A Model of Consumer Decision Making for a Mud Based Game

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Abstract. A networked, multi-player, simulation-based, interactive multi-media, educational environment (the SELL game) was implemented to teach the principles of micro-economics, retailing and targeting. To effectively teach these concepts, it is necessary that an "authentic" economic simulation be provided, in order to preserve the player's interest over a period of several weeks. This paper describes the economic model underlying the simulation -- in particular stressing the elements of simplicity and plausibility that makes it succeed.

Introduction

SELL is a multi-user, educational, economic game implemented in LambdaMoo, which is an object-oriented MUD[1]. The SELL game economic model is designed to simulate consumer decision making. In SELL players run small retail stores located in Springfield, a virtual city of around 100,000 residents. Springfield is divided into eight neighborhoods, each with its own social and economic flavor. Each store is located in one of these neighborhoods and each player must be aware of the impact the local neighborhood has on their store in order to succeed.

SELL is a turn-based game where each turn players set their prices, service level, inventory levels, and advertising. These decisions, for all players, are then sent to the main server. The server then computes each store's sales based upon all players decisions and the interests, wants and location of consumers of Springfield.

For players of SELL there are no absolutely right strategies which will work all the time. Rather the returns of any action will depend on the actions of competitors and interests and desires of the consumers in Springfield. Since different consumers live in different neighborhoods, one action which will succeed in one area may fail in another. To be successful the player must know who are their potential customers, where they live, how far they can travel to shop, what they are interested in buying, how much service they want, how much they are willing or able to spend, and how strongly they are attracted to high quality or low cost items. Also the player must know how to reach potential customers through advertising.

Educational Goals

The goal of this project is to teach a wide set of skills associated with running a retail business by allowing the student to run a simulated store in a simulated economy. In order to survive in SELL's open competition the player must set a competetive price, hire the appropriate staff, and select appealing products while always keeping an eye on the competition. The player must think about who their likely customers are, what goods these customers want, and how they can use their advertising dollar most efficiently to reach these customers. The strategy of carefully selecting consumer groups is often called targeting by marketing and advertising experts, and targeting is the key teaching goal of SELL.

An educational game should be both fun and informative. Players should acquire concepts and skills as a consequence of playing the game, and this learning should transfer to contexts outside the game. The challenge then is to construct a game of sufficiently interesting complexity that is true to its premise. When the player acts in the simulated environment, the environment

[1]MUD stands for Multi-User Domain (although originally the "D" was for Dungeon).

must re-act in consistent and plausible ways. Without this veracity the game will fail the ultimate test: the players will not play it.

