# Webinar: Challenges and Opportunities in Inventory Management

***Optimize the use of inventory throughout the Supply Chain***


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**Supply Chain Management (SCM) Certificate**

## Inventory Planning and Management

**Sept 22-24, 2015** | GT Global Learning Ctr (Atlanta, GA)

[www.scl.gatech.edu/invmgmt](http://www.scl.gatech.edu/invmgmt)

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# What's the agenda for this webinar?

- Inventory "issues"
- Current modeling strategies
- Common problems with current methods
- Approaches and technologies for improvement



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# Other faculty…

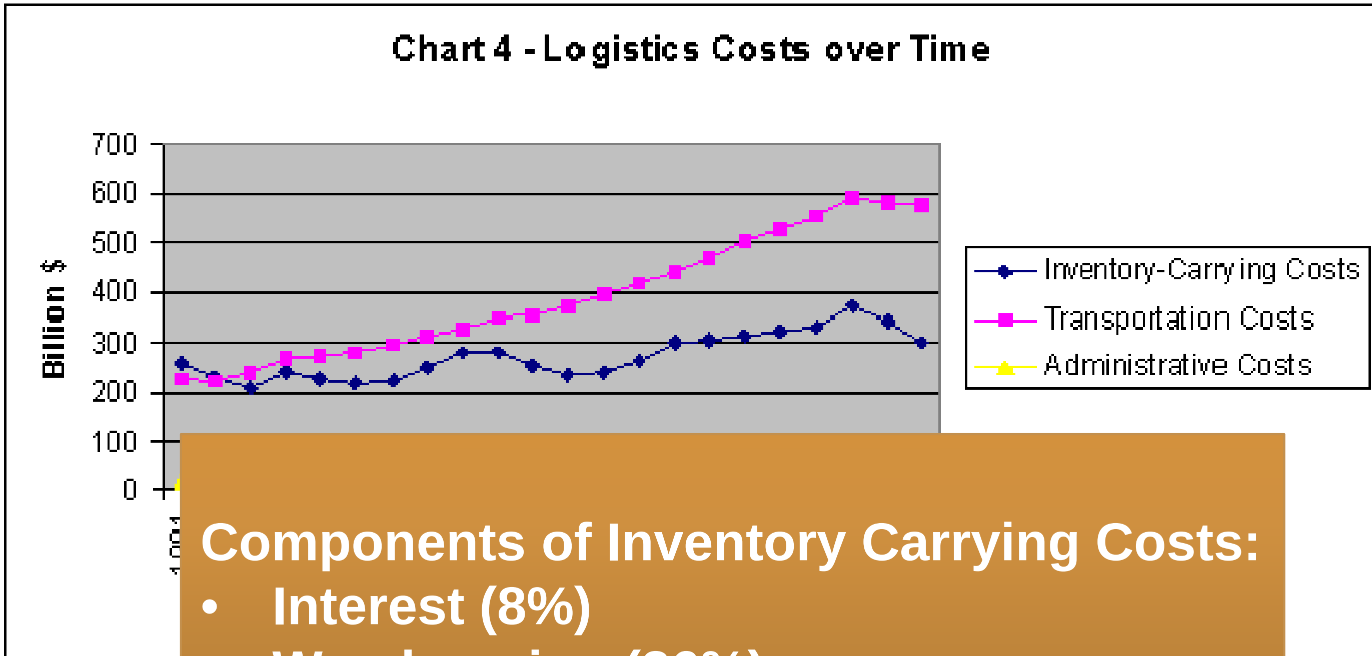
Julie Swann

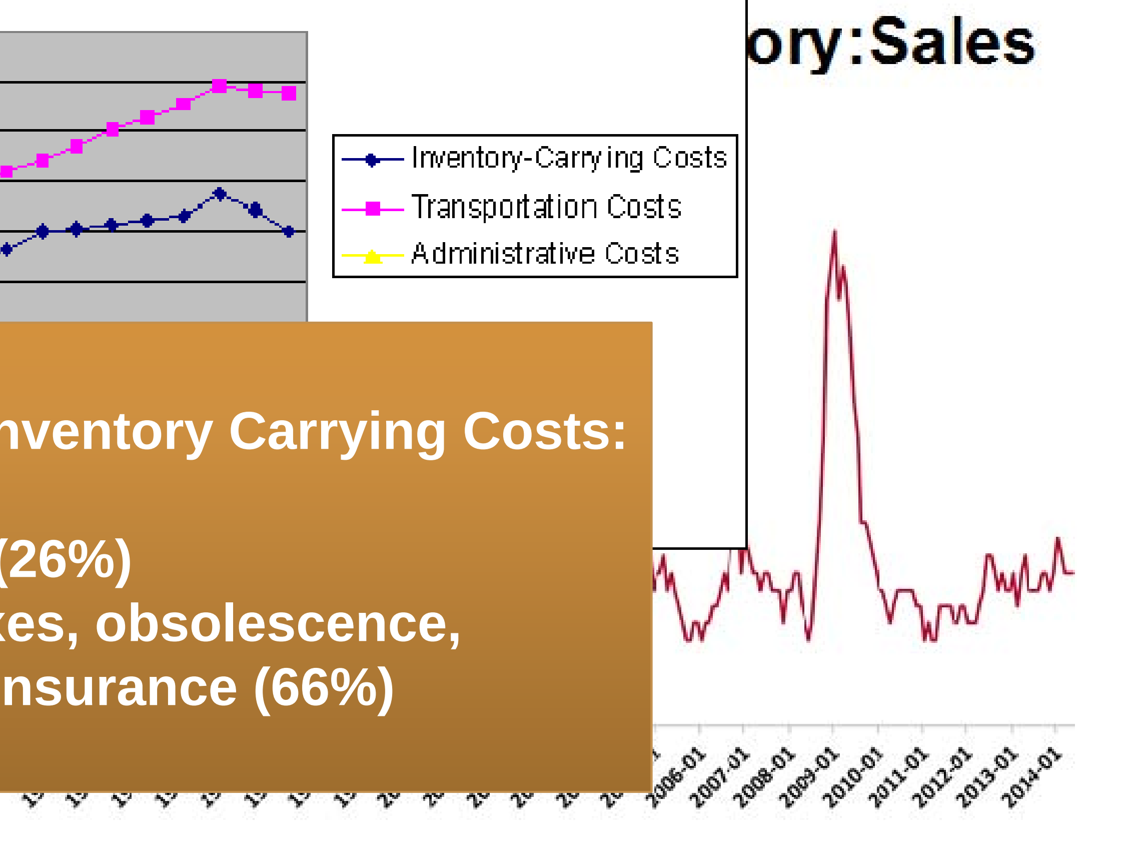
Harold R. and Mary Anne Nash Professor
Stewart School of Industrial & Systems Engineering

Pinar Keskinocak

William W. George Chair and Professor
Stewart School of Industrial & Systems Engineering

