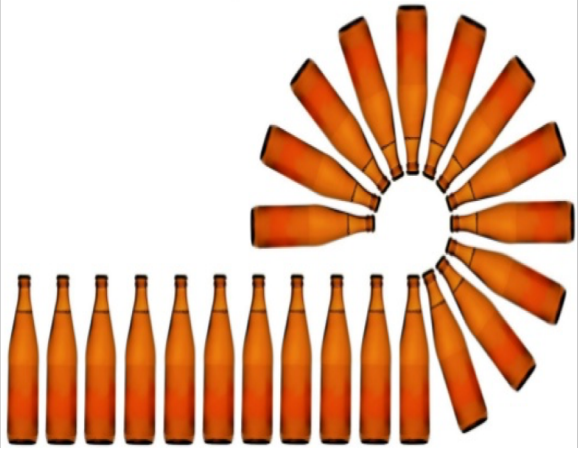
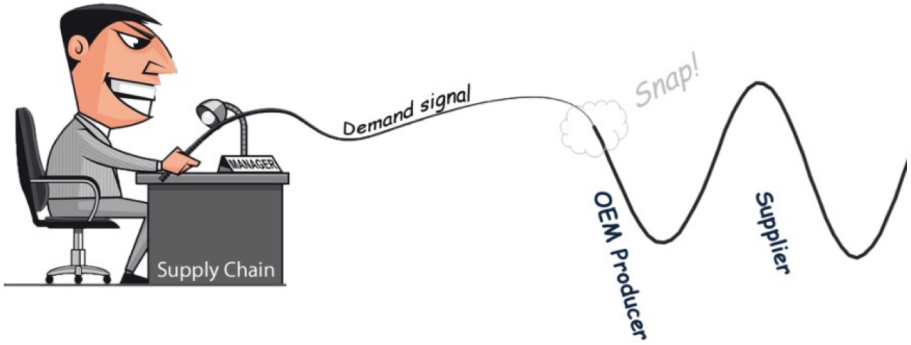
# Week 5:



# The Beer Game and the Bullwhip Effect

**MIS 3537: Internet & Supply Chains**

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# Learning Objectives

- Understand the "bullwhip effect"
- Learn what causes the effect
- Learn ways to counteract the bullwhip

# The "Pampers" problem

Pampers – a P&G product

- What Drives Consumption of Pampers?

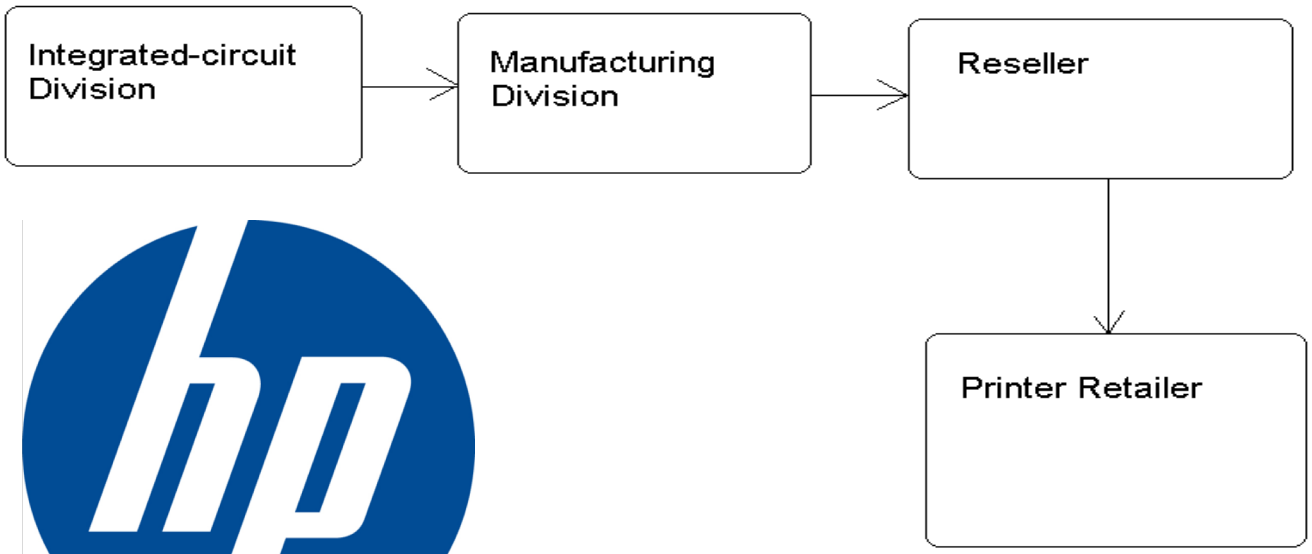
# The "Pampers" problem

Pampers – Real World Supply Chain

- Mild fluctuations in retail sales --> excessive fluctuations at distributor level
- The orders of materials to the Pampers' suppliers, e.g.: 3M, fluctuated even more
- Yet, Pampers were "consumed" at the same steady rate
- What explains the variability?

