TRACKING FORECAST ERROR TYPE, FREQUENCY AND MAGNITUDE WITH THE FORECAST ERROR PACKAGE

Aspy P. Palia
University of Hawaii at Manoa
aspy@hawaii.edu

ABSTRACT

The Online Forecast Error Package is used to identify and track the type, frequency and magnitude of sales forecast errors over the course of competition. Competing participant teams use this package to determine the extent of ending inventory, stockouts, and overtime production for each of their nine strategic business units at the end of each decision period. Later, the teams use the package to present consolidated sales forecast errors during the team presentation at the end of competition. Then, the teams present a sales forecast using a linear unrestricted single equation multiple regression model and check its accuracy. The use of the Forecast Error Package highlights the need for and significance of forecast accuracy in improving team performance.

INTRODUCTION

The Forecast Error Package enables competing participant teams in the marketing simulation COMPETE (Faria, 2006) to assess the accuracy of their sales forecasts for each of their nine strategic business units (SBUs). SBUs are specific product offerings in specific regions that have specific target markets with specific needs and purchase motivations, a specific set of strategies, facing a specific set of competitors with specific competing strategies. The Forecast Error Package is used in conjunction with the Shipment Analysis worksheet. Based on the demand forecast, ending inventory and a safety stock, the Shipment Analysis worksheet enables participant teams to decide on the level of shipments. Later, the Forecast Error Package enables them to assess the congruence between supply based on shipments and demand based on the marketing mix.

The new Excel-based Forecast Error Package automatically extracts relevant data via external links from the Excel-version of the COMPETE simulation results. The Excel-version of the simulation results are generated by the instructor/administrator from the original dos-text based COMPETE simulation results. Later, the Excel-version of the simulation results are uploaded to the COMPETE Online Decision Entry System (CODES) repository for subsequent access by competing participant teams. Only relevant data on ending inventory, stockouts and overtime production in units are extracted in order to determine the congruence between demand created via marketing mix decisions and supply based on shipment decisions. Demand forecasts are needed to determine the potential profitability of a marketing strategy. Accurate demand forecasts enable marketing managers to allocate available resources effectively and efficiently. This decision support package saves substantial time needed to identify and enter the relevant data and reduces the potential for data entry error.

DECISION SUPPORT SYSTEMS

Several scholars have commented on the value of including decision support software/systems in computer simulations (Keys & Biggs, 1990; Teach, 1990; Gold & Pray, 1990; Wolfe & Gregg, 1989). In addition, the literature is replete with references to the use and impact of decision support systems with computer simulations (Affisco & Chanin, 1989, 1990; Burns & Bush 1991; Cannon et al., 1993; Fritzsche et al., 1987; Grove et al., 1986; Halpin, 2006; Honaiser & Sauaia 2006; Markulis & Strang 1985; Mitri et al., 1998; Muhs & Callen, 1984; Nulsen et al., 1994; Palia, 1989, 1991; Peach, 1996; Schellenberger, 1983; Shane & Bailes, 1986; Sherrell et al., 1986; Wingender & Wurster, 1987; Woodruff, 1992).

Decision support systems (DSSs) are defined as …a collection of data, systems, tools, and techniques with supporting software and hardware by which an organization gathers and interprets relevant information from business and environment and turns it into a basis for…action (Little, 1979; Burns & Bush, 1991). In addition, they are defined as computer-based information systems that support the process of structuring problems, evaluating alternatives, and selecting actions for more effective management (Forgionne, 1988). Further, they are described as the hardware and software that permit decision-makers to deal with a specific set of related problems by providing tools that amplify a manager's judgment (Sprague, 1980).