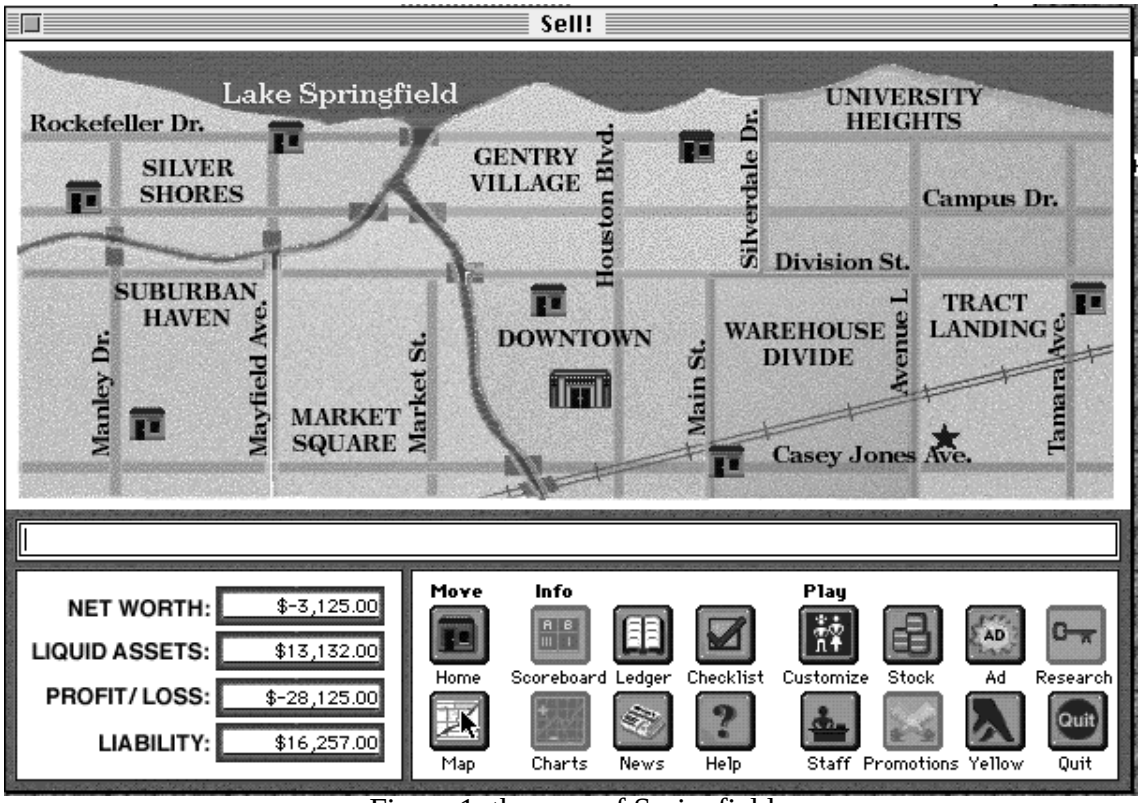

Figure 1: the map of Springfield

Game Play

There are a number of choices each player must make during the game. The player must first decide where to locate. Then, each turn, the player must decide what to sell, how much to stock, who to buy from, and what price to set. They must decide what service level to offer and choose from a number of advertising options.

To support the making of these decisions SELL provides a number of tools. SELL provides financial tools, which tell the player their inventory, assets, liability, expenditures, and profits. SELL also provides tool which give the user important information concerning competitors, including their inventory, prices, profits, liabilities, and staffing.

Sell provides a newspaper where players can learn general information about Springfield's business environment as well as reading other players print advertising. Players have a business-to-business yellow pages which allow them to contact wholesalers. Each player has a radio with which they can "hear" other stores radio advertising. The player can also get important information by selecting questions to ask their own staff.

SELL provides a map of Springfield (figure 1), showing all the neighborhoods, other player's stores, and the Springfield Bank. Double clicking on an area provides important information about the character of that area. Double clicking on another player's store takes one to that store (figure 2), where the player can ask questions of the staff, check prices and inventory, or engage in an on-line conversation with the other player directly. Double clicking on the bank takes the player there, where they can apply for a loan.

A demographic information tool is provided so users can query all important information about the general types of consumers a in Springfield and their preferences. For example a player can see which are the largest consumer groups in a certain area. They can see what products these groups are most interested in, what media they are most exposed to, how much they value low

prices or high service. With this SELL promotes learning about targeting. At the end of each turn the user can also see which consumers shopped at their store and what they bought.

For this paper we look at two example stores: Tom's Bike located in Gentry Village (described below), and Bob's located in the neighboring Downtown area. For this example these are the only two stores in all of Springfield. Tom's sets his service to a low level (service level=1) in order to keep costs low, while Bob's offers high service (service level=3) in order to attract wealthier clients.

Figure 2: a store in Springfield

The Model of Consumer Decision Making

Realistic simulations are computationally complex and therefore computationally expensive. This complexity is desirable if players are to believe the simulation, but undesirable if the game is to be played in real time. A balance between complexity and efficiency must be found or the game will be either too simple or too slow. The SELL game comes close to this center point; the simulation is easy to maintain, easy to expand, and efficient while still being sufficiently complex the hold the players interest.

