New Technologies and Innovations in Agricultural Economics Instruction

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Incorporating a Computer Simulation Program into an Undergraduate Agribusiness Class: Experiential Learning or Recreation?

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Introduction

The increased use of experiential learning tools and management games in college classrooms and business workshops has been well documented (Dale and Klasson, 1964; Faria, 1987; Grahan and Gray 1969; Horn and Cleaves 1980; Kibbee Craft and Namus 1961); McRaith and Goeldner 1962; Wolfe 1985 and Ralphs and Stephan 1986). In theory, these games and simulation programs duplicate the key elements of real-world business situations and challenge students to apply the principles from the text book and/or lectures. A wide number of business simulation programs and computerized games are now commercially available.

The increase in microcomputer and electronic spreadsheet capabilities has also made it much more feasible for instructors to develop their own simple simulation games. Most agricultural economics departments have one or more faculty who have developed budgeting and financial statement spreadsheet templates. In many cases, these templates can form the basis of simple simulation games with the addition of a little imagination and simple programming. The availability of spreadsheet add-ons such as @RISK[1] further enhances this process.

While the availability of simulation games is clear, the usefulness of these products is a more complex question. The developers of simulation games expound on the realistic features, flexibility, and theoretical foundations of their creations. The response of students to these types of activities is also generally positive. The ability of simulation games to enhance learning objectives is somewhat less clear. The purpose of this paper is to relate student decisions observed during a simple computer simulation game to specific learning objectives.

Background

In the fall of 1991, I developed a simple spreadsheet-based agribusiness simulation game for use in my junior-senior level agribusiness management class (AGEC 3313) at Oklahoma State University. This decision was based in part on the enthusiastic response toward a simulation game which we received from agribusiness executives during an overseas workshop. The decision to utilize a spreadsheet-based program was based on ease of modification and ability to customize the example in accordance with regional agricultural patterns. While examples from the simulation game were incorporated into the lectures, the overall strategy was for the game to complement the material in the textbook and lectures. In other words, it was hoped that the game would generate enthusiasm for the concepts covered during the course without requiring a major commitment of class time.

The class was divided into six teams of 10-12 students each. The game was run six times during the semester, not counting a trial run which was designed to acquaint the students with the input and output forms and major components of the game. The game was incorporated into the grading criteria and

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accounted for 15 percent of the overall grade, with the teams being judged by the net incomes of their firms. Prior to the trial run, the students were provided with a handout which the described the game. After each run of the game, the students were provided financial statements for their simulated company along with input forms for the next run. This allowed the teams the opportunity to analyze their next course of action outside of class. The teams were then allowed approximately fifteen minutes during class to reach a consensus concerning the input variables and to submit their team's input form for the next run.

The Agribusiness Firm

The game simulated an agribusiness supply firm which provided four major products and had five major competitor firms. The managers (team members) had the ability to set the price, advertising level, and credit policy for each product. In addition the managers ordered product and planned short-term loans and repayments on a quarterly basis. After the third run of the simulation game, the managers were allowed to increase or decrease their storage and trucking capacity and to hire or fire employees.

Demand Curves

Carvalho (1991) discusses the theoretical properties of a market demand function in the context of business simulation programs. A realistic demand function should incorporate the extended law of diminishing returns. For example, assume the marketing variables can be increased to the point that all of the consumers in the marketplace are persuaded that attributes of the product provide sufficient value to purchase the product. Beyond this point, additional marketing expenditures will be useless. Likewise, if the marketing variables are decreased to some minimal point, there should be some level at which there are no purchases because no consumer can be persuaded that the marginal utility/price level warrants a purchase. A demand curve which describes the proportion of the market which will purchase as a function of each marketing variable must therefore asymptotically approach zero when the MU/P approaches zero and approach one when the MU/P ratio approaches infinity. The demand curve or demand function must therefore have an inflection point. Various methods have been suggested to construct demand functions for business simulators. Gold and Pray (1983) suggested selecting elasticities and solving simultaneous equations. Goosen 1986 suggested an interpolation technique, while Decker, et al. (1987) suggested constructing a function with a particular form. Carvalho (1991) also suggests a cumulative probability density function approach. All of these methods provide the means to create continuous demand functions with the desired properties in a microcomputer-based simulation program.