DSSs used with business simulations yield several benefits. These include greater depth of understanding of simulation activity with resulting increase in planning (Keys et al., 1986), in-depth understanding of quantitative techniques as students visualize the results of their applications, sensitivity to weaknesses in techniques used, and experience in capitalizing on their strengths (Fritzsche et al., 1987). Other benefits include minimization of paperwork and errors, error-free graphical representation of output, a competitive tool with increasing value as simulation progresses, and potential for participants to create their own DSSs (Burns & Bush, 1991). In addition, DSSs enhance

understanding of complex business relationships and provide additional value over time (Halpin, 2006). Further, DSSs provide realism, relevance, literacy, flexibility and opportunity for refinement (Sherrell et al., 1986).

Some authors contend that combining an active student generated database in the form of a simulation game with a DSS will result in improved decision making, lead to improved pro-active rather than re-active strategic planning, and result in improved simulation game performance and enhanced learning (Muhs & Callen, 1984). Others have reported no support for the premise that DSS usage improves small group decision making effectiveness (Affisco & Chanin, 1989), and that DSS usage to support manufacturing function decisions resulted in decreased manufacturing costs and increased "earnings/cost of goods sold" ratio in the second year of play (Affisco & Chanin, 1990).

Given the inconsistent findings with regard to the efficacy of DSSs reported in the literature, does DSS usage increase decision effectiveness and/or enhance learning? One scholar notes that while the DSS assists the decision maker, it does not make decisions, nor can it substitute for intelligent analysis and synthesis (Schellenberger, 1983). In addition, as with other computer-based or experiential learning techniques, the effectiveness of DSSs or the decisions made are less important than the insights they generate. The level of insight generated depends heavily on the clear explanation of the purpose, significance, assumptions, usage, and limitations of the DSS and underlying concepts applied, by the instructor. In addition, the level of insight generated depends heavily on the debriefing process used by the instructor to crystallize student learning (Cannon et al., 1993).

The primary purpose of this paper is to present this new user-centered learning tool that helps to prepare students for sales forecasting, production scheduling, inventory management, and marketing decision-making responsibilities in their future careers. The objective of this decision support package is to provide participant teams the opportunity to forecast sales, schedule shipments, and manage inventory effectively and efficiently.

SALES FORECASTING

A major responsibility of marketing is the preparation of sales forecasts. First, market opportunities are identified through marketing research. Then, the size, growth and profitability of each market opportunity are measured and/or forecasted. Sales forecasts are used (a) by finance to raise the needed cash for investment and operations, (b) by manufacturing to establish capacity and output levels, (c) by purchasing to acquire the necessary supplies, and (d) by human resources to hire the needed workers (Kotler, 2003).

Accurate sales forecasts facilitate effective and efficient allocation of scarce resources. Over-estimates of demand lead to several problems. First, excess inventory uses up valuable shelf space and leads to obsolescence. Next, scarce working capital blocked up in inventory carrying charges [funds used or borrowed (a) by manufacturers to produce goods, or (b) by retailers to purchase goods] cannot be used for other purposes such as R&D or promotional expenses. Third, storage charges are incurred to store excess inventory in public or private warehouses. Finally, margins are reduced when excess inventory is removed through end-of-year clearance sales.

Under-estimates of demand lead to a different set of problems. First, stock-outs lead to wasted shelf space. Next, insufficient inventory leads to lost sales and consequent lost margins. Third, failure to keep up with customer demand may necessitate the use of limited and expensive overtime production leading to lower profitability. Finally, and most importantly, the firm may lose customers, when prospects facing an empty store shelf, try an alternative brand or go to an alternative store, and are satisfied by the competitive offering. Given the detrimental impact of inaccurate forecasts, marketers use a variety of sales forecasting techniques in order to forecast sales accurately (Palia, 2004).

