Online Simulations in Management Education about Information and Its Uses

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ABSTRACT

This chapter reports on computerized simulation / games developed and used in graduate and executive education of managers (MBA programs). Managers may be among the toughest candidates for education. Online, computerized and network-mediated simulations amplify many of the traditional advantages of games in learning, and may be part of the solution to the difficulty of educating managers. Computerized games can be classified and compared by the nature of competition embedded in their topology: player vs. machine, player vs. player, and player with player. We report on one computerized simulation in each of these categories. The Lemonade Stand simulation is a person and machine implementation of business and information decision making processes. The Online Auction simulation introduces social, and interactional aspects of economic behavior. And the "Hulia" online computerization of the Beer Game allows groups to experience collaboration and competition in a complex, real time online environment. We conclude this chapter with a discussion of the expected and experienced benefits of simulations in training, as achieved through online gaming.

This chapter reports on computerized simulation / games developed and used in graduate and executive education of managers (MBA programs). Our purpose is to describe a few internet-based, computerized simulations devoted to teaching management skills. In the following, we discuss some of the unique opportunities to teaching and learning made available through the use of such online simulations, drawing on a series of simulations we have developed and implemented in a large number of managerial training and education settings.

Managers may be among the toughest candidates for education. The personality and conduct expected of managers may diverge from the leisurely, inquisitive and in-depth nature to which academe is accustomed. Quite to the contrary, managers, and often managers-in-training, are often expected to want to cut-to-the-chase. They are less patient with theories. Managers as well as students of management are often selected for the personality and behavior traits of brevity and practicality. How then do you convey complex, abstract notions to such students?

Managerial theories, on the other hand, are among the more complex, involved and contingent of the behavioral theories. Furthermore, the transition from theoretical knowledge to the ability and propensity to implement abstract knowledge in a highly abstract area like management is not simple. How, then, do we get managers in training to be excited about the subject matter they learn, internalize the knowledge, and be more likely to put such knowledge to use in real life situations?

Online, computerized and network-mediated simulations amplify many of the traditional advantages of games in learning. Adrenalin rush, attention and motivation are at their peak in simulations (Harper, Squiers, & McDougall, 2000; Rieber, 1996). Consequently, learning stands a better-than average chance. Our argument and expectation, now supported by several years of experience, is that simulations, especially of the computerized and online variety, are likely to be part of the answer to the difficulties of conveying complex and abstract ideas to managers and managers in training. Discussions and debriefing that follow the experience of a competitive or dynamic simulation tend to be the best and most internalized learning experiences (Parker & Swatman, 1999; Rafaeli et al., 2001, 2002b).

One Game is Worth a Thousand Words

The spirit of "one game is worth a thousand words" is captured when game playing is harnessed as an instructional tool. A fairly brief simulation / game session can deliver a strong message and modify attitudes that would otherwise take many hours of reading, lecturing or work on written assignments. The effectiveness of various business and e-commerce simulations is widely accepted and has been documented in previous research (Cox, 1999; Croson, 1999; Parker et al., 1999; Yeo & Tan, 1999).

Despite their utility, simulations are often avoided by teachers. The main reasons that inhibit using simulations in the classroom are the logistics of managing classes and groups during games, the time consumed by simulations and the special difficulty in simulating social situations. Following is a discussion of how computerizing and placing simulations on the internet can provide added value, and decrease the barriers to use of simulations..

Well-developed computerized simulations can remove many of the inhibitors that are built into traditional games. Computerizing games may add value to the teaching process by controlling unintended errors, reducing cheating errors, increasing result precision, easing the administration chores, cutting down on setup and explanation time, teaching more by reducing the cognitive load, allowing the player to focus on decision making, enabling easy manipulation of the game parameters, and creating a more amenable infrastructure for evaluation and development research.

Computerized games delivered over the internet allow even more advantages. Networked games place developers much closer to their customers, enabling faster customization and parameter tweaking. Internet-based delivery allows international distribution of games, and international as well as intercultural participation (Cox, 1999). Play itself is no longer limited to a single location. Internet-based delivery of simulations allows a-synchronic games, and enables the meeting of players from a variety of linguistic and cultural backgrounds.

Computerized games can be classified and compared by the nature of competition embedded in their topology: player vs. machine, player vs. player, and player with player. In the simplest case, simulations can be played in solitaire fashion, wherein each participant/student faces their own challenges and learns their own lessons. This is both the most popular and simplest form of game. With the advent of computer-based simulations, these were the first form of simulations to evolve. Alternatively, games can be an opportunity to pit players against each other. In games of this sort, participants encounter the presence of others. There is a different set of skills and thought processes required to acknowledge, process and compete with others for resources and wins. A third possible format for games, in general, and in computerized simulations in the service of management education in particular, are games featuring collaboration, cooperation and sharing among participants.

In this chapter we report on, and compare all three types of games. We have developed and run these games with many hundreds of participants, in numerous universities and corporations from several countries. As the games are computerized, each round leaves behind quantitative tracks in the form of logs. These data can be used in both short-term de-briefings immediately following the experience, as well as in longer term evaluations with the participants and in research.

We will describe the following games, one each representing each of the three categories described above:

1) Lemonade Stand II: A computer implemented market for information.

2) Online Auctions : Computer implemented markets where sellers set the rules and buyers set the price.

