Computerized Beer Distribution Game Management Flight Simulators: A Review

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ABSTRACT

The Beer Game has been used to demonstrate the bullwhip effect often observed in supply chains, i.e. the amplification of demand variance upstream in the supply chain in multiple echelon systems. In recent years, computerized Beer Games have been developed at a number of schools to facilitate or replace the traditional manual game.

This thesis reviews five existing computerized Beer Distribution Games, discusses their differences, and introduces a new computerized Beer Game currently being developed.

Key words: Beer Distribution Game, Supply Chain Management, System Dynamics, System Thinking, Computer Simulation, Internet, Intranet

BACKGROUND

The Beer Distribution Game, better known as the “Beer Game”, is a group exercise developed in the early 1960s at MIT as part of Jay Forrester’s research on industrial dynamics [Sterman 1989]. The game is a simulation of a production-distribution system or supply chain. The notional product is beer, but this cover story is largely irrelevant – the game applies to a wide range of manufactured goods.

To play the game, the group is divided into teams. In each team, the participants are assigned one of four roles: Retailer, Wholesaler, Distributor, or Factory. Each echelon maintains its own inventories and orders. In each game period, every echelon makes decision on the order quantity as well as shipment quantity for this period. The echelon receives an order from their customer and then places an order with their supplier. All orders are received after an order processing delay. All shipments are received after a shipping delay. The game is initialized in equilibrium. The goal of the team is to minimize the total costs of the entire supply chain, which is the sum of inventory holding cost and back order cost. To achieve that goal, each sector in the team needs to determine the best way to balance supply and demand.

The Beer Distribution Game demonstrates the relationship between nodes on a supply/demand chain with time delay. More importantly, it demonstrates the impact of system structure on human performance in a relatively complex process. It emphasizes the importance of information flow in multiple echelon systems. It provides a vivid example to introduce instruction on systems concepts. The game has also been played by many executives. It has demonstrated how experienced decision-makers can still fall into a trap of thinking of their actions as isolated. The game helps them to better understand their roles within systems. It allows decision-makers to begin to look at the entire system and see the effects of their actions, and to realize it is usually their own behavior that produces the problems they encounter ([Sterman 1989], [Senge 1990]). The popularity of the game is a good indicator of its significant educational value in system thinking.

PLAYING THE GAME

There are two ways to play the Beer Game, manually or with a computerized Beer Game software package.

MANUAL

This is the traditional method of playing the game.

Supplies

The manual game uses a game board which portraits the production and distributions of beer (see Figure 1). It uses chips or coins to represent cases of beer. A deck of cards is used to represent incoming consumer orders. Paper slips are used to record orders and will be passed up the chain to the suppliers. Record sheets are given to each role in the team to record their ordering and shipping decisions.

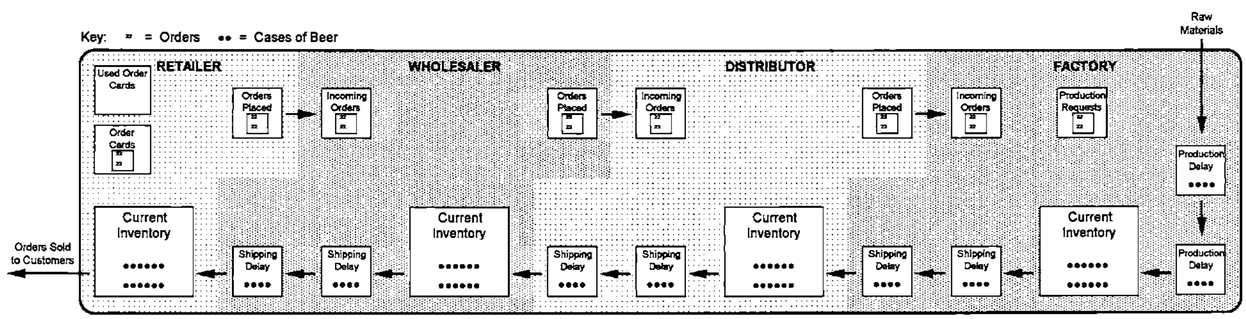

Figure 1. The Game Board for the Manual Version of the Beer Distribution Game

Information Availability

In the manual game, each echelon has access only to the inventory and ordering information of its own echelon. There is no communication up or down the supply chain. Of course, players can easily look at the entire board and gain some cross-echelon information in this fashion.

Gaming

The manual game requires at least four participants. Usually one or two players manage each echelon. The participants sit next to each other along the game board. In each game period, the players make ordering and shipping decisions according to the customer orders and their inventory level. Then they write down the order quantity on an order slip and pass it to their suppliers. Shipments are made by passing the corresponding number of chips to the players down the supply chain.

Time Management

One person is needed to manage the timing of the game periods. This is usually done by the instructor of the class. The facilitator informs the players of the starting of the next game period. The players repeat the actions of decision making, ordering and shipping for each period till the end of the game. The game is usually played for 36 periods; subjects are told the game will run for 50 weeks to prevent end-game effects.

