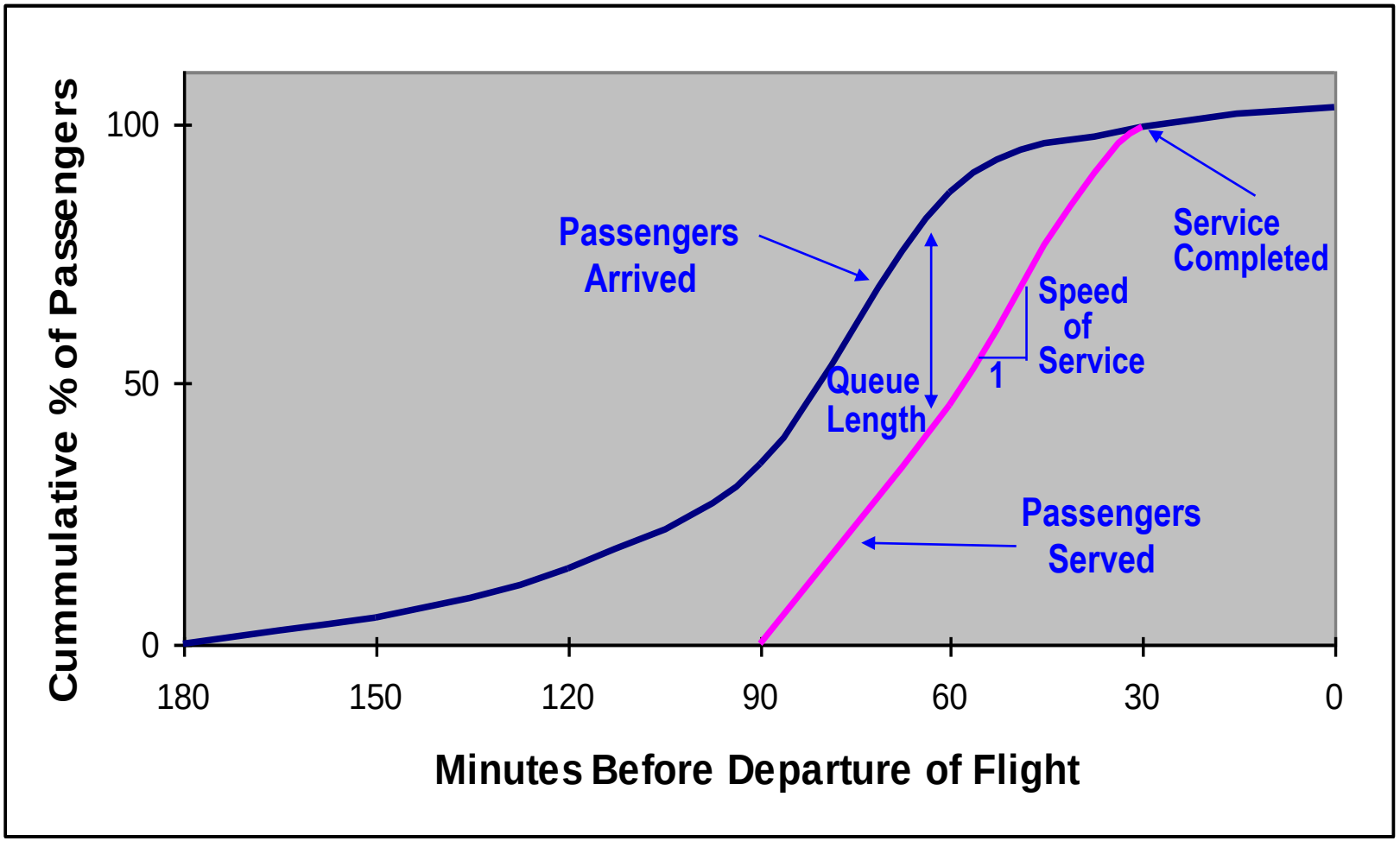
Passengers spend time in shops, etc. before gates
The earlier they arrive, the longer they shop, etc.



Final Cumulative Load Diagram Downstream from first arrival



Interpretation of Cumulative Load Diagram



Note Carefully: Management will define loads!