My approach was to use 24 (four products times six firms) Cobb-Douglas-type demand curves. The demand curves incorporated own-price, cross-price, own-advertising, cross-advertising, and own-credit policy effects. In addition, the demand curves were affected by crop and livestock income in the region, a parameter which could be manipulated (and then announced) by the instructor, and incorporated seasonal effects. This approach could be criticized for not meeting the diminishing return criteria discussed above. However, it does have the advantage of (relative) simplicity, and does incorporate the effects of major marketing variables. The students were presented with general information about a five year sales history for each product which was generated from actual simulation runs from the game, using a "simulated" set of price and advertising decisions.

The Game Output

The simulation game output included quarterly income statements, balance sheet, and cashflow statements for the given year (run). The participants were provided information on their capacity utilization and current inventory levels for each product. Information was also provided as to whether "emergency" overtime labor, capacity rental, or short-term funding were invoked by the game.

Objectives for Use of the Game

Intent of the game was to provide examples and experiential learning relating to the major course topics. These topics included simple forecasting techniques, principles of demand, cashflow forecasting, and capital budgeting. In addition it was hoped that the game would increase student interest, promote interaction, and generate questions. Another objective of the use of the game was to provide a framework to integrate the principles studied in class into a real-world example. The decision to utilize net income as the grading criteria was intended to promote understanding about how all of the individual management decisions eventually manifest themselves in the firm's bottom line.

Results

The game was received enthusiastically by the students--a reaction which is not surprising, since the game represented a reprieve from lectures and note-taking. The game did seem to promote some friendly competition between the groups, with some students naming and promoting their firms. Discussion during the input periods was extremely enthusiastic, with the classroom taking on a "zoo" atmosphere. Despite the fact that some teams consistentlyachieved low ranking, no group raised any objection to the incorporation of the game into the grading criteria. An analysis of the finalgrades also indicated that the game scores had only a minimal affect on the final grades.

Forecasting

The teams completed the first run, which included ordering products, prior to the formal introduction of forecasting techniques. In the class discussion which followed, the students indicated that they had detected patterns (trends and seasonal effects) in the past sales data. The game setting therefore provided the opportunity to frame the problem of forecasting in terms of a realistic example and to show the link between the formal techniques and the teams' intuitions. A simple seasonally- adjusted trend model was then applied to the past data and compared with the teams' estimates. The results of this comparison are provided in Table 1. As the table indicates, two of the teams were able to provide intuitive estimates which compared favorably with the seasonally adjusted trend model. However, the remainder of the teams could have substantially improved their estimates through the use of the model.

Table 1
Comparison of Intuitive Forecasts with Trend Model

	Mean Absolute Deviation (MAD)	Mean Average Percent Error (MAPE)
Team 1	5.88	2.60%
Team 2	7.69	3.12%
Team 3	44.27	16.07%
Team 4	32.09	10.32%
Team 5	33.02	10.77%
Team 6	44.57	18.20%
Seasonally Adjusted Trend Model	5.68	2.77%

A better test of whether the use of the game improved the students' knowledge of forecasting is provided by the improvement of the teams' ability to forecast demand. Figure 1 provides the forecast error (difference between the apparent forecast of demand indicated from the product ordering and inventory levels and the actual demand levels) for each team over the course of the game. As the figure indicates, all of the teams experienced some drop in their forecasting success during the second run, as the teams started actively changing all of the marketing variables. However, most of the teams did experience some improvement in their forecasting success over the course of the game. A comparison of the individual forecasts with the seasonally adjusted trend model over the course of the game (not tabulated due to space) indicated that all of the teams could have improved their forecast by use of the model. In other words, despite the evidence provided to the students in Table 1, none of the groups took it upon themselves to improve on their intuitive forecasting approach.