Several scholars have referred to the use of sales forecasting by business simulation participants (Arellano & Hopkins, 1992; Burns, 1977; Cannon & Burns, 1999; Cannon & Ternan, 1997; Cosenza et al., 1985; Day, 1986; Dickinson & Faria, 1994; Dickinson et al., 1990; Edwards, 1987; Faria & Whiteley, 1990; Faria & Wellington, 2004; Faria & Wellington, 2005; Goosen, 2008; Gray et al., 1986; Green & Faria, 1995; Hall, 1987; Hemasi et al., 1987; Keys, 1977, Keys & Gooding, 1990; Keys, 1982; Keys, 1987; Napier, 1974; Neuhauser, 1976; Peach, 1996; Peach & Platt, 2001; Schellenberger, 1981; Schellenberger & Masters, 1986; Snow, 1976; Sord, 1977; Sugges, 1982; Thavilkulwat, 1986; Wellington & Faria, 2006; Wellington et al., 2008; Wellington et al., 2009; Wellington et al., 2010; Whiteley, 1989).

SALES FORECASTING TECHNIQUES

Marketers forecast sales by (a) extending past behavior, and/or by (b) predicting future behavior. Extending past behavior techniques are applied when past sales data are available. These techniques tend to be more quantitative. They extend past data into the future, and assume that the future will be like the past. These techniques include trend extension, the factor method (using one or more factors such as the Buying Power Index, and the SIC code to forecast the sales of industrial products), time series analysis, the use of leading series, and indices such as the consumer price index, producer price index, and the index of leading economic indicators (McCarthy & Perreault, 1987).

Predicting future behavior techniques do not rely on the availability of past data. Instead, they rely on judgment, and are used when there are changing conditions in the marketplace or changes in the marketing mix used. They are also used to forecast the sale of unstable (fashion)

goods and new products. These techniques include the Jury of Executive Opinion, salespeople's estimates, surveys of final buyers, retailers and/or wholesalers, panels of stores and/or final consumers, market tests of existing products, test markets of new products, the substitute method, and needs analysis (Perreault & McCarthy, 1996). There is no best method of forecasting in all circumstances. Confidence in the accuracy of sales forecasts is derived by corroborating the results using two or more methods (McCarthy & Perreault, 1984).

FORECAST ACCURACY/ERROR

Forecasting accuracy has been proposed and/or used to assess management performance in business simulation games with mixed results (Anderson & Lawton, 1990; de Souza et al., 2010; Gosenpud et al., 1984; Hand & Sims 1975; Newgren et al., 1981; Peach & Platt, 2001; Teach, 1989; Teach, 2006; Teach, 2007; Washbush, 2003; Washbush & Gosen, 2002).

Hand and Sims (1975) used path analysis to investigate the relationships among thirteen performance criteria (Swanson, 1977). They were able to reduce the number of performance criteria from thirteen to two – sales forecasting error (the primary "driving variable") and profits (the primary "end result"). Gosenpud et al. (1984) used multiple regression to ascertain the influence of elven independent variables on organizational effectiveness, and performed factor analysis to determine the relationship among the independent variables. They found that forecast accuracy with the largest regression coefficient (Beta = 0.32) affected ROE significantly. Teach (1989) investigated the relationship between forecasting accuracy and simulation performance. He concluded that market share, unit sales, net cash flow and profit/loss forecast accuracy were directly related to simulation performance. Further, his ongoing research (Teach 1987, 1989, 1990, 1993a, 1993b, 2007) suggests that there is a positive correlation between forecast accuracy and simulation performance.

Washbush & Gosen (2002) examined the relationship between learning and forecast accuracy but did not find a consistent correlation between the two variables. They suggest that forecast accuracy may be a proxy for other simulation performance measures. In a follow-up study, Washbush (2003) evaluated the proposition that there is a correlation between forecast accuracy and total enterprise simulation performance. The major findings of this study were consistent with Teach's findings that forecast accuracy correlates with simulation performance. Most recently, deSouza, Bernard & Cannon (2010) used multiple regression to evaluate whether reduction in forecast error can be used as a predictor of team performance. They found that forecast accuracy explained 40.75% of the variance in company performance, and that forecast accuracy for high-level functions (general management) had the greatest predictive impact and low-level functions (sales, human resources, and finance) the lowest. In addition, several scholars have discussed forecasting techniques (Harmon et al., 2009; Kamath & Roy, 2005; Wei & Wang, 2007), forecast accuracy (Dong & Zhu, 2008; Makatosoris & Chang, 2008; Piirainen et al., 2009) and forecast error (Ahlert & Block, 2010) in industry.

