The Greenwich Manufacturing Workshops
Supply Chain Management
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The Beer Game

The Production - Distribution System of the Beer Game
WHAT IS THE BEER GAME

- A microcosm of how real organisations function - first developed at the MIT Sloan School of Management.
- A replica of Jay Forrester’s supply chain model (Industrial Dynamics 1961)
- A system for producing and distributing a single brand of beer (single product supply chain)

BEER GAME - AN ECHELON

Order In 4 4 Order Out

Shipment Out Distributor Shipment In

BEER GAME LAYOUT

Customer 4 4 4 4 Supplier

Retailer Wholesaler Distributor Factory
BEER GAME RULES

- Minimize Costs
  - Inventory = $0.50 per case
  - Backlog = $1.00 per case
- No communication between teams (echelons)
- Customer orders fixed stock

NEW RULE

Your mission is to keep your retailer out of backlog.

A penalty will be applied to each group of 10 N² where N is the number of weeks the retailer is in backlog.

BEER GAME STEPS

- 5 Steps per Week
  - Take Order In
  - Fulfil Order (Shipment Out)
  - Move Shipment In
  - Place Order Out
  - Record Inventory/ Backlog and Order Placed
BEER GAME STEPS

Shipment Out  Shipment In

Order In  Order Out

Shipment Out  Shipment In

IMPORTANT POINTS

- No communication between teams
- Only interaction is for placing and fulfilling orders
- Record Inventory, backlog and orders placed
- Backlog = Orders to be fulfilled minus available inventory for that order
- Backlogs must be fulfilled, if not it is accumulated
- Sum of total inventory and total backlog costs
- Plot orders and inventory / backlog graphs

THE BEER GAME II

Information Distortion and The Bullwhip Effect
The figure displays a typical outcome of the Beer Game showing the variation of effective inventory for the various sectors. Generally speaking, the Beer Game is characterized by large-scale oscillations that grow in amplitude from the retailer to the wholesaler and from the wholesaler to the distributor.

Another feature of these games is the increase in orders, which propagate in a wavelike fashion down the chain, depleting inventories one by one until it is finally reflected at the brewery at which point the large surplus of orders placed during the out of stock period is produced.
WHY PLAY THE BEER GAME?

- It is a “laboratory replica” of a real setting, rather than reality itself. We can isolate the disabilities and their causes more sharply than is possible in real organisations.

- It reveals that the problem originates in basic ways of thinking and interacting more than in peculiarities of organisation, structure and policy.

WHY PLAY THE BEER GAME?

- Illustrates that the order decisions of many players are in fact noise and cyclic.

- Therefore players upstream of these noisy individuals do in fact experience realistic demands.

- The behaviour of these players is not statistically different from that of the retailers, indicating that the use of a step input does not reduce the generality of the results.

WHY PLAY THE BEER GAME?

- More fundamentally, are the main features of the experimental behaviour observed in real production-distribution systems?

- It has long been recognised that production distribution networks in the real economy exhibit the three aggregate behaviours generated in the experiment:
  - oscillation
  - amplification (from retailer sales to primary production)
  - phase lag
LESSONS OF THE BEER GAME?

1. Structure influence behaviour
   - Different people in the same structure tend to produce qualitatively similar results
   - When there are problems, or performance fails to live up to what is intended, it is easy to find someone or something to blame
   - But, more often we realise, systems cause their own crises, not external forces or individual's mistakes

LESSONS OF THE BEER GAME?

2. Structure in human systems is subtle
   - We tend to think of structure as external constraints on the individual
   - But, structure in complex systems means basic interrelationships that control behaviour
   - In human systems, structure includes how people make decisions - the "operating policies" whereby we translate perceptions, goals, rules and norms into actions.

LESSONS OF THE BEER GAME?

3. Leverage often comes from new ways of thinking
   - In human system, people often have potential leverage that they do not exercise because they focus on their own decisions and ignore how their decisions affect others.
   - In the beer game, players have it in their power to eliminate the extreme instabilities that invariably occur, but they fail to do so because they do not understand how they are creating the instability in the first place.
THE BEER GAME AND REALITY

Reality in production-distribution systems are often worse than the beer game

- A real retailer can order from three or four wholesalers at once, wait for the first group of deliveries to arrive, and cancel the other orders.
- Real producers often run up against production capacity limits not present in the game, thereby exacerbating panic throughout the distribution system.
- In turn, producers invest in additional capacity because they believe that current demand levels will continue into the future, then find themselves strapped with excess capacity when demand collapses.

THE BEER GAME AND REALITY

- “In the last 20 years, the beer game has been played thousands of times in classes and management and training seminars, on five continents, culture origins, and vastly varied business backgrounds.”
- Yet every time the game is played the same crises ensue. By the end of the experiment, almost all players are sitting with large inventories that they cannot unload.

The causes of the behaviour must lie beyond the individuals.
The causes of behaviour must lie in the structure of the game itself.

INFORMATION DISTORTION

The Bullwhip Effect

- Order variability is amplified up the supply chain: upstream is worse.
- Apparent information distortion: what you see is not what you face.
- Bullwhip, whip-saw, whip lash effect or acceleration principle or the Beer Game phenomenon.
CAUSES OF THE BULLWHIP EFFECT

- Information sharing problem - sharing data has traditionally been considered proprietary
- Forecasting is usually done separately by retailers, manufacturers, and suppliers
- Batching orders - companies make a practice of batching because it saves time and money
- Gaming - when in shortage of supply, reorder to get higher priority
- Price variation - when manufacturers offer bargains, retailers stockpile inventory and don’t order again for months

IMPACT OF INFORMATION SHARING

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<th>Market Information Enrichment Strategy</th>
<th>Order Amplification</th>
<th>JIT Capacity Level</th>
<th>Number of Stock Turns</th>
<th>Order Range on Shop Floor</th>
<th>Frequency of Ramp Up-Down</th>
<th>Strategy Rank</th>
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SUMMARY

- Bullwhip effects are harmful to the efficiency of a supply chain.
- Understanding the causes critical to devise counter-strategies
- Industry responses require:
  - information co-ordination
  - collaborative efforts
  - ways to split investments and gains
  - overcome organisational barriers