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PURPOSE AND LEARNING BENEFITS OF BUSINESS SIMULATIONS: A DESIGN AND DEVELOPMENT PERSPECTIVE

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ABSTRACT

In the development of business enterprise simulations the designer uses as his knowledge base, procedures, theories, and fundamental drawn from accounting, finance, marketing, economics, production, and management courses. The problem is that in each discipline there exist alternative procedures and theories and unresolved issues. Since the simulation designer must choose specific procedures and theories, the personal bias of the designer enters the picture and can not be avoided even if the designer attempts to avoid bias. The learning benefits of a specific simulation are thereby affected by what is and is not chosen as the knowledge base.

INTRODUCTION

“A special feature of the application of gaming as a teaching tool is that the teacher and game designer knows beforehand what has to be learned by the participants; in other words, the desired output (knowledge and skills) of the game is known and so are the standards that must be met by the participants.” (Peters, Vissers, & Heijne, 1998)

This laudatory statement implies that simulation designers have an inside track concerning the learning benefits of simulations. This statement deserves further examination and raises some interesting questions. No study has been found that reports on purposes and objectives of simulation developers/designers.

The authors of this paper are all designers and developers of published business simulations (Jensen, 1996, Keys & Wells, 1997; Goosen, 1995), and we believe that our collective experiences in designing simulation might provide some insights concerning the learning benefits as well as the limitations of simulations.

We believe that a close examination of the problems that confront simulation designers and the procedures employed in the design process might be helpful in providing some understanding as to potential benefits as well as limits for learning about decision-making.

The term “simulation designer” does not necessarily refer to a single individual but also may refer to a team of designers. Some of the current enterprise simulations are the creation of a single author, and in some other cases the simulations are the result of a development team.

NATURE AND SCOPE OF TOTAL BUSINESS ENTERPRISE SIMULATIONS

To better understand the nature of simulations one only has to look at the business curriculum of the fifties. The planning, organizing, directing, staffing, controlling functions of management as advocated by Koontz and O’Donnell undoubtedly were a strong influence. The various approaches to management were broadly categorized by Koontz and O’Donnell (1972) as the:

- Operational approach
- Empirical or case approach
- Decision approach
- Communications center approach
- Mathematical approach

Simulation designers of the fifties and sixties basically adopted the decision approach. Even so, elements of the operational and mathematical approaches appear significantly in those simulations that were developed at that time.

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Among the more popular business enterprise simulations there is no unanimity about which decisions at a minimum should be included. A comparison of ten well known simulations in terms of decision variables (Keys & Biggs, 1990) showed considerable variation in the selection of decisions. Regarding the ten simulations, only three decisions appeared in all ten: price, research and development, production scheduling. The dividend decision was an option in nine of the ten. Seven of the ten simulations allowed students to change the commission rate. Surprisingly, only 50% of the enterprise simulations allowed advertising as a decision option. Regarding credit terms, only one of the ten allowed simulation participants to change the credit terms. However, seven of the ten did provide for credit terms that could not be changed by participants. Consequently, each period a portion of uncollected sales would be reported as accounts receivable on the balance sheet.

As shown in Figure 1, different simulation developers have significantly different viewpoints about what constitutes the important or key decisions. Why some decisions are considered more important than others does not appear to be an issue that has been discussed in the literature. It is apparent that simulation designers do not perceive certain decisions to be as relevant as others. Dick Teach has aptly stated, "The totality of a business setting is usually much too complex to be included in any simulation. But what is to be included and what excluded?" (Teach, 1990)? No evidence of any authoritative design guidelines can be found; therefore, each individual designer appears to be the sole judge as to the answer to Teach's question. Nevertheless, an important issue exists. How does the choice of specific decisions affect or change the potential for learning?

THE SIMULATION DESIGNER'S KNOWLEDGE DOMAIN.

An important question is: from what knowledge source does the simulation designer draw upon to develop a simulation? Is it primarily experience in

real world business or is it basically academically derived knowledge? We contend that the underlying knowledge domain of simulations is basically derived from the traditional business administration core as learned by simulation designers and only secondarily from real world business experience. Real world experience, however, may influence the designer in regard to what theory is selected. Development of the enterprise simulation requires that the designer have a broad knowledge of all aspects of the business administration core. Although it is advocated that the key characteristic of simulations is the portrayal of realism, the fact is that simulations for the most part are based on constructs drawn from academic courses in accounting, finance, management, marketing and economics.