Debriefing

After the game is over, the facilitator collects the record sheets, tallies the ordering and shipping decisions, calculates the total costs for each team, and generates graphs for the history of the game. These results are discussed at a debriefing session later.

Game Parameters

Each manual game period represents a week. At the start of the game, each sector has an inventory containing 12 cases of beer. The initial throughput is four cases per week. In the standard protocol, the customer demand steps up from 4 to 8 cases in week 5. Then it remains at that level till the end of the game.

The inventory holding costs are \$.50 per case per week. The stockout cost is \$1.00 per case per week. The shipping delay and the order processing delay are both two weeks.

Computer-based Gaming

The manual game has been a great learning experience for the players. However, it is time-consuming to play. The game usually is made up with three parts, gaming, tabulating results, and debriefing. With manual recording of ordering and shipping decisions for each period, it is possible that the results would be affected by human errors. In addition, the manual game requires the participation of other players.

In recent years, several computer-based Beer Game Management Flight Simulators (MFS) have been created and implemented at a few universities and firms to replace or supplement the manual game. These simulators are usually based on the manual game but there are some variations. The following is a list of the computerized beer game software reviewed in this article.

Standalone

- Beer Game Management Flight Simulator: MIT Macintosh version
- NWU PC version: Distributed on the CD-ROM accompanying textbook "*Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*" by David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi

Internet/Intranet

- Intranet version at Harvard Business School
- Internet version at Indiana University
- BeerNet, an Internet version at Northwestern University

CONTENTS OF REVIEW

The following categories have been used when reviewing each of the Beer Distribution Game software packages.

- Functionality
  - How well does the simulator run?
  - Is it user-friendly and easy to play?
  - Are there any glitches in the program? How stable is the system?
  - Is there documentation available?
- Flexibility in Scenario Configuration
  - Can players remove one or more echelons or otherwise reengineer the supply chain?
  - Does it allow each sector to access inventory and order information of the other sectors?

- Are there computer-simulated players available for one or all of the echelons? If so, what decision rules do they use and can they be customized by the user?
- Does it allow customer demand patterns other than the standard "Step"?

- Network Usage Availability
  - Does the game allow multiple users to play with each other on networked computers? If so, does it require human players for each of the other sectors?
- Management of the Game
  - Is a facilitator necessary to manage the timing of the game? If not, how are the time periods controlled?

BEER GAME SOFTWARE REVIEW

The following is a review of all the Beer Distribution Game Management Flight Simulators listed above.

STANDALONE VERSIONS

The Beer Distribution Game Management Flight Simulator, Macintosh Version, MIT (MIT)

Contact

Professor John Sterman, Sloan School of Business, Massachusetts Institute of Technology

This simulator was developed in 1995 by Professor John Sterman and Thomas Fiddaman at MIT.

http://web.mit.edu/jsterman/www/SDG/MFS/beerMFS.html

Technology

It runs on the Macintosh family of personal computers.

Gaming

The simulator corresponds to the board game in demonstrating the bullwhip effect in the supply chain. In addition, it takes advantage of the computer simulation and provides the players with more ways to observe the bullwhip effect.

- **Players** - This is a standalone version. The player or players can choose one echelon and let the computer simulate the other three echelons. Alternatively, they can have the computer simulate the entire supply chain.
- **Supply Chain Levels -** The number of echelons in the supply chain may be varied. The player can choose to remove one or more echelons out of the supply chain. The four options are:
  - Factory Only
  - Retailer + Factory
  - Retailer + Distributor + Factory
  - Retailer + Wholesaler + Distributor + Factory (Default)

  This helps to demonstrate the impact of supply chain complexity on supply chain effectiveness and system behaviors.
- **Order Quantities –** Small order quantities are used in the manual game in order to keep the game and calculation simple. With the computer game, the initial order and inventory quantities are moved up to the more realistic hundreds of cases.
- **Demand Patterns –** Four demand patterns are available in this game: Step, Double Step, Ramp, Wave and Mystery. ***Step*** is the standard scenario for the manual game, except that the step increase in orders occurs in week three rather than week five. In ***Double Step***, the customer orders first increase, remain at that level for a certain number of weeks, then fall to a quantity that is in between the first two levels. In ***Ramp***, the orders start at the same quantity for a few weeks then ramp up at the same rate of growth till the end of the game. ***Wave*** produces a wavy demand pattern. The ***Mystery*** scenario is different each time it is run.

- **Length of Delay -** In the manual game, the shipping delays are two game periods long, which equals two weeks. With this simulator, three options are available to choose from: zero, one or two weeks.
- **Game Intervals** – The players have the options to select the number of periods to advance the game with one mouse click. They can also step continuously to the end of the game with a fixed order amount. This is useful when the players want to see the results of a fixed order/shipment policy.
- **Simulation** - The simulated players use adaptive expectations to determine desired inventory and supply line levels. The simulated players use the decision rule for orders estimated from actual subject play in [Sterman 1989].
- **Information Availability -** The player can choose from two information availability conditions. One is the same as the manual game, allowing them access to the inventory, order and shipment information of their own sector only. The other option is to make the reports of all sectors available (global information).
- **Save Game and Replay** – The game parameters and results can be saved. The players can use the game program to reopen a result file later, to either replay or study the game. During a game, the players can also go back to a certain period of the game and replay the remaining periods.

