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A DECISION SUPPORT SYSTEM FOR PLANNING SALES, PRODUCTION, AND PLANT ADDITION WITH MANAGER: A COMPUTER SIMULATION

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ABSTRACT

This paper introduces a decision support tool for use with the simulation 'MANAGER: A Simulation' (Smith & Golden, 1997). The spreadsheet presented here is intended to supplement the worksheet provided by the authors of the simulation by analyzing factors that impact three important forecasts for firms operating in this simulated environment - sales, production, and plant size. After repeated use of this tool, decision makers become more comfortable forecasting sales and more knowledgeable about the relationship between projected sales and production as well as between production levels and planning for plant expansion.

INTRODUCTION

Manager: A Simulation (Smith & Golden, 1997) is a general management simulation that has teams of students managing companies that manufacture portable AM/FM radios/CD players. This simulation has been used at the author's institution for a number of years in an introductory business course, International Business, which is required of all business administration majors and minors. Teams of three to four players manage their firms over several periods of play by making marketing, production, and financing decisions for their operations. The authors of the simulation package provide a one-page spreadsheet that aids participants in planning decisions from one period to the next. The 'what if' capabilities of this tool are extremely valuable since this allows users to change certain variables such as plant size and marketing expenditures then view the effects of these changes on the income statement and balance sheet of the firm. Known as decision support systems, these tools aid in forecasting and are intended to provide support and rationale for managers' decisions.

From time to time instructors who have used a package for several years find it helpful to create additional spreadsheets for more detailed analysis in areas such as sales and production (Palia, 1989). Such is the case for the author of this paper who is presenting here an additional spreadsheet that focuses on improving estimates of three variables in this simulation – sales, production, and plant size. Participants enter known (inventory levels, plant size, etc.) and forecasted (economic growth, market share, etc.) data to generate reasonable estimates of three variables that have a major impact on a firm's success. Anecdotal feedback suggest that actual results from period to period are very close to the forecasts generated by this additional spreadsheet and that users find it of great benefit during the planning process.

DECISION SUPPORT SYSTEMS

A Decision Support System (DSS) is a decision making tool which offers users a model to structure problems and review alternative solutions prior to selecting a course of action (Forgionne, 1988; Palia, 1991). In a business setting a DSS provides value to mangers by integrating information from the firm's activities (operations, finance, marketing, etc) as well as external factors (interest rates, competitors' data, etc.) into a model which then summarizes the information, presents relationships among the variables, and provides forecasts to aid decision making (Sprague, 1980). The goal for users of this type of tool is to gain a greater understanding of a problem and to understand the implications of various alternatives (Pickett & Stell, 1987). An effective DSS is one that provides 'what if' scenarios and allows for alternative solutions as managers work towards the 'best solution' to a problem (Palia, Keong, & Roussous, 2000).

One goal of business schools/programs is to prepare students to make decisions in a complex and often uncertain environment. The use of general business and functional computer simulations provides students an opportunity to face decision-making in a competitive environment with time constraints and uncertainty (Palia, 1989). A DSS in this environment is an effective tool for students as they plan decisions from one period to the next. When used consistently, this tool will show relationships between variables and provide for a number of alternatives as they progress through the planning process. Forecasting should be thought of as one type of decision support system, which has as its goal predicting the outcome of a business situation (Pickett & Stell, 1987). Successful forecasting goes beyond simply extending past data out into the future. Consideration of past patters, environmental factors, and internal variables creates a unique planning situation for decision makers (Cox, 1984). The purpose of this paper is to provide a decision support system to aid users of a general management simulation, MANAGER: A Simulation (Smith & Golden, 1997), in forecasting three elements of

their operations – sales, production levels, and plant addition.

FORECASTING

Planning involves managing and deploying the resources of a firm (Forgionne, 1988). Forecasting helps in deciding to which areas of the firm resources should be allocated. Forecasting, however, requires knowledge of a wide range of factors ranging from labor demand and interest rates to plant utilization and product sales. Those responsible for planning within an organization need methods of predicting with as much certainty as possible the future progress of the firm (Cox, 1984). A DSS is one tool that can aid in this effort.

Amongst educators, forecasting is viewed as an important skill for students to acquire yet forecasting classes are often not required at the undergraduate level (Pickett & Stell, 1987). An alternative to an entire course on forecasting is to expose students to methods of/tools for forecasting at intervals during their program of study. A DSS linked to a simulation provides an ideal learning situation for future managers to improve their understanding of and skills in forecasting.

Students learning to use a forecasting model should understand clearly which components of the model are known (plant size, number of employees, etc.) and which are unknown or known with much less certainty (economic forecast, competitors' prices, etc.). As with any software package users should understand the elements of and relationships among the variables of the model before being introduced to the software (Pickett & Stell, 1987). It should also not be so complicated as to result in more confusion for students as they prepare decisions from one period to the next. Developing a model that will improve the forecasting and decision-making ability of students is the goal of this paper.

