ISYE 3104
Supply Chain Modeling: Manufacturing and Warehousing
Fall 2013

Instructor: Pinar Keskinocak

Pinar Keskinocak

Education
- M.S. in Industrial Administration, Carnegie Mellon University, Pittsburgh, PA (1994)
- B.S. and M.S. in Industrial Engineering, Bilkent University, Ankara, Turkey (1991, 1992)

Experience
- Faculty member at Georgia Tech since 1999
- Co-director, Center for Health and Humanitarian Logistics
- Associate Director for Research, Health Systems Institute
- IBM T.J. Watson Research Center, Yorktown Heights, NY (1997-1999)

Research
- Health and humanitarian applications
- Supply chain management
- Revenue management (Price/lead time quotation, auctions)

Teaching
- ISYE 3104 - Supply Chain Models: Manufacturing & Warehousing
- ISYE 4231 (3133) - Engineering Optimization
- ISYE 4104 - Senior Design
- ISYE 6230 - Economic Decision Analysis
- ISYE 6320 - Health and Public Applications of OR/MS
- Executive teaching
  - SCL short courses
  - College of Management executive courses
  - EMIL (Executive Masters for International Logistics)
  - University of Lugano (Switzerland) - Humanitarian Logistics Management
- Syllabus
- Homework #0 and introductions
- Office hours
A typical supply chain

Suppliers              Manufacturing     Distribution      Channels/retailers      End users

Materials, products, services, information, money

Supply chain activities
- Design
- Manufacturing
- Procurement
- Planning and forecasting
- Order fulfillment
- Distribution

The goal in SCM:
Deliver the **right product** to the **right place** at the **right time** for the **right price**, while minimizing system-wide costs and satisfying service requirements.
Supply Chain Decisions

Strategic Level

Long Term
- Corporate objectives
- Capacity/Facilities
- Markets to operate
- Location
- Resources

A supply chain for PCs – Strategic decisions

- In which markets to serve?
- Where to locate facilities?
- Choice of vendors

Sites
- Component Vendors
- Markets for PCs
- PC Manufacturing Plant
- Regional Distribution Centers

Lanes
- Inbound from Vendors
- Plant Direct to Market
- Plant to Regional DCs
- Regional DCs to Markets

Source: CAPS Logistics
Supply Chain Decisions

Strategic Level
- Corporate objectives
- Capacity/Facilities
- Markets to operate
- Location
- Resources

Tactical
- Aggregate planning
- Resource allocation
- Capacity allocation
- Distribution
- Inventory management

A supply chain for PCs – Tactical decisions

- Which markets to serve from which facilities?
- Aggregate production planning
- Inventory policies

Source: CAPS Logistics
Supply Chain Decisions

Strategic Level
- Corporate objectives
- Capacity/Facilities
- Markets to operate
- Location
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Tactical
- Aggregate planning
- Resource allocation
- Capacity allocation
- Distribution
- Inventory management

Operational
- Shop floor scheduling
- Delivery scheduling
- Truck routing

A supply chain for PCs – Operational decisions

- Shop floor scheduling
- Daily routing of trucks

Sites
- Component Vendors
- Markets for PCs
- PC Manufacturing Plant
- Regional Distribution Centers

Lanes
- Inbound from Vendors
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Source: CAPS Logistics
Think about a product you currently own

- Where did you purchase it?
- Where was that product made?
- What about its components?
- What kind of manufacturing processes do you think were used to produce that product?
- In how many different locations do you think the product was stored before it reached you?
- What kind of transportation mode(s) may have been used to deliver the product to you?
- What happens to this product when you no longer need it?

Where does SCM fit within the firm’s strategy?

- Business strategy
  - selecting market(s) to compete
  - level of investment/ allocation of resources
- functional area strategy
  - marketing
  - finance
  - production and operations
    - decisions related to production, storage, distribution of goods and services
Wal-Mart

Corporate Strategy
- Gain competitive advantage by providing customers access to quality goods, when and where needed, at competitive prices

Operations Strategy
- Short flow times
- Low inventory levels

Operations Structure
- Cross docking
- EDI
- Fast transportation system
- Focused locations
- Communication between retail stores

Source: Mark Ferguson

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Why need SCM?