3) Supply Chain Management Simulation: Network mediated disintermediation?

LEMONADE STAND II: THE MARKET FOR INFORMATION

General Description of the Game

The lemonade stand simulation-game is based on the traditional individual business game, in which each participant is expected to balance business inventory and cost considerations in anticipation of a demand pattern set by the market. Managers playing this game usually demonstrate a less-than rational behavior toward information, showing a strong preference to consuming information regardless of the usefulness of that information.

The game is given as part of a lesson plan dealing with information economics. The meeting starts by explaining the purpose of the game and its rules. The purpose of the lesson is to call attention to the peculiarities of information as a good and to discuss what kind of information can be useful for decision-making. The misuse of information during the game triggers a lively discussion during the debriefing that comes after playing. The lesson ends with a formal lecture on the value of information. Some of the main points of the lecture are highlighted by the students' game performance and thus, we believe, the lesson is highly effective in producing better infosumers.

Motivation for Simulation Development

The Lemonade Stand simulation was developed as a tool to examine the value of information in trading and sharing situations. Information has several unique characteristics that render it difficult to valuate. Information is an unusual good in terms of production, distribution and consumption. Information is expensive to produce and cheap to reproduce (Bates, 1989; Shapiro & Varian, 1999). In fact, distribution is done mainly by reproduction or copying.

Digital information is virtually costless to copy meaning that cost is irrelevant to valuation, in contrast to physical goods. People consume information both by sharing and by commerce while most other goods are consumed by commerce only. The existence of these two different modes of obtaining information may suggest interdependence between them. Such interdependence may influence value perceptions in both modes. For these and other theoretical reasons, the value of information is subjective and reflects individual perceptions rather than an economic formula (Ahituv & Neumann, 1986).

Our simulation helps reveal actual individual behavior and subjective value. We discover the value of information by giving players opportunities to place their private value bids for information. Theoretical background which supports this methodology comes from research on the Endowment Effect (Camerer, 1995; Horowitz & McConnell, 2000; Kahneman, Knetsch, & Thaler, 1990; Thaler, 1980; Thaler, Kahneman, & Knetsch, 1992)

Briefly, the Endowment Effect shows that people's willingness to pay (WTP) for an object is much lower than their willingness to accept payment (WTA) for the same object. The disparity between WTA and WTP is much larger than can be explained by traditional economic assumptions such as diminishing marginal value or bargaining. During the game players are asked to place their bids for WTA and WTP using an incentive compatible method known as the BDM method (Becker, DeGroot, & Marschak, 1964).

We have applied the WTA/WTP bidding mechanism to the Lemonade Stand, in a manner which requires only minimal instructions to the user and is easy to operate. There is no prior background required in business or economics or computer operation. Players are drawn into the game thanks to its simplicity, amusing animation, the feedback it produces, and the promise of a prize for the best lemonade seller (player with highest profit). While paying attention to maximizing their profits, participants are not necessarily aware of the main focus of the simulation, the value of information. Class discussions during debriefing reveal this blind spot to the surprise of participants. This makes the value of information all the more important and memorable for the future. The ensuing lecture on information economics is then received with much interest and motivation to explore the peculiar nature of information as an economic good.

Detailed Description of the Game

In the original version of the Lemonade Stand game, participants were expected to run a small business, a lemonade stand. Based on previous work by others, we developed a computerized, Java, Perl and Oracle over http implementation of this game. The simulation-game is played in a Java applet delivered to participants' browsers over the internet. The original applet was programmed by Derek L. Ramey, with improvements added by Ravid, Rafaeli and Raban. All behavior by participants, all decisions made, and all outcomes are recorded and reported online to the server. We add a special challenge to the cyclical issues of predicting and managing customer demand, marketing and production scheduling issues. In our improved version, participants are also drawn into an information market. In addition to regular production, pricing and inventory decisions, they are offered the opportunity to buy or sell information pertinent to the managerial decisions. Hundreds of participants have played this game in multiple iterations each.

In this simulation the player owns a lemonade stand and must operate it so as to maximize his/her profits by selling to passers-by. Participants make quality, pricing and inventory decisions. Each player is permitted to modify product quality parameters for the lemonade (amounts of sugar, lemons, and ice) and may also set the price charged per cup.

Furthermore, players decide how much inventory (lemons, sugar, paper cups, ice) to purchase at each round (day), such purchases to be selected from three predefined options per raw material. Price, quality, and inventory decisions are affected by information about weather conditions, made available prior to each business day (Figures 1, 2), and also by the reactions of their clients, which appear as textual bubbles above their heads during the trading day (Figure 3). After entering all quality, inventory, and pricing decisions the player presses the "sell" button at his/her leisure to start the trading day. Selling is done automatically, based on the parameters entered, and cannot be interrupted by the player. During the trading, the player sees an animated representation of the stand, clients walking by, and the textual feedback with comments from clients. Typically, a "day" takes two minutes. At the end of a business day the player is given feedback about clients' satisfaction (Figure 4). After playing for several consecutive days, which constitute a cumulative "game", the player is notified of the clients' satisfaction, inventory losses (Figure 5) and the overall net profit or loss (Figure 6). Players are urged to maximize their profit and are rewarded monetarily according to the actual profit achieved. The simulation enables different language interactions. We have run it in both Hebrew and English to the benefit of native speakers of each language.

