Mechanical Engineering 101

University of California, Berkeley

Lecture #13
Today’s lecture

• Supply Chain Management
• Safety stock
Beer Game Questions

a) Did you feel controlled by the system, or in control?
b) Did you blame the people next to you?
Systems Effects

• often the **system structure** is to blame!
Discussion

- realistic?
- order delays?
- production delays?
- Shipping delays?
- Middlemen?
Effective supply chains

- mfr
- retailer
- **orders**
- **Product**
- **external demand**
- **Information about orders**
- **external demand**
Effective supply chains

• Communication of info across supply chain
  – production coordinated with actual demand
  – decrease in lead times
    • from ability to anticipate incoming orders
    • leads to decrease in inventory and variability
  – better service (delivery) levels
  – reduced product obsolescence
CISCO case study

- “the hardware maker that doesn’t make hardware”
  - focus on marketing, product innovation
  - contract out manufacturing
- integrated information systems key
- yet forced to write off $2.2 billion in inventory for components ordered but unable to use

CISCO’s supply chain

Built like a pyramid:

- Customers
- CISCO
  - Celestica
  - Solectron
  - Flextronics
- Chip supplier (Intel, Xilinx)
- Optical gear (JDS Uniphase, Corning)
What happened?

• CISCO’s SCM only communicated w/ contract manufacturers
• would request bids from each manufacturer
• manufacturers would request bids from suppliers
• suppliers couldn’t see overlap
  – order for 10,000 switches looked like order for 30,000
  – perceived shortages of components
What happened?

• Similarly for CISCO’s customers
  – ordered duplicate hardware from competitors
  – only bought first delivered

• CISCO locked in huge inventory of supplies believed to be scarce to satisfy perceived demand
Solution

- integrated SCM system for all suppliers
- show aggregated demand
  - based on order overlap
Evolution of CISCO’s SCM System

Cisco’s old supply-chain system failed because it communicated only with contract manufacturers—leaving most other suppliers in the dark. eHub is designed to keep almost everyone in the loop, eliminating double ordering, parts shortages, and other inefficiencies.

Announcements

• Homework return
• Final Project Idea updates at end of lecture
Today’s lecture

• Supply Chain Management
  – Variance acceleration
  – Safety stock
    • Locating inventory
Variance and standard deviation

• data series \( X \) of \( n \) values \( x_1, x_2, \ldots, x_n \)
  – samples of a larger population
• average value \( \bar{X} \)
• sample variance
  \[
  s^2 = \frac{\sum (X - \bar{X})^2}{n-1} = \frac{\sum_{x_i \in X} (x_i - \bar{X})^2}{n-1}
  \]
• sample standard deviation
• STDEV in Excel
  \[
  s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}
  \]
Sums of random variables

• normal distributions $X$, $Y$
  – standard deviation $\sigma_X$
  – standard deviation $\sigma_Y$

• assuming $X$ and $Y$ independent
  – variance $\sigma^2$ for $X+Y = \sigma_X^2 + \sigma_Y^2$
Supply chain implications

• if demand at n retailers have standard deviations $\sigma_1, \sigma_2, ..., \sigma_n$

• demand at centralized warehouse that serves them has standard deviation

$$\sigma = \sqrt{\sigma_1^2 + \sigma_2^2 + ... + \sigma_n^2}$$

• if demand at different retailers independent
Safety stock location

- goal: 97 1/2% demand filled from stock
- total SS requirement if SS kept at retailers is
Safety stock location

- goal: 97 1/2% demand filled from stock
- SS kept at retailers
  - $2\sigma_1 + 2\sigma_2 + \ldots + 2\sigma_n$
- SS kept at centralized warehouse?
Supply chain implications

• if demand at n retailers have standard deviations \( \sigma_1, \sigma_2, ..., \sigma_n \)

• demand at centralized warehouse that serves them has standard deviation

\[
\sigma = \sqrt{\sigma_1^2 + \sigma_2^2 + ... + \sigma_n^2}
\]

• *if* demand at different retailers independent
Safety stock location

• goal: 97 1/2% demand filled from stock
• say all retailers have same demand variance
  – $\sigma_1 = \sigma_2 = \ldots = \sigma_n = \sigma$
• SS kept at retailers
  – $2\sigma_1 + 2\sigma_2 + \ldots + 2\sigma_n = n2\sigma$
• SS kept at centralized warehouse

$$2\sqrt{\sigma_1^2 + \sigma_2^2 + \ldots + \sigma_n^2} = 2\sqrt{n\sigma^2} = \sqrt{n}2\sigma$$
Tradeoff

• centralization
  – lower inventories
  – operating efficiency
• lower responsiveness
Summary

• System effects
• Strategies for reducing variance acceleration in SCM
  – Information sharing
  – Warehouse sharing (centralization)
Final Project Ideas

- We’ve randomly numbered them
- Any updates?