PRESSURES FROM TODAY’S COMPETITIVE ENVIRONMENT

- Rapidly changing demand and market conditions
  - Diversity of customer requirements in global markets
  - Demands for mass customization/product variety
  - Short product life cycles

Compaq computer estimates it lost $500 million to $1 billion in sales in 1995 because its laptops and desktops were not available when and where customers were ready to buy them.

In 1993, IBM lost a major fraction of its potential sales of desktop computers because it could not purchase enough chips that control the computer displays.

Parts shortages are spreading to U.S. assembly and repair operations of Japanese auto makers. Toyota Motor Corp. warned its U.S. dealers that they face a shortage of some replacement parts while Honda Motor Co. and Subaru of America this week said they would curb U.S. assembly operations to conserve parts. (Wall Street Journal, March 2011)

Boeing Aircraft, one of America’s leading capital goods producers, was forced to announce writedowns of $2.6 billion in October 1997. The reason? “Raw material shortages, internal and supplier parts shortages...”. (Wall Street Journal, Oct. 23, 1997)
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Supply shortages

- What kind of products?
- When? Why?
  - Unexpected spike in demand
  - Problems with manufacturing or suppliers
  - Discounts/promotions, advertisement
- Impact on current and future business?
- What do you do about it?
Stock more to avoid shortages?

- "Almost every single smart e-tailer is moving to stock more and more." Julie Wainwright, CEO of pet-supplies site Pets.com (11/1999)

In November 2000, Pets.com announced it was closing

Why need SCM?

PRESSURES FROM TODAY’S COMPETITIVE ENVIRONMENT

- Rapidly changing market and demand conditions
  - Need flexibility and shorter time-to-market
  - Short innovation/Product development cycles
  - Inventory becomes a major risk
- Increased competition
  - Focus on core competencies
  - Outsourcing
  - Virtual integration/collaboration
- Rapid changes in technology, new business models
Why need SCM?

“**Acer**, the world's third-biggest PC company by sales, in June **wrote off $150m worth of inventory** in Europe, where the consumer PC market has been particularly damped by macroeconomic concerns.” (FT, July 2011)

“**Nanya**, Taiwan's biggest manufacturer by sales of D-Ram memory chips for PCs, said last week that its **inventory levels were now double the normal two to three weeks' worth of stock.**” (FT, July 2011)

“Despite booming sales in the U.S., **Southcorp** (Australia’s No. 1 wine company) has been struggling. It recently reported a $646 million U.S. loss for fiscal 2003. ... Working off **excess inventory** took the annual operating profit down from analysts' original expectations of north of $210 million U.S. to $132 million U.S.” *(Business Week, October 2003)*

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Why need SCM?

- **Nortel** posts $19.2 billion loss for the second quarter.
  - Inventory write-downs of $15.2 billion.
  - Lays off 20,000 employees.
  - Nortel CEO John Roth: "It was only in October that customers stopped beating me up for not shipping fast enough, and now they say, 'Ship what? I don't need it.' " *(June 2001, The Industry Standard)*

- **Apple Computer** has reported a record $740 million second quarter loss in 1997
  - huge writedowns of inventories, which climbed nearly $2 million
  - increased outsourcing of various operational functions
  - liquidation of certain assets
  - reductions in total headcount; 2,800 jobs over the next 12 months
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Excess inventory

- What kind of products?
- When?
- Why?
- Impact on current and future business?
- What do you do about it?
Goal in SCM: Profitably match supply and demand

SUPPLY  MATCH  DEMAND

Inventory management  Product development
Production planning  Pricing
Scheduling  Promotions

Flexibility on both supply and demand sides leads to a better match.
Examples of flexibility: Flexible capacity, outsourcing
But flexibility usually comes at a cost!

Buffering variability and uncertainty: backordering demand,
holding inventory, carrying extra capacity

Some strategies for “flexibility”

- Focus on core competency, outsource other activities, e.g.,
  - Manufacturing
  - Fulfillment
  - Distribution
- Virtual integration/collaboration
Focusing on core competencies

- **Xerox** announced that it will exit the small office/home office (SOHO) business segment. The decision was necessary for Xerox to focus on its core office and production printing segments, which the company sees as higher-growth opportunities (June 2001).