# At Hewlett-Packard

- Similar problem at HP – major printer manufacturer

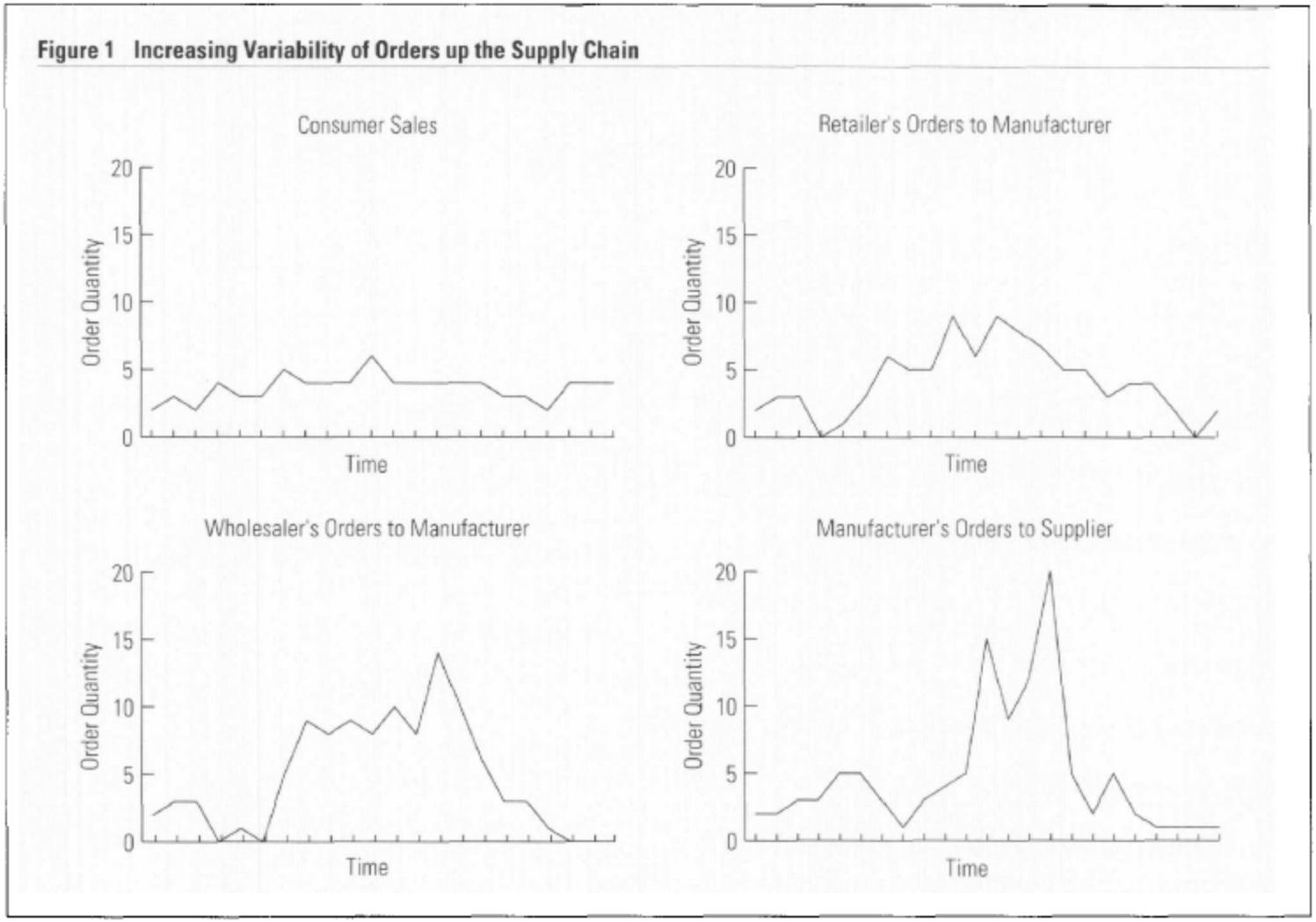


# Fluctuations at HP

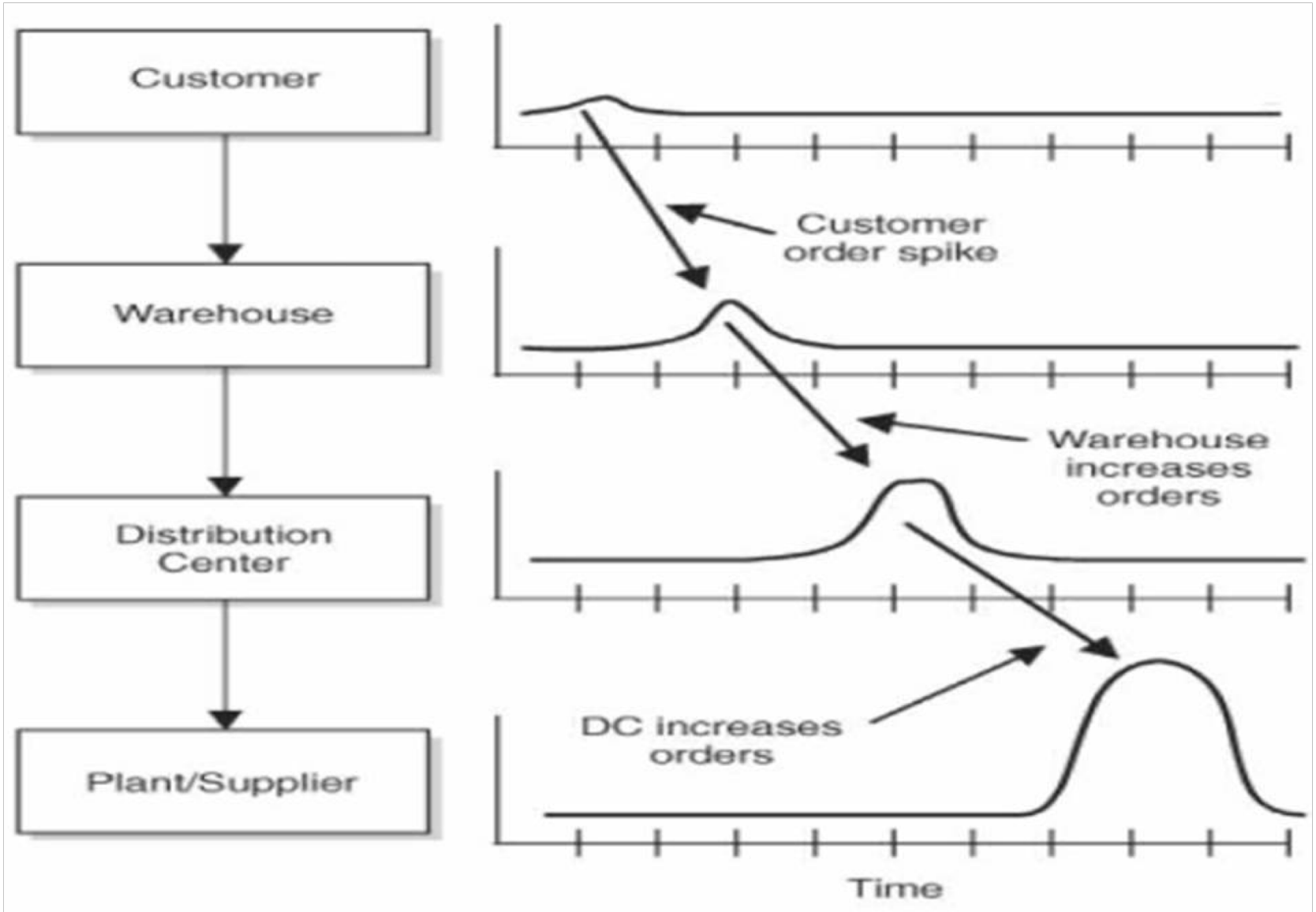
- Some fluctuations at retailer level are understandable
- More fluctuations at reseller level
- Much greater fluctuations in manufacturing division's orders to the Integrated Circuit division