Graphs and Reports

Players access the information through diagrams, graphs and tables. *Player information* includes Costs, Forecast, Orders, Shipments, and Stock. *System information* includes All Cumulative Costs, All Inventory or Backlog, All Orders Placed, All Shipments Received, All Supply Lines, All Weekly Costs, and Total Costs.

Documentation

The game comes with a Briefing Handbook and an Instructor's Guide. Online Help provides instructions for the game and the explanation of the function of each command.

The Beer Game, PC version (Simchi-Levi)

Contact

Professor David Simchi-Levi, Kellogg Graduate School of Management, Northwestern University

This game is distributed in the CD-ROM accompanying textbook "*Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*" by David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi.

According to the Introduction of the game, the game is created "to make it easier to play the Beer Game, as well as to illustrate certain Supply Chain Management issues which cannot be demonstrated by the traditional (non-computerized) Beer Game."

http://primal.iems.nwu.edu/~levi/prolog/beergame.html

Technology

This computerized game is played under the Windows operating environment, with more flexibility and more options than the traditional board game.

Gaming

This is a standalone program where the players select one of the four roles in the supply chain. The other roles are simulated by the computer. The program gives the users literally a pipeline view by displaying all sectors on the entire supply chain in the user interface. The interactive player is in color while the others are gray. The supply chain image includes all the delay stages in between the sectors next to each other, with numbers representing the inventory amount at each delay.

The players can start the game once they have set all the game configurations (see ***Configuration***). The game starts with the click of the Start button. A dialog screen pops up with the most recent order from the downstream customer, current backorder and the inventory supplied, and prompts for the players' order for this period. Once an order is entered, the dialog screen closes and the supply chain display is updated with the order entered by the player and those calculated by the computer. The players continue to the next game period by pressing the Next Round button.

Configuration

This computerized version of the Beer Game was designed to be faithful to the original manual version. On the other hand, it also gives the players more flexibility when setting up the game in order to explore the full benefits of the computer simulation.

The players can customize the game with the following categories:

- **Policy**: Policy determines the inventory control scheme used by the computer-simulated players.

  The players first determine the following four numbers for each simulated sector:

  - **s** – Lowest inventory level allowed before replenishment
  - **S** – Inventory level to replenish to
  - **Q** – Order quantity
  - **M** – A multiplier

  With the above numbers, one can choose to use one of the six inventory policies, i.e.

  - **s-S** – the system places an order to bring the inventory position to S when the inventory position falls below s.
  - **s-Q** – the system places an order for Q when the inventory position falls below s.
  - **Order to S** – The system places an order to bring the inventory position to S.
  - **Order Q** – The system orders Q.
  - **Updated s** – The order-up-to level is determined using the moving average of demand received by that player over the past periods, the lead time, adjusted by the multiplier M and an estimate of the standard deviation of demand during the lead time.
  - **Echelon** – a modified version of the standard echelon inventory policy.

- **Short lead-time**: When selected, one of the two delays is removed from the supply chain. The lead-time becomes 1 week for each player.
- **Centralized**: When selected, the interactive players manage the factory. They have to visualize the external demand and react to it. Inventory is immediately sent forward to the next sector once it is received so that only the Retailer holds inventory. This is analogous to a vendor managed inventory system.
- **Demand**: There are two choices to set up the demand stream. *Deterministic* follows the traditional Step pattern and requires the input of an initial demand, number of periods this demand will last, and the demand for the rest of the period. *Random Normal* requires an initial demand, initial standard deviation, total periods of this demand, then a new demand and a new standard deviation.
- **Global Information**: When selected, the system displays inventory and cost information at all of the sectors on the game screen.

Information Availability & Graphs and Reports

The players can choose to view all orders placed by themselves or the simulated sectors, as well as the mean and standard deviation of these orders. Graphs and reports of orders and costs are available at any time of the game.

Documentation

This Beer Game program comes with detailed searchable online help.

NETWORKED VERSIONS

Intranet version, Harvard Business School (HBS)

Contact

Professor Roy Shapiro, Harvard Business School

http://www.hbs.edu/it/tools/tool_interactive.html

Named the **Sim**U**lated** **D**istribution **S**ystem (SUDS), this online version of the beer game has been in existence since the early 1990s. The game is available via the HBS Intranet and used once every year in the Technology and Operation Management class. The benefit of the computerized game, according to Professor Shapiro, is that the players are less distracted and able to concentrate more on the game and the decision-making process. The total costs are lower, compared to the manual game.

Technology

This is a web-based application developed with Java. It is compatible with both Netscape and Microsoft Internet Explorer.