- **Boeing** now promotes itself as a company with a "core competency" not as an airplane builder, but as an integrator of complex electronics and IT-intensive systems. Plane-making has the inherently slower growth of any mature manufacturing business, which is why Boeing is outsourcing more and more metal-bending work and pushing what it calls "new frontier" opportunities, most of them in the company's high-tech Space and Communications unit, which includes major IT-intensive projects. (April 20, 2001)

Outsourcing manufacturing - Computing and electronics industry

- Original equipment manufacturers (OEMs) outsource production and logistics to electronic manufacturing services (EMS) providers
- Speed and scale
- Improved asset utilization and low cost production
- Access to global markets
- Supply chain coordination and logistics services
Outsourcing fulfillment

Stage I: In-house fulfillment
- 80,000 sq. ft. low-tech warehouse in CA
- 75% of orders come from east coast
- Major fulfillment problems during holiday season 1998

Stage II: Outsourcing (1999)
- Warehouse and distribution agreement with Fingerhut Business Services
- Access to one million sq. ft. facility in Utah, highly automated
- Additional value-added services
eToys - Fulfillment operations

- Stage III: In-house (again!)
  - Delivered 96% of merchandise on time during 1999 holiday season
  - Higher than expected order fulfillment costs
  - $62 million in inventory
  - 400,000 sq. ft. warehouse in Danville, Virginia
- Stage IV: Closing doors
  - Filed for bankruptcy in March 2001

Warehousing

- Webvan filed Chapter 11 bankruptcy protection and laid off most of its remaining 2,000 workers (July 2001)
  - Spent millions of dollars on high-tech warehouses
  - Realized that small-scale delivery services worked better than its costly distribution network. Its first and only market to turn an operating profit was Orange County, where the company operated out of one of HomeGrocer’s facilities, which were about a third the size of the massive warehouses that Louis Borders had devised.
Vertical vs. virtual integration
Vertical integration example – Ford in the early 20th century

- Focus: mass customization – make Model T better, faster, and cheaper
  - Owned rubber plantation, glass factory, steel mills, iron ores, railroads and ships, etc.
  - **Cost/price**: The price of Model T fell from $825 in 1908 to $290 in 1924
  - **Market share**
    - By 1914, Ford had a 48% share of the American market
    - By 1920 Ford was producing half the cars made worldwide.

What are the benefits/problems with this approach?

Decentralized supply chain example – General Motors

- Decentralization instead of vertical integration
  - Chevrolet, Oldsmobile, Buick, Cadillac (and a few year later Pontiac)
  - Use outside suppliers
- New models every year
- By 1960s, GM's profits were three times Ford's
- Cadillac sales slumped from 350,000 cars in 1978 to 172,000 in 2001, by which time the average Cadillac buyer was 66 years old
- In 2004 GM announced it would stop making Oldsmobiles, a brand that went back to 1897 and was older than GM itself

What are the benefits/problems with this approach?
Virtual integration - Dell example

- Suppliers maintain nearby ship points; delivery time 15 minutes to 1 hour
- Suppliers own inventory until used in production
- Demand forecasting is critical – changes are shared immediately within Dell and with supply base
- Customers frequently steered to “recommended configurations” with high availability to balance supply and demand
- Demand pull throughout value chain – “information for inventory” substitution
- Focused on strategic partnerships: suppliers down from 200 to 47
- External logistics supplier used to manage inbound supply chain

PC SUPPLY CHAINS

Typical PC Supply Chain

Dell Supply Chain
Dell Model Benefits

- No production launch until customer order booked (pure pull!)
- Very high product (configurable) variety – mass customization!
- Direct fulfillment - no intermediaries
- Very low finished goods inventory (costs) - high inventory turns (raw material inventory influenced by “recommended configurations”)
- High velocity material flows & fulfillment

Losing Sight of the Common Objective

I'm glad that the hole is not on our side!