Rather than attemping to model economic behavior solely with complex mathematical formulae, SELL uses psychographic characterizations manipulated by simple arithmetic calculations combined with a detailed though simple representation of consumers and products. This simplicity facilitates the implementation of products and consumer groups, and makes it fairly easy to add and modify products. Further, this simplicity and modularity allows the rapid creation of new scenarios.

Assumptions

The SEll economic model assumes rational, cost-minimizing consumers. Therefore, consumers consider travel costs, search costs, service benefits, and product quality as well as price when making buying decisions.

SELL assumes that advertising increases sales by reducing the search cost to consumers in finding information about desired products. In this way advertising helps consumers find the best value on goods they already want. Not all economists are so positive about advertising, many assert that advertising increases a companies sales by misguiding consumers into paying more then they need to or instilling in the consumers desires that they would not normally have (Galbraith 1961, Thomas 1981) Sell assumes that players do not have access to a budget sufficient to afford the kind of advertising that would be needed to change consumers preferences or create artificial desires (i.e. no player can "create" desire, their means are too limited).

Sell models the entire consumer population by defining it in terms of cluster groups (CG). The concept of cluster groups is similar to the idea of psychographic segmentation, employed by many advertisers and marketers. Psychographic segmentation is the classification a of population

into groups which share similar values, attitudes, and lifestyles (Rice, 1988; Piirto, 1990). The premise is that persons with similar values and lifestyles will have similar buying behavior. Psychographic segmentation is a growing method in marketing, for it promises insight into the emotional and lifestyle factors which motivate consumer's buying behavior.

Representations

To simulate consumer decision making SELL uses an explicit representation of the population of Springfield along with their values and preferences for certain products. It is the representation of the consumers which drives the model. Since the main goal of this project is to teach marketing skills it was decided to use a form of psychographics to represent the population of Springfield. This virtual city is thus represented with cluster groups. A cluster group is a coherent segment of the population where the members are alike in age, income, life narrative, interests, values, and lifestyles. As a consequence the members of a cluster group have similar consumer behavior. In SELL there are 20 distinct cluster groups. The following are three cluster groups used in the SELL consumer model,

cg1	Working Class: middle aged couples with children, renters
cg2	White Collar Singles: young singles, renters, upwardly mobile
cg3	College students.

Table 1: Sample cluster groups

To model a specific neighboorhood's total population a population is given to each of the 20 cluster groups for that area. There are eight neighborhoods which comprise the city of Springfield. Each of these areas has its own particular flavor, comprised of very different populations mixes. For example there is University Heights, mostly made up of college students and professors, or Gentry Village home to most of Springfield's young professionals. The population for the three example cluster groups in Gentry Village is:

cg1	Working Class	1255 persons
cg2	White Collar Singles	4123 persons
cg3	College Students	1185 persons

Table 2: Sample cluster groups as population of Gentry Village

Products

Sell uses a two-level representation of products: product classes and models. SELL has 30 models in 7 product classes. A model represents a particular good for sale, while a product class is used in this implementation to describe the market for a entire class of goods. For example the bike model "Road King 1000" is a adult bicycle possessing certain features and quality level. While the product class "adult bicycles" contains data about the market for all adult bikes. All models must belong to one and only one product class. All models in the same product class compete with each other while no models in different product classes compete. This certainly is an over simplification, since almost any product can compete with any other product for the consumers dollar. For the purposes of this game though the convention made running the simulation much more efficient. Also, even though all products can possibly compete with each other in the real world, most competetion goes on between very similiar products rather then disparate products.