Total business enterprise simulations are used primarily in the business policy/strategy course, the traditional capstone course of the business administration curriculum. The business strategy capstone course presumes a foundation of completed study of other courses as shown in Figure 2. The simulation designer basically designs and develops the simulation by extracting theory from these various disciplines and develops a model that integrates the components of the various theories to produce quantitative output reports that are similar in appearance or perhaps indistinguishable from similar real world reports. The development of a business enterprise simulation in essence is an attempt to integrate basic theory of the various business administration disciplines.

An important and perplexing design problem is that in many business administration disciplines there are multiple theories and alternative procedures, some of which conflict and produce different results when implemented. Also, general agreement as to which theory should prevail is often lacking. For a given simulation, the simulation designer must choose a single theory or procedure even though that theory does not have universal acceptance. For example, several simulations treat fixed production costs as periodic charges on the income statement; that is, use an approach called direct costing in

accounting

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FIGURE 1

Percentage of Decisions included in Simulations Compared in Keys and Biggs Study.

Decisions included in Simulations	Percentage of Simulations	Decisions included in Simulations	Percentage of Simulations
Marketing Decisions		Second shift	60%
Price	100%		
Advertising	50%	Hire workers	20%
Research and development	100%	Wage rates	30%
Multiple market areas	60%	Purchase materials	30%
More than one product	50%	Engineering	40%
Commission rate	70%	Quality control	40%
No. of sales reps	70%	Finance	20%
Sales reps salary	40%	Short term loan	50%
Sales reps training	40%	Credit terms	60%
International market	20%	Emergency loans	50%
Distribution centers	20%	Factoring	50%
Purchase of market information	40%	Long term loans	50%
Production Decisions		Bonds	50%
Change in plant capacity	80%	Accounts payable	20%
Production scheduling	100%	Issue of stock	80%
Multiple plants	100%	Dividends	90%
Overtime	40%	Investment in securities	20%

FIGURE 2

General Model of the Business Administration Core Curriculum

Business Policy (Strategic planning and Mission Statement Development) *Goals * Environmental analysis * Evaluation * Implementation * Control			
Major Course Requirements			
Prod. Mgt.	Money & Banking	Business Law	Production Mgt.
Statistics	Mgt. Info. Systems	Marketing	Gen. Management
Accounting	Finance	Economics	General Business

literature (E.G., Garrison, 1997). Also, most of the currently marketed simulations use a stock market algorithm that ignores the most recent advances in finance theory (Goosen, 1995). In terms of price theory, the simulation designer must decide how advertising shifts the demand curve, an issue that continues to be debated in the discussion of oligopolistic theory. Also, the effect of advertising on demand is still an issue that is the subject

of concern (Cannon, McGolwan & Sung-Joon Yoon, 1994; Goosen, 1994).

In order to understand the simulation designer's dilemma regarding conflicting theories and procedures, a brief discussion of these conflicts in the following areas will be given: accounting, finance, economics, marketing, and production.

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Accounting theory

All enterprise simulations treat decisions as inputs and financial statements as output. However, regarding financial statements, the simulation designer must choose from alternative financial statement formats. Also the simulation designer must choose between external and internal formats of reporting. The designer is confronted with a dilemma concerning the design of simulation financial statements output: that is, simplicity versus real world complexity. This phase of the simulation involves selecting one approach from the following areas:

- Financial statement format
 - Single versus step
 - Classified versus non-classified
- Segmental Reporting
 - Full cost reporting versus segmental contribution reporting
- Procedures:
 - Inventory: Fifo, Lifo, or weighted average
 - Amortization of plant cost: Straight-line versus accelerated depreciation
- Cash flow statement:
 - Direct method or indirect method
- Choice of accounting terms
 - Gross margin or gross profit, cost of goods sold or cost of sales, etc.
- Fixed manufacturing overhead
 - Absorption costing versus direct costing
- Income:
 - Net operating income versus net income

As mentioned above, a particularly difficult problem concerns the treatment of fixed manufacturing overhead. Some simulation designers have opted to treat plant depreciation and other fixed production costs as operating expenses and not as production costs. Consequently, finished goods inventory only contains variable production costs; that is, direct

material and direct labor. This is a direct costing approach. Direct costing simplifies many calculations and solves some conceptual design problems, particularly those problems that arise when production and sales are not equal. Under direct costing the cost per unit of finished goods will not fluctuate because of differences in units sold and units manufactured. However, the problem is that this method does not have the approval of the FASB, the regulatory body for accounting standards, or the IRS. The use of direct costing by designers conveys to students misleading information as to what is acceptable real world external reporting practice.