How is this possible?

- Because Managers influence staffing of various processes (check-in agents, etc.)
  - ✈ Several different managers – airport, airlines, security services, frontier control
- Managers set the staffing of processes, they thus determine rate of exit from process
  - ✈ Defines slope of pink line in diagram

Management will vary service

- Staffing decisions may vary by time of day
  Why is this? **Examples?**
- Open service with few employees, increase staff later toward peak => saves labor costs
- These decisions directly affect queue both
  - Queue length; Wait time
  - And whatever happens downstream
- London/Heathrow Example:
  - passport control slow, long waits
  - “no wait” at bag claim afterwards

Calculating Storage Facilities

Use Cumulative Arrival Diagram to explore trade-offs between size and service

1. **Estimate, plot arrivals of Customers based on local measurements**
2. **Superimpose departures of Customers generated by service rate of check-in, security, gate, immigration control, etc.**
3. **Establish Maximum Customers Waiting as difference between arrivals and departures**
4. **Explore Effect of Alternatives**

Detailed analysis now done by simulation

Calculation Reminders

- **Area calculations:**

  Area = (Customers) (sq. m. per person)
  using appropriate space standards and dwell time

- **Queue Length**

  Queue Length ~ (Customers) (~ 0.6 m. per person)

- **Queue Length note**
  - **Queues generally project awkwardly**
  - **Often block passage for other customers**

Example Application
Paris / de Gaulle Terminal 2

- **First some Motivation for the Example**
- **Experience of Terminal 1 – original master plan saw it as 1st of 5 identical buildings**
  - ✈ very poor experience with bags
  - ✈ About 1% were “lost” in that could not be delivered to passengers in reasonable time (and thus had to be taxied to hotels, etc. at great expense)
- **Experience motivated design of Terminal 2 – passengers carry bags to gate check-in. No check-in until previous flight cleared (so bags do not get mixed)**

Paris/de Gaulle

- This is Terminal 1, where the bags got lost
- Note road wrapping building, garage on top.
- Passengers debark diametrically opposite gate!

Source: Aéroports de Paris

Paris / de Gaulle Terminal 1

Summary of Issues

- Totally inflexible for expansion
  - Main building in a hole
  - Wrapped around by roadway lanes
  - Capped by parking garage
- Confusing
  - Departure gates opposite plane locations
  - Road turns passengers through ~ 720 degrees
- Bag room a mess
  - Too small – bags stacked outside in weather
  - Piled on top of each other
  - Inefficient technological innovation!

