

# Introduction to Transportation Systems

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**PART II:**

**FREIGHT**

**TRANSPORTATION**

# **Chapter 16:**

## **Car Costs and Level-of-Service**

# A More Subtle View of Costs (1)

## System Options



System Options

- Skipping Yards
- Train Frequency
- Terminal Upgrading

Now we have to think more subtly about what the cost structure is. To simplify, consider only how much it costs the railroad to operate the service between the two extreme points of the network, A and D (we ignore the network effects).

Figure 16.1

# A More Subtle View of Costs (2)

We subdivide operating costs into three categories: train costs; terminal operating costs; and car costs associated with the costs of owning rolling stock.

$$\text{Costs} = \text{Train Costs} + \text{Terminal Operating Costs} + \text{Car Costs}$$

# Train Costs and Terminal Costs

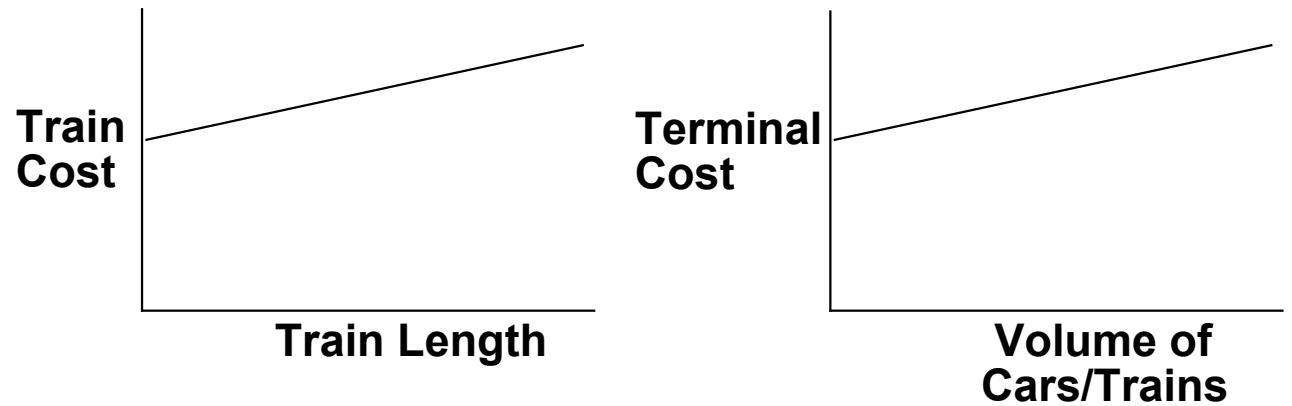


Figure 16.2

# Car Costs

## Freight Car-Cycle

- ◆ A freight car moves through the railroad network as follows:
  - Railroad places car at shipper siding
  - Shipper loads car
  - Railroad moves car through system to destination
  - Consignee unloads car
  - Railroad picks up empty car and places car at next shipper's siding

In equation form, we write:

Car Cycle (CC) = Shipper Loading  
Time + Transit Time (loaded) +  
Consignees' Unloading Time +  
Transit Time (empty)



# Fleet Size Calculation

Assume we have a volume ( $V$ ) of car-loads per day going from A to D; we can compute the number of cars,  $NC$ , we need in the fleet to perform this service.

$$NC = V * CC$$

This is a simplification:

- ◆ The system is not deterministic, but rather probabilistic.
- ◆ Empty cars often are sent to some point other than the one from which they came, as shown in the following figure.