Gaming

In the class, students play the game in the computer lab. The players are divided into teams and play the game simultaneously. In each team students are assigned the roles of manufacturer, distributor, wholesaler, or retailer. Each role of each team plays on a separate computer. The game for the team starts when all players log into the program.

The game screen is divided into three frames. The top frame uses animations to demonstrate the arrival of goods from the suppliers and the customer ordering activities. There are also sound effects such as the ringing of a telephone to complement the animation. The bottom left frame shows a log of all activities to date, and is updated every period. The bottom right frame displays messages regarding the status for this sector. The players are prompted to enter their decisions for orders at this frame.

The timing is completely dependent on the order inputs of the players. For each team, the server waits for all four sectors to enter their decisions. Once that happens, the server will update with the inputs, display the new information for each sector, and move on to the next game period. If one sector fails to enter their decisions, the system will continue to wait until human intervention.

Graphs and Reports

There are no graphs or reports available during the game. The activity log on the screen contains the following information for each period: Inventory Received, Customer Order, Shipment, Your Order, Current Inventory, Current Backlog, Cost and Cost To Date. The players can print out the log in the clipboard.

At the end of the game, students are asked to plot their impression of the consumer demand curve with the computer. The instructor will then print out the inventory/backlog and order graphs by sectors for each team, then distribute them at the class discussion.

Features to be added

Currently the game is only used for demonstrating the bullwhip effect in the supply chain. All parameters are the same as those in the manual game. It is under consideration that various customer demand patterns be added to the game in the near future.

Documentation

There is no documentation available for this game at this time.

BeerNet, Internet version (BeerNet)

Contact

Professor Ravi Anupindi, Kellogg Graduate School of Management, Northwestern University

Professor Yehuda Bassok, Marshall School of Business, University of Southern California

Professor Eitan Zemel, Stern School of Management, New York University

http://kaizen.kellogg.nwu.edu/BeerNet/

Described as "a remote group software for studying supply chain dynamics" by the user manual, this computer-based Beer Game is designed as a multi-person game played using the Internet. According to the manual of the game, it was the first Internet version of the beer game in which four live players can plan without the constraint of being in the same location.

Technology

The game is implemented as a client-server architecture. The instructor uses the server software to configure the parameters of the games. The client presently works on Windows 95/98/NT and UNIX machines. The players download the self-extracting executable client setup file from the BeerNet web site and install the game on their computers.

Gaming

To start the game, a player needs to connect the client to the BeerNet Server first. On the setup screen, the player enters a nickname to identify him/herself, enters the IP address of the BeerNet server, and clicks the Connect button. Once the connection is established, the player selects a game from the game list, chooses a role and joins the game. The player can view the details of the game, e.g. delays, cost structure, time available for decision making, other players who have already joined the game, etc. by clicking the Query button.

Once all four players have joined the game, each player is prompted to confirm the start of the game. After all four players have confirmed, the game screen will be presented on the computer. In each period, the player determines the Ship Out quantity by choosing the lesser of Gross Demand and Total Inventory. With that decision, the system calculates the New Inventory and New Backlog. The player then determines the order quantity with such information. Once both decisions have been submitted, the period is over and the program waits for all other players to submit their decisions.

Game Time Management

The time players are allocated per decision round is set by the instructor when setting up or modifying the game. A clock sits at the upper left corner of the player screen reminding the players of the time remaining for each period. The clock turns red when 80% of the allotted time is up. When the time is up, the game will move to the next period even if the players have not entered their decisions for the period. When that happens, the system assumes zero order and zero shipment for the echelon for this period.

Available Information

- The players can view their own order and shipment history during the game. At the end of the game, the players have the choice to save a game log for later discussion and analysis. The game log is in text format.
- One setup option of the game is to make the information on the other supply chain players available. The information includes demand, inventory, shipments and backlog.

- The players can view the actual order pattern graph at the BeerNet homepage after the game is over.

Server Configuration

The instructor uses the server to add, remove or modify a game. The following are the configurations the instructor can set at the game setup screen:

Game Parameters: Total Turns, Decision Time, Learning Time (for the instruction and explanation in the first period), Game Objective (Cost Minimization or Profit Maximization), and Demand Source.

The customer demand can be generated from two sources, random distribution or a text source file.

Role Parameters: Initial Inventory, Selling Price, Purchase Price, Backlog Cost, Inventory Cost, Information Delay, Shipment Delay, Enqued Shipments and Orders (starting pipeline of outgoing shipments and orders), and Information Permission for this player.

Features to be added

Professor Anupindi plans to add the following features to the game.

1. Real-time graphing
2. Profit Maximization including transfer pricing and retail pricing
3. Options for Demand Generation (include demand as a function of price) and Demand Forecasting
4. Automating roles in the supply chain: adding a robot who can play the game as a client
5. Web Browser interface for server

Future Plans

Future plans include extending BeerNet platform to simulate non-linear supply chains (e.g. multiple retailers).

Documentation

A user manual for both the client and the server is available for the BeerNet.