	Cluster Group Name	I	USB	UQB	UTC	USC	feature/ Road	feature/ Race	PS	MIN	MAX
cg1	Working Class	60%	$1	$80	$25	$25	$0	$0	130%	$80	$400
cg2	White Collar Sngls	180%	$10	$120	$10	$20	$0	$50	90%	$200	$800
cg3	College Students	210%	$8	$100	$30	$30	$30	$0	100%	$100	$600

Table 3: The product class definition for Adult Bikes

Product Class Definition

The product class definition is the heart of the SELL simulation. It contains all information on consumers likes and dislikes for a given product. SELL uses the explicit data about consumer preferences stored in the product class definition to generate consumer behavior. Based on the information stored in the product class representation consumers decide how much of a product they want to buy, which stores they buy from and how much they can afford to spend. By changing the data in the product class definition one changes the consumer behavior generated by the simulation (see Table 3).

A product class definition contains firstly a number for the average potential demand (APD), which is the average number of persons who will be want to buy the product over a given time. All other information is stored in a table, with all the cluster groups on one axis and all the features and consumer values on the other. Each column is a dimension of the consumers decision making. The values underneath represent the value of the cluster groups.

In the product class definition each cluster group has a percentage number for their relative level of interest compared to the overall average potential demand (I). So cluster groups with high interest in a product class will have a percentage number over 100% while those with low values will be below 100%. These numbers were based loosely upon market research information obtained from Simmons demographic data (Simmons, 1993).

For each cluster group a dollar amount is given for unit search cost (USC). The unit search cost is the cost for a group to gain information about a particular store per unit of distance between store and consumer. The greater the distance between store and buyer that more expensive it is for a consumer to learn about what the store is selling and at what prices. This unit search cost is used to simulate advertising.

Unit transportation cost (UTC) is the unit cost to each cluster group of getting to a store and getting the product back home. Some cluster groups are more mobile then other and therefore have lower transportation costs. For example retired persons have very high transportation cost, while families with homes, who own cars, have much lower transportation costs.

The product class definition also contains data about benefits that products or stores may offer. The product class definition gives values for unit service benefit (USB) and unit quality benefit (UQB). The unit service benefit is a dollar amount a cluster group is willing to pay for a unit of added service. The unit quality benefit is the dollar amount a cluster group is willing to pay for a unit of added quality. Both of these benefits will be subtracted from the price of a model in calculating the overall consumer's real cost.

Also contained in the product class definition is an enumeration of all the possible features a model of this class may have. For example a bicycle may be a racing bike or a road bike. In SELL televisons have the features of being color or black and white, of being 12", 17" or 21", of being monphonnic, stereo, or sound-around. Models have the features enumerated in their product class definition. Different features are valued differently by different consumer groups. For each feature enumerated, the product class definition contains each cluster group's value for that feature in dollars. This is the amount a cluster group will pay for that feature. Some features may be so disliked by a particular cluster group that they have a negative value for them, which means a players would need to offer a lower price than for a product without the feature, in order to make them want to buy it.

The product class definition also contains data about cluster groups sensitivity to price in the form of a percentage number called price sensitivity (PS). This percentage tells how sensitive a group is compared to an average price sensitivity, where 100% means that a cluster group has average price sensitivity, and a lower number means that the cluster group is less concerned about getting the best buy .

Finally, product class definitions also contain two numbers for each cluster group which represent how much they can afford to spend: a maximum dollar amount (MAX) which is the price at which no one in the cluster group can afford to buy the product and a minimum (MIN) which is the price at which everyone in the cluster group can afford to buy the good. All these values will be used to calculate consumers' decision making.

Models

A model represents a particular item that player's sell --- it is an instantiation of the abstract product class. Each model has a pointer to its parent product class definition, along with its name, feature settings, manufacturers suggested retail price (MSRP), and an iconic picture. All models in the same product class class compete against each other, but not against the models in another product class. For example, high quality adult bikes compete against more affordable bikes, while neither competes against children's bikes. Three models created for the SELL game are shown in Table 4. Notice, for example, from the feature/Race column of Table 3, that white collar singles are willing to pay an extra $50 for a racing bike like the Euro-Elite in Table 4.