Information Aspects of the Game

As in real life, the Lemonade Stand simulation game involves the use of both explicit and implicit information: Visible information as well as desirable, but not available, information. Visible information is unambiguous information which appears on screen and is available to all players equally. Some examples include: Prices of various ingredients and raw materials, weather information, when available, customer feedback, and net profit or loss at the end of a game period. Visible information can be seen in Figures 1-6.

Desirable but not available information is information that would greatly help the players but is not available on screen. The players must deduce this information by themselves or play intuitively. Most players choose to play intuitively. Examples for such information include the best lemonade price for given weather conditions, best lemonade formulation for given weather conditions, number of people who will pass by the stand for given weather conditions (market demand). Table 1 summarizes the availability of information in the game. It highlights two interesting points:
(1) Many types of information are available for manipulation in this simulation. (2) Weather conditions influence pricing, formulation, and market demand. Therefore, information about the weather is important to players of the game.

Hence, we have chosen to manipulate weather information. Instead of making weather information available by default, we have created an information market. Players who do not have information but wish to purchase it, are given an opportunity to submit a purchasing bid. Players who have information are given an opportunity to submit a selling bid. Each player is given opportunities both to buy and to sell information. The bids reflect the players' willingness to pay or accept payment for information thus shedding light on their information purchasing and usage behavior.

In a somewhat more complex version of the game we add two dimensions: Originality of information and source of information. By originality we distinguish between exclusive information and copy information. By source we differentiate between information products (for example, a document) and personal knowledge (for example, expertise).

In a further version of the game we conduct an "information bazaar" rather than an information market. Instead of buying and selling information we seek information sharers thus checking people's propensity to share. Technically this is done by adding a chat system to the game and collecting the players' responses.

In summary, the Lemonade Stand simulation is a tool which allows experiencing information economics before formal learning. When a formal lecture follows managers are more open and responsive to the material taught. We have seen that experience given by this controlled tool is an effective method to correct the misuse of information and the inclination to hoard information.

ONLINE AUCTIONS

The second simulation described here is an example of a setup that emphasizes the presence of others (in the game as well as in real life). The point of this simulation is to highlight social and interactional aspects of economic behavior. The importance of demonstrating economic behavior to managers, especially in an electronic environment, is obvious. Managers can draw conclusions about best practices for their companies' e-business endeavors.

Online auctions are one of the most dominant examples of online behavior, and are rapidly becoming a dominant mode of economic and managerial behavior. Auctions are a meeting place for both electronic commerce and mass adoption of online arrangements. Auctions in general, and online implementations of the auction format in particular, are of both research and training interest for a variety of reasons (Kagel, 1995). They represent a renaissance of dynamic pricing regimes, and a challenge to the prevailing fixed pricing arrangements. In auctions the seller sets the rules but the buyer determines the price. Game theorists have turned their attention to auction behavior, as auctions are considered by some of the pure markets, at least potentially (Vakrat & Seidman, 1999). The estimated value of business conducted in auction mode as a proportion of total business continues to increase (Chui & Zwick, 1999; Jap, 2001; Sarkar, Butler, & Steinfield, 1997).

The social impact of electronic commerce has received little direct treatment in research (Herschlag & Zwick, 2000). The social impact on electronic commerce has received even less attention so far. The auction simulation is an attempt at theoretically frame and examine this impact, while allowing participants to experience the process, frenzy and vicissitudes of actual auctions under close-to-real conditions.

The online auctions described here are two standalone simulations of a "Dutch" descending price auction and an "English" ascending price auction.

Our research and these simulations focus on the growth in online auctions, and the emergence of instant messaging and communication availability technologies. These trends merge in our research to provide a collaborative online social framework in which computer mediated communication may affect the behavior of participants in online auctions. The interactions between buyers and sellers in traditional, face-to-face markets create social phenomena such as social facilitation and social influence where the presence of others impacts behavior and performance of the participants.

The Simulation Framework

Each simulation is self contained and delivered online, enabling the participant to experience the simulation without any additional trainer interference. The simulation operates concurrently on the client and the server computers and enables simultaneous execution by several participants at once.

In the client side, the simulation runs as a Java applet operating on any Java supporting Internet browser. Each simulation is wrapped with HTML pages and CGI scripts operating at the backend. The server side includes the Web server.

Both the "Dutch" and the "English" simulations are supported by maintenance scripts that provide control over the appearance of the auction, by manipulating the various parameters, and ability to collect data gathered during the simulation and store it in a database on the server.

What have we simulated?

Our aim was to generate a standalone auction framework/experience for each participant. This framework enables participation in what seems to be a believable, real auction. Face validity of the simulation and the sense of immersion are crucial for both research and training purposes.

Each simulation is composed of the following modules:

- Auction management – this module is responsible to execute the auction according to the auction rules and present this general information to the participant.

- Participant simulation – this module is responsible for simulating the other participants (see below)

- Visualization and computer mediated communication – this module presents in various ways the other participants and implements instant messaging mechanism to enable a simulated chat environment.

The Dutch Auction Simulation

Ball (Ball, 1997), originally developed the Dutch auction simulation. It is a Java based applet implementing an online Dutch auction that simulates both the auction environment and the other auction participants. This simulation was adapted and extended to serve as a framework of a research on social facilitation during online auctions (Rafaeli & Noy, 2002a).

