Introduction to Transportation Systems

PART I:

CONTEXT, CONCEPTS AND CHARACTERIZATION

Chapter 7:

Transportation Systems: Key Points 11-17

Direct Elevator Service
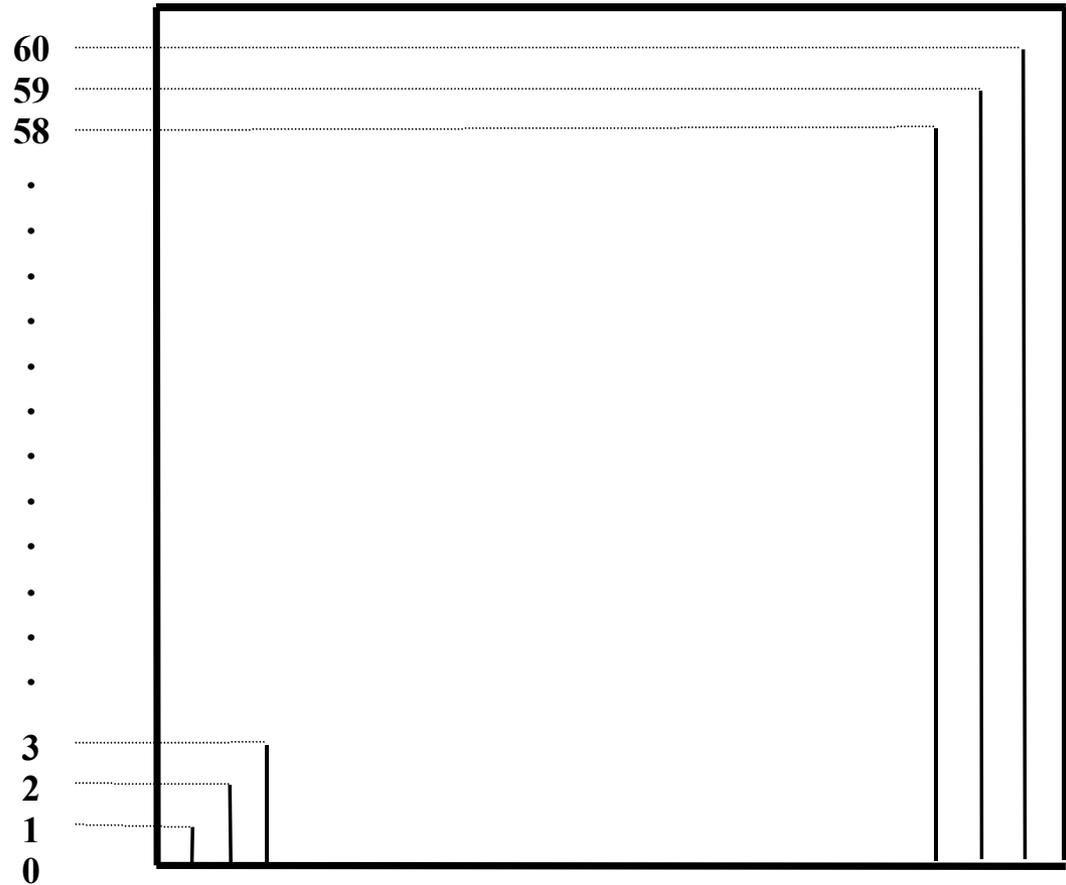
Figure 7.1

Another Elevator Configuration
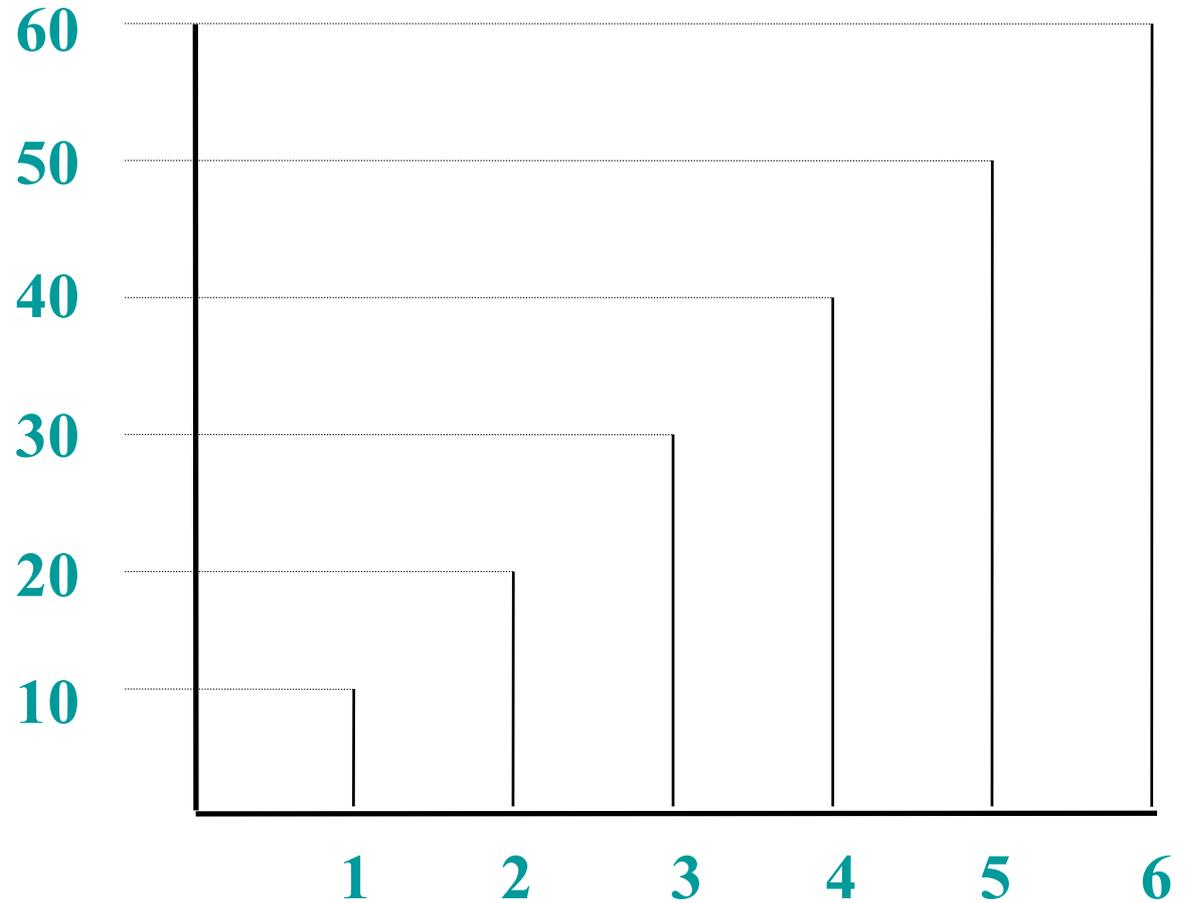
Figure 7.2

What configuration of elevators makes the most sense?

What is the basic trade-off here from the viewpoint of the building owner?

Key Point 11: Infrastructure "Shape"

The "shape" of transportation infrastructure impacts the fabric of "geo-economic" structures.

Key Point 12: Costs, Prices and LOS

The cost of providing a specific service, the price charged for that service, and the level-of-service provided may not be consistent.

For example, in a bus network, the routes affect who gets better and worse service.

If the urban bus system charges the same fare for all customers who experience different levels-of-service, there may be inequities. In thinking about transportation systems design, we must consider who benefits and who pays for the system.

Key Point 13: Cost of Service

The computation of cost for providing specific services is complex and often ambiguous.

For example, if a passenger train and a freight train both use the same rail line, how do we allocate the maintenance costs for that line to passenger and freight service?