Cashflow

One imperfect measure of the cashflow management of the teams was the level of interest expense. Since the automatic loans which the program invoked had a much higher interest rate, teams which were able to forecast their cash needs generally experienced lower interest costs. The pattern of interest expense for each firm is provided in Figure 2. In general there was no clear pattern of improvement of cash management during the duration of the game. Since most of the groups invoked conservative credit policies, short-term credit needs were fairly small and remained relatively constant. One team experienced high interest costs by the third run of the game and subsequently significantly improved their cashflow management. On the other hand, two other teams began with fairly low interest costs and apparently failed to monitor their cashfows, resulting in high costs in the latter runs.

Capital Budgeting

Capital budgeting techniques were not covered until late in the course. However, the material was covered prior to the fifth run of the simulation game. The lectures stressed how capital budgeting techniques could be used to decide if investments or dis-investments in plant and equipment assets were justified. It was hoped that this information along with some subtle suggestions, would encourage the teams to examine the profitability of liquidating or making additional investments in plant and trucking capacity and consider hiring or firing employees.

The pattern of labor expense (including overtime), storage rental costs, and trucking rental costs are provided in Figures 3-5. As the figures indicate, there was no apparent evidence that any of the teams made adjustments which affected these costs during the fifth run. Prior to the sixth run, the teams were provided brief management reports which highlighted in qualitative terms the strengths and weaknesses of their firm. Subsequent to this report all of the teams did make adjustments to their work force, equipment, and facility which reduced costs. Since the "management reports" provided no information regarding the magnitude of the adjustment, the ability of some of the teams to drastically reduce their costs provided weak evidence that some of the capital budgeting concepts had been applied.

Net Income

As in any firm, all of the decisions of the teams were reflected in the net income results. However, the competitive market structure also implied that increases in sales for a particular team came at the expense of the other teams. The pattern of the net income levels for the various teams (Figure 6) was therefore not surprising. The figure does indicate that two of the teams consistently under-performed the other teams throughout the duration of the game.