Some business enterprise simulations allow for multiple products and multiple markets. For these simulations, income statements that show segmental net income or segmental contribution would be ideal. However, not all multiple product/multiple market simulations show operating results on a segmental basis; rather all revenues and expenses of the various segments are combined in the net income statement so that only aggregate results are received by simulation participants. None of the enterprise simulations examined in this paper reported segmental contribution. It is left to the student teams to manually prepare segmental statements, which they may not be inclined to do.

Accounting courses as taught today are classified as being primarily financial or managerial in nature. Managerial accounting courses emphasize an internal management format for income statements. Segmental reporting, direct costing, and contribution reporting are advocated in management accounting as important decision-making tools. Paradoxically, simulation designers for the most part have chosen simplified external reporting formats which are not nearly as useful as internal formats for purposes of making decisions. Combining segmental income statement results in a single column format achieves programming simplicity but does not contribute to the learning by participants of the decision-making importance of segmental results.

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Financial Theories

In developing a simulation, the designer must confront some complex issues concerning finance theory. Two broad issues face the simulation designers: cash flow and market value per share (Goosen, 1998, 1994). The cash flow issue is usually dealt with by providing a statement of cash flow as one of the financial statement reports. However, a major theoretical problem must be dealt with. Two formats for this statement are available (Fess & Warren, 1993). The direct method theoretically is a superior method from a logical viewpoint; however, the indirect method which is almost always used in business and easier to implement but more difficult to understand. However, both methods result in the same calculation of increase or decrease in cash. Also, the classification of sources and uses of cash in some simulations do not correspond to the required classification as set forth by the FASB, the regulatory body that sets the standards for external reporting in the United States.

The second issue concerns market value per share. All business enterprise simulations provide as an output value the market value per share. The problem is that the elements that determine market value and how the stock market actually works have been the subject of intense debate among financial theorists, particularly in the last 20 years. Since Miller & Modigliani (1961) published their award winning paper, the debate over the effect of cost of capital and capital structure on market value has resulted in several theories that differ significantly from previous theory on several key issues. The effect of capital structure on cost of capital and the effect of dividends on market value have been key issues. Current simulations for the most part have glossed over this problem by using very simple stock market algorithms. These algorithms would not be considered theoretically sound in terms of current finance theory (Goosen, 1994).

Economic Theories

Total business enterprise simulations are implicitly

based on the assumption that the industry being modeled is of the type classified by economists as oligopolistic competition. As explained in most principles of economics texts the modeling of demand of an oligopolistic industry is difficult and fraught with theoretical difficulties (Lipsey, Steiner, & Purvis, 1984). The effect of product differentiation, the response of customers to a firm that raises its price above the industry average, "kinked" demand, and flat bottom average cost curves are still issues.

Unquestionably, the most complex and demanding algorithm in a simulation is the demand algorithm that determines and then allocates demand to the individual firms. Some important papers in this area have been published in ABSEL proceedings (Gold and Pray, 1983; Goosen, 1981; Teach, 1984, Carvalho, 1991). The ability of one team to capture market share from other teams is the essence of interactive competition in total business enterprise simulations, and simulations must take care to design a demand allocation system that appears realistic.

A second problem concerns disclosures of these relationships in the simulation scenario. Simulation designers as a whole have chosen not to present any information about the nature of their demand functions; consequently, students void of information for analysis often resort to guessing. The amount of information to provide about demand relationships appears to be a fruitful discussion area between simulation designers and users.

Business enterprise simulations are often used to teach concepts of strategic planning and management strategy (Wolfe, 1997). Two broad elements of strategic planning concern revenues and cost. In the long run, the opportunity to increase revenues and decrease costs must exist in order for effective strategic planning to take place. The design of most enterprise simulations effectively allows for the development of long run revenue strategy; however, some simulations are weak in the cost decision-making area. A good business

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simulation should allow for long run cost reductions. If a firm is able through judicious decision-making to reduce production cost per unit of output, then a firm should be able to lower price to achieve an even greater increase in profits. Opportunities to decrease equipment cost or plant cost in some simulations are minimal or non-existent (Keys & Biggs, 1990).