Model Name	Road King Street Bike	Super-Elite	Euro-Elite
Model Slogan	"Your Basic Street Bike"	"The King of Street Bikes"	"The Best Racing Bike You Can Buy"
MSRP	$310	$600	$700
Quality	Quality = Basic (= 0)	Quality = High (=3)	Quality = High (= 3)
Feature	Kind = road	Kind = road	Kind = race

Table 4: Three Models of the Adult Bikes Product Class

Tom's bike store, hoping to attract bargain hunters sells only the Road King Street Bike for $310, while Bob's tries to attract up-scale clients with the Super-Elite, selling for $600, and the Euro-Elite selling for $700.

Advertising

SELL models the effect of advertising by first determining the search cost, to a consumer group, of finding out if a particular store sold a desired item and at what price they sold it --- if that store did not advertise. This is found by multiplying the cluster group's unit search cost (USC), found in the product class definition (Table 3), by the unit distance between store's nighboorhood and consumer's nighboorhood. Advertising reduces that search cost by some percentage. The amount an ad reduces this search cost is called the percentage search cost reduction (RSC).

Different advertising reaches different consumers. SELL models an advertisement by giving, for each cluster group, a percentage number for the reduction in search cost. Different advertisements in different media and different sizes have different percentage numbers (Table 5)

	Cluster Group Name	Leisure Section, Quarter Page, RSC	Sports Section, Quarter Page, RSC
cg1	Working Class	8%	5%
cg2	White Collar Singles	15%	10%
cg3	College Students	5%	20%.

Table 5: Two Quarter Page Print As in the Leisure and Sports Sections

Bob's takes out a quarter page advertisement in the Leisure section while Tom takes out a quarter page advertisement in the sports section. For the working class cluster group, a quarter page advertisement in the leisure section reduces search cost 8% while one in the sports section reduces search cost 5%. A quarter page ad in the sports section reduces college students search cost 20%, while one in the leisure section only 5%. The SELL game supports 8 forms of print media and 3 radio stations.

Algorithm

Each turn the virtual consumers decide what they want to buy, how much and from whom. The model of consumer decision making has four main steps. First, each group of customers decides how much of a particular product they want to buy; second, they decide which stores they like best; third, the real costs are calculated; and fourth,they decide how much they can afford to buy. After all the players decisions about hiring, pricing, purchases, and advertising

have been submitted, the server determines the market share for each store. First the server determines the level of consumer interest in each product. Then it ranks each store's products according to over all value to each cluster group. Finally, it distributes sales based on relative value ranking and then checks how much can actually be afforded.

Step 1. The level of consumer interest in a product.

First, each cluster groups potential demand (PD) in each product is determined. The server obtains this by looking at the population representation and the product type definition. A particular cluster group's level of interest is calculated by taking the population in each cluster group and multiply it by percentage potential market of that group for that product. The formula for potential demand is:

```
PD= P * I * ADM
```

where:

```
PD   = potential demand
P    = population
I    = demand index
ADM  = average demand.
```

This is repeated for each cluster groups in an area, and and then for all areas in Springfield. For example the potential weekly demand for adult bikes for three example cluster groups living in Gentry Village are shown in Table 6:

	Cluster Group Name	Potential Demand (PD)
cg1	Working Class	23
cg2	White Collar Singles	223
cg3	College Students	75

Table 6: Potential Demand for the Adult Bicycle Product Class

That is, there are 223 White Collar Singles (cg2) in Gentry Village who want to buy bikes every week plus 75 college students and 23 working class families.

Step 2. Real cost to cluster groups is calculated.

Next each cluster group's real cost is calculated for all products for sale in a product type. Real cost is calculated with the following formula:

```
RC = P + TC + SC - (SB + FB).
```

where

```
RC = real cost
P  = price
TC = transport cost
SC = search cost
SB = service benefit
FB = feature benefit.
```

The transport cost is calculated by:

```
TC =  2 * UTC * D(S,C);
```

where

```
TC     = transportation cost
UTC    = unit transport cost for the cluster group
D(S,C) = distance from store to cluster group neighborhood.
```

In Table 3 the UTC for white collar singles is $10 --- this represents the notion that college students have less personal resources and less cars then many other cluster groups and therefore view transportation as more costly. Thus college students are much more likely to shop in their own areas.