In this simulation, (http://research.haifa.ac.il/~avinoy/auction/) participants face a trading screen where they may bid for merchandise under "Dutch" (i.e. descending price) conditions. Their performance (market savvy and profit) is compared, online, with other participants. We added several modifications and variations on the original theme. The simulation exposes participants to varying levels of pressure, as expressed in time constraints and pace, as well as in the graded availability of information about, and synchronous communication access to other participants in the auction.

In the Dutch auction, the participant faces an auction clock that displays the descending price. In our simulation, this clock appears in the upper left corner of the screen (Figure 7). The clock starts at a relatively high price, which is lowered periodically by the auction mechanism. The current price is displayed both on the clock and in the text field above it. The auction starts after the participant presses the "Begin" button. Bidding is done by pressing a "Bid" button. The first participant who bids stops the clock and "wins" the auction and the object. The results of the auction are displayed in the middle of the screen. Since the Dutch auction is short in time, the simulation is able to perform several consecutive auctions, gathering cumulative data and saving it.

The varying levels of virtual presence are controlled and manipulated by the research design. We hypothesized and our findings indicate that as the virtual presence of the other bidders is increased, a social facilitation occurs. In a training context, the simulation helps experience the process of bidding, as well as the attendant social dynamics that surround it.

Psychological processes have been emulated by computerized simulations for over two decades, see, for example, (Steinhauer, 1986). In our simulation we tried to simulate both the bidding behavior and the synchronous interaction between the bidders.

Since auctions are social processes (Smith, 1989) and used for commerce, the bidding behavior is affected by numerous parameters. All simulations are based on a model. A model is a simplified but accurate representation of some aspects of the real world (Maidment & Bronstein, 1973). In both situations (ascending and descending price auctions) we modeled the important variables and built a dynamic simulation that drives these parameters.

As human behavior is hard to simulate, the development of a social simulation is more difficult than the development of a physical simulation. There are fewer reliable rules to this behavior. Thus performance of people in groups is more difficult to predict. There are simply too many variables with which to contend (Maidment et al., 1973). This is precisely the point of the online auction simulations.

In Dutch auctions participants may bid only once per descending price round. The first bidder wins the object that is auctioned. Usually the Dutch auction is shorter than the English auction. These two characteristics may affect the participant of the Dutch auction, differently. The model is constructed of the following parameters:

- Basic characteristics – Including name and picture of the bidder.
- Bidding characteristics - In order to distinguish between bidders, they were categorized according to their bidding experience level and their auction participation type (business vs. amateur participation).

- Bidding decision – Whether to bid for the object on the auction or not. This decision is based on other parameters including the bidder limit.
- Bidder limit - Our research hypothesized that a even though the price that the bidder is willing to pay is not always clear to the bidder in advance or even after the auction has begun, a limit exists and can be influenced. This parameter specifies the price limit in which the bidder will bid for the object.

The bidder model in the Dutch auction simulation is simpler than the model of the English auction simulation that is described below.

Simulating Participation in an online Chat

The Chat simulation aim is to increase the level of virtual presence of the other bidders. As the other bidders are simulated, the chat is simulated too. Messages posted to the chat by the simulated bidders were displayed to the participant. The participant can send messages by typing a sentence in the message line and pressing “Send”. This message will also appear in the chat window (Figure 8).

The simulated chat is constructed of three sets of messages originated by the simulated bidders. Table 2 summarizes the usage of these sets.

The chat model consists of the following parameters:

- Sentence - Every set contains several sentences. Each sentence to be displayed is selected randomly from this collection. Once used, sentences are marked and dropped from the set. This avoids repetition of sentences that might affect the perceived realism of the chat process.

- Initiating bidder – In case of periodic messages, this parameter specifies the bidder that will initiate the message.
- Initiating rule – Not all messages are issued immediately. This rule specifies if the winner, the loser or a periodical message will be issued at all.

Using this set of rules we ensured and verified (Rafaeli et al., 2002a) perceived realism of the chat.

The English Auction Simulation

The English auction simulation (http://research.haifa.ac.il/~avinoy/auction/) is a Java based applet implementing an online English auction. It simulates both the auction environments and the other participants under different virtual presence conditions. The participants are offered an ascending price auction where they can bid for an object that is displayed on the screen.

English auctions have many variations (Lucking-Reiley, 2000; McAfee & McMillan, 1987). The English auction simulation enables realization of a minimal bid and a minimal predefined bid increment. The participant may bid several times by entering a bid in the appropriate field and pressing the “Bid” button. In all conditions, the picture and the description of the object that is sold are displayed. In different settings, as presented in the following figure (Figure 9), additional information about the other bidders is displayed.

The upper left window is the proxy window, which describes the bidders in the bidding room in a radar like layout. The proxy idea is based on Erickson at el. (Erickson, Halverson, Kellog, Laff, & Wolf, 2001). The bounding circle represents the bidding room. First time bidders just joining the room, (i.e watching but not yet contributing), are represented by color dots outside the circle. When a bidder posts a bid, the bidders' dots move towards the center of the circle. Higher bids are displayed closer to the center of the room.