# Historical measures



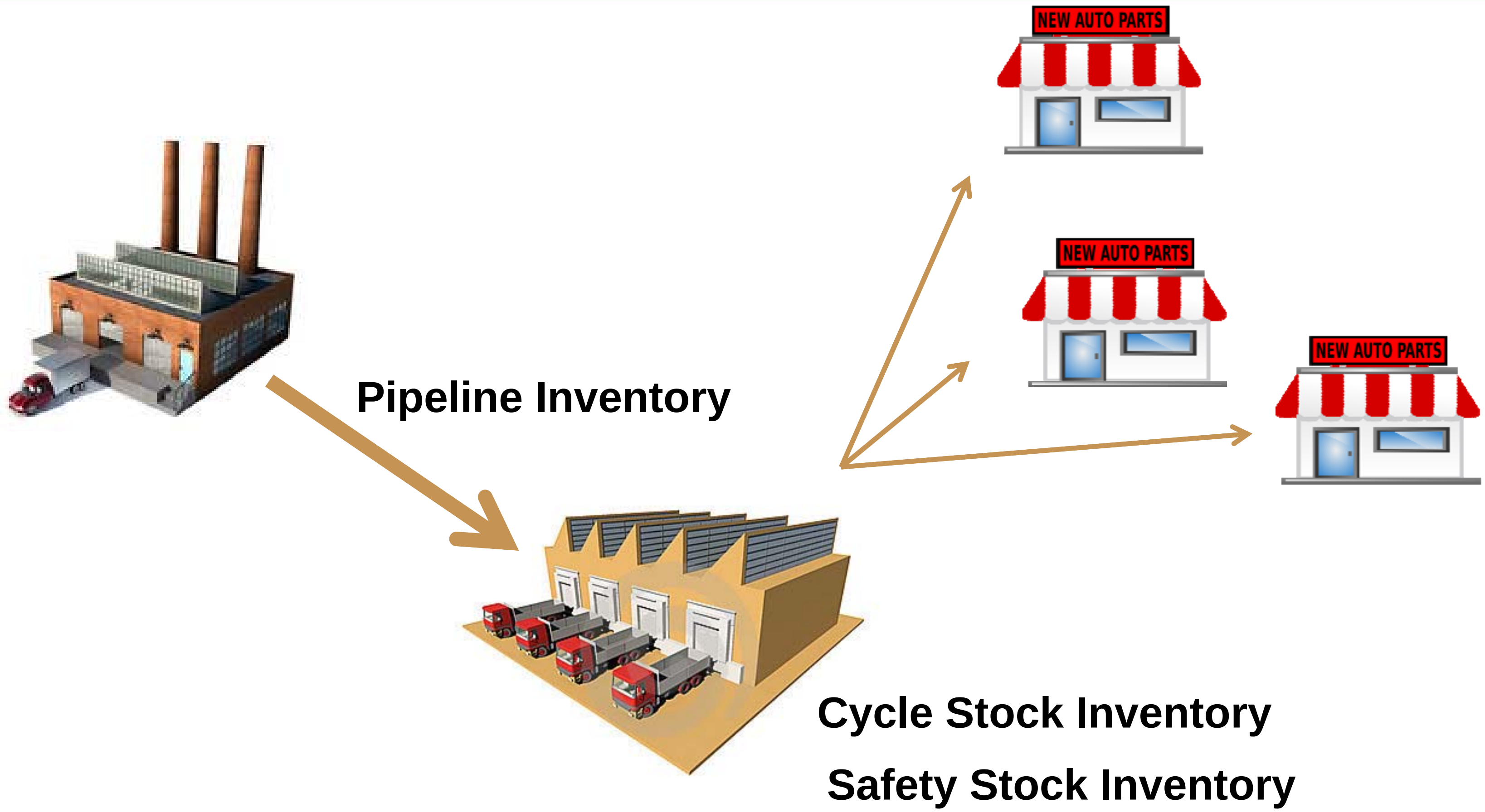




**Components of Inventory Carrying Costs:**

- **Interest (8%)**
- **Warehousing (26%)**
- **Other, e.g., taxes, obsolescence, depreciation, insurance (66%)**

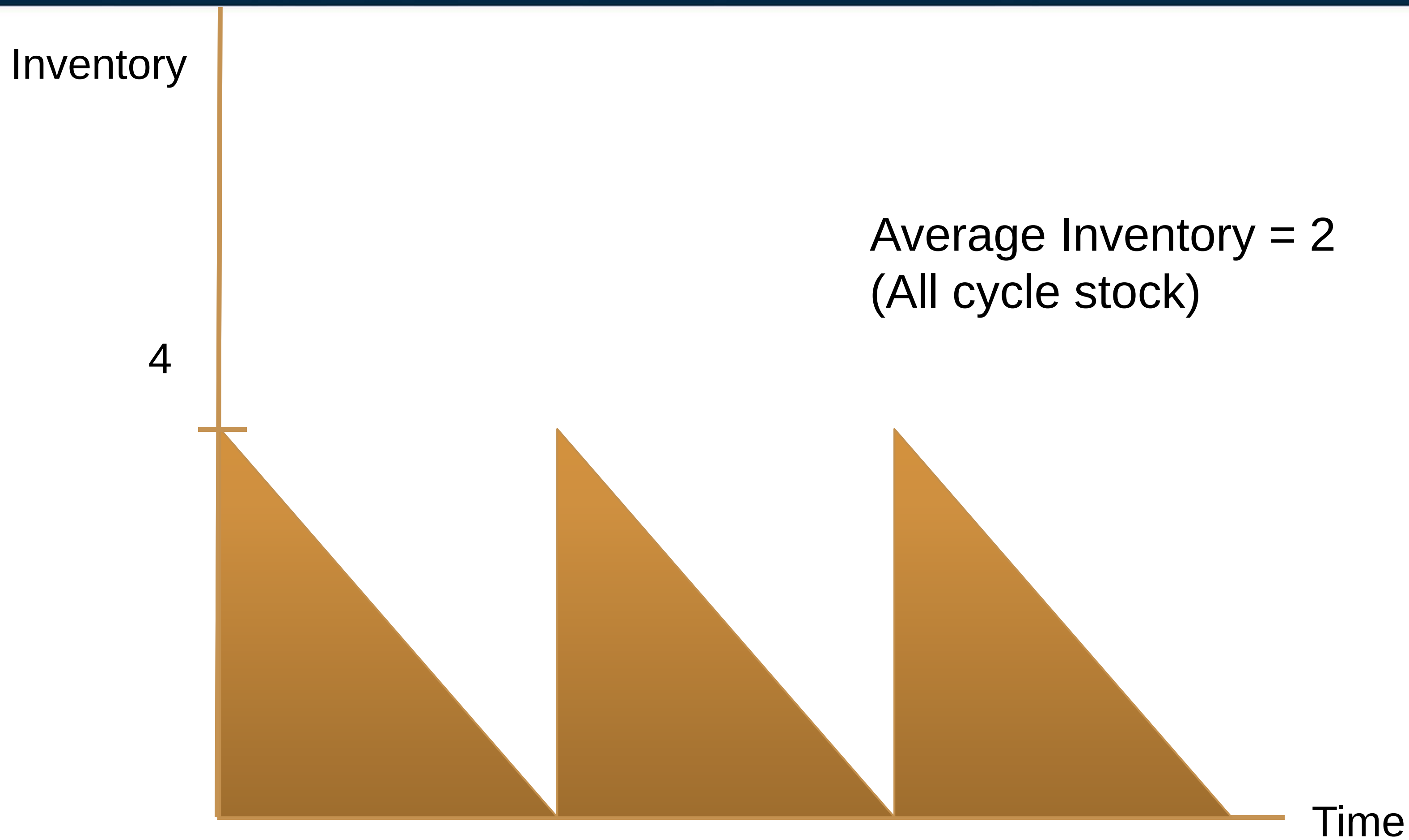
(*Source*: US Department of Transportation)