Internet version, Indiana University (Indiana)

Contact

Professor F. Robert Jacobs, Kelly School of Business, Indiana University

http://jacobs.indiana.edu/p561/beerdocs.htm

Technology

The players work at personal computers in a classroom, using a web browser to play the game. A special program residing on a web server keeps track of the game. Multiple teams can play the game at the same time. To date, as many as eight teams have played the game simultaneously.

Gaming

Similar to the manual game, this game needs an instructor to lead the teams through each game period. The instructor uses the instructor form to initialize the game. The number of teams and the choice of demand stream are required inputs.

Players are divided into teams. In each team, each of the four roles is assigned to one or two players. Eight teams are listed on the beer game start screen. Players enter the system by clicking on their role button of their team. The gaming screen is divided into three frames. The first frame at the upper left is used to prompt for shipping and ordering decisions. The upper right frame displays the data for the current game period. Information listed include: Current Demand, Backorder, Current Shipment, (Inventory) On Hand, Due Next Period, Due in Two Periods, Current Order Release, Inventory Cost and Backorder Cost. The bottom half of the screen is a graph representing the inventory, backorder and order for the player.

In each game period, the players enter their decisions at the prompt and then press the decision button to submit it. The program does not allow the player to ship more than the combined current demand plus backlog, nor can the player ship more than what is available in the current inventory.

The players can change their decisions for the current period any time before the end of the period. The game instructor determines when the period ends and manually triggers the update of the system with the instructor's form. The server records the decisions and updates the inventory and costs. The players refresh their screens by using the Reload or Refresh button of the browser. The graph is refreshed at the same time to reflect the inventory and order position with the latest update.

The game is normally played for 35 to 40 periods. A debriefing session can start immediately after the game is completed. The players can view a debrief graph that shows the history of order, shipment and inventory of all sectors of the team.

Documentation

Information regarding this game can be found in **[Jacobs 2000]**.

DISCUSSION

Based on the review of the five computerized Beer Distribution Games, the following is a discussion of the differences of the games and their pros and cons.

Game Time Management

The manual game is often played by multiple teams simultaneously with only one facilitator. The teams who finish first have to wait for the other teams to finish in order to advance to the next game period. In addition, it takes time for the facilitator to tabulate players' manually written decisions and prepare graphs for the debriefing. Therefore, the manual game usually takes more time to play.

The standalone **MIT** and **Simchi-Levi** do not have this time-keeping issue. The users enter their decisions and move to the next game period.

Indiana requires a human facilitator to control the game intervals, which is the same as the manual game.

With **HBS**, the server controls the timing and advance only when players of all echelons have entered their decisions.

In **BeerNet**, fixed time intervals are preset and the game uses a clock to keep the players informed of the time available. If the time runs out and the users have not entered the decisions, the system takes a default decision. With this setting, the players could potentially miss the chance to enter their decisions and cannot change it once the period is over.

ACCURACY

In the manual game, errors could happen when the players count or move their coins or chips, or when they record their decisions. The computerized games basically eliminate the potential of such human errors.

INFORMATION DURING THE GAME

The manual game players can only see their current level of inventory, orders and shipments. In all the computerized games, the players can view the history of their inventory, orders and shipments at any time. **MIT** and **Simchi-Levi** also provide costs information.

Graphs are available in **MIT**, **Simchi-Levi** and **Indiana** during the game. The graphs in **MIT** are updated automatically as the game continues. In **Simchi-Levi** and **Indiana**, the users need to trigger the refresh of the graphs as the game advances.

FLEXIBILITY

The computerized games provide options to customize the game. With such flexibility, the users can see in details how different parameters affect the outcome of the game, and understand better the influence of the parameters and the dynamics in the systems.

COMPUTER SIMULATIONS

The computerized games with simulation, **MIT** and **Simchi-Levi**, provide the ability to run the game with a more realistic customer demand pattern, e.g. noise or seasonality.

DECISION INPUT

In the manual game, shipments are the lesser of inventory or new orders plus any previous backlog. **MIT, Simchi-Levi** and **HBS** automatically compute shipments using the same rule. **Indiana** and BeerNet ask for both order and shipment decisions. In **BeerNet,** the players need to enter the shipment amount. The system follows the same rules and does not allow the players to ship less than ordered. If the inventory contains less than the amount ordered, the users have to ship their entire inventory. If a shipment quantity other than the right amount is entered, a message pops up to prompt the users for correction. **BeerNet** makes this decision easier with the display of the Gross Demand and Inventory. The players only need to look at the two quantities and click the button next to the one with the less quantity. **Indiana** allows players to hold back inventory if they think that the request from the downstream position does not seem reasonable.

MIT also requires subjects to enter a demand forecast. The players and researchers can use it in comparison with the actual demand and see how the two correlate to each other, and how order behavior depends on actual expectations rather than imputed expectations, as it does in **Simchi-Levi**. A computerized game with the former approach is more realistic and similar to the manual game than that with the latter, because in the manual game, the players of the other sectors are unlikely to systematically calculate the optimal order quantities as the computer does.