Each bidder has a "bidding path" (angle) from the outside to the middle of the room. When the bidder places a new bid, the dot is moved on the path towards the middle of the room. Other dots are rearranged according the new high bid. The participant itself is represented using a red dot. The participant bidding path is vertical from the top of the circle towards the middle. When a bidder does not respond for more than 30 seconds, the bidder's dot changes into a small gray circle and an indication is given to all the participants in the message line. Other indications are given when new high bids are posted and when a new participant arrives.

The red circle in the middle of the bidding room represents the clock - the time remaining for the auction. The clock circle is initially empty. As the auction time passes it is painted red. When the auction ends, no more bidding is allowed and an indication is given to the player. The upper middle window displays information about the auction. It includes data about auction start time, auction end time, last update time, number of products that are sold on this auction, number of previous bidders, a list of the five highest bids arranged in descending order, and a total interested web surfers who visited the auction – whether they participated or not. The lower left window may display information about the other bidders. This information arrives from the bidder model.

Additional information about the product may be presented to the participant, depending on the auction settings. This information appears in the bottom window.

Simulation of Bidding Behavior in a English Auction

The English auction is characterized by an ascending price mechanism. The auction participants may bid repeatedly (if at all) in response to other bidders' behavior. This mechanism was translated to a bidding model that takes into account the following parameters:

- Basic characteristics – Including name and picture of the bidder.
- Bidding characteristics – In order to distinguish between bidders, they were categorized according to their bidding experience level and their auction participation type (business vs. amateur participation).
- Arrival time – The time that a bidder joins the auction. While this parameter is applicable to an English auction (since the auction lasts for more than a few minutes, we neutralize it in the Dutch auction simulation, when we assumed, due to the short auction time, that all participants are attending the auction from the beginning).
- Bidding decision – Whether to bid for the object on the auction or not. This decision is based on other parameters.
- First bidding time – The first time that the bidder places a bid (after arrival).
- Reaction time – How long it takes for a bidder to analyze the previous bid and decide whether to raise their bid.
- Bidder limit – As is the Dutch auction case, we hypothesize that a limit exists and can be influenced. This parameter specifies a price limit to the bidder model.

- Bidder next bid – After someone else has raised the bid, the bidder may choose to raise it again. This parameter specifies if and by how much the participant will raise the bid. This parameter is tightly connected to the characteristics of the bidder.

A screen shot example of our English Auction simulation is given in Figure 10.

In summary, the online auction simulations are a use of the computer and the net to experience the presence and influence of others in one of the most quintessential economic behaviors: bidding and competition in a market. We use simple as well as sophisticated techniques to express the presence of others. Research results reported elsewhere (Rafaeli et al., 2002a) indicate that participants are in fact impacted by the simulated presence of others. Informal observations and conversations with students and trainees suggest that these simulations are a very memorable experience for the participants. The social aspect of processes can be articulated through artificial online stimuli.

SUPPLY CHAIN MANAGEMENT SIMULATION: NETWORK-MEDIATED DISINTERMEDIATION?

Interaction among groups of managers

In the context of work, a group is a designated collection of two or more individuals working together in a dynamic, reciprocal and adaptive manner to achieve specific, common and valuable goals (c.f. (Bowers, Sals, & Connon-Bowers, 1997)). The simulation of group activity is especially attractive and uniquely complex. Hulia, a computerized version of the beer game, is designed to highlight the intricacies of inter-organizational groups and the bottlenecks that characterize their work. Managers have indicated that participation in Hulia has given them unique insight into problems of information flow and into concepts such as intermediation.

Modern work groups operate in a rapidly changing environment. Such contexts require learning processes and practices. The efficiency and flexibility of work groups requires structure that enables and encourages the exchange of information. Information flow and exchange are essential for group survival (Senge, 1990; Senge et al., 1999; Sproull & Kiesler, 1991). Organizations and teams do learn from their individual members, but there are barriers to the processing of the information that is garnered. Thus, the sharing of information among work teams, and the flow of information in an organization are an important issue for design, study and experience (Olson, Olson, Storrosten, & Carter, 1993; Sproull et al., 1991; Townsend, DeMarie, & Hendrickson, 1998).

What is the Beer Game?

The Beer Game, known also as Sterman's production-distribution simulation, was invented and developed by the Dynamic Systems group at MIT's Sloan School. The original game is described fully elsewhere (Senge, 1990; Sterman, 1989, 1992a, b). The original version used a board-game architecture and has been used extensively in the literature about process engineering and the management of supply chains. This simulation is a competition between groups. Each group is charged with maximizing the aggregate team profit, but individual participants are only offered information about their personal performance and standing.

A distribution system is simulated, in which each group stands alone, comprising four roles along the supply chain: Factory, Distributor, Wholesaler, Retailer -- fulfilled each by a different participant. Participants send orders up the chain while producing and shipping products down the chain (see Figure 11). Delays are introduced in the delivery of information about orders and in the simulated flow of shipments. Participants are forwarned about the delay.

The general structure of structure of supply chains as well as the chain in this game is such that the Retailer is closest “to market”. It is the retailer who “owns” the most valuable information regarding actual market demand. In repeated cycles (“days”), participants go through the motions of uncovering the daily demand, receiving shipments, preparing shipments, and making daily decisions about orders.