# Inventory example



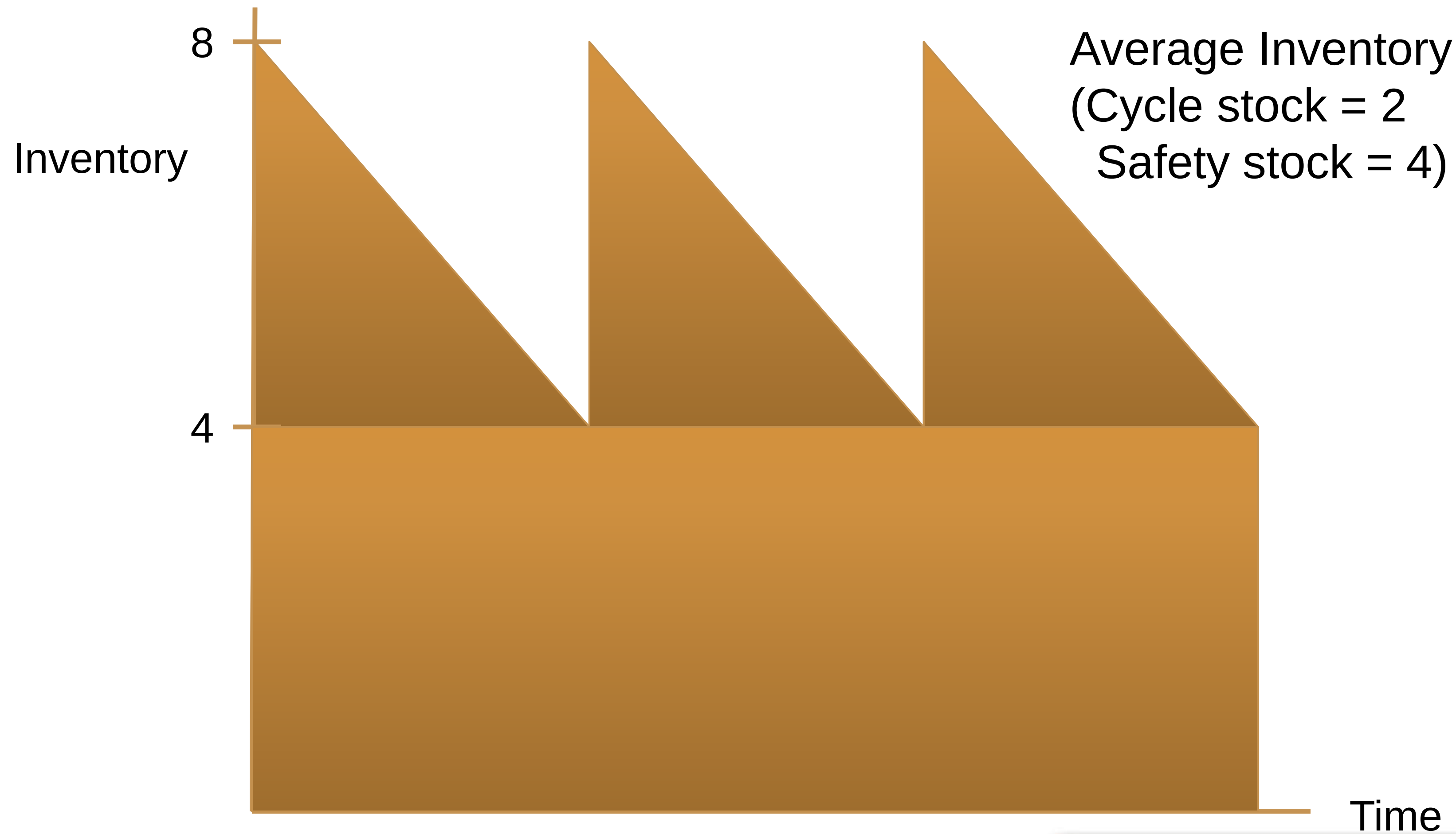
# Illustrative example

- Warehouse serves 2 customers and desires perfect service
- Each customer orders 1 item per week
- Replenishment occurs every two weeks
- Replenishments are instantaneous (replenishment leadtime is zero)


Inventory
Average Inventory = 2
(All cycle stock)
4
Time

# Illustrative example continued

- **Everything is the same except:**
  **Customers order 1 item per week (on average):**
  **2 items half the time, 0 items half the time**

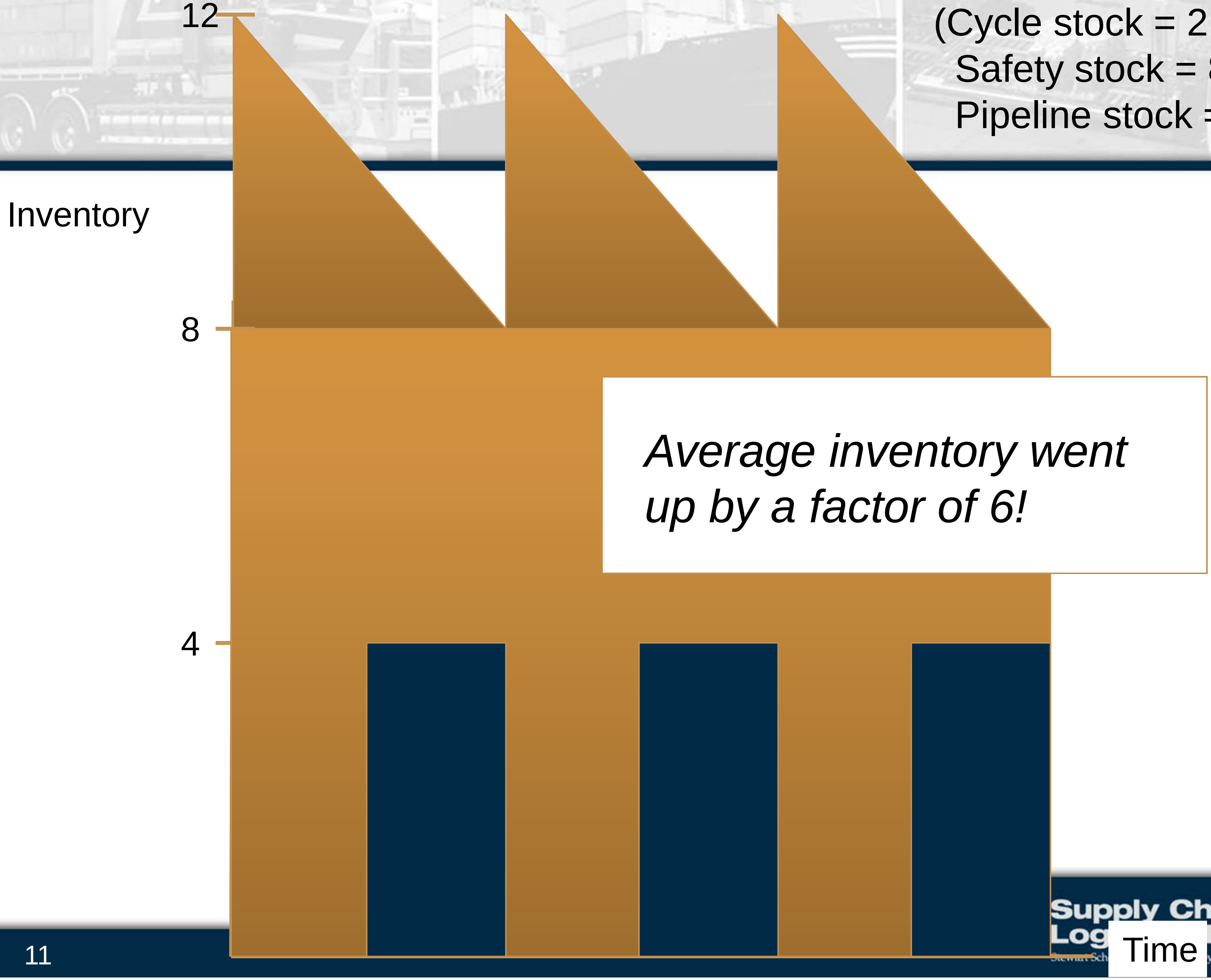



Average Inventory = 6
(Cycle stock = 2
Safety stock = 4)