Illustrating the Cost/LOS Trade-off

Elevator Dispatcher Policy

NUMBER OF PASSENGERS NEEDED TO DISPATCH

(12)

(6)

1   2   3   4   5   TIME (minutes)
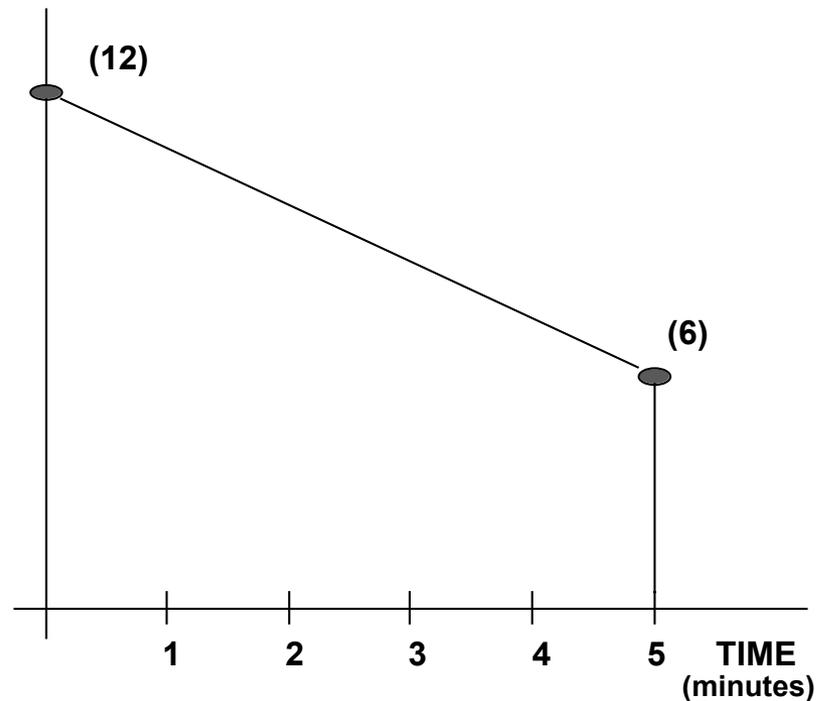
Figure 7.3

Illustrating the Cost/LOS Trade-off (continued)

