Week 5:
The Beer Game and the Bullwhip Effect

MIS 3537: Internet & Supply Chains

Prof. Edward (Ed) Beaver
The rules: On the Clock

Last Week (Intro)

- I gave you as much time as you need
- Proceed to next week when all orders have been placed

This Week (Round 1)

- There will be a timer (upper right of screen)
- If counter is zero without your input, system will reuse previous decision
Let’s play the game!
Break Time
Your thoughts

- Which role are you playing?
- How are you Feeling?
Your thoughts

- What were your individual costs? What was the total supply chain cost?

- What could have helped you bring down the costs?
Learning Objectives

- Have some fun with the beer game
- Understand the “bullwhip effect”
- Learn what causes the effect
- Learn ways to counteract the bullwhip
The “Pampers” problem

- Pampers – a P&G products

- Mild fluctuations in retail sales; excessive fluctuations at distributor level

- The orders of materials to the Pamper’s 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

- Consumer Sales
- Retailer's Orders to Manufacturer
- Wholesaler's Orders to Manufacturer
- Manufacturer's Orders to Supplier
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
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”.
Learning Objectives

- Have some fun with the beer game
- Understand the “bullwhip effect”
- Learn what causes the effect and
- Learn ways to counteract the bullwhip
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

Mobile-phone supply chain example

1. Retailer anticipates selling 100,000 handsets a month—requires 100,000 in stock and 300,000 on order from manufacturer.
2. Consumer demand drops 5%.
3. Retailer has 20,000 excess phones—5,000 unanticipated phones left over in stores at the end of the month, as well as 15,000 too many arriving in the next 3 months.
4. Retailer reduces next month’s order by 20%.
5. The demand signal is further magnified as it moves upstream.
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 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 doesn’t 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

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

- Practice session (completed in class) – February 4
- Complete Round 1 – in class February 11
- Team decision (via e-mail to professor) on Round 2 change – by February 18
- Game reset and ready to start Round 2 – February 20 (see blog post)
- Complete Round 2 and Submit deliverables – by March 10
Root Beer Game: Round 2 Options

Each Team Can make 1 of the following changes for Round 2

A. Point of Sale (POS) information available to all Roles (not just retailer)
B. Shipping Delay reduced to 1 week from 2
C. Information Delay (Order) reduced to 1 week from 2
Root Beer Game: Note

- The demand pattern may change between the different rounds.
- The intent of playing multiple rounds is to demonstrate how manipulating certain aspects of the game can influence the performance of the supply chain.
- Here are the deliverables of the beer game (one submission per group):
  1. Complete the performance spreadsheet of our group (click here)
  2. Prepare a short writeup on how you played the game, what strategies you employed, and how your strategies changed when you played the beer game for the second time compared to the first time (you can use the questions below to prepare your talking points).

- What was your strategy in the game with respect to order placing and holding inventory?
- How was the communication and cooperation between various players in the group?
- When you played the game for the second time, how did your strategy change in terms of ordering and inventory strategy? cooperation with team members?
- What lessons from the beer game would you give to supply chain managers?
Root Beer Game: Deliverables

One submission per group

1. Complete the performance spreadsheet of your group (link in blog)

2. Short write-up: How you played the beer game. What strategies you employed and how they changed when you played the beer game the second time compared to the first. e.g.

   - What was your strategy in the game for placing orders placing and holding inventory? How did this strategy change for Round 2?
   - How was the communication and cooperation between various players in the group? How did it change from Round 1 to 2?
   - What lessons from the beer game would you give to supply chain managers?
Next week...

- Exam 1
  - Study Guide and sample test posted soon

- RFID Lecture