MANAGER: A SIMULATION

Computer simulations allow students to make decisions in a complex, dynamic, and uncertain environment. With repeated iterations, students can practice their decision-making skills while incorporating principles learned from texts (Palia, 1989). MANAGER: A Simulation (Smith & Golden, 1997) is a general management simulation requiring students to make some twelve decisions as they manage an enterprise that manufactures and sells portable AM/FM radios/CD players. Each set of decisions represents one period of operation and requires decisions regarding marketing (price, marketing spending, research & development, marketing research), production (quality, plant addition, production), financing (debt, equity, dividends, investment) and an ethical dilemma/incident. This simulation has been used at the author's institution for roughly a decade in an introductory business course taught to first year business majors. The course, International Business, uses an international business text plus this simulation to introduce topics on the global economy along with the functional areas of a business organization.

Provided with the simulation is a one-page spreadsheet that organizes information for a firm as it plans each set of decisions. Included are: a decision form, pro forma income and expense analysis, pro forma cash flow analysis, and three sections with statistical information including breakeven analysis. With each piece of information entered users can view its impact on operations as well as the financials of the firm. This is often a student's first exposure to 'what if' analysis and they learn quickly the value of varying inputs to generate a range of possible outcomes. One key to success in this simulation is for managers to accurately predict three variables of the firm – sales, production level, and plant addition. These take some time and much thought to prepare before entering them on the worksheet. The need for an additional tool to help users work out the details for these three decisions motivated this paper's author to develop a supporting worksheet to aid in forecasting these variables. The following section and accompanying appendix describe this decision making tool.

A MANAGEMENT DSS

The Sales, Production, and Plant Addition Worksheet presented in Appendix 'A' was created several years ago to aid students to arrive at reasonable and constructive estimates of three variables that have long-range implications for running their firms. Projecting realistic 'Sales' levels aids in forecasting revenue projections – the lifeblood of a company. Planning for adequate 'Production' levels requires an understanding of both current and future demand along with current and future 'Plant Size' at the firm. Combining these variables in one interactive worksheet helps managers view the interdependence of these factors as they progress through the decision-making process each period.

When using the worksheet, students enter known information about their firm and industry plus reasonable estimates about what they and the industry are likely to do in order to improve their accuracy in forecasting sales, production, and plant addition. The numbers on the worksheet that are followed by an asterisk (*) are those entered by students. Some of these are entered only once yet appear in more than one section of the spreadsheet. The remaining numbers are generated by formulas pre-set in the worksheet. The following paragraphs describe in detail each section of the DSS.

Industry Demand for the Next Two Quarters

This section requires industry sales for the past period along with economic forecasts offered in a market research report that can be purchased each quarter by firms. The spreadsheet generates an estimate of industry demand for the subsequent two periods. This data is needed by firms to predict their sales in each of the next two periods.

Your Firm's Estimated Sales for the Next Two Quarters

Sales in the most recent period along with any lost sales are entered here to determine the firm's actual market share last period. Students estimate market share for the next two periods and the model generates two sales forecasts. Market share in future periods should be based on a firm's pricing, R&D, and marketing strategies. If the plan for a firm is to maintain its current position in the market, market share percentages should be estimated at roughly the same level (within 1 or 2 percentage points). The number displayed next to 'Your Firm's Estimated Sales Next Quarter' should be placed in a cell on the primary spreadsheet to generate the Sales Revenue figure on the Pro Forma Income Statement.

Production Level Needed to Meet Demand Next Quarter

Current inventory, desired ending inventory, plant size, and production level are entered in this section to generate the number of units a firm can produce in the current period. From information entered earlier on the spreadsheet the number of units the firm must produce to meet demand is shown as well. Any discrepancy between these two numbers (Surplus or Shortfall) is shown and a footnote advises students how to proceed. In the case of a shortfall changes in one or more inputs are suggested such that production will be able to meet expected demand. This section generates the decision regarding Production (line 3 on decision form).

Should You Buy More Plant to Meet Demand Two Quarters From Now?

Current plant size, desired ending inventory, and planned production levels are asked for here to estimate plant needs for the next two periods. Students enter only two of the nine pieces of information needed. The other items were entered earlier on the worksheet so they are pulled in from above. An estimate of plant addition is provided at the end of this section along with an explanation of what a surplus and shortfall mean for the firm's production facility. This feedback is critical for teams operating the simulation since there is a one-period lag from when new plant is requested to when it becomes available. Without a systematic method of forecasting this variable firms easily overlook this critical piece of their operations. The number displayed next to 'Plant Addition Needed (Units)' is the number managers should enter on line 6 of the decision form, Plant Addition.