# Illustrative example continued

- **Everything is the same except: Replenishment leadtime is 1 week**

Average Inventory = 12
(Cycle stock = 2
Safety stock = 8
Pipeline stock = 2)




*Average inventory went up by a factor of 6!*

# Bottom line...

- **Inventory is a result of**
  - Uncertainty/variability
  - Leadtime

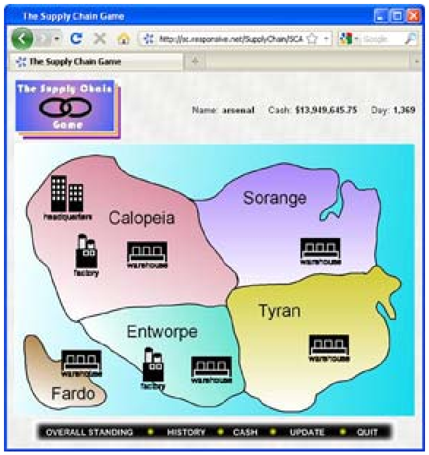
- **To reduce inventory**
  - Shorten leadtimes
  - Reduce variability
  - Improve accuracy

Will focus on these issues today rather than on policies

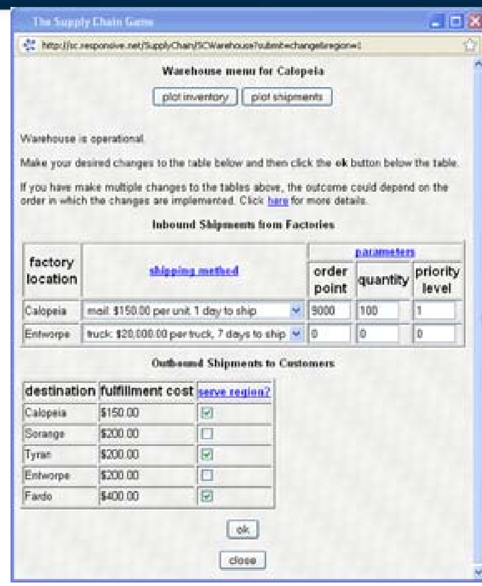
# How topics are covered…

- **Interactive case studies**
- **In class games and simulations**
  - Supply chain game
  - Beer game
- **Presentations from faculty**

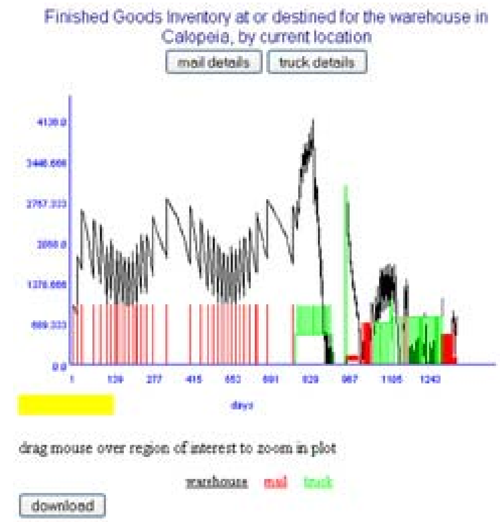
# Example: supply chain game




Participants monitor their supply network through web portal




Participants choose which regions they will serve, and which method of transportation to use




Participants view and download historical data to understand the effects of past decisions and to guide future decisions.

# Basic inventory problem

- *When* a replenishment order should be placed
- *How large* a replenishment order should be
- *How often* the inventory status should be determined

- Different products may need different control systems and different policies



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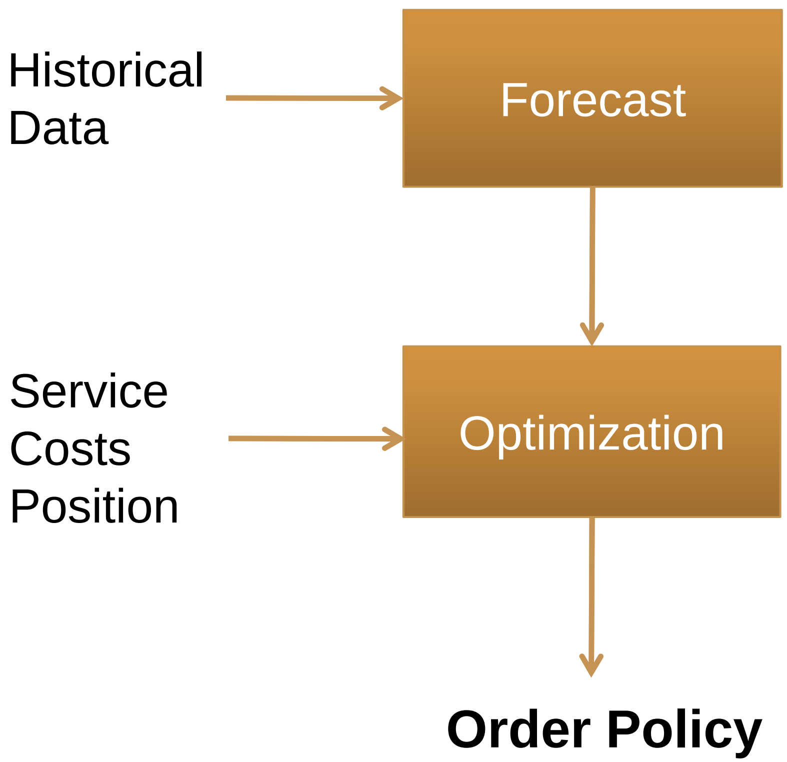
# Typical modeling framework