Passenger Arrival Pattern
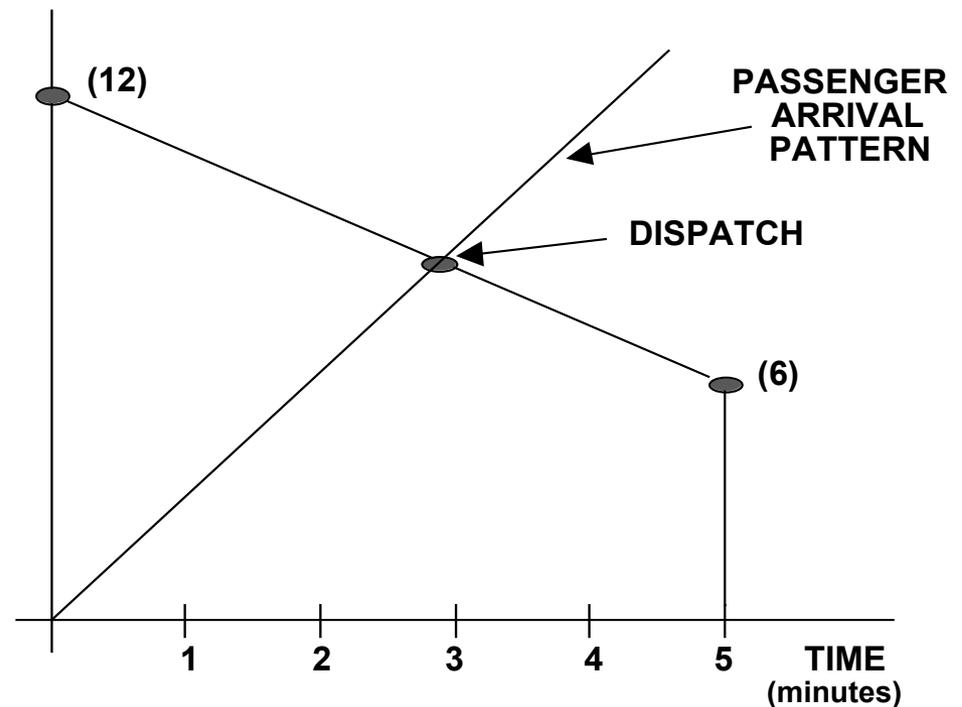
Figure 7.4

Building a Train
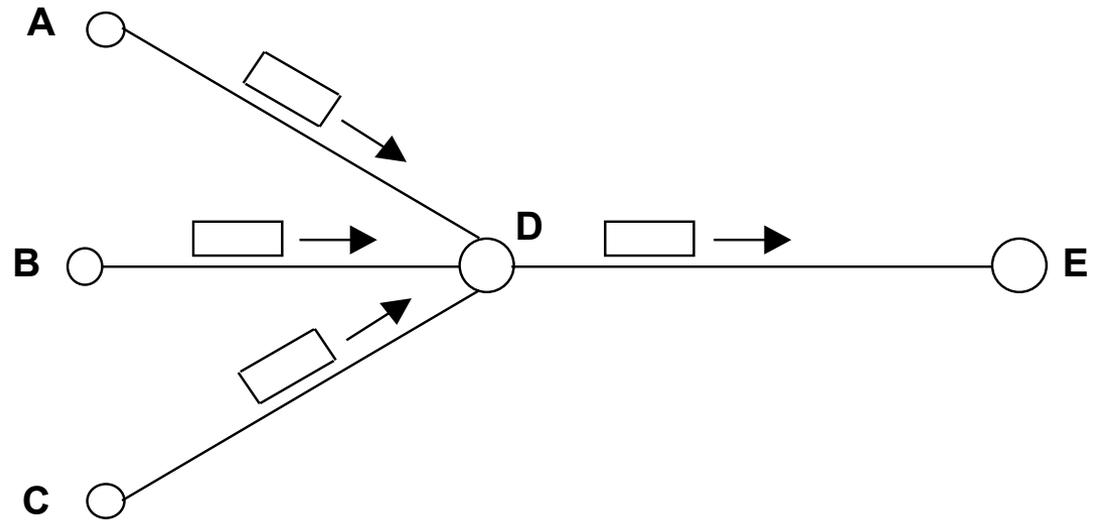
With trains coming in from stations west, we build an outbound train that will have cars from many different inbound trains. When do we dispatch the train from the terminal? We are balancing the LOS for the cars already on the outbound train with those that have not yet arrived.

Also, the longer the train, the smaller the cost/car.

Figure 7.5

Key Point 14: Cost/Level-of-Service Trade-offs

Cost/level-of-service trade-offs are a fundamental tension for the transportation provider and for the transportation customer, as well as between them.

Key Point 15: Demand Consolidation

Consolidation of like-demands is often used as a cost-minimizing strategy.

For example, when an airline runs a hub-and-spoke operation, it is consolidating people from different origins who have common destinations into airplanes to lower costs.