Source: Mumin Kurtulus
### Multiple facets of collaboration

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### Intra-enterprise vertical collaboration - Example: Marketing & Manufacturing

**MARKETING** → **PRODUCTION**

**Common Incentives:**
- Maximize Revenue
- Maximize Volume

**Common Incentives:**
- Minimize Cost
- Increase Operational Efficiency

- Dividing a firm for performance measurement on accounting terms lead to misaligned incentives (Otley, 2002)
- “How to increase cooperation and decrease conflict between marketing and manufacturing?” (Shapiro, HBR, 1977; Malhotra and Sharma JOM, 2002)
- AMR Research Report “Price Management: How the Leaders Succeed”:
  - Centralized pricing function, adjustment of sales incentives to include margin, not just volume.

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**Intra-enterprise horizontal collaboration - Example: procurement**

Multiple divisions with similar functionality within a firm/organization collaborate for improved efficiencies

- Using centralized procurement, Dial Corp. was able to eliminate $100 million in total costs in five years (1996-2001)
- Siemens Medical Systems cut its costs by 25% over a three year period (1998-2001)

**Multiple facets of collaboration**

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Strategic partnerships with suppliers

“The Big Three [US automakers] set annual cost-reduction targets [for the parts they purchase]. To realize those targets, they'll do anything. [They've unleashed] a reign of terror, and it gets worse every year. You can't trust anyone [in those companies]”

-Director, interior systems supplier to Ford, GM, and Chrysler, October 1999*

“Toyota helped us dramatically improve our production system. We started by making one component, and as we improved, [Toyota] rewarded us with orders for more components. Toyota is our best customer.”

-Senior executive, supplier to Ford, GM, Chrysler, and Toyota, July 2001**

Arm’s Length

Suppliers

US auto man.

Toyota

Partnership

Collaboration/partnerships

Boeing and IBM today announced a strategic alliance that's potentially valued at > $200 billion over 10 years. Since Boeing understands system integration and building military and space platforms such as fighter jets, helicopters, rockets, and surveillance satellites, says Roberts, "the part we really need is the information management. [IBM] will help us take the power of the network to turn that data into rapid information and intelligence." (Business Week, September 2004)
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#### Intra-enterprise

#### Inter-enterprise

#### Inter-enterprise horizontal collaboration - Example: procurement

**Multiple firms/organizations** (which may be potential competitors) collaborate on specific functions for improved efficiencies

- Group Purchasing Organizations (GPO) Directory: more than 700 GPOs and multi-hospital systems which own, manage, or provide purchasing services to hospitals
- PAHO Revolving Fund for Vaccine Procurement
  - purchase of vaccines, syringes/needles, and cold chain equipment
  - establishes annual vaccine contracts on behalf or member states
Industry initiatives for collaboration

- Voluntary Inter-Industry Commerce Standards Committee (VICS, www.vics.org)
  - A standard set of processes and a protocol for sharing a wide range of data over the Internet
  - A platform for negotiation before agreeing on a forecast

Roadmap for ISYE 3104

- Make-or-buy decisions, learning curves
- Aggregate planning
- Deterministic inventory models
- Stochastic inventory models
- Lot sizing, scheduling
- Warehousing
- Layout design
- Optional topics (depending on time and interest)
  - Reverse logistics
  - Supply chain collaboration
**Additional slides**

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**Dell performance**

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**DELL IS A MASTER AT MANAGING INVENTORY...**

**AND TURNING SALES INTO CASH—FAST...**

**DELL**

From order to cash in hand

1 Day

$1.3 Billion

**COMPAQ**

From order to cash in hand

35 Days

$3.9 Billion

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**MAKING IT TOPS IN HIGH-TECH PROFITABILITY**

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**DELL**

Intel

Cisco Systems

Microsoft

**COMPAQ**

IBM

Return on invested capital

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Recap from Tuesday August 21

- Activities in a supply chain
- Strategic, tactical, operational decisions
- Examples and consequences of
  - Excess inventory
  - Excess demand
- TODAY
  - Examples of “flexibility”
  - Chapter 1 game

Recap from Thursday August 23

- Examples of “flexibility”
  - Outsourcing manufacturing, distribution, fulfillment
  - Chapter 1 game

TODAY

- Vertical vs. virtual integration
- Supply chain collaboration
- Make-or-buy decisions
- Learning curves