Computerizing the Beer Game

Board-based games have numerous limitations. The location and space involved are narrowly prescribed. Proximity to a single game board is required. Administration is a challenge, as it requires constant attention, monitoring and calculation. At the same time, the manual administration of the game often slows it down. There have been several attempts to computerize the the Beer Game. Among these attempts are at least two a-synchronous versions in the University of Indiana (http://jacobs.indiana.edu/beer) and at the University of Darmstadt in Germany (http://130.83.11.91:8080/). A synchronous version, based on a Local Area Network connectivity model was developed at the University of Michigan by Severance and Murray, as the Michigan Interactive Logistics Simulation Game (MILS).

Our computerized version of the Beer Game is titled "Hulia" (chain-link in Hebrew). Hulia is similar to the MILS game in facilitating synchronous operation. However, Hulia is internet-based, multi-lingual and international in orientation (Rafaeli et al., 2001, 2002b; Ravid & Rafaeli, 2000). In a development beyond traditional and older online versions of the Beer Game, Hulia also allows modular and monitored online communication facilities such as email and group communication between players in a team.

The online implementation of the Beer Game allows experience, investigation, and exploration of information sharing in a team. Information sharing is, at once, a highly abstract concept and a crucial managerial skill.

As an internet-based game, Hulia helps alleviate some of the weaknesses of traditional games. Participants face a computer workstation rather than each other, making for increased realism and external validity. Administration of the game is improved as the trainers are able to monitor, audit and control all information flows. These are recorded by the computer and available for future use. Recall that the information flows, i.e. both formal and informal messages that travel between participants, as well as numerical and graphical data requested by participants and displayed by the computer are the main point of conducting the experience in the first place. Furthermore, the content, directionality and pace of the information flows are logged and available for inspection and exploration in both real time and in retrospect, following the game.

While a manual version of the Beer Game is highly detailed, its interface is simple, and the dynamics are at a medium level of complexity. Computerizing the simulation does not change the mathematical decision model that underlies the game. Therefore the dynamic complexity is preserved, however interface complexity is increased and detail complexity is reduced.

Figure 12 displays a screen shot of the main information and activity panel. Players face this game for the larger portion of the game, and it is here that they are provided information about physical product flows, incoming demand, the progress of real and game-simulated time, etc. Players may click on tabs that replace this screen with dynamically updated numerical and graphical reports that pertain to financial, production and inventory data. An extension of the Beer Game was developed in the model displayed in Figure 12, where email and distribution options are made available to the participants.

Many thousands of students in graduate and post graduate education contexts have been involved in Beer Game simulations since the 1960s. Results of the game have been described extensively in the literature, as in Sterman (Sterman, 1989, 1992b), Senge (Senge, 1990), and Goodwin & Franklin (Goodwin & Franklin, 1994). In the traditional setup, the participant enacting the Retailer position faces a demand function that is stable save for one growth step that occurs several days into the game. Other than that single "bump", demand remains even throughout the game. As the Retailer is the only participant who really knows the demand, the communication system within the group results in a negative feedback loop with a delay that causes fluctuations, amplification and less than optimal decision making (Senge, 1990).

Managers and students find the simulation to be very stimulating as well as realistic. One of the main lessons picked up by managers is the impact and cyclicality of the effects of system structure. An out of control whiplash effect on inventories and the untamable chain reactions are experienced first hand.

Participants' behavior and performance in Hulia (the online version) repeats the patterns discerned in manual, board-based implementations of the Beer Game (Rafaeli et al., 2001).

The online version allows players to be located anywhere – next to each other, spread around a campus, or even located in different countries. Nevertheless we have typically used Hulia with co-located, synchronous groups. The concurrent availability of players for the game and the immediately following debriefing preserves the competitive spirit and atmosphere. Talking got their neighbors and running into other groups during the simulation allows the formation of a sense of placement vis-à-vis other groups.

The Beer game has a very simple set of simple rules. Participants are required to make one decision per game (or simulated) day. The pricing of the various resources and activities (raw materials, production, inventory, shipping, etc.) is designed such that there is a theoretical chance to make a profit. Thus, participants enter the game highly confident that they face a surmountable challenge. However, participants quickly find out that task is only seemingly easy. Participants report that their sense of efficacy is rapidly brought into question by the early deterioration of business outcomes.

WHY SHOULD WE PLAY AT ALL?

Surfing the web constitutes a "pull" process. By using a browser and input devices (i.e., keyboard, mouse etc.) the surfer actively searches for the information. In contrast, "Push" modes employ different methods of receiving information: In a "push" environment, the user is passive while the provider plays a more central role. Active channels, Netcenter and portals are a few examples of push products.

The Push vs. Pull dichotomy serves well in understanding simulations and games. Traditional, in-class board-and-chalk teaching systems are based on the "push" model. Students have little or no control in the process. Games, on the other hand, constitute a "pull" model. Here, participants are less passive, are pulled into the learning process and are encouraged to participate. Students are actual partners in determining the learning process when they use simulations and simulation-games.

Simulation and simulation-games are experiential learning processes where knowledge is created by the transformation of experience (Saunders, 1997). Usually the process is cyclic. There are six basic underlying assumptions: 1) learning is defined by the process and not by the outputs; 2) learning is based on experience; 3) learning must include conflict; 4) learning is a process of adopting a discovered “world”; 5) feedback between the learner and the environment is required; 6) learning creates knowledge.