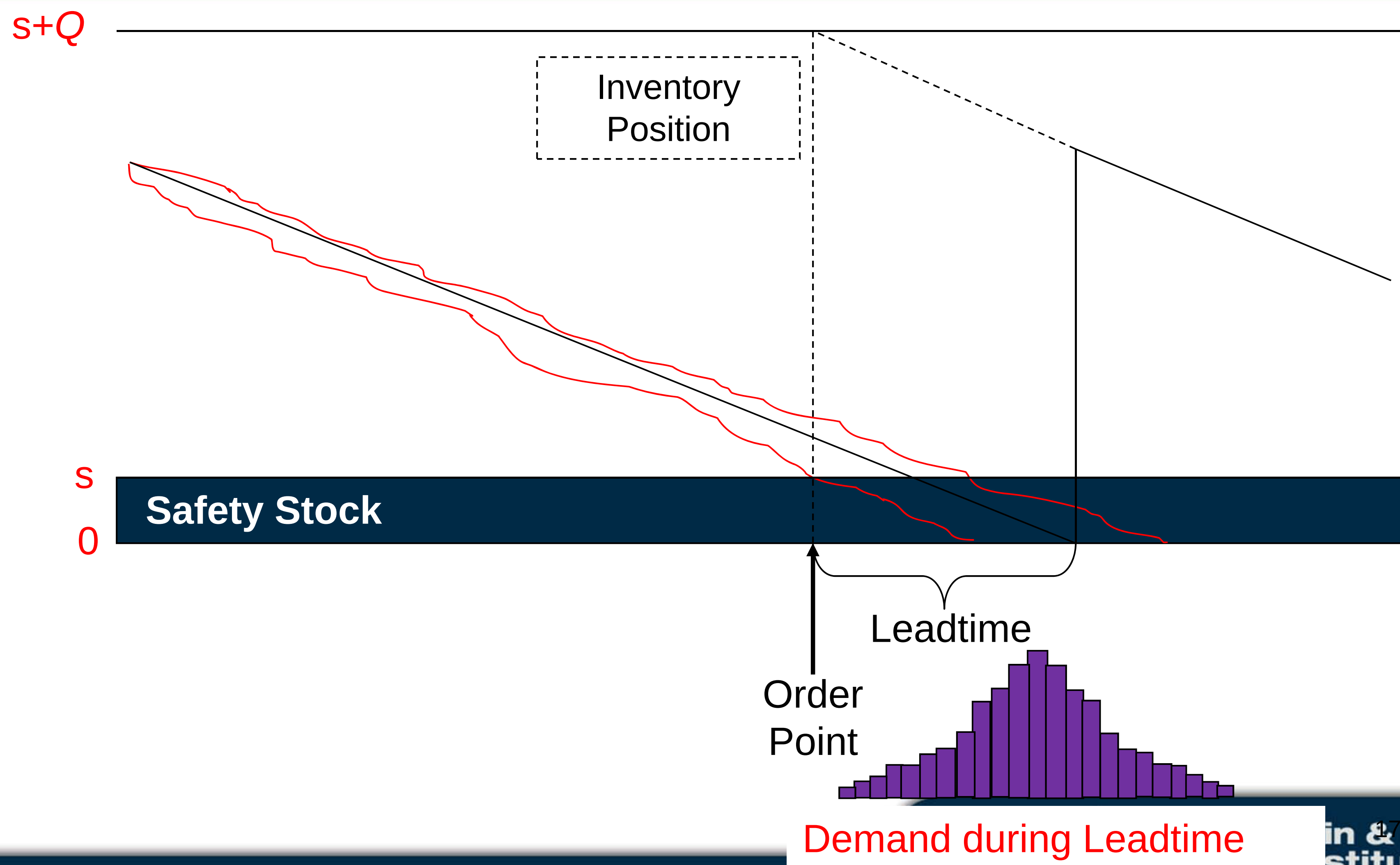



Two most common approaches:

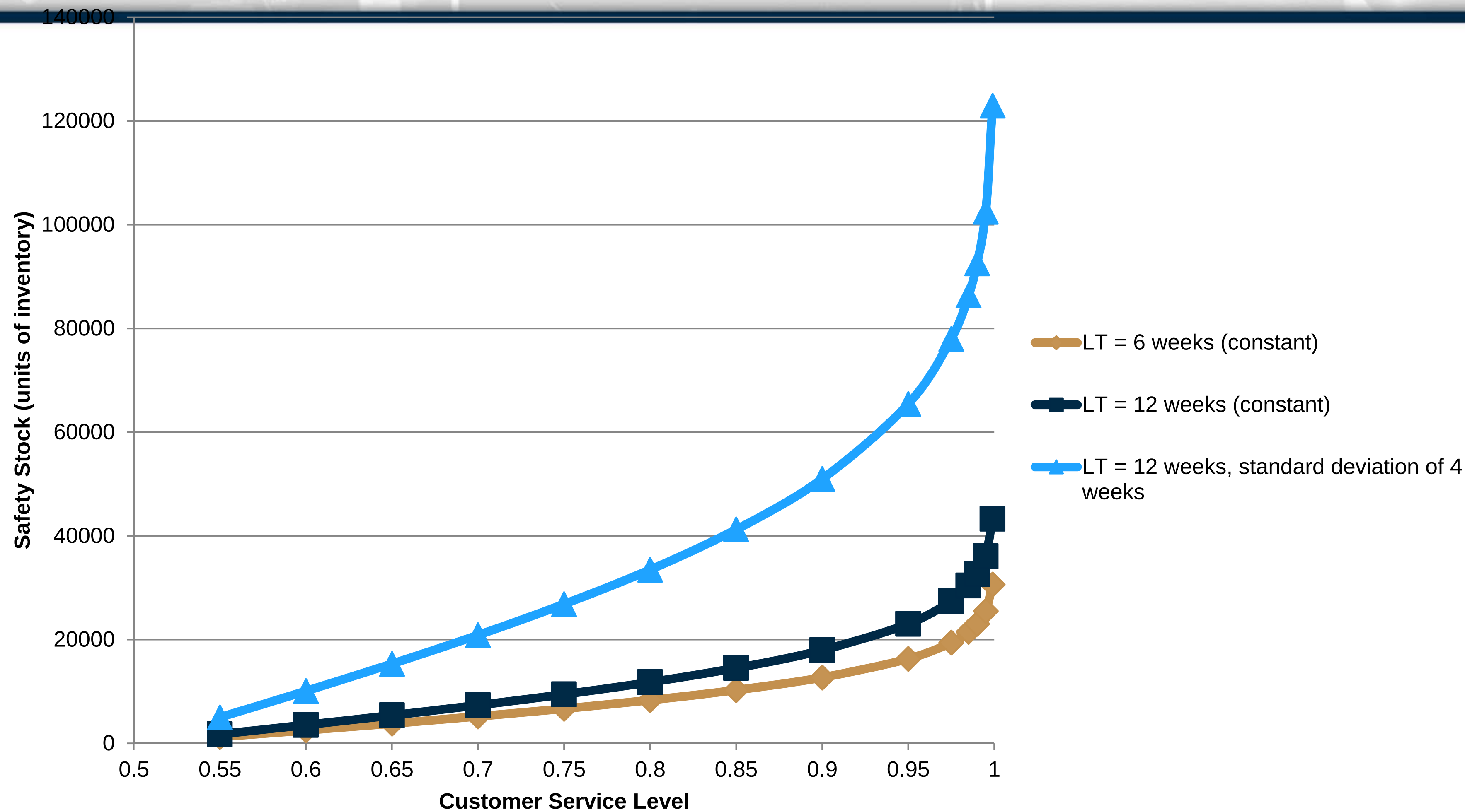
- Fixed-order quantity
- Fixed-time period

**Typical tradeoff**: service versus inventory costs

# Uncertain demand & certain leadtime



# What level of service is enough?



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# Question…

- What level of "service" is acceptable to you when you go grocery shopping (i.e., percentage of time that the item you want is out of stock)?

- A. 0% to 5%
- B. 6% to 10%
- C. Greater than 10%

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# Some common challenges

- **Defining proper parameters**
  - Holding cost?
  - Service level?
  - Shortage cost?