# Fluctuations along the chain

**Figure 1 Increasing Variability of Orders up the Supply Chain**

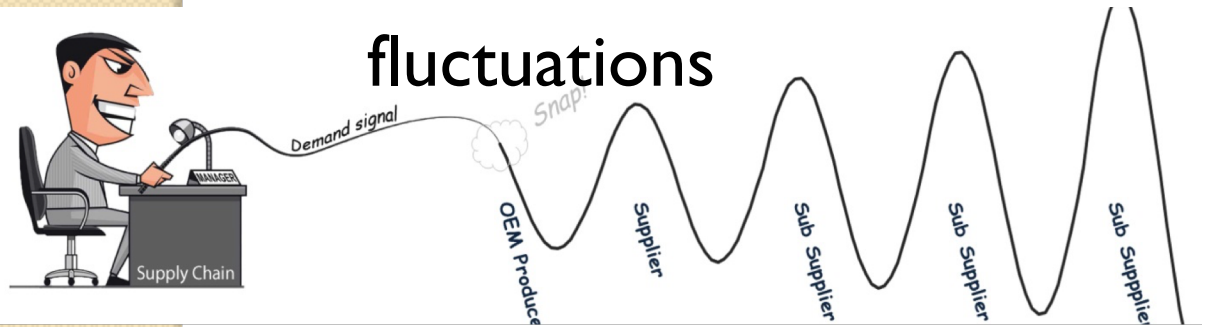


# Fluctuations along the chain



# Fluctuations along the chain

- Consumer sales are relatively stable
- The retailer's orders show more variability
- The wholesaler's orders show even more variability
- The manufacturer's orders show much greater fluctuations