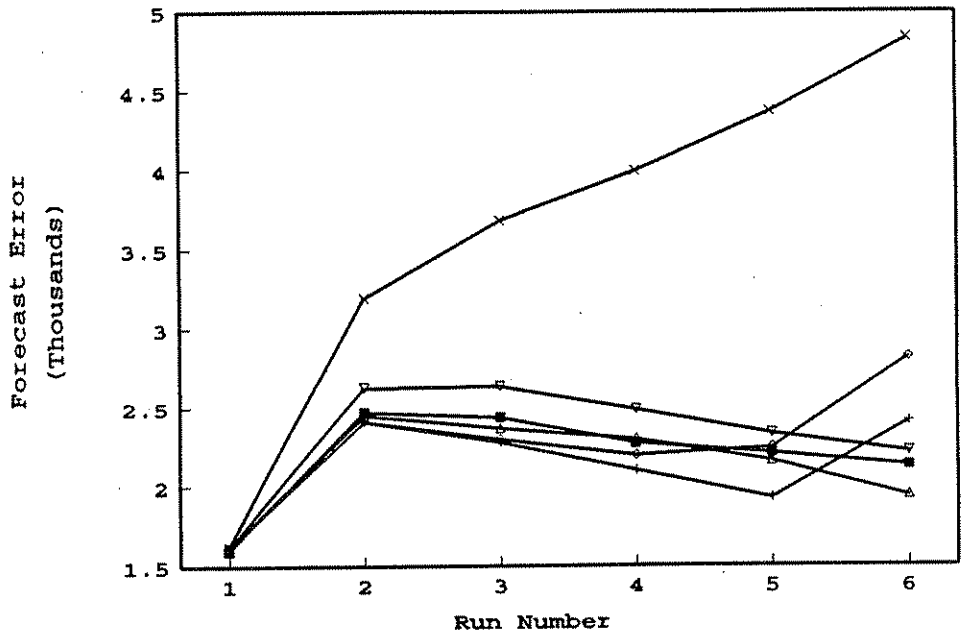

Figure 1. Forecast Error
Agribusiness Simulation Game

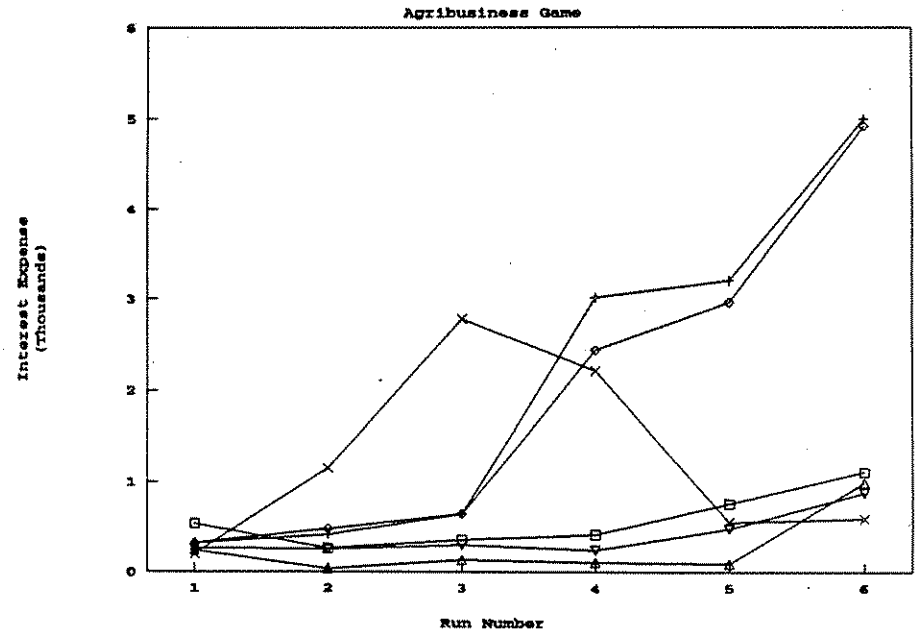

Figure 2. Interest Expense

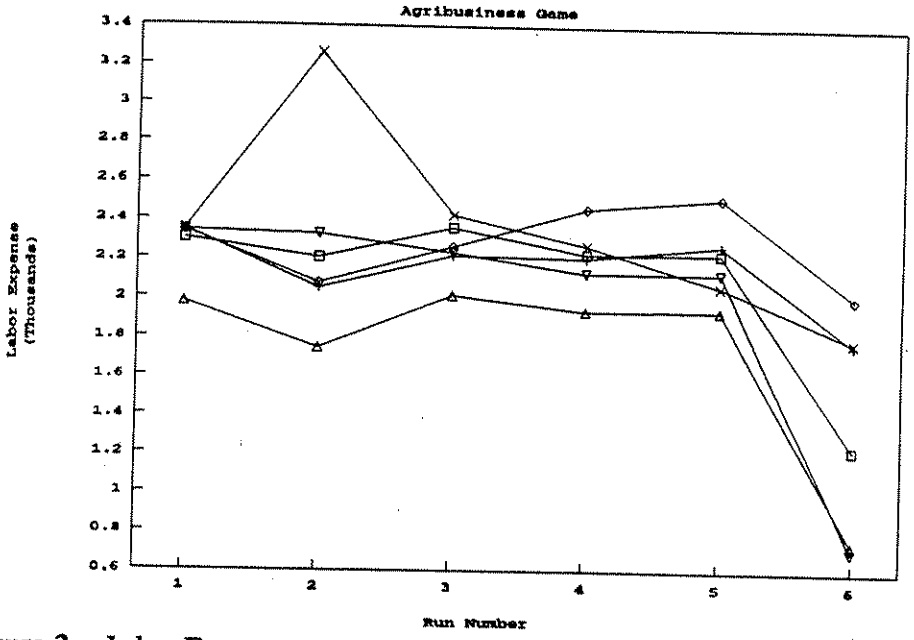

Figure 3. Labor Expense

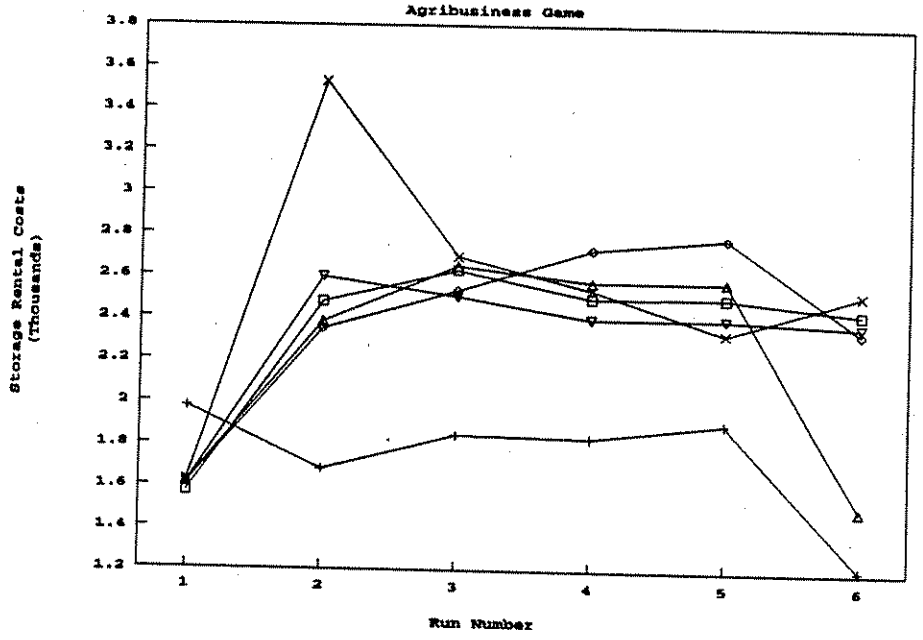

Figure 4. Storage Rental Costs

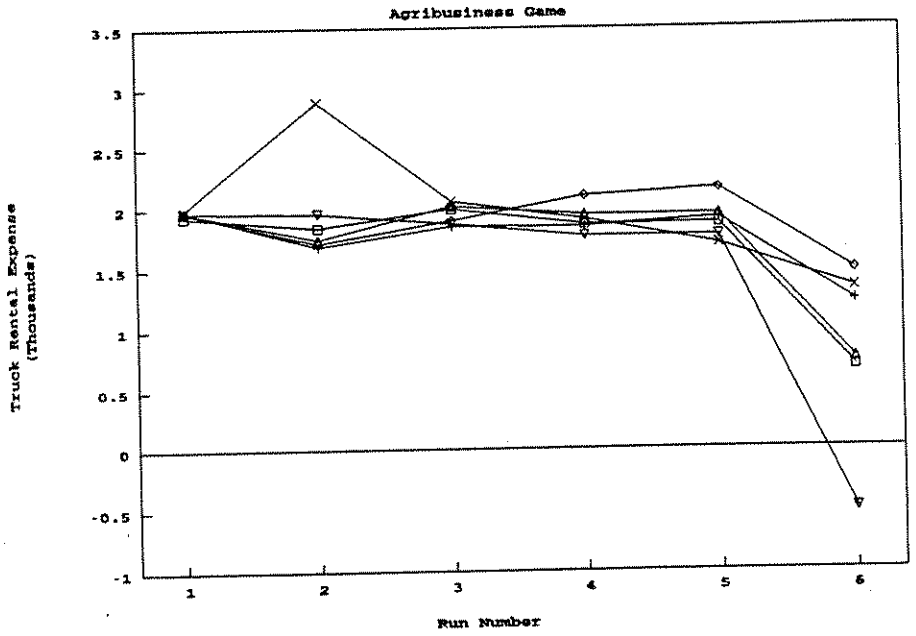

Figure 5. Truck Rental Expense

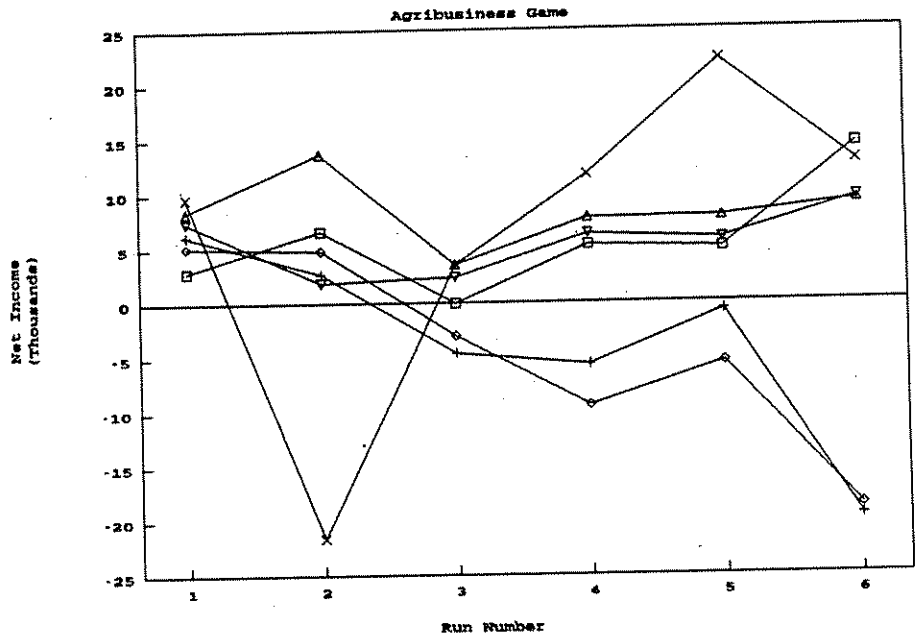

Figure 6. Net Income

Table 2
Effect of Team Composition on Performance

	% Ag-Econ Majors	% Ag-Econ & Accounting Double Majors	% Animal Science Majors	Team Grade
Team 1	75%	0%	25%	90.83%
Team 2	89%	0%	11%	84.17%
Team 3	100%	0%	0%	76.67%
Team 4	18%	36%	46%	88.33%
Team 5	60%	0%	40%	90.00%
Team 6	91%	0%	9%	81.67%

Team Composition

The make-up of the various teams with respect to major is provided in Table 2. Since the Agricultural Economics students generally had more economic and business background coming into the course, it was of interest to determine whether the percentage of AgEcon majors affected the team's performance. As the table indicates, the composition of the teams, at least in terms of major of study, had no apparent effect on the team's performance.