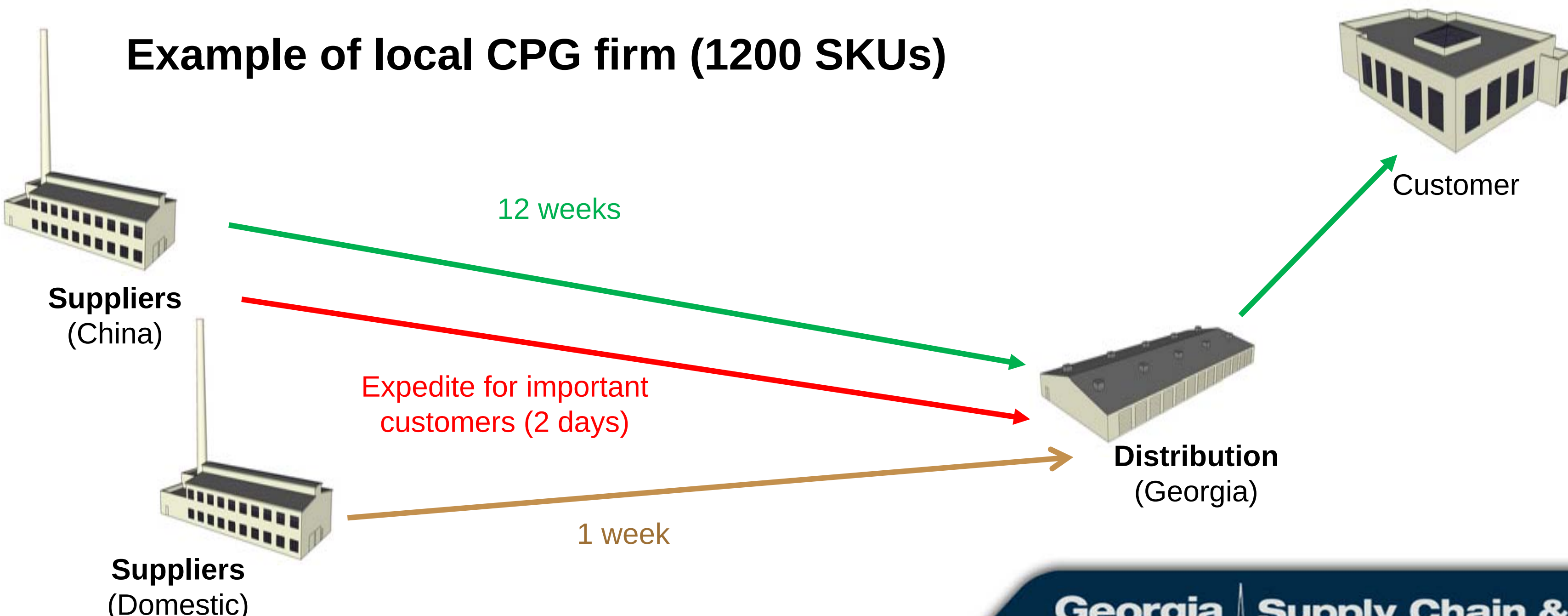
**Gartner** (2014): Roughly 70% of firms do not perform any rigorous analysis for determining their holding cost

- **Forecasting**
  - Assume the past is representative of the future

**Chief Supply Chain Officer Forum** (**CSCOF**; 2015): Forecasting is cited as the biggest concern (>50%; inventory optimization cited as second biggest concern)

# Common challenges

- **How to manage different products**
  - Common approach is to set safety stock to a number of days of inventory and order based on forecast



# CPG example continued

- **Hold 28 days (4 weeks) of safety stock for sourced items from China (less for domestic)**
- **Ordering**
  - Order to maintain desired safety stock
  - Use minimum order quantity of 7200 units
  - Air expedite for important customers if backordered (done approximately 20% of time)

# Example continued

- **Current practice**
  - On hand holding = $1,002,100
  - Emergency ship = $4,032,870
  - Average number of weeks with backorders = 6.9
- **Shift to periodic review (with each SKU)**
  - On hand holding = $903,039
  - Emergency ship = $1,216,942
  - Average number of weeks with backorders = 1.6
- **Potential benefit from goodwill**



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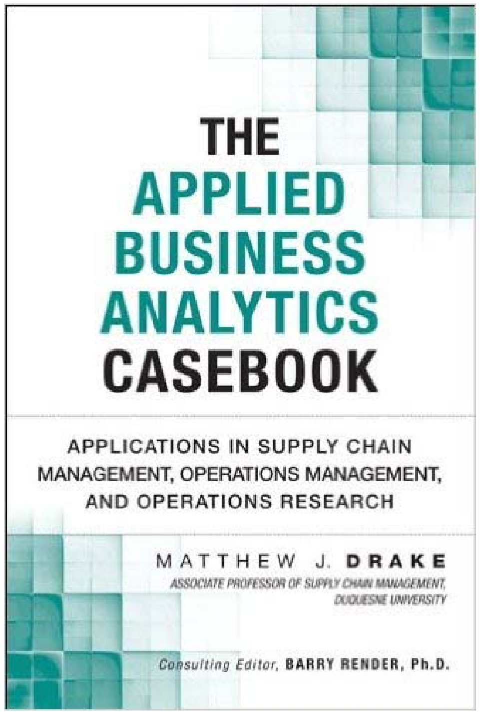
# How we cover this…

**Case Study**: “Inventory Management at Squirrel Hill Cosmetics”

- Work with actual data
- Build a spreadsheet model
- Analyze different scenarios



# Reducing variability

- **Variability in demand and leadtime can have tremendous costs**
- **So what can we do?**
  - Improve forecasting…though hard
  - Try to reduce variability directly
  - Develop strategies that reduce your risk to variability

**Three** approaches
- Pooling (reduce variability)
- Contracting (reduce risk to variability)
- Analytics (improve quality of information)



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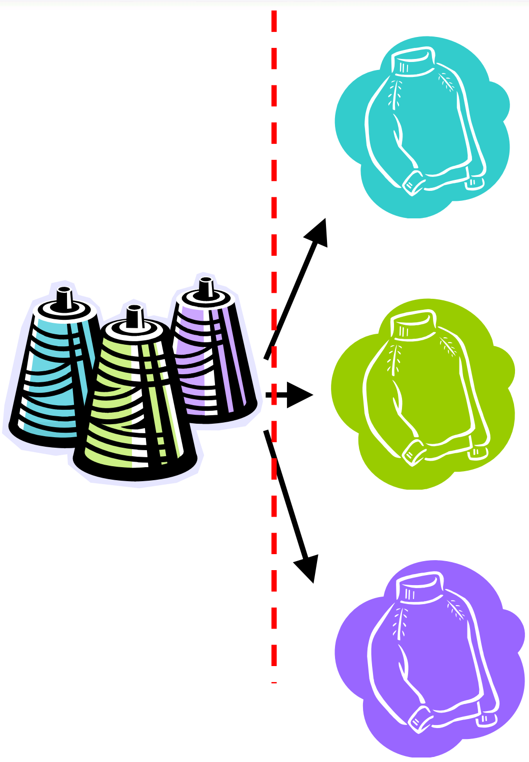
# Local firm example

- Firm supplies goods to Wal-Mart, Target, CVS, and Walgreens (60% of business, 500 customers)
- DC manages approximately 1000 SKUs
- Each of the big 4 customers have unique packaging requirements
- Leadtime to DC from China is 10 weeks (0.2 weeks packaging and 9.8 weeks transit)