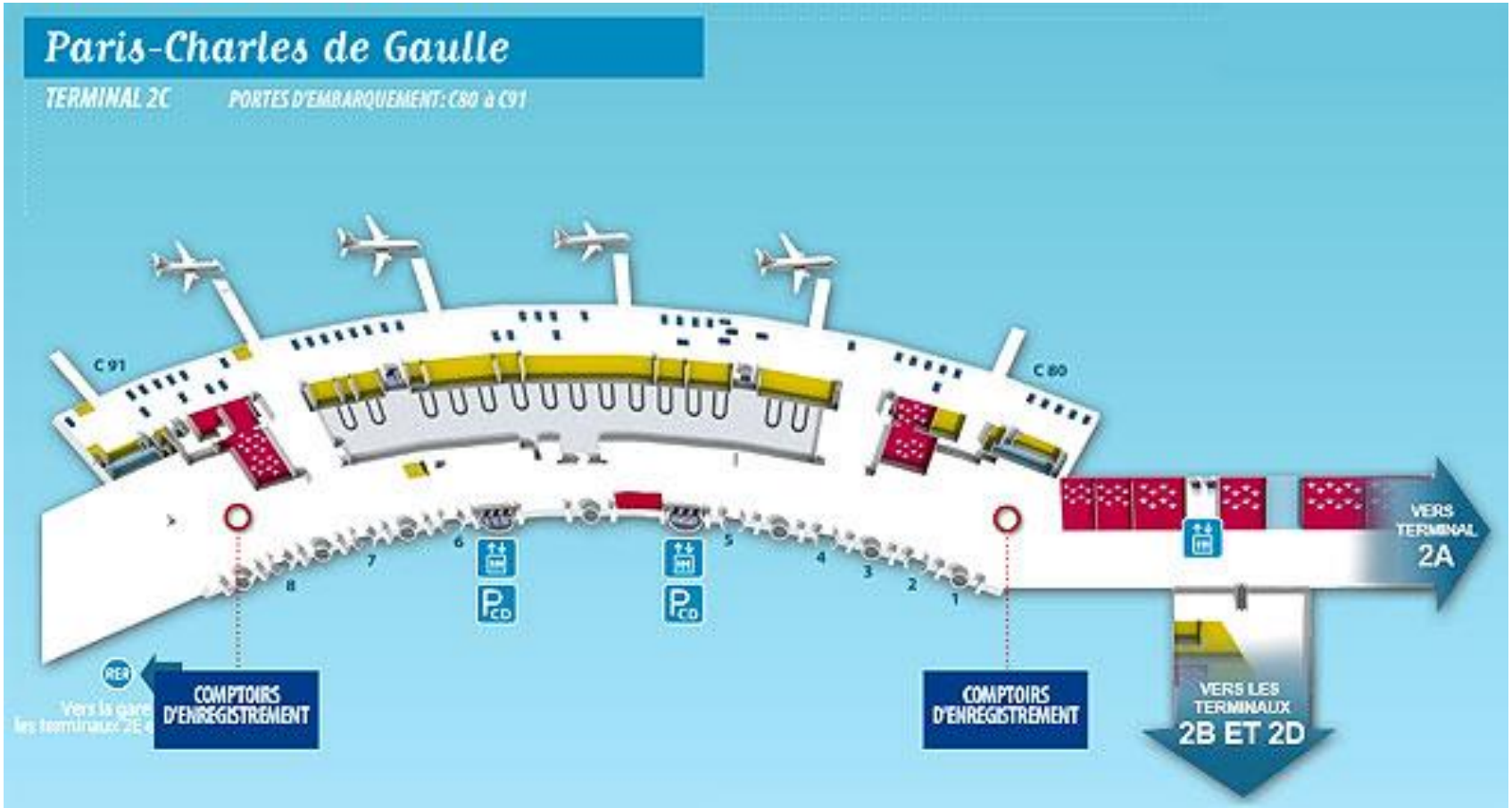
Paris/ de Gaulle Terminal 2C

- Note distance between building and aircraft
- Much waste of valuable space!