The search cost are calculated:

```
SC = RSC *(USC * D(S,C) ^2)
```
where
```
SC     = search cost to cluster group
RSC    = % reduction in search cost from ads by store
USC    = unit search cost to cluster group
D(S,C) = distance between store and cluster group.
```

The service benefit is calculated as
```
SB = USB * SL
```
where
```
SB  = service benefit of store to cluster group
USB = unit service benefit of cluster group
SL  = service level set by store (an integer from 0 to 4).
```

The store sets this level by hiring a certain level of staff --- higher service levels cost more. For example white collar singles have a $10 per unit service benefit for adult bikes while college students have a $8 per unit service benefit. If a store set its service level at three units, the white collars would view that as a $30 discount from the real cost of an adult bike while the college students see it as a $24 discount. Obviously, a player should set their service level higher when targeting the White Collar Singles (cg2) than college students (cg3).

The feature benefit is equal to
```
FB = ∑(PF * CBF)
```
where
```
FB  = benefits to a cluster group of all features,
PF  = a product feature,
CBF = consumers benefit of feature
```

The benefit of feature of a item for sale is a sum of the features of that model times the benefit to cluster groups of that feature. One feature every model has is quality. In SELL their are three levels of quality: basic, good, and high. These three levels are represented with the set [0,1,3.] The working class cluster group may have a $80 unit quality benefit UQB (see Table 3). While white collar singles have a UQB of $120. Super Elite racing bikes are high quality (quality = 3). Working class families will see this as a $240 discount while white collar singles will see it as a $360 discount. Therefore white collar singles will be willing to spent $120 more for the bike, since high quality is more valued by them.

In this way SELL models the different values and tastes important to different consumer group decision making. A model may have any number of features. This allow us to make products which are more and more complex, with any number of features which effect consumer decision making.

	Cluster Group Name	Tom's Road King	Bob's Super Elite	Bob's Euro Elite
cg1	Working Class	$384	$498	$598
cg2	White Collar Singles	$341	$288	$338
cg3	College Students	$368	$412	$542

Table 7: The real cost to the three example cluster groups living in Gentry Village, for the three kinds of bikes for sale in the two stores

Step 3. Percentage distribution of sales based on real cost

Next consumer group sales are distributed based on real cost to the cluster group. The lower a models real cost relative to other models real cost to a cluster group, the great that model's share of the overall demand for that cluster group. This is done with a simple distribution formula:

```
PSD = ( 100% / n) + PS (ARC - PRC).
```

where

```
PSD = percentage sales distribution for a store.
PS  = price sensitivity of a cluster group for a product class
n   = number of stores in a particular market.
ARC = average real cost for all models sold by all stores.in a product
            class,
PRC = a single players real cost to a cluster group.
```

This formula returns a percentage of the total demand of a cluster goup for a product a store's particular model has won. If all stores were to offer the same model at the same price in the same location with the same service level then they would split the demand evenly between them. For the example we are working on it comes like this:

	Cluster Group Name	Tom's Road King	Bob's Super Elite	Bob's Euro Elite
cg1	Working Class	62%	32%	6%
cg2	White Collar Singles	28%	43%	29%
cg3	College Students	50%	40%	10%

Table 8: Percentage of total demand assigned to each model for sale in each store

Step 4. Consumer group determines how much they can afford

In the last step each cluster group determines how much of their desire for a product they can afford to actually satisfy. This is done with the following formula:

```
AFD   = 100% + (100% (min- price)/(max - min))
```

where

```
AFD   = percentage of a cluster group that can afford a particular price
price = actual price of a model
min   = the price at which all members of a cluster group can afford the
            model (Table 3).
max   = the price at which no members of a cluster group can afford the
            model (Table 3).
```

Generally the wealthier a consumer group the higher the min and max numbers will be. For the adult bikes product class, table 3 shows that the max for white collar singles is $800 and the min is $200.