# Fluctuations along the chain

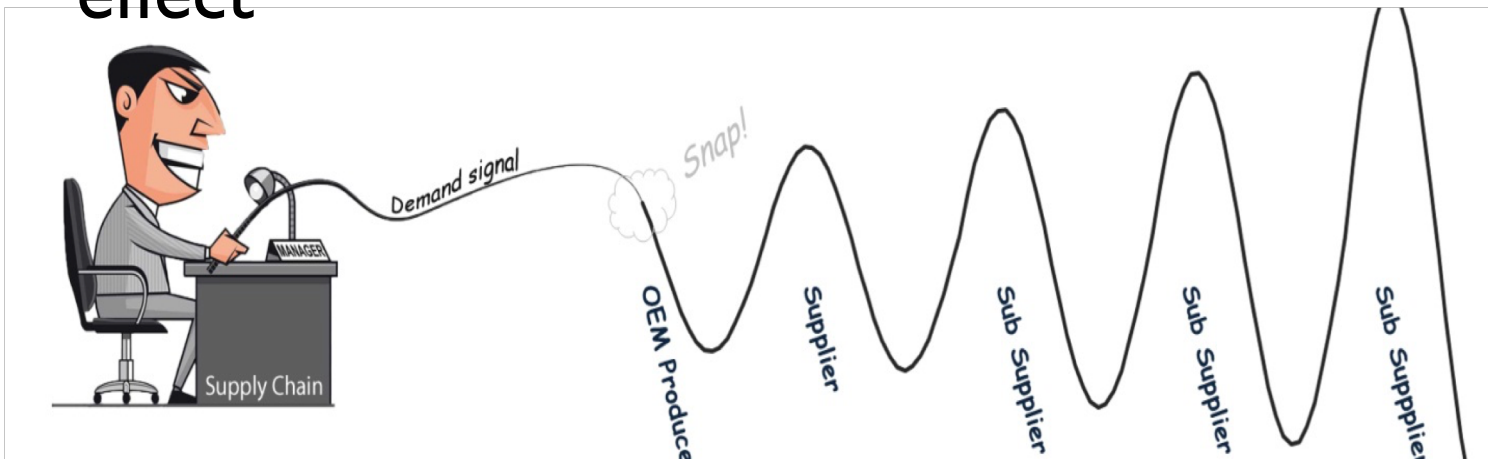
Three main patterns emerge:

- Oscillation: inventory/ backlog goes down, then up
- Amplification: height of oscillations (and hence costs) increases the farther away one is from the end customer
  - The distributor usually illustrates significant oscillation because the factory is buffered by having no limits on capacity
- Lag: the swings (generally) happen later in time and increase as one goes farther away from the end customer