Source: Aéroports de Paris

Paris / de Gaulle

Plan view of Terminal 2C



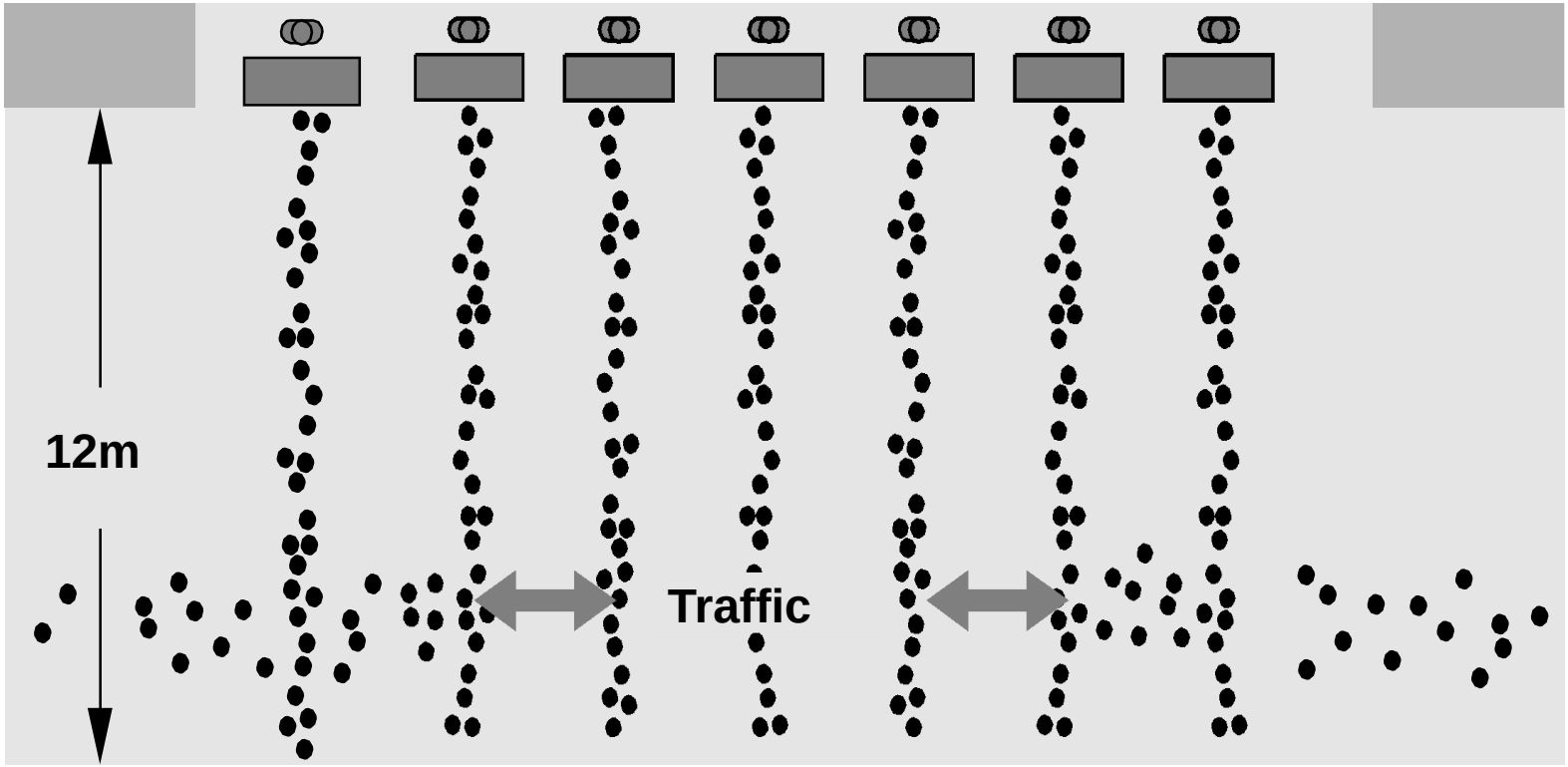
Source: Aéroports de Paris

Original Design: Paris / de Gaulle Terminal 2

- **Anticipated Capacity before revision:**
  - 1 hour flight turnaround at gate
  - 300 passengers per flight capacity
- **Design features**
  - 6 check-in counters per flight
  - 12 m. between counters and wall
- **Service assumptions**
  - 1.5 minute check-in time per passenger
  - 0.6 m. per passenger in line

Hot Spot in front of check-in Paris / de Gaulle

Details of “hot spot” in Terminal 2C



Specific Difficulties
Paris / de Gaulle Terminal 2

- **Hot spot: concentration of passengers in front of check-in counters:**
  - ✈ **Many passengers arrive before counters open**
  - ✈ **These crowd check-in when it opens**
- **Counters insufficient**

  Passengers per minute = 300 / 50 = 6

  Counters required = 6 (1.5 min) = 9 > 6
- **Queue Space insufficient**

  If 150 passengers wait:

  Average queue = 150 / 6 = 25

  Average queue length => 25 (0.6 m.) = 15 > 12 m.

Design Revision: Paris / de Gaulle Terminal 2

Two main steps:

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

- **Capacity loss: from 10 to ~ 6 flights/day**
- **50% more space needed to service load**
- **Very Expensive problem!!!**

Take-aways

- **“Hot Spots” key concept, defines effective capacity, in Time and Space**
- **Look for them by thinking like a passenger, location and timing**
- **Need to explore detailed flows**
- **Cumulative Arrival Diagram to define maximum Queue Length, Wait Time**
- **Detailed analysis: computer simulation**