System Learning Benefits

In the manual game, the human interaction among players at different echelons is an important part of the experience gained from the game. Frustration and chaos are inevitable in a real-life system. The computerized games take away much of the human interaction. The players often generate better results compared to the manual game; however, they are also deprived of the more emotional and realistic experience of the manual game.

Summary

Both the manual game and the computerized versions have their pros and cons. To fully take advantage of the learning experience offered by the Beer Distribution Game, we recommend the combination of both the manual game and a computer simulated game. The players play the manual game first to learn about the process and experience the interaction with the other players. Then they could play the computerized games with simulated players, which takes less time and allows parameter variations, to study the system's behavior in detail.

NEW GAMES IN DEVELOPMENT

We are in the process of creating a computerized Beer Game for the Windows environment. Currently at the beginning stage of the development, the game is a standalone version with similar functionality with **MIT**. It is designed to follow the principles of the manual game with computer simulated players. It will provide more options to study how the elements of a supply chain affect how it works, and help researchers to understand how the players use available information to make their decisions.

CONTACT

Professor John Sterman, Sloan School of Business, Massachusetts Institute of Technology

TECHNOLOGY

The game is developed using Microsoft Visual Basic.

GAMING

The gaming is similar to that of **MIT.** Among all the games we examined for this review, **MIT** seems to have the most options to reengineer the supply chain. We will keep these options available in the new game and provide the users with the choices of different Information Availability, Supply Chain Levels, Length of Delay, Demand Patterns, etc.

Besides the current options, the following is also under consideration for the new game –

- Correlated or non-correlated stationary random demand
- Random walk for Demand, possibly with a drift parameter

REPORTING

Diagrams and reports in the new game will be similar to **MIT.**

RESEARCH VALUE

In addition to providing a tool to study supply chain characteristics and system behaviors, the new program will also work on collecting information that will help the researchers to understand the decision making process.

The new program will allow the players to save the game parameters and results to a file, which can be re-opened and re-examined later. The result files of multiple games can be combined to study the decision processes of the players.

Another new piece of functionality that will also contribute to this study is to record all the events during a game. The game software will create a log of mouse clicks, forms/reports opened, decisions entered, and so on. The log will be useful in analyzing whether the information the players consult help them to make better decisions. We hope this functionality will help to answer questions such as whether players who spend more time in the game do better, and whether graphs and other information help improve performance. For an example, see [Diehl and Sterman 1995].

EXAMPLES

The following figures show some of the displays in the new game.

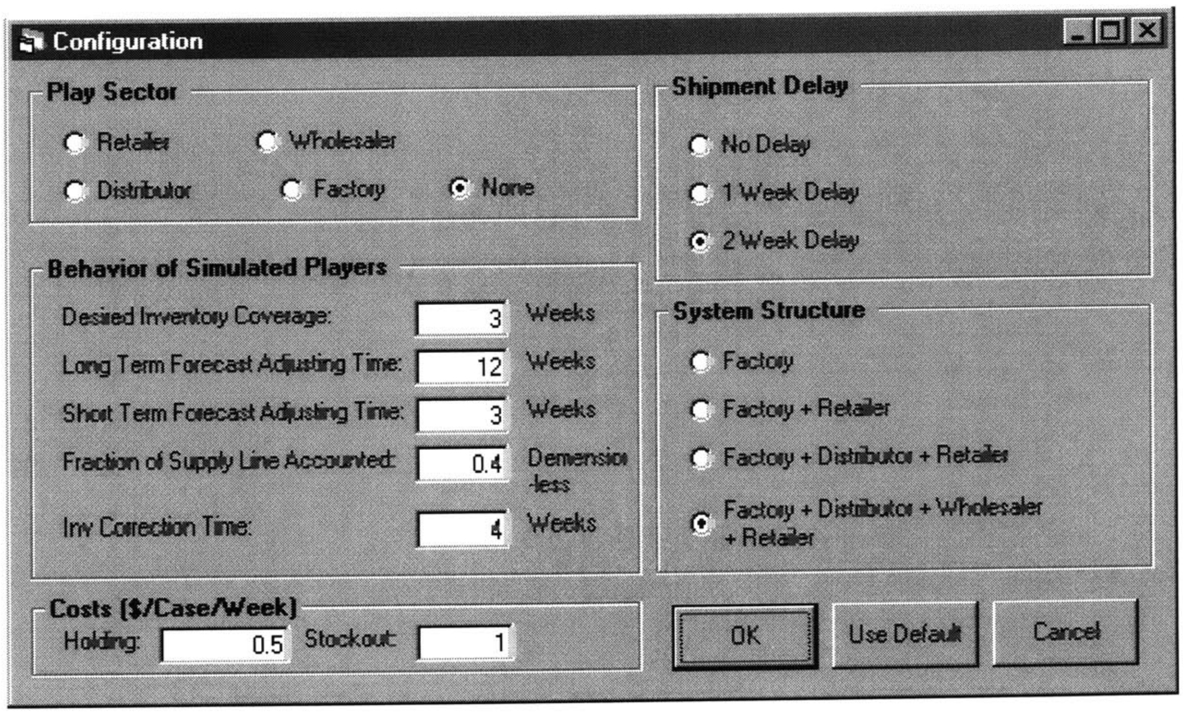

Figure 2. Configuration

The Configuration form in ***Figure 2*** pops up at the beginning of the game to allow the players set different options for the game they are going to play.