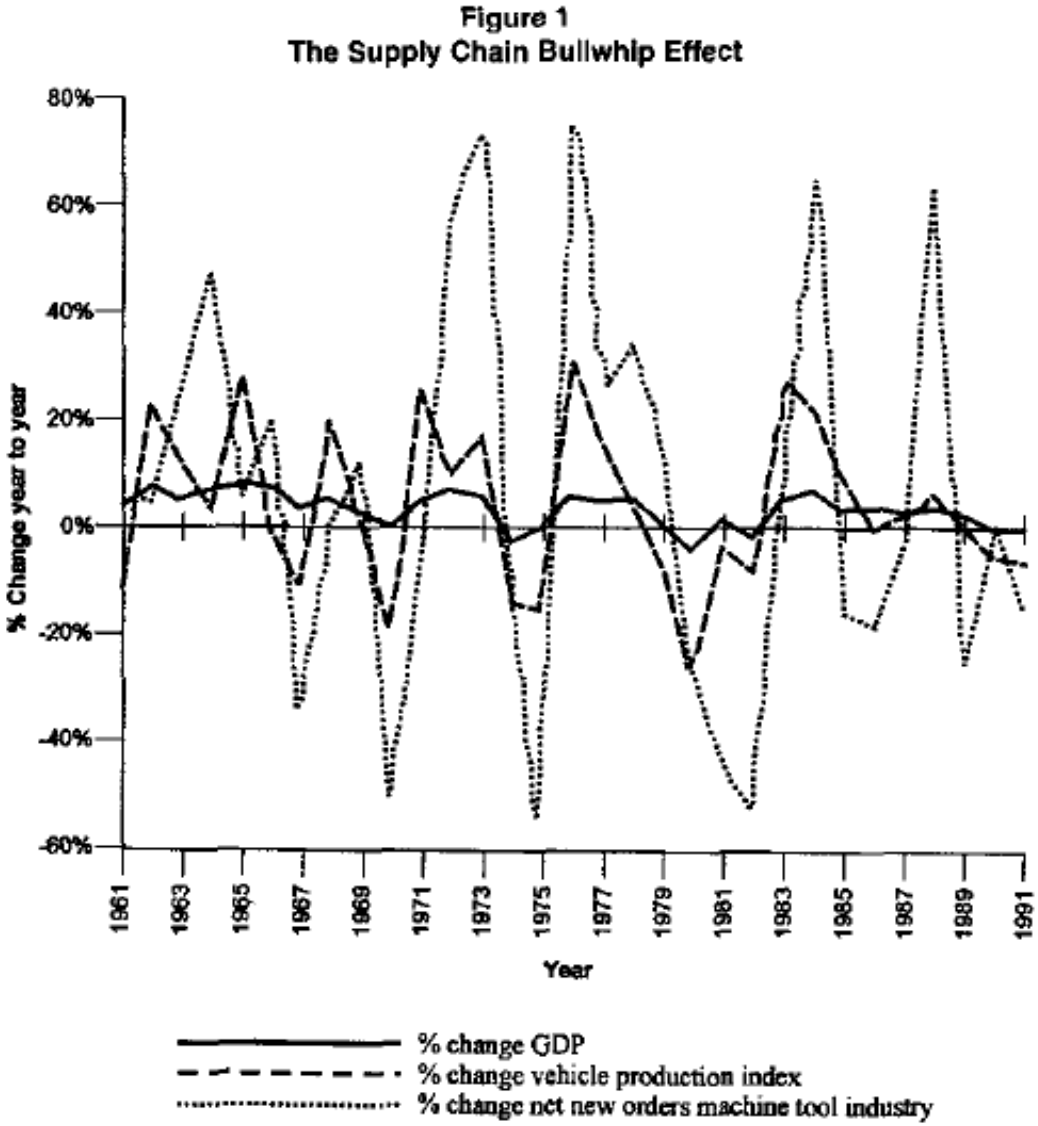
# The bullwhip effect

- Distorted information from one end of the supply chain to another creates a fluctuation in how the various entities behave

- The resulting variability in forecasts, orders and inventory levels is called the "bullwhip effect"



# Forrester effect

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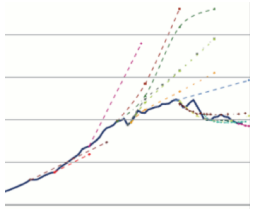
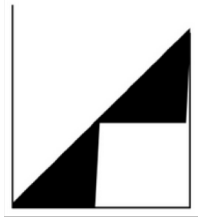
# What causes the bullwhip effect?