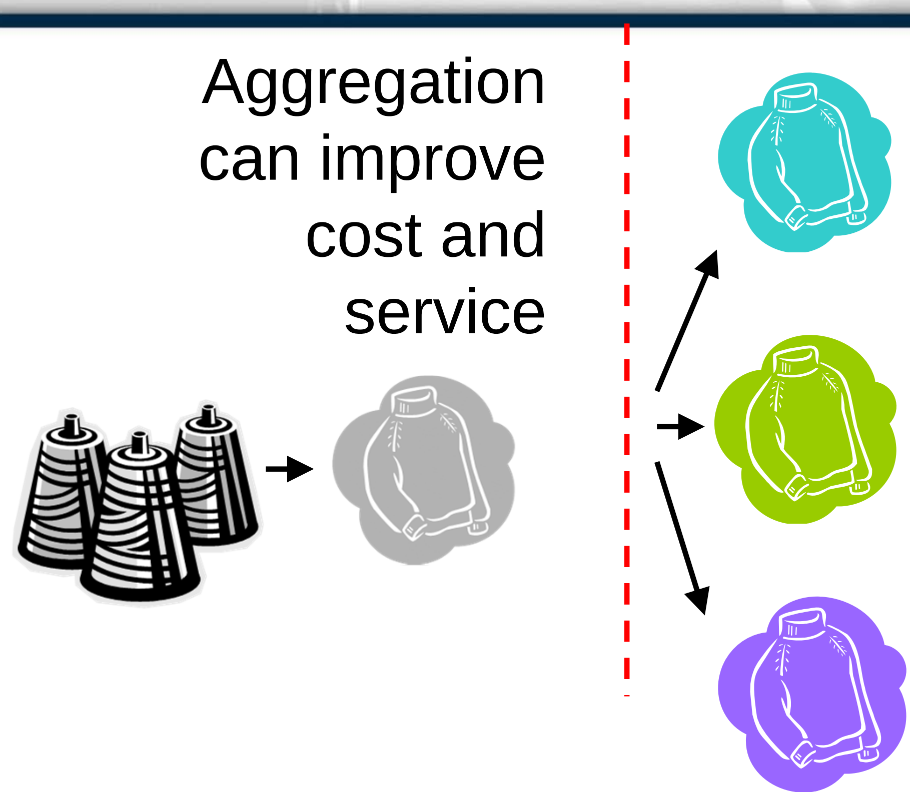
# Example continued

- **Incident in June for one of the SKUs**
  - CVS runs a promotion that you weren’t informed of, and wants 30,000 more than you have in stock
  - In response, Wal-Mart, Walgreens, and Target each order 10,000 less than anticipated
- **What can be done?**

# Postponement (delayed differentiation)



Aggregation can improve cost and service



Limiting the total number of SKU's can also result in reduced inventory from aggregation of variability

# Question…

- If we could “postpone” packaging to the DC, how much reduction in safety do you think we could achieve?

- A. 0% to 25%
- B. 25% to 50%
- C. Greater than 50%

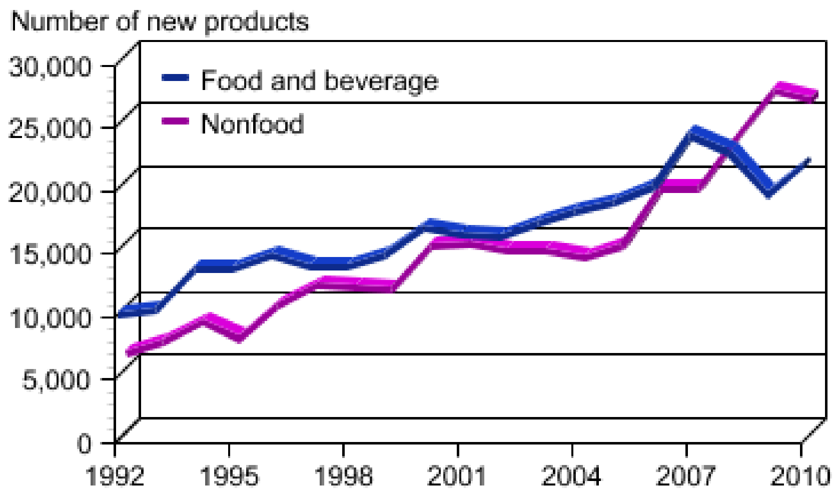
# Example continued

- **If we could "postpone" packaging to the DC, there would be two effects**
  - Reduction in customer-specific leadtime (goes from 10 weeks to 0.2 weeks)
  - Reduction in required safety stock
    - We get a safety stock reduction of over 50%
    - If there were no unique packaging, the reduction would be 89%

# Impact of SKU growth

**New product introductions of consumer packaged goods, 1992-2010**

After declining between 2007 and 2009, the number of new food and beverage products rebounded in 2010




Source: USDA, ERS calculations using data from Datamonitor.

***Example***: from 2014 to 2015, number of IPA (beer) SKUs increased by 37%

**What is the right level of complexity?**



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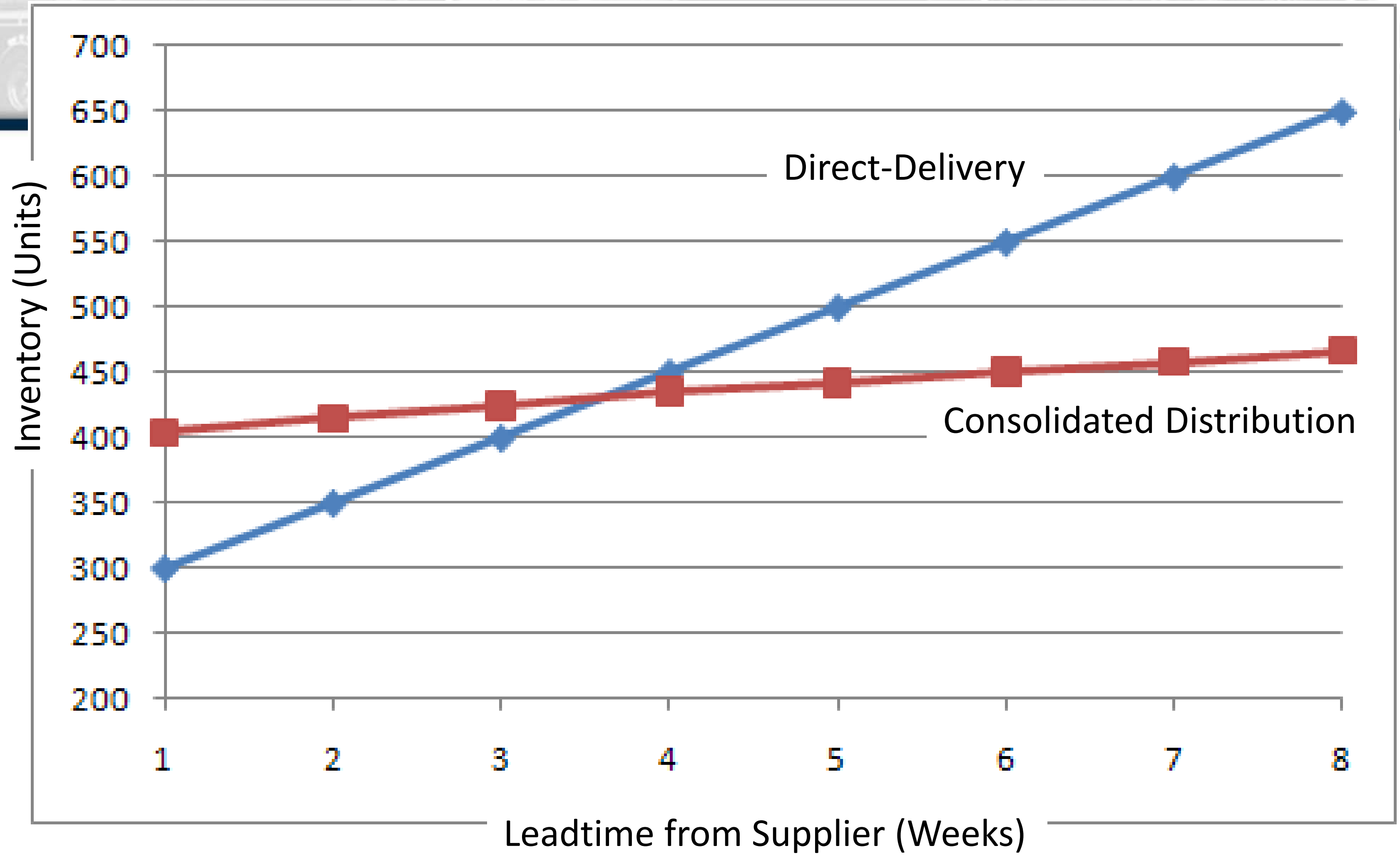