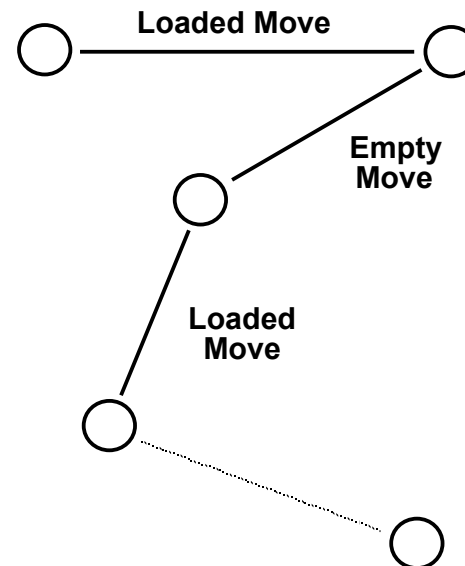
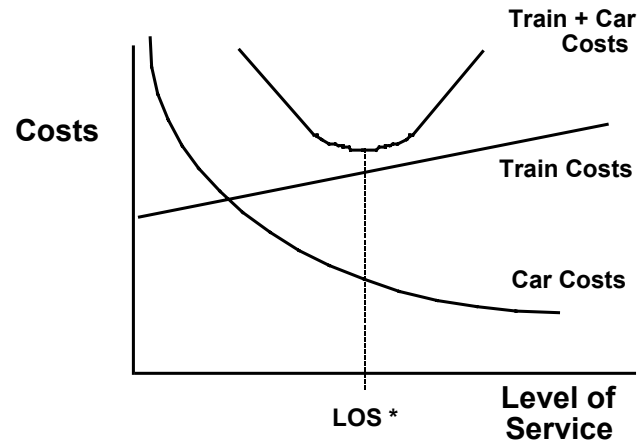


Figure 16.3

# One Way of Looking at Car Costs

$$\text{Car Costs/Day} = \text{NC} * \text{Daily Cost of Owning a Car}$$

# Cost vs. LOS



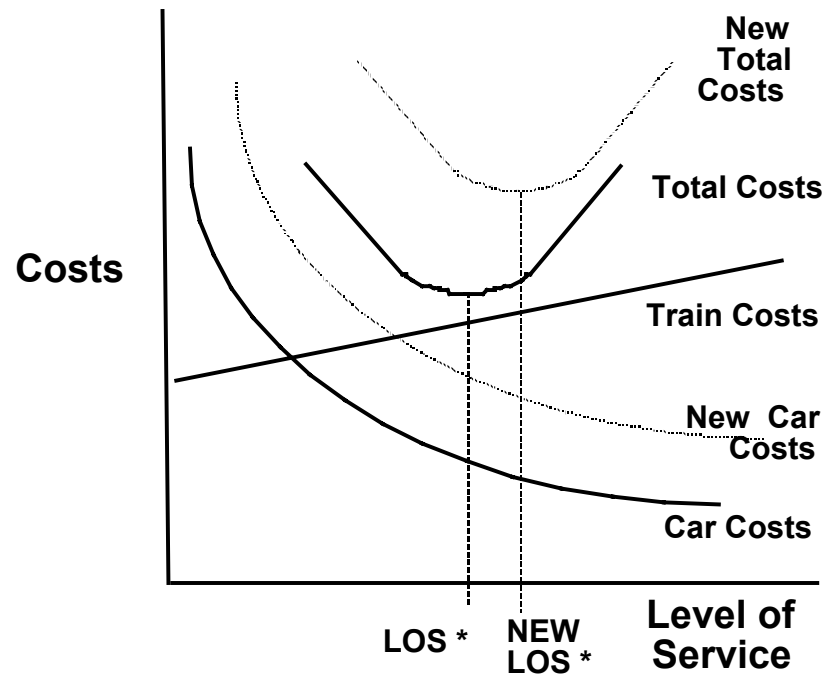
- ◆ You provide a better service by running shorter, more frequent trains, bypassing yards, etc. The train costs go up with level-of-service because you have more and shorter trains.
- ◆ On the other hand, car costs will go down as level-of-service is improved. Because the fleet is more productive when we bypass yards and run more frequent trains.
- ◆ Therefore, the fleet size needed to operate will be lower. So car costs will go down as you improve level-of-service.

Figure 16.4

## CLASS DISCUSSION

- ◆ *Should we not include terminal operating costs?*

# Cost vs. LOS -- Another View



As car costs go up and train costs go down, you may in fact be operating at the wrong LOS from *purely a cost viewpoint*. You may very well want to operate, given current cost trends, *at a higher level-of-service, even without consideration of the market benefits of doing so*.