In a large survey of corporate training practices published in Training in 1994, over half of the companies whose training practices were studied were found to use simulations in their organizational training. Following are attributes of simulations that need to be considered when constructing simulations to be used in training:

- Realism: the more realistic the “game world” the more effective the simulation will be (Redfern, Fairweather, & Watson, 1996; Stumpf, Watson, & Rustogi, 1994).
- The player’s experience needs to be added to the game reality (Lehaney, Kogetsidis, Platt, & Clarke, 1998; Redfern et al., 1996).

Attributes related to the nature of the simulation:

- Simulations enable time compression. It is possible to simulate a long, real period such as months or several business quarters in the course of only a few in-classroom minutes (Butterfield & Pendegraft, 1996; Faria & Dickinson, 1994; Filipczak, 1997; Gilgeous & D'Cruz, 1996; NSC, 1999).
- Feedback can be immediate (Faria et al., 1994; Fripp, 1997).
  - Simulations are an inexpensive training tool (Gilgeous et al., 1996).
  - Simulations can be familiar since they are well spread (Lehaney et al., 1998).
  - Realism motivates (Manzoni & Angehrn, 1998).
  - Realism adds new perspectives to uncertainty (Gilgeous et al., 1996).
  - Simplification enables focus on the main issues (Butterfield et al., 1996; Keys, Fulmer, & Stumpf, 1996).
  - Simulations permit inexpensive experimentation (Faria et al., 1994; Fripp, 1997; Gilgeous et al., 1996; NSC, 1999).

Conclusions and lessons from simulation-games:

- Participants make strong and stable connections between theory and reality (Manzoni et al., 1998; Redfern et al., 1996)
- Simulations teach analytical methods (Faria et al., 1994)
- Simulations provide unbiased results (Thavikulwat, 1995).
- Players tend to continue to search for relevant information, even after the game is over (Manzoni et al., 1998).
- Lessons-learned survive for longer time periods (Manzoni et al., 1998).

In the preceeding sections, we described three online, internet-based simulations used in teaching managers. The applications described range from individual level, one-person tasks, through virtually simulated group activity, to real-group simulations. Common to all these simulations is the dressing of managerial dilemmas and dynamics in the guise of a fast-paced, competitive simulation. All simulations involve the interactive use of computers by participants. Furthermore, all situations expressed here evolve beyond plain and traditional business decisions. Simple business games, even computerized games, have been in use for decades. In these traditional games, the purpose was typically to simulate activity in a market situation. Here, the focus is somewhat more subtle. The situations simulated here are expressions of information predicaments faced by managers. The focus is on the information problem: how to share it, how to accept it, how to deal, sell or buy it.

The distinction between the simulations rests on the dimensions of single vs group and competition vs. collaboration. The utility, performance, attraction, motivation and learning in training are the declared goals of these simulations (Dowling, 1997; Gredler, 1996). Due to the subject matter and the nature of the prospective students, the popular exhortation to “tell, show, involve” (Rapert, 1981) is perhaps most apt in business education.

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TABLE 1
Visible and Deduced Information in the Lemonade Stand.

Visible Information	Deduced Information
Weather information	Best lemonade price for given weather conditions
Prices of cups, lemons, sugar, and ice	Best lemonade formulation for given weather conditions
Help screens	Number of potential clients that will pass by the stand for given weather conditions (market demand)
Feedback bubbles during the game	
Feedback summary at the end of a business day	
Inventory losses at the end of a business period	
Net profit or loss at the end of a business period	

TABLE 2
Simulated Chat in the Dutch Auction

Message type	Usage	Initiating event
Regular	Used periodically by all simulated bidders	1. Beginning of the auction 2. Periodically
Win sentences	By the auction winner	Winning the auction
Lose sentences	By other auction bidders	Loosing the auction

FIGURE 1
Lemonade quality and Price Determination Screen

FIGURE 2
Lemonade Inventory Control

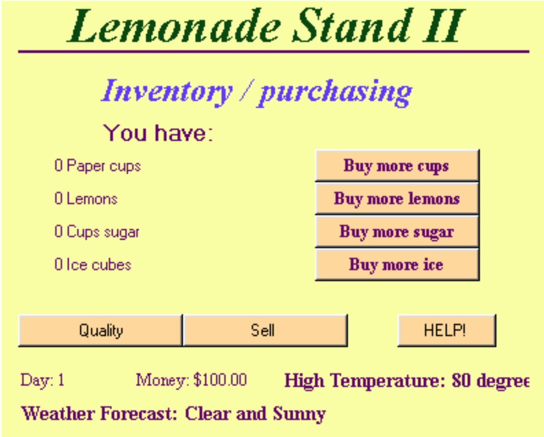

FIGURE 3
Lemonade Animated Business Day Including Weather Information, Total Income, and Inventory Status

FIGURE 4
End of Business Day Report Including Information on Client Satisfaction and Popularity