- Demand forecast updating

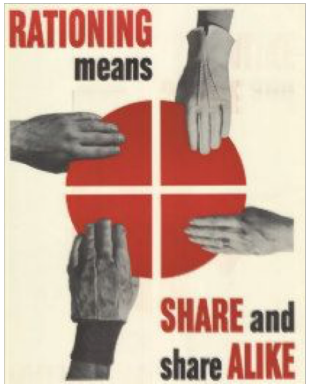


- Order batching

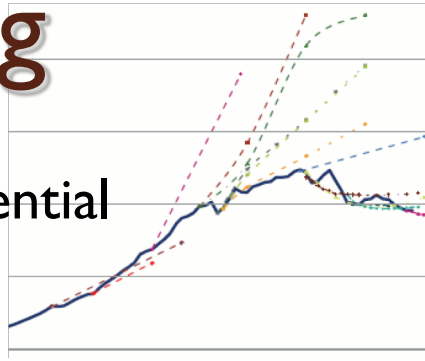


- Price fluctuation

- Rationing and shortage gaming

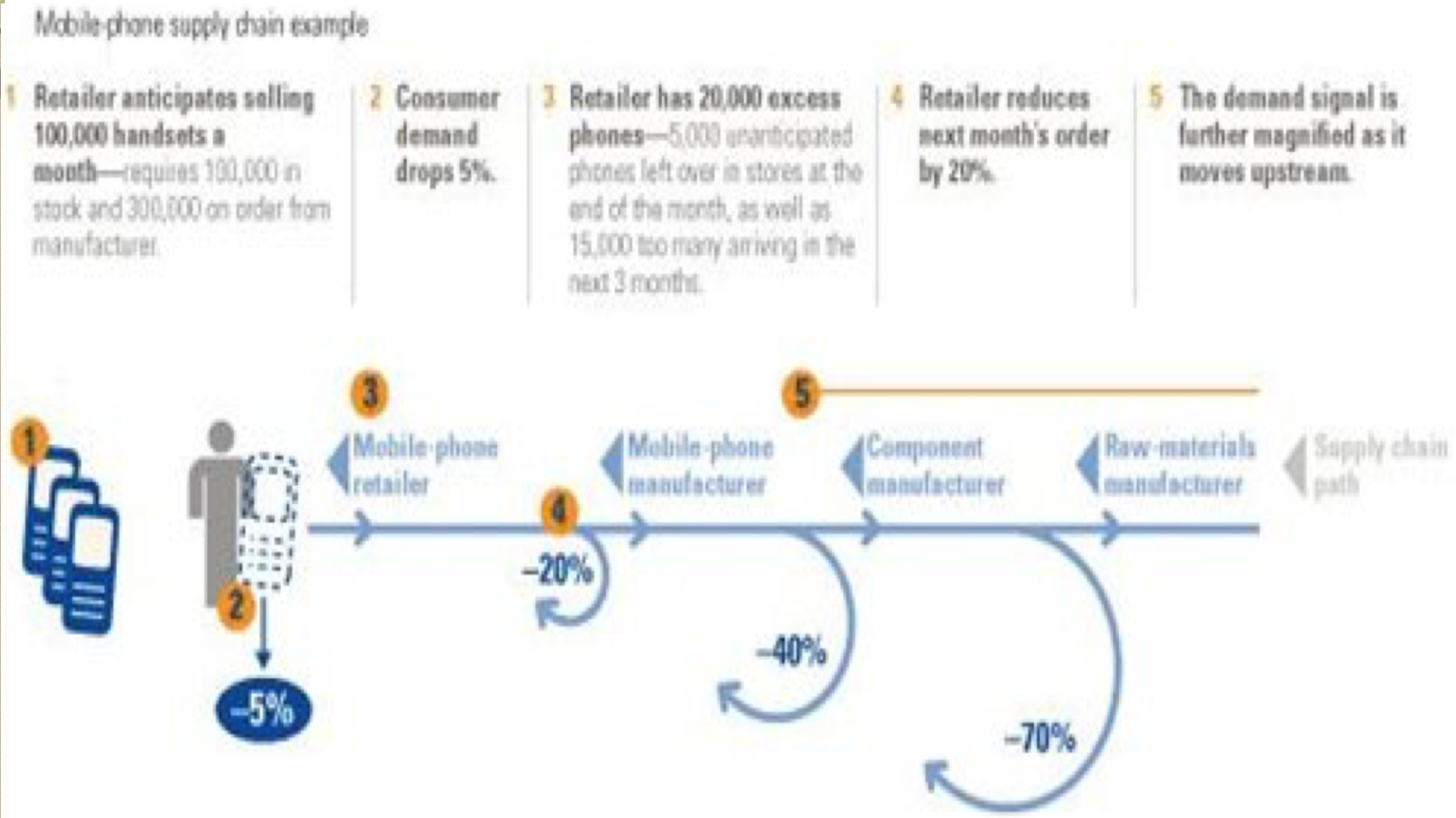


# Demand forecast updating



- Forecasts are generally made using the exponential smoothing technique
- At each level in the supply chain, the input to the demand forecast is the orders from one level below in the supply chain (esp. when level is different company, organization)
- As orders from the level below keep changing, so does your forecast
- Your forecast is the input to the forecast of the entity one level above
- As your forecasts vary, their forecasts vary even more

# Demand forecast updating

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# Counteract: Avoid multiple demand order forecasts

- What causes multiple demand order forecasts?
  - Forecast from one entity becomes input for higher-level entity
  - Simply put, different entities in the supply chain work with different demand data

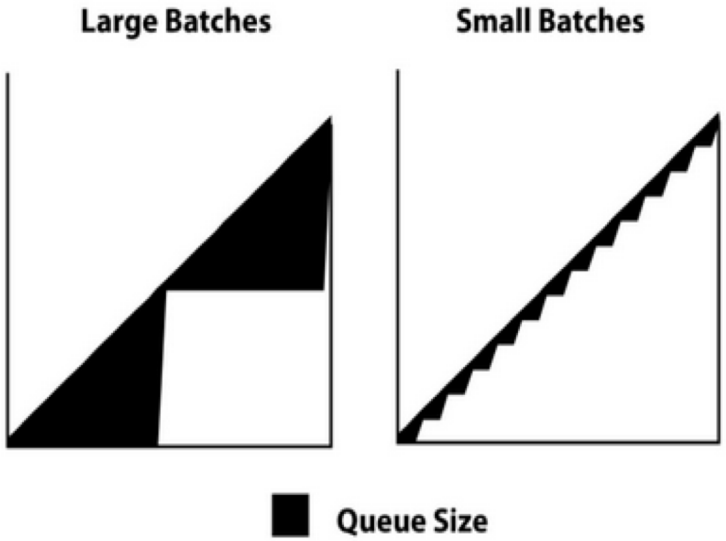

- To counteract
  - Share data
  - Create demand forecasts using same raw data

# Avoid multiple forecasts (contd.)

- Tools & techniques
  - Use point-of-sale data
    - The actual sale data becomes the raw data for forecast updates along the system
  - Electronic Data Interchange / Internet
    - EDI or Internet web services ensures that the same data is shared across multiple entities at frequent intervals
  - Computer-assisted ordering