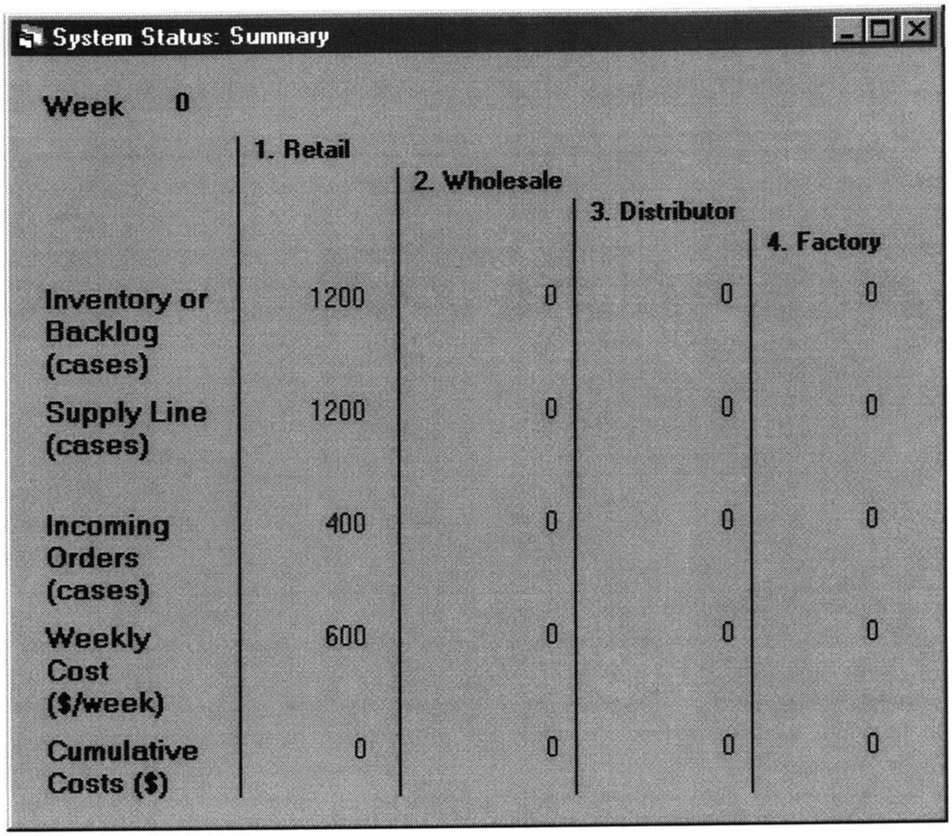

Figure 3. System Status: Summary

Figure 3 System Status: Summary shows the status of all players. In this case, the player has the retail position, with the other three echelons simulated by the computer. The game is set to have the local information condition. In the global information condition, data from all four echelons would be displayed.