A critical issue concerns cost behavior. For a simulation to be realistically perceived, a simulation must involve fixed and variable costs. Should variable cost functions be curvilinear as assumed in price theory, or should the designer use simplified straight-line relationship as is taught in managerial accounting courses? Even if the attempt is made to use linear relationships for fixed and variable costs, it is almost inevitable that some costs will be stepped in nature. Purchase of additional equipment will cause a step up in depreciation expense. Supply and demand algorithms must be carefully designed so that the simulation will generate marginal revenues and marginal cost, although cost functions do not necessarily have to be continuous in nature. Several excellent papers pertaining to cost modeling appear in ABSEL proceedings (Gold & Pray, 1989; Goosen, 1991)

In the real world, some decisions involve trade-offs. Variable costs can be replaced with fixed costs. Factory labor cost (variable) can be replaced with automated equipment (fixed cost). However, the potential increase in profits from converting variable costs to fixed is accompanied with increased risk. Once in place, the fixed cost can not be easily, if at all, converted back to a variable cost. Consequently, the switch to fixed costs create opportunity for greater income if demand increases, but results in decreased income if the anticipated demand does not occur. Ideally, enterprise simulations should involve these types of long term trade-offs.

Marketing Theories

Demand in business simulations normally does not depend solely on the price decision. Marketing

decisions such as advertising, research and development, size of sales force, sales promotion, distribution channel are also factors, and most simulation designers develop models that incorporate some or all of these decision variables. However, a challenging problem exists. Just how do changes in these marketing decision elements affect demand? And what are all the consequences of the interaction of three or more variables?

A critical marketing design issue decision concerns the number of products. In the real world, single product firms are non-existent. Firms that appear to be a single product firm are not, in fact, if the same product is sold in different sizes and weights. In the Keys and Biggs article (1990), only 50% of the enterprise simulations allowed two products. None of the simulations allowed for more than two. If the simulation designer decides to allow multiple products, then problems of allocating production resources arise. For example, the pool of labor and the available supply of material may require allocation as in the *Business Management Laboratory* (Jenson, 1996). Single product simulations provide only a very limited range of learning benefits relative to the full spectrum of marketing fundamentals. Single product simulations do not allow the introduction of product differentiation or market segmentation concepts. How a product in a business simulation may be given different attributes was recently addressed by Gold and Pray (1998)

Advertising in the real world is a major decision. Typically it absorbs at least 10% of sales revenue. However, in the Keys & Biggs article only 50% of the simulations provided for an advertising decision. The simulation designer faces several conceptual problems when introducing advertising (Goosen, 1995). First, it must be incorporated into the demand model. Secondly, the simulation designer must decide whether advertising expands the size of the market or whether it simply transfers demand from one firm to another? A third major issue relating to advertising concerns temporal effects. Does the amount of advertising budgeted in one period carry over and benefit succeeding

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periods?

Most simulations in the Keys & Biggs study (70%) allowed students to change the number of sales reps. From a development viewpoint, the designer must determine whether the number of sales reps affects total demand or whether sales reps are basically order takers. That is, does inadequate sales reps simply result in lost sales as a consequence of willing customers not being called upon?

Sales reps compensation is frequently an allowed decision; however, while most of the of the simulations (70%) permitted changes in the commission rate, only 40% allowed changes in salaries. A difficult design problem is determining the consequences of changes in the compensation mix. For example, does the change in the commission rate increase demand or does it increase motivation to sell and, therefore, reduce the need for the number of reps?

In marketing theory, selection of the channel of distribution is an important factor in creating sales revenue. In the total enterprise simulations reviewed, selection of a channel of distribution was not a decision choice.

Production Theory

Although not as glamorous as marketing decisions, the design of good production decisions and algorithms are critical to the learning value of enterprise simulations. The design and development of the production function in a simulation involves four major areas:

- Material
- Labor
- Manufacturing overhead
- Capacity

Material - Again, the problem of realism versus simplicity confronts the designer. In the real world, there are many types of decisions that can reduce material and labor costs such as changes in suppliers, reduction in waste and defects, and

expenditures to improve the skills of workers.

Only a few simulations (30%) allowed the simulation participant to make material purchase decisions. However, in those that do, carrying costs are usually charged on the ending inventory. In the real world excessive inventory is often a serious problem. Apparently, many simulation designers regarded the purchase of inventory as a short term tactical problem and, therefore, chose to not allow participants the option of making this decision.

In production management courses and also in some accounting and finance courses the use of EOQ models to make inventory decisions is considered important. However, the use of EOQ models in a simulation play would require that the participants be allowed to determine order size and the number of orders per period. None of the simulations in the Keys and Biggs study allowed the number of orders and order size to be decisions. Also, in a simulation the incurrence of both carrying costs and ordering (purchasing) costs must be factors in order for the use of an EOQ model. Only the incurrence of carrying cost appears to be allowed in some currently published enterprise simulations.

Plant Capacity - In real businesses, the production process usually involves a series of connected production processes. Only two of the ten companies in the Keys and Biggs study involved more than one production process, and these two only provided for a two stage production process. From a design viewpoint, the introduction of more than one production process tremendously increases the complexity of simulation programming.