DISCUSSION

The author of this paper has found that offering this spreadsheet to users of the simulation has helped increase their understanding of the complex relationships that exist in a business enterprise and appreciation for reviewing alternative actions before arriving at a set of decisions. A couple of challenges for students using this simulation are that they are predominantly first-year students so this is typically their introduction to the world of business simulations. They often feel overwhelmed making decisions early on so when the worksheet is introduced this is often viewed as cumbersome, unnecessary, and difficult to understand. It is not until they use the tool for approximately two periods that they begin to understand the value of the information it provides. Anecdotal feedback from students indicates that as they begin to appreciate the complexity of the relationships in the simulation they become more dependent on the spreadsheet to organize their thinking and prepare decisions each period.

A second challenge for students is that some are unfamiliar with spreadsheets though this has changed dramatically over the last few years. The spreadsheet requires a limited knowledge of Microsoft Excel© and even if students are unfamiliar with this program it takes only a few minutes for them to become comfortable entering data and scrolling up and down the worksheet. In addition, some students erroneously think that when they enter a forecast such as sales, that that is the actual number that will be sold. A few may ask after receiving their results for the first period why their actual sales were different from those entered on the worksheet. It sometimes takes one or two periods for these students to understand that a forecast is simply a plan or expected outcome not what is necessarily going to occur.

CONCLUSION

Forecasting is an important skill for future managers in an organization to acquire and maintain. At business programs that do not require a forecasting course of their majors, instructors using general management simulations have an opportunity to introduce forecasting techniques and tools to students as they take on the role of decision makers at a firm. The worksheet presented in this paper provides administrators and users of one simulation with a tool to help improve the forecasting skills of students. Future research should be aimed at quantifying the accuracy of forecasting with the use of this tool.

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APPENDIX 'A'

MANAGER SIMULATION
SALES, PRODUCTION, AND PLANT ADDITION WORKSHEET

I. Industry Demand for the Next Two Quarters	
Total Industry Sales (Units) Last Quarter	150,000*
Expected Growth in Industry Next Quarter (Economic Forecast)	1.01*
Expected Growth in Industry Two Quarters Out (Economic Forecast)	1.02*
Estimated Industry Demand Next Quarter	151,500
Estimated Industry Demand Two Quarters Out	154,530
II. Your Firm's Estimated Sales for the Next Two Quarters	
Your Firm's Sales (Units) Last Quarter	27,000*
Lost Sales (Units) Last Quarter	0*
Your Firm's Market Share Last Quarter (Including Lost Sales)	18%
Your Firm's Estimated Market Share Next Quarter	18%*
Your Firm's Estimated Market Share Next Quarter	18%*
Your Firm's Estimated Sales Next Quarter	27,270
Your Firm's Estimated Sales Two Quarters Out	27,815
III. Production Level Needed To Meet Demand Next Quarter	
Current Inventory (Units)	3,250*
Desired Ending Inventory at the End of Next Quarter	2,000*
Current Production Capacity (Units)	33,500*
Percentage of Plant Size to Operate at This Quarter (70%-90% is Ideal)	90%*
Number of Units You Can Produce this Qtr. at Desired Capacity of 90%	30,150
Number of Units You Must Produce this Quarter given your firm's Current Inventory, Estimated Demand, and Desired Safety Stock at the end of Next Quarter (Production Decision – Line 3 of Decision Form)	26020
Production ***Surplus***	4,130[1]

[1]If you face a Surplus your plant is adequate to meet demand next quarter. Hopefully, you are producing at 70% to 90% capacity. If you face a Shortfall your plant is too small. Consider reducing your Safety Stock or producing at more than the desired capacity of 90%. If you are at 100%, you can accept that you will 'stock out' or consider adjusting your decisions (e.g. raise price) so that demand for your product will decline to meet your production capabilities at this time. If you decide to increase your plant size later you can then change your decisions back to those that will produce an increase in demand for your product.

IV. Should You Buy More Plant to Meet Demand Two Quarters From Now?

Current Plant Size (in Units)	33,500
Plant Size One Quarter From Now if No New Plant is Added (Deprec. of 3%)	32,495
Planned Ending Inventory Level at the End of Next Quarter	2,000
Desired Ending Inventory Level Two Quarters Form Now	1,500*
Percentage of Plant to Operate at One Quarter From Now	90%*
Number of Units You Can Produce Next Quarter at 90% Capacity (Assuming you add no plant now your plant will shrink by 3%)	29,245
Number of Units You Need to Produce Next Quarter Given Your Firm's Estimated Demand & Desired Safety Sock at the End of Each of the Next Two Quarters	27,315
Production ***Surplus***	1,930[2]
Plant Addition Needed (Units)	0

[2]If you face a 'Surplus' your plant is adequate to meet demand two quarters from now.

If you face a 'Shortfall' your plant will be too small one quarter from now to meet your needs for the quarter after that. You could 1) adjust downward your 'Desired Ending Inventory Level Two Quarters From Now' to reduce your plant needs and/or 2) increase your 'Percentage of Plant to Operate at One Quarter From Now'. This last option is risky though since you may end up with an inadequate number of units in inventory and/or push your costs per unit up. In any case, if you have a 'Shortfall' in units your plant size is inadequate by the Shortfall number. Buy more plant now to be prepared down the road.