"Lumpy" Investments
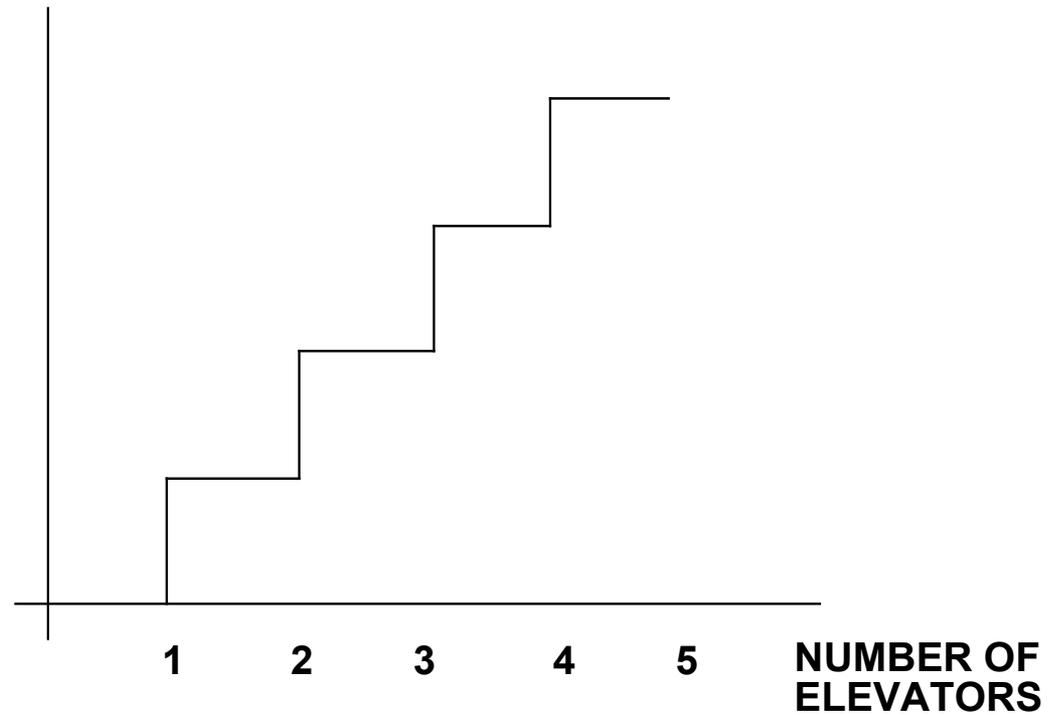
Figure 7.6

Key Point 16: "Lumpy" Investment

Investments in capacity are often lumpy (e.g., infrastructure).

Capacity of Single vs. Double Track Rail Line

SIDINGS

SINGLE TRACK
(OPERATIONS IN BOTH DIRECTIONS)