None of the simulations in the Keys & Biggs study allowed replacement of existing capacity equipment with more efficient equipment or plant or the conversion of variable costs to fixed costs. *The Management Accounting Simulation* (Goosen, 1995) does allow for replacement of old equipment with more efficient equipment, however, this simulation was considered as a functional simulation in the Keys & Biggs study.

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Quality control and quality management issues have become important in recent years. Only 40% of the simulations in the Keys and Biggs study provided for some type of quality decision. The issues of how to program quality control issues into business enterprises have been significantly addressed by Pray (1992) and Thavikulvat (1992). As any simulation designer knows, even small changes in a simulation can become a major programming task.

Factory Labor - Surprisingly, in the Keys and Biggs study only 30% of the simulations allowed the participants to change wage rates and determined the number of factory workers. Apparently, these decisions were considered to be more tactical than strategic in nature. If the factory wage rate is an allowable decision, then the simulation designer must develop an algorithm that has consequences for changes in the wage rate such as increases or decreases in labor productivity and factory worker turnover.

In the Keys and Biggs study, 60% of the simulations provided for overtime, and only 20% allowed for second shifts. If additional plant and equipment can be built, then questions arise as to whether the plant is immediately available or whether use of the new plant must be delayed for one or more periods. The simulations in the Keys and Biggs study for the most part involve one or more periods of lead time.

Other Design Issues

In addition to design problems that arise from conflicting or alternative theories as presented in various business administration courses, the simulation designer is confronted with issues that do not directly relate to business administration courses. Some of the more important issues concern (1) lost sales, (2) stock outs, (3) international business, (4) design of the participant's manual and, (5) choice of a programming language. Gold and Pray (1984) have addressed the problem of lost sales and stock outs. Thavikulwat (1995) has been one of the first ABSEL members to discuss theoretical design

relative to simulations oriented to international issues. However, it is beyond the scope of this paper to discuss the problems confronted by simulation designers in this AOther Design Issues@ category.

DILEMMAS CONFRONTING SIMULATION DESIGNS

The above discussion pertaining to the necessity of the simulation designer having to choose necessary design elements from the various academic disciplines shows that the simulation designer is confronted with a number dilemmas. The simulation designer would like to eliminate personal biases and viewpoints, but in order to develop a working model is forced to choose from conflicting theories and alternative procedures. Irvine, Levary, and McCoy (1998) in their article, "The Impact of Judgemental Biases on The Validation of Simulation Model" stated:

"Individuals may introduce bias because of overconfidence in themselves or belief in their own authority when they interact with the designer. Thus, it is apparent that, even unintentionally, bias can be introduced and compounded in the development of a simulation model."

What the designer chooses to exclude or the alternatives not accepted may be as important to understand as the choices made.

In addition to the conflicting theory and alternative procedures dilemmas, other dilemmas exists. Should the chosen decisions be primarily strategic or primarily tactical? Should the simulation be realistic and include many tactical and strategic decisions or strive for simplicity and have a very small decision set? Should one area of decision-making be weighted more heavily than another (marketing decisions versus decisions)? Hopefully, well thought out learning objectives would will help solve or minimize the dilemma of realism versus complexity .

CONCLUSIONS

Business simulations from the designer's viewpoint are selected sets of strategic and tactical decisions that are logically and harmoniously related through algorithms and mathematical equations for the purpose of revealing the consequences of decision interaction in the form of financial statements and other reports. The algorithms are based on selected theory from the academic disciplines of accounting, finance, marketing, production, economics and management. The problem is that in all of the core business administration areas, diverse alternatives, of conflicting theories and unresolved issues theory exists force the simulation designer to make difficult choices.

An inevitable problem is that the simulation designers are able to employ personal biases in the selection or creation of algorithms that do not necessarily reflect mainstream thinking. And in most cases, the detection of these biases is not easy. Therefore, it is important that the user's guide explain why certain approaches have or have not been used.

Since the number of selected decisions varies considerably in business enterprise simulations, a question exists: what decisions at a minimum are required to teach the concepts of business strategy? It may be that an effective simulation that allows the teaching of strategic planning requires more decisions than would be required by a simulation intended to be used as a tool for teaching the use of decision-making tools such as business budgeting, break-even analysis, and EOQ.

This paper may have raised more questions than have been answered. However, we believe that it is necessary for users to understand the many dilemmas that confront simulation designers and what approaches and theories were selected to solve the dilemmas. Also, it is important to realize that the number and type of decisions vary significantly and, therefore, the consequences of decision-making also vary considerably from one simulation to another.

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