# Order batching

- A retailer orders products in batches
- When demand comes in, the retailer does not order immediately, but accumulates demand and then orders again in batches
- This causes a constant ebb and flow



# Counteract: Break order batches

- Orders involve paperwork and red tape
- Also companies offer differential pricing between full-truckload and less-than-truckload (LTL) transportation
- How to counteract?
  - EDI
  - Truckloads with different products (Mixed Loads)

# Price fluctuation

- On average, 80% of transactions in the grocery industry is "forward buy"
- Forward buying results in price fluctuations
- Also, there are price discounts, quantity discounts, coupons, rebates etc.
- Hence customers buy in quantities that do not reflect immediate needs
- How often have you bought an extra box of corn flakes or an extra bottle of juice because of a temporary price reduction?


# Counteract: Stabilize prices

- Problem
  - Forward buying leads to price fluctuations
  - Price discounting leads to uneven demand patterns

- How to counteract?
  - Reduce frequency and level of wholesale price discounting
  - Everyday Low Price / Value pricing strategy

# Rationing and Shortage Gaming

- Scenario: Demand exceeds supply
  - Manufacturer can ration product supply
  - If total supply is only 50% of total demand, customers will receive only 50% of their order
  - Knowing this, customers exaggerate their real needs when they order
  - When demand cools, orders get cancelled


Examples: Sales of DRAM chips in the 1980s; disappearance of HP Laserjet orders

# Counteract: Eliminate shortage gaming

- Problem
  - Demand exceeds supply
  - Suppliers order more to counteract lower supply

- How to counteract?
  - Do no allocate products on basis of orders alone
  - Allocate in proportion to past sales records

# Eliminate shortage gaming (contd.)

- Information sharing
  - "Shortage gaming" arises due to lack of trust
  - Sharing information can help overcome this

- Stop generous return policies!
  - Penalties for returns to manufacturers; this ensures that retailers will not exaggerate needs, and later cancel orders