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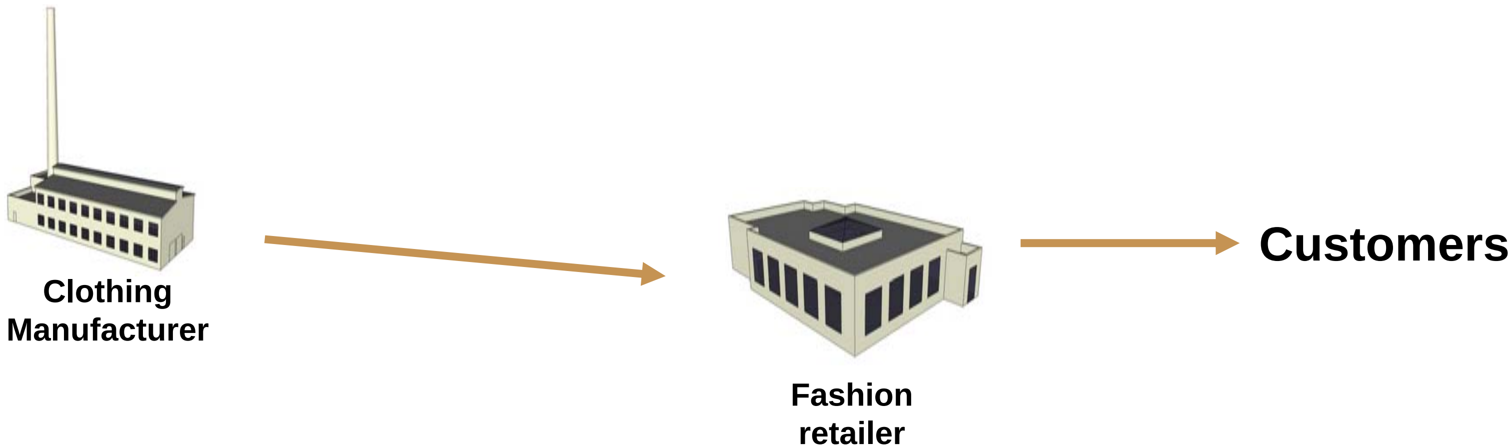
Direct-Delivery
Consolidated Distribution
Inventory (Units)
Leadtime from Supplier (Weeks)

# Contracting

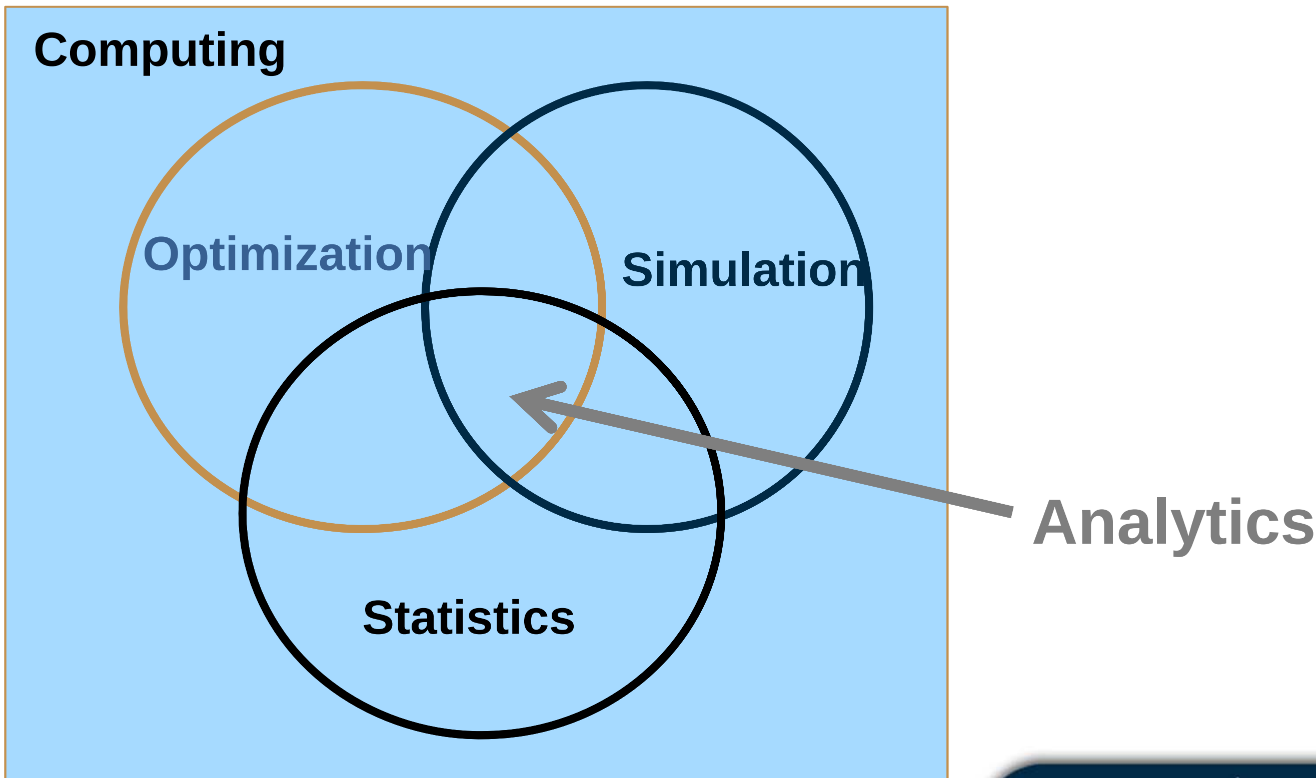
- **Challenge of centralized planning**
  - Complexity of problem
  - Harder issue of implementation
- **Incentive-based contracts to share risk**




**Manufacturer produces for a selling season**
**Order quantity is determined by retailer**

# Inventory analytics

- **The scientific process of transforming data into insight for *making better decisions***



# Potential change in inventory modeling

**Traditional Approach**

Historical Data → Forecast

Forecast → Optimization

Service Costs Position → Optimization

Optimization → **Order Policy**

**Data from product interactions** (orders, potential customers, supplier transactions, environmental factors, etc.)

**Computational platform**

- Optimization
- Machine learning

(Exploit patterns/ correlations)

**Identify best relationships**

# Potential benefits

- **Doesn't completely rely on *a-priori* data**
- **Ability to "learn" dynamically**
- **Adjusts value of information by latency**
- **Can support multiple objectives**

- **Currently, most applications help with visualization**

# Challenges

- **Lack of good data**
- **Willingness to share data (privacy/security)**
- **Systems are complex (decisions)**
- **Computational resource requirements**
  - Velocity of data and not just volume
  - Who is going to pay for the support?
- **Getting the underlying assumptions correct**
- **What are the right questions?**

# Summary

- **Effective inventory management involves balancing key trade-offs**
- **Reductions of safety stock (without changes in service level) can be achieved by reducing leadtime or variability**
- **Good inventory policies require good information**
- **Relationships and technology can improve these factors**
  - Contracting/risk sharing
  - Pooling/technology
  - Big/wide data and analytics



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