	Cluster Group Name	Tom's Road King	Bob's Super Elite	Bob's Euro Elite
cg1	Working Class	5%	0%	0%
cg2	White Collar Singles	76.50%	85.30%	77%
cg3	College Students	46.40%	37.60%	11.60%

Table 9: percent afforability in Gentry Village per cluster group,
per store, per model of the adult bike product class

Therefore the most any white collar single will pay for an adult bike is $800, though very few will. Any white collar single is willing to pay $200 for an adult bike. Therefore even if a players store is a monopoly they can often increase sales by decreasing prices. SELL calculates total sales by multiplying potential demand in each cluster group by affordability and market distribution. These steps are repeated for all cluster groups in all nieghboorhoods over the entire virtual city of Springfield.

	Cluster Group Name	Tom's Road King	Bob's Super Elite	Bob's Euro Elite
cg1	Working Class	1	0	0
cg2	White Collar Singles	48	82	50
cg3	College Students	17	11	1
Totals		66	93	51

Table 10: total sales in Gentry Village by cluster group, per store, per model of adult bike

Evaluation and Conclusion

During the Spring and Summer of 1995, a group of approximately 20 adults played the SELL game against each other. Each player "inherited" $25,000 and a store-front location in a randomly assigned Springfield neighborhood. The product types were restricted to consumer electronics (i.e. several models of audio and video products), and bicycles and complementary products such as helmets and roller blades. The purpose of this test was to see if the simulation would work over a sustained period, and whether the users believed they were part of an authentic economic environment (see Slator and Chaput, 1996).

In general, players found the game play realistic to the point they were able, without access to internal representations, to identify a particular product that was mistakenly represented. They were able to tell that it did not "act right". For a period of several weeks, the game sustained a lively interest.

Ultimately, a few players were able to dominate the simulated market and it became nearly impossible to compete against them. It turned out these few players got an early advantage, due to either an optimal location or to constant effort. Over the weeks, this small group, since they had accumulated vast capital compared to the other players, were able to undercut the competition and could afford to operate near margin, but made it up in volume. This outcome was quite realistic and plausible given that SELL simulates a completely unregulated business environment. As originally constituted, SELL replicated the monopoly formation of the last century. In the absence of external control it would seem, the rich do indeed get richer.

Acknowledgments

The following have all contributed in ways great and small to the development of the Sell! game: Dave April, Mike Bakula, Ray Bareiss, Richard Beckwith, Carol Biolsi, Don Bora, Patrick Brockhagen, Cliff Chaput, Gregg Collins, Ralph DeStephano, Arnease Diggs, Eric Domeshek, Danny Edelson, Andy Fano, Katie Feifer, Ric Feifer, Kerim Fidel, Hamed Hashmy, Jon Hickey, Bob Hooker, Camille Jayne, Debra Jenkins, Neil Josehart, Amy Juhl, Bob Kaeding, Robin Karlov, Alex Kass, Laural Koroncey, Jeff Lind, Marek Lugowski, Rich Lynch, Doug MacFarlane, Scott MacQuarrie, Colette Marine, Doug Miller, Paul Ring, Mark Schaefer, Roger Schank, Don Schultz, Audrey Slator, Brian Slator, Sandor Szego, Pete Tevonian, Kristen Thomas-Clarke, Brendan Towle, Ana Vitek, Paul Wang, Thomas Zeilonka, and Laura Zelinski.

The Institute for the Learning Sciences was established in 1989 with the support of Andersen Consulting, part of The Arthur Andersen Worldwide Organization. The Institute receives additional support from Ameritech, an Institute Partner, and from North West Water.

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