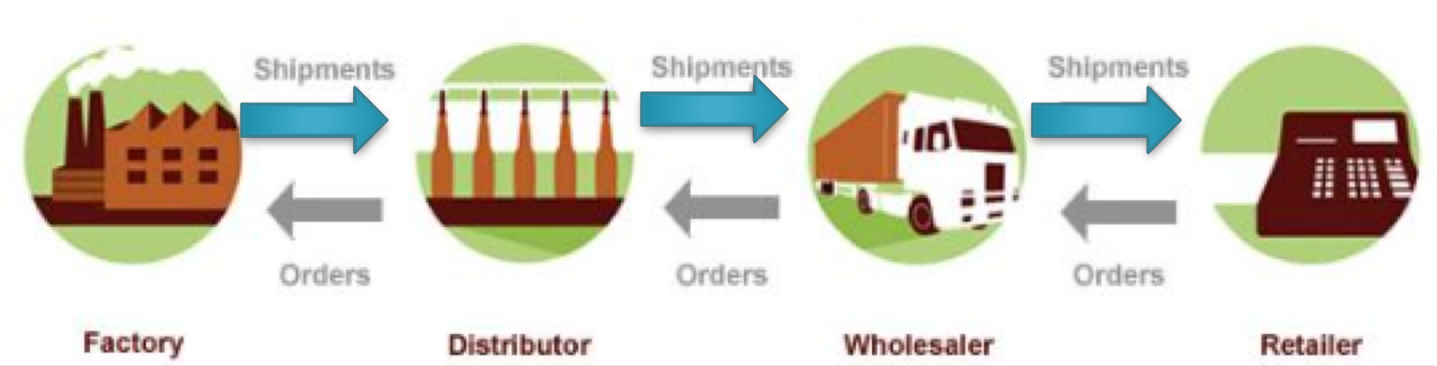
# Summary

| Causes of Bullwhip | Information Sharing | Channel Alignment | Operational Efficiency |
|---|---|---|---|
| **Demand Forecast Update** | • Understanding system dynamics<br>• Use point-of-sale (POS) data<br>• Electronic data interchange (EDI)<br>• Internet<br>• Computer-assisted ordering (CAO) | • Vendor-managed inventory (VMI)<br>• Discount for information sharing<br>• Consumer direct | • Lead-time reduction<br>• Echelon-based inventory control |
| **Order Batching** | • EDI<br>• Internet ordering | • Discount for truckload assortment<br>• Delivery appointments<br>• Consolidation<br>• Logistics outsourcing | • Reduction in fixed cost of ordering by EDI or electronic commerce<br>• CAO |
| **Price Fluctuations** | | • Continuous replenishment program (CRP)<br>• Everyday low cost (EDLC) | • Everyday low price (EDLP)<br>• Activity-based costing (ABC) |
| **Shortage Gaming** | • Sharing sales, capacity, and inventory data | • Allocation based on past sales | |

# The beer game

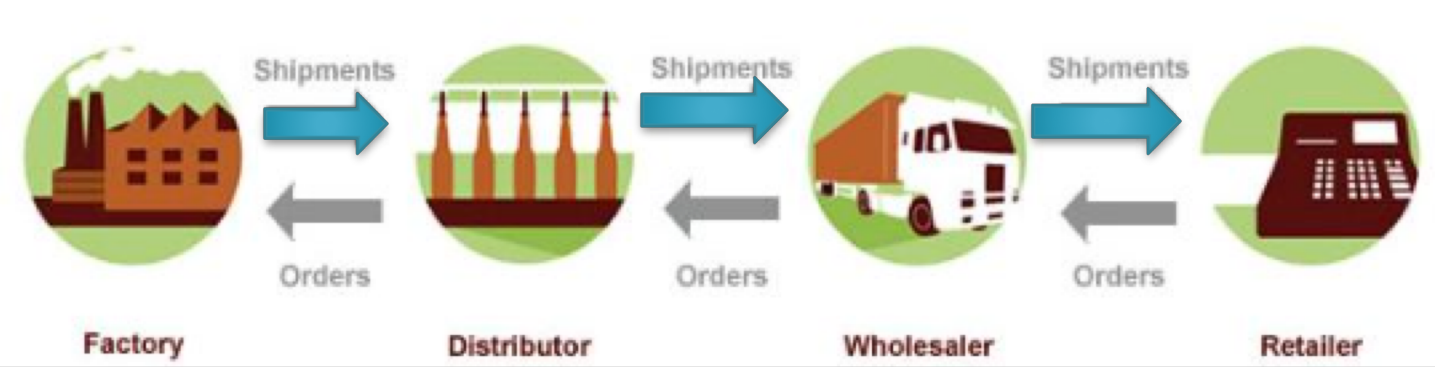
- Originally conceived at MIT
- A very good exercise in understanding the bullwhip effect
- The structure and rules…

# Game Roles (SC Players)




- Factory : Manufactures root beer
- Distributor : Bottling and package (case)
- Wholesaler : Local warehousing
- Retailer : Sale to customer

# Game Flows




- Types
  - Physical
  - Information (orders)
- Frequency: once per period (week)
- Delays (displayed on the ordering box and can vary for different groups) – e.g.
  - 2 weeks order to ship
  - 2 weeks ship to delivery

# The rules of the game

- You, the player, can play one of the four roles; you are the owner at either:
  - Retailer
  - Wholesaler
  - Distributor
  - Factory


- The factory has access to unlimited amounts of raw materials, labor etc.

# The Rules: Routine


- Each week you will receive orders from downstream
- You '**must**' ship the order if you can. If you can't – it goes into backlog and **must** be shipped in later week(s) when stock is available.


- Each player replenishes stock from ordering from the partner upstream (except factory which produces)

# The rules: Decisions

- Each player must work with these data parameters
  - Orders: the order amount received from the next level along your supply chain
    - A retailer's orders are dependent on the perceived demand; a wholesaler's order amount is based on what demanded by the retailer and so on.
  - Inventory: the numbers in stock
  - Backlog: unfulfilled orders from past week(s)

# The rules: On the Clock


This Week (Intro)

- Make teams of 4 students
- Post team details on community, as a comment to post titled – Beer Game Groups
- Register for the Beer Game (*everyone must register)*

# The rules: Winning

How do you win?

Lowest Total Cost for entire Supply Chain (inventory cost + backorder cost)

- Inventory cost: For every item in the inventory, the holding entity (retailer, etc.) is charged $ 0.50

- Backorder cost: For every item unfulfilled, the entity unable to fulfill the order is charged $ 1.00

# Let's play the game!

# Root Beer Game Completion Schedule

- Practice session (completed in class) – *Feb 19*
- Complete Round 1 – in class *February 19*
- Game reset and ready to start Round 2 – *February 19*
- Complete Round 2 and Submit deliverables – *by Feb 26*