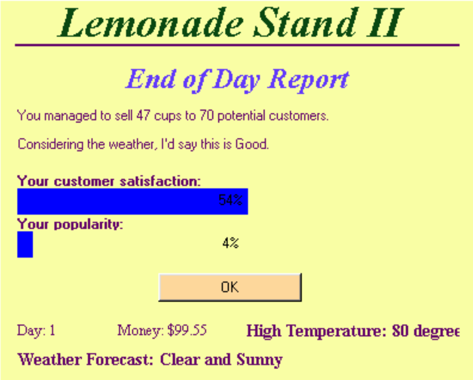

FIGURE 5
End of Business Period (3 Business Days) Report on Inventory Losses

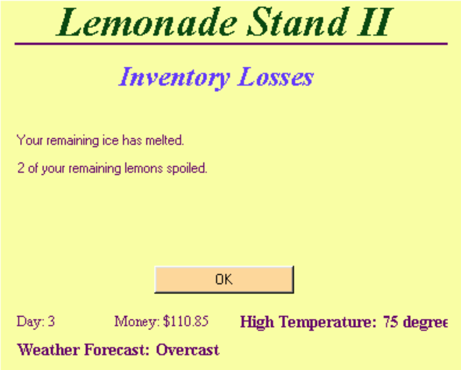

FIGURE 6
End of Business Period Report Including Gross Income, Expenses, Inventory and Net Profit or Loss

FIGURE 7
The Dutch Auction Screen

FIGURE 8
Simulated Chat in the Dutch Auction

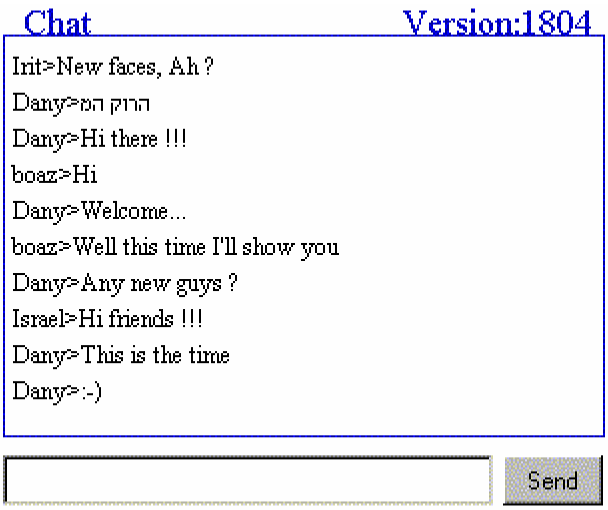

FIGURE 9
The English Auction Simulation : Low and High Virtual Presence

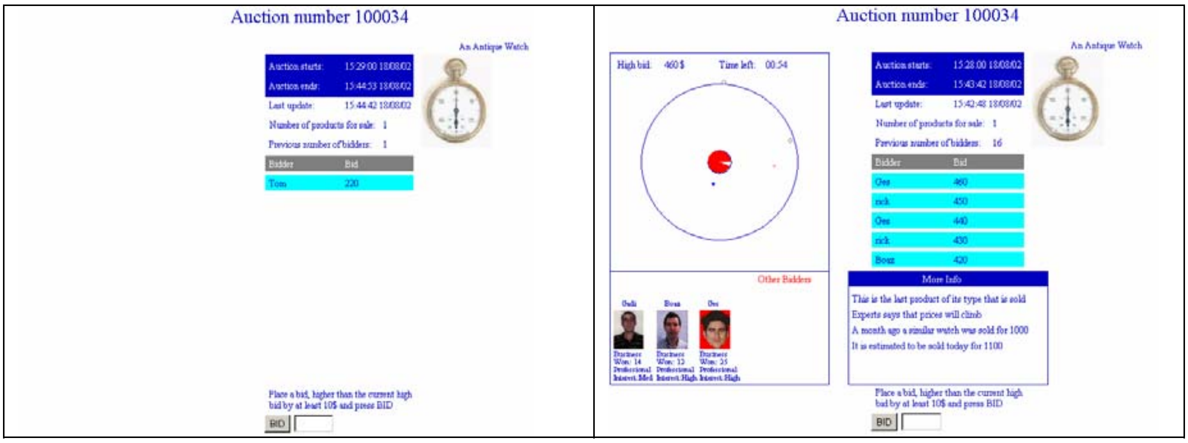

FIGURE 10
The English Auction Simulation

FIGURE 11
Supply Chain Topology

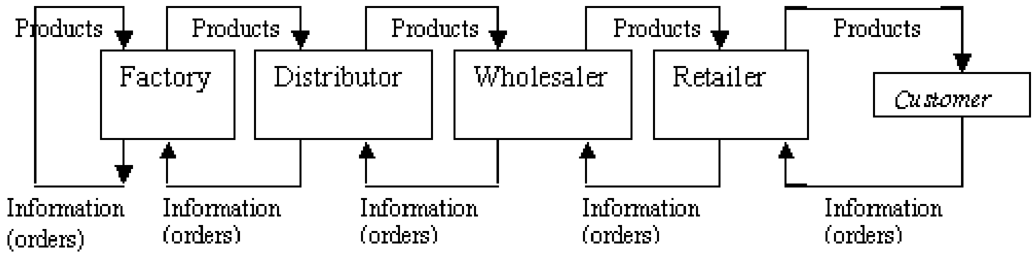

FIGURE 12
Screen Shot of the Hulia Game

FIGURE 13
Screen Shot of Electronic Mail Pattern