Summary and Conclusions

The use of an agribusiness simulation game had observable positive impact in terms of student morale and interaction. The game also provided a convenient "platform" from which introductions into new techniques could be launched. There was some evidence that the teams' ability to forecast demand and adjust pricing and advertising variables increased over time. However there was no evidence that any of the teams took the time to use the forecasting techniques which were covered in class, despite evidence of improved forecasts. There was also little evidence that the participants incorporated other concepts covered in class (such as cashflow forecasting and capital budgeting techniques) into their decision process. However, there was evidence that the teams could effectively use some of these techniques once the problem areas were specifically pointed out to them.

These results provide some insights into how business simulation programs may or may not fit into class room instruction goals. They indicate that simulation games may be more effective in illustrating simple concepts than in providing "holistic" examples. They also indicate that realism and flexibility may be in conflict with an ability to demonstrate basic economic principles. Realistic games (in which a large number of factors influence the firm's performance) are difficult to analyze in terms of the objectives.

These results also raise the question of the role of the instructor in overseeing the simulation game. The principles of experiential learning would suggest that the instructor should try to make the game replicate business situations and allow the participants to learn from their decisions. However, these results indicate that when the instructor is also trying to limit the time commitment to the game, he/she may need to take a more active role in assisting the participants in applying economic and business principles.

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Endnotes

1. @RISK is a trademark of Palisade Corporation