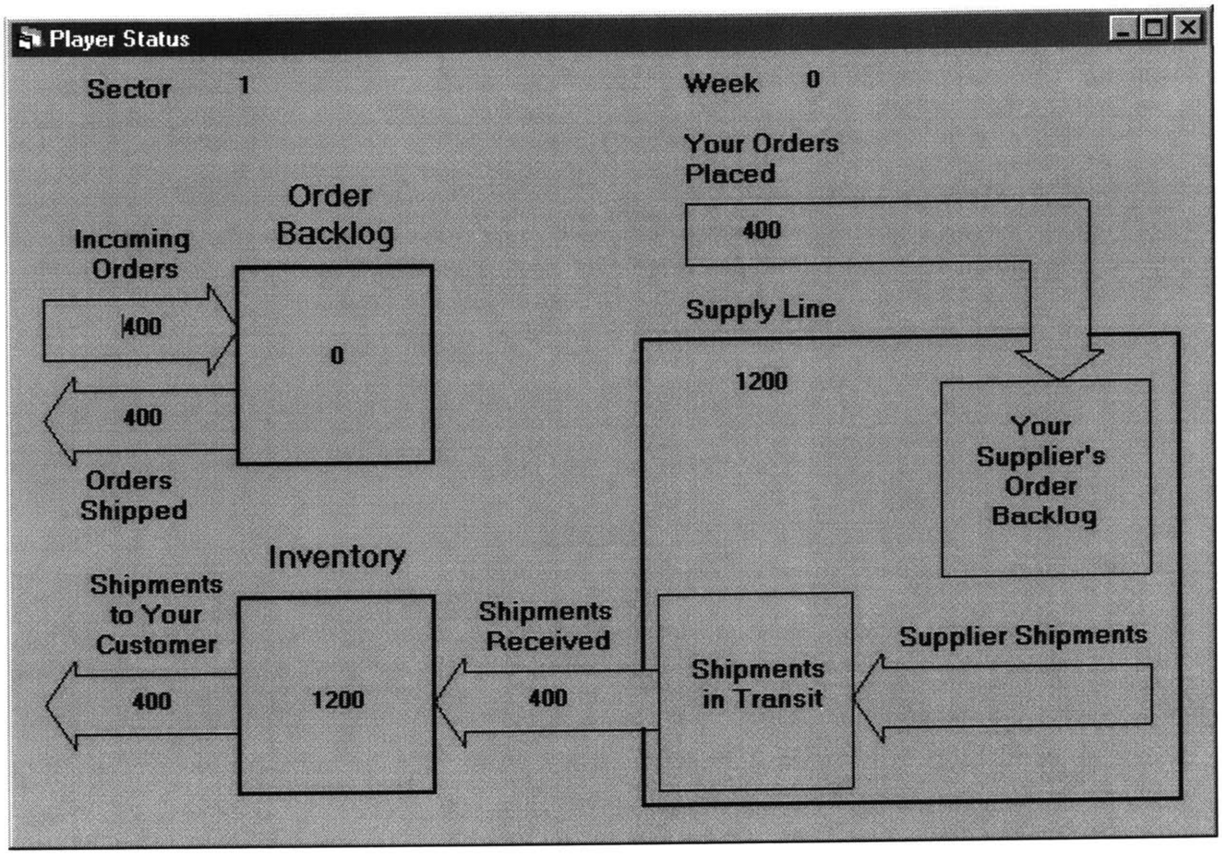

Figure 4. Player Status

Figure 4. Player Status is the diagram of inventory flow for sector 1 (Retailer).

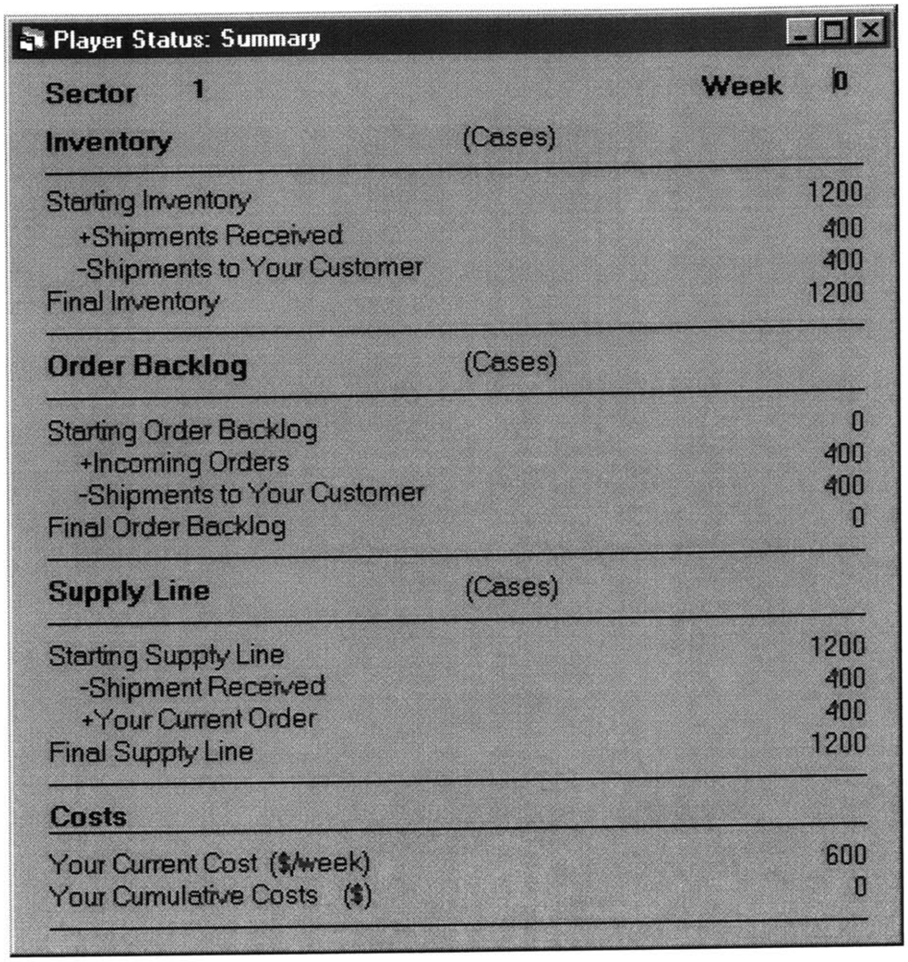

Figure 5. Player Status: Summary

CONCLUSION

A few other computerized Beer Distribution Games have also been made available as this paper is being written. The development and utilization of both the manual game and the computerized games certainly confirm the importance of the Beer Distribution Game in the education of system concepts as well as supply chain management. It also illustrates that people manage to gain a better understanding from playing the game with the help of information technology.

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