WESTBOUND

EASTBOUND

DOUBLE TRACK
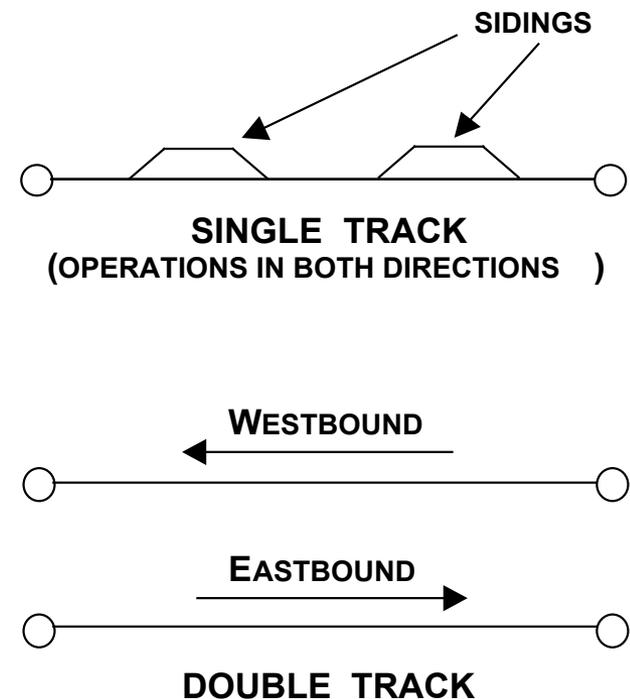
Figure 7.7

Another Elevator Configuration

60

40

20
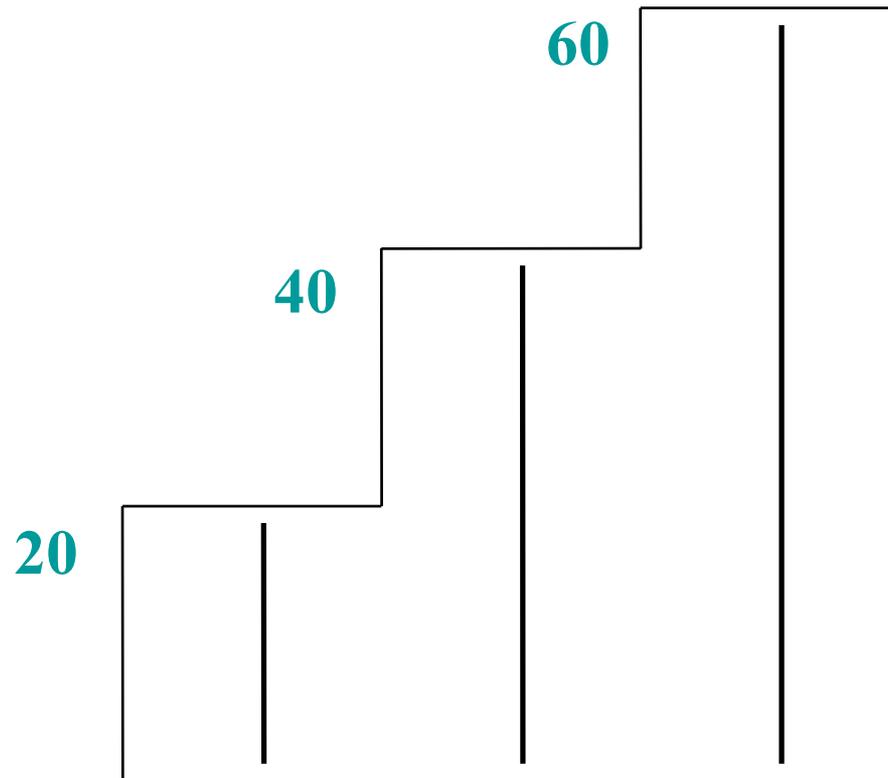
Figure 7.8

Capacity vs. Number of Buses

CAPACITY

NUMBER
OF BUSES
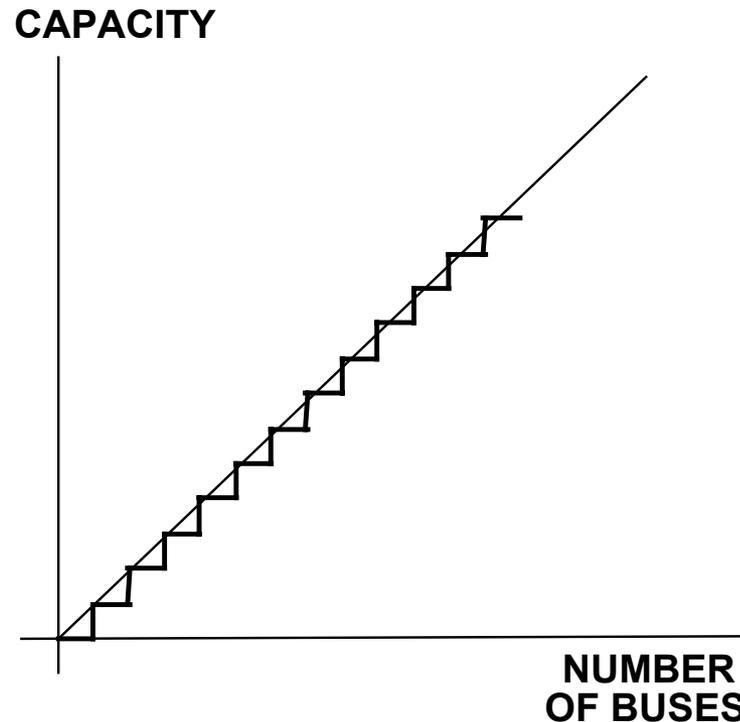
This is lumpy, but there are so many vehicles, we can approximate the relationship as smooth (linear).

Figure 7.9

Think of resources and think of investments in capacity in a very broad way. (Refer back to Key Point 2: Transportation -- part of a broader system.)