Figure 16.5

# Another View of Car Costs

- ◆ So far, we have simply taken the ownership costs of the car and divided it by a projected life to arrive at a daily cost of owning the car.
- ◆ One could argue that this cost is too low. Suppose we are operating during a strong economic period and that the railroad had an “infinite queue” of loads that needed service; the railroad can just keep servicing loads as long as it can provide cars for them.
- ◆ One could argue that car costs in this situation include not only the ownership costs but also the forgone profits when you do not have enough cars available to carry loads.

# “Contribution”

- ◆ Consider the concept of “contribution”, which is the revenues that could be generated, say, per day, by that car, minus the costs of carrying that load per day; this gives a measure of the profitability of that particular move.
- ◆ Profits are forgone by not having cars available. We charge ourselves for cars on that basis, pushing car costs up further; there is an incentive to run a still shorter car-cycle, which again means a better level-of-service for customers.

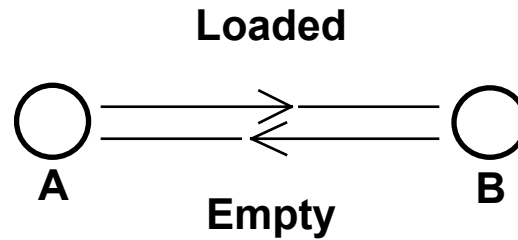
# How Performance Measures Affect Decisions

- ◆ The way in which managers would be charged for car use should affect their railroad operating decisions.
- ◆ If they are not charged *anything* for car use, they may choose to run very long trains because it does not cost *them* anything -- as *their* performance is measured -- to delay cars a long time in the yard.
- ◆ On the other hand, if they are charged substantially for car use, they may run short trains and provide a better level-of-service at the same time.
- ◆ The way in which people are measured and the incentives they are provided will alter the way they operate. [Key Point 28]



# Variability in the Car-Cycle

## Stochastic Car Cycle



“Unreliable” loaded and empty moves.

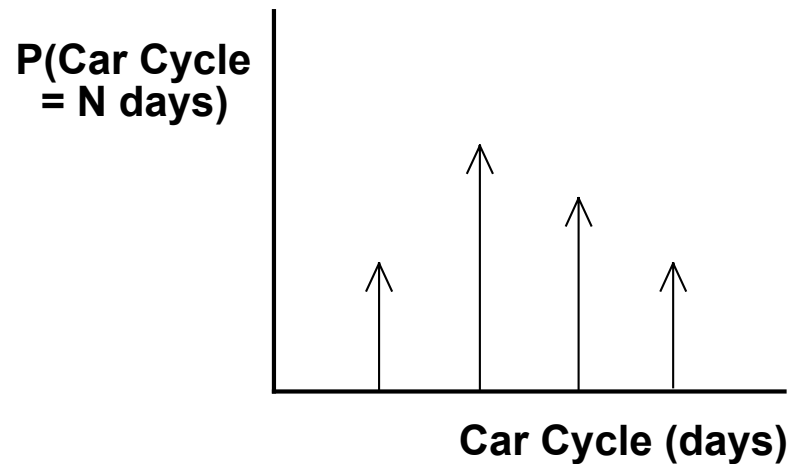


Figure 16.6

# Car Inventory

- ◆ The railroad operator has an inventory problem. There are unreliable deliveries of empty cars back to the originating point. So, under the assumption that the railroad wants to provide all the cars that the shipper wants, you need a bigger fleet. *The railroad needs to buffer itself against its own reliability.*
- ◆ So the size of the fleet needed to provide a continuous flow of cars to the shipper will go up under conditions of unreliability on the network -- as opposed to the deterministic transit time on the network assumed earlier.
- ◆ So unreliable operations costs *the railroad money in several ways*. It costs money because the railroad has to provide an additional inventory of empty cars. The loss is in addition to the lost business, because service was unreliable in the first place.