Session goals

- The challenges of inventory management in practice
- Approaches
- The supply chain dimension
- Role of technology
Why do companies hold inventory in the first place?

- It’s a buffer in the Supply Chain
  - Time mismatch between supply-demand
  - Variability (supply, demand, forecast error)
  - Economic (costs, discounts)
- Main tradeoff
  - Service level
  - Inventory cost
- Keep it to a minimum
The fundamental tradeoff

Target Service Levels

Inventory Investment
Three simple questions …

Three basic questions you want to answer through inventory management:

1. How often should I check my inventory?
2. How do I know if I should order more?
3. How much to order?
What you have learned so far...

- Not all items are created equal
  - Segmentation is needed
- Various models with different assumptions
  - EOQ
  - \((s, Q)\)
  - \((s, S)\)
  - \((R, s, S)\)
  - \((R, S)\)
  - Periodic vs. Continuous
- Definitions of service level matters
Reality check …

“More than 60% of companies use overly simplistic inventory management methods. These companies frequently have 15-30% more inventory than they need and lower service levels. By contrast, companies that reported using new optimization methods…, commonly drove 20-30% reductions in on-hand inventory and 10-20% improvements in time to market.”

Aberdeen Group, March 2005
Good news & bad news

- **Good news**
  - Understanding theoretical models is important and matters
  - You can make money on this field!

- **Bad news**
  - Models are not used exactly as you have learned them
  - Technology matters
  - Business processes matter even more
Q1: How often?

- Home Depot Retail*
  - 1,800+ stores
  - 40,000 – 50,000 different items
  - Approx. 72-90 Million item/store combinations
- Processing power may be the bottle neck
  - Single server example:
    - Single database can process 500 transactions per second
    - 40-50 hours to “check” inventory
  - And you still need to do the math…
  - Distributed power
- Other examples
  - Department Store – 200,000+ items
  - Grocery Store – 100,000+ items
  - Book Store – 150,000 + items
  - Online Store – 5 million+ items

* Source – Home Depot 2004 Annual Report
Q1: How often?

- Segmentation
- Constrained by technology
  - Fashion Retailers – Daily/Weekly
  - Grocery Retailers – Hourly / 3-4 times a day
- Constrained by business processes
  - When are sales reflected in your inventory?
  - How often can you receive merchandise?
  - How often do you get orders from your clients?
  - Vary by time of the year?
Q2: Should I order?

- Function of two variables
  - Inventory Position
  - Order Point

- Inventory Position
  - On hand
  - On order
  - Committed
  - Backorders

- Order Point is a function of the inventory model
Inventory position: What can go wrong?

- **Source:** from ERP/legacy systems
  - Databases
- **On hand**
  - Incorrect product codes
  - "Fat Finger"
  - Scanner/Reader problems
  - Missing product codes
  - Shrinkage
  - Returns
- **Physical Inventory / Reconciliation**
Inventory position: What can go wrong?

- When is something On-Order?
  - Order has been generated by the system
  - Order has been transmitted to the supplier
  - Order has been accepted by the supplier
  - Order has been shipped by the supplier

- Usually when an order has been generated by the system is added as an “on-order”
  - Includes an expected arrival date

- Expected arrival date is important
  - Will this expected arrival date get updated? By whom?
  - How about partial orders?
  - How about multiple vendors?
Inventory position: What can go wrong?

- Backorders & Committed
  - Cancellation policy
  - “Phantom Orders”
Q3: How much to order?

- Function of the inventory model
  - Order Point
  - Order Quantity

- Segmentation is widely used for selecting between inventory models or model parameters
  - ABC analysis on volume/sales dollars
  - Problems
    - Homogenous at the sub-class/item level
    - Little thought around variability
    - Not revised frequently enough

- Technology – Automated Replenishment
  - Exception based
  - Analysis tools (limited)
Which inventory models are used?

- Which ones are supported by my vendor or legacy system?
- Vendor selection becomes crucial
  - Cost/ROI
  - What is the problem I am trying to solve?
  - How does it fit with my business process?
  - Which inventory models are supported?
  - Do I have the data?

- Retail
  - Two broad types of products:
    - Basics – longer lifecycles, mostly seasonal
    - Fashion – short lifecycle, always seasonal
  - (R, s, S) – Also called min/max
  - Variations of (R, s, S) to accommodate seasonal demand
  - Variations of (R, s, Q)
    - To accommodate seasonal demand
    - Life cycle

- Manufacturing
  - All types of approaches
  - Forecasting based
  - “Supply Chain” based
Inventory models challenges - Assumptions

- Non - Stationary demand
  - Forecasting
  - Recalculate parameters on a regular basis
    - Manual
    - $(R, s[t], S[t])$
    - $(R, s[t], Q[t])$
  - May help with life-cycle

- Finite Capacity
  - Rough adjustments

- Independent items-locations

- No crossing/split of orders

- Demand size of one
Inventory models challenges - Data: Garbage In, Garbage Out

- Business Goals
- Manufacturing
- Demand Management
- Financial
- Supply Management
- Forecasts
- Sales & Operations
Inventory models challenges - Data: Garbage In, Garbage Out (cont.)

Consider generic reorder point calculation:

\[ s = X_{L+R} + k \cdot \sigma_{L+R} \]

- Are forecasts accurate?
  - Demand vs. Sales?
  - Promotions?
- Who collects lead times?
  - How often are they updated?
- How was error estimated?
  - Includes lead time variability?
- PDF assumed?
  - Who defines/owns service levels?
  - How often are they updated?

- Technology & business processes are the main drivers to minimize the impact
Inventory models challenges - Consistently inaccurate data

- Holding & ordering costs
- Service levels
  - Definition
  - Financial impact
- Service level targets at the item-location level
- Capacity
  - Push vs. Pull
Beyond the item-location

- Inventory decisions are made at the item-location level
- “Optimal” decisions at item-location may not be the best decisions for the system
  - Ex: Service level
  - Ex: Presentation stock
  - Ex: Substitute items
  - Ex: Vendor level management
  - Ex: Multi-echelon
Multi-echelon inventory management

Where should I keep the inventory?
The fundamental tradeoff

By looking at the whole supply chain, you may be able to change this trade-off

Target Service Levels vs. Inventory Investment
Multi-echelon inventory management

- Ignore it
  - Bullwhip effect - upstream levels of the supply chain observe higher variability which translates into higher safety stock levels

- Tackle it
  - Increase complexity
  - Visibility & data sharing
  - Advanced inventory models
  - Business processes!!!!!
Technology landscape

- Legacy systems
  - Various degrees of sophistication
- ERP/SCP vendors provide inventory models in their base replenishment packages
  - Users have to configure parameters
    - Daunting task
    - Support tools sold separately
  - Integration with forecasting (data level)
  - Check the assumptions!
- Niche vendors connect to ERP systems to provide tailored inventory management models
Niche vendors

Manufacturing

Distribution

Inventory Configuration

Inventory Policy

- Oracle
- Optiant
- Logic Tools
- i2
- GAIN Systems
- Smart Ops
- Tools Group

Figure by MIT OCW.
Questions?

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