Capacity vs. Cost
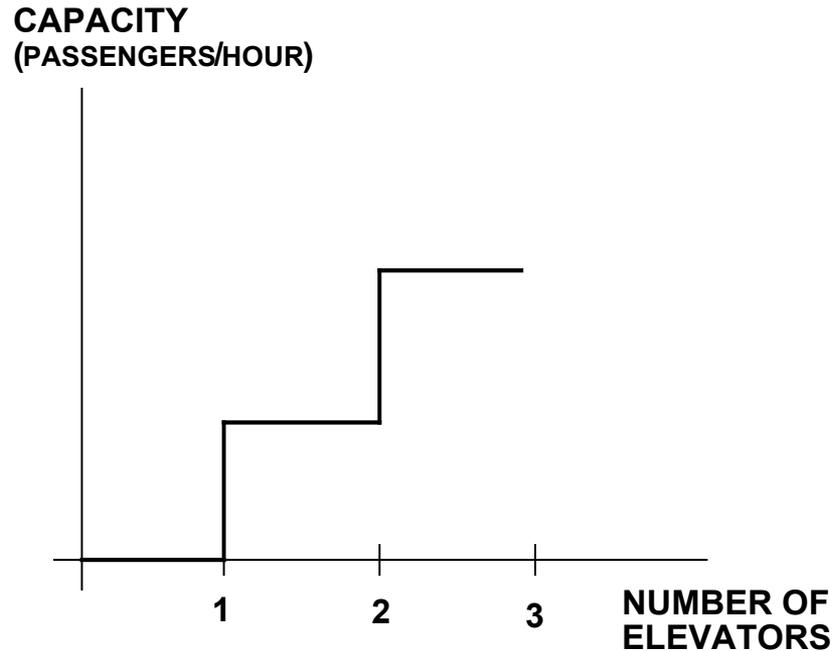
We can have inexpensive, low-capacity systems or more expensive, high-capacity systems. Making decisions about which systems we need or want is a continuing theme in transportation.

Figure 7.10

The concept of *level-of-service* is related to the cost and capacity trade-off. The level-of-service provided by the transportation system is a function of the volume being carried by that transportation system (see Key Point 9: Transportation Supply).

Typical Supply Functions
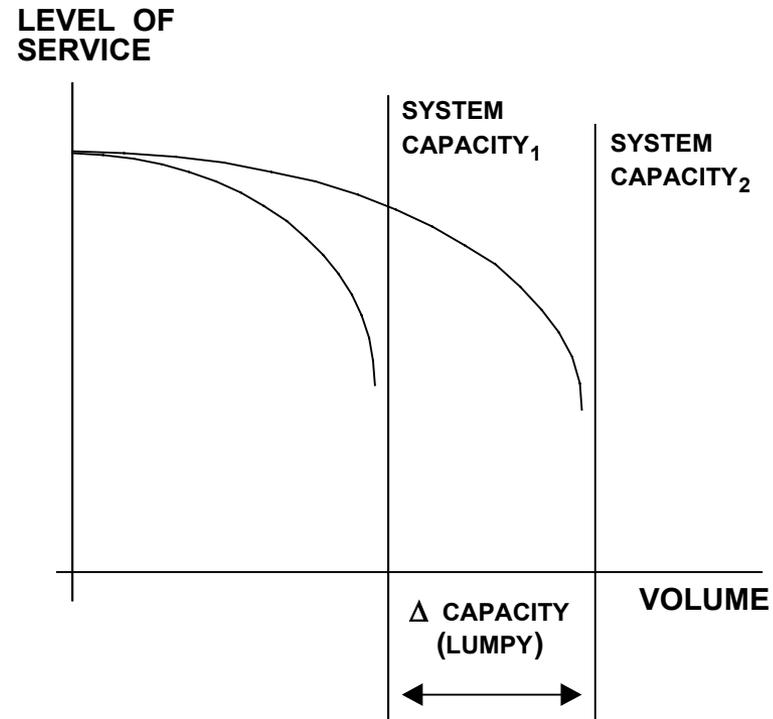
Often, there is a precipitous fall-off in level-of-service as the volume approaches capacity, sometimes called a "hockey stick".

Figure 7.11

Key Point 17: Capacity, Cost and Level-of-Service

The linkages between capacity, cost and level-of-service -- the lumpiness of investment juxtaposed with the "hockey stick" level-of-service function as volume approaches capacity -- is the central challenge of transportation systems design.

If we underinvest in capacity, our level-of-service may be uncompetitive. If we overinvest, level-of-service may be fine, but costs will be high and our prices may not be competitive. Making this decision, faced with *lumpy investments* and the "hockey stick" LOS/volume relation, is difficult indeed. This leads to the central challenge of transportation system design.

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