Given the relationship between forecast accuracy and simulation performance, an effort is needed to learn and use a variety of forecasting techniques. As there is no single best forecasting approach for all situations, an understanding of the strengths and weaknesses of each technique needs to be understood. Next the sales forecasts need to be monitored in order to establish the frequency of stockouts, overtime and excessive ending inventory and the consequences thereof to team performance and customer satisfaction. Once the consequences of forecast error on revenues, costs, margins, and customer perceptions are clearly understood, simulation participants will better understand the need to learn and develop forecasting skills. They will be motivated to learn the ability to develop accurate sales forecasts in order to improve subsequent team performance. The Forecast Error Package tracks the type, frequency, and magnitude of forecast error for each of their nine SBUs over the course of competition.

THE MARKETING SIMULATION COMPETE

COMPETE (Faria, 2006) is a marketing simulation designed to provide students with marketing strategy development and decision-making experience. Competing student teams are placed in a complex, dynamic, and uncertain environment. The participants experience the excitement and uncertainty of competitive events and are motivated to be active seekers of knowledge. They learn the need for and usefulness of mastering an underlying set of decision-making principles.

Competing student teams plan, implement, and control a marketing program for three high-tech products in three regions Region 1 (R1), Region 2 (R2) and Region 3 (R3) within the United States. These three products are a Total Spectrum Television (TST), a Computerized DVD/Video Editor (CVE) and a Safe Shot Laser (SSL). The features and benefits of each product and the characteristics of consumers in each region are described in the student manual. Based on a marketing opportunity analysis, a mission statement is generated, specific and measurable company goals are set, and marketing strategies are formulated to achieve these goals. Constant monitoring and analysis of their own and competitive performance helps the teams better understand their markets and improve their decisions.

Each decision period (quarter), the competing teams make a total of 74 marketing decisions with regard to marketing their three brands in the three regional markets. These decisions include nine pricing decisions, nine shipment decisions, three sales force size decisions, nine sales force time allocation decisions, one sales force salary deci-

sion, one sales force commission decision, twenty-seven advertising media decisions, nine advertising content decisions, three quality-improvement R&D decisions, and three cost-reduction R&D decisions. Successful planning, implementation, and control of their respective marketing programs require that each company constantly monitor trends in its own and competitive decision variables and resulting performance.

COMPETE ONLINE DECISION ENTRY SYSTEM (CODES)

The COMPETE Online Decision Entry System (CODES) is a web-based simulation interface that enables competing participant teams with Internet access, to register their teams, enter and submit their decisions, and subsequently to retrieve and print out their results from a remote site (Palia, Mak & Roussos, 2000).

The teams log in to the CODES website (Palia & Mak, 2001; Palia, Mak & Roussos, 2000). Their login is validated against a database of participating teams for each industry, and they have access to their decisions and printouts (results) for all prior decision periods.

Once the team ID and password are validated against a database of participating teams, the user (participant) is presented with a personalized Welcome screen with several options. In addition to the "Main Menu" option, the user is presented with one or more of three dynamic links "Grades," "Handouts," and "Performance" only if and when the corresponding files are uploaded to their industry folder on the web server by the administrator (Palia, 2006; Palia, 2007; Palia, 2008).

At the "Main Menu" webpage they select "Enter Decisions" to enter their team decisions prior to the decision deadline. At the decision deadline, the administrator downloads the team decision files, runs the simulation, and uploads the text and Excel versions of the simulation results to the Web Server. Later, the teams log in to CODES, proceed to the Main Menu, and select "View Results" to view their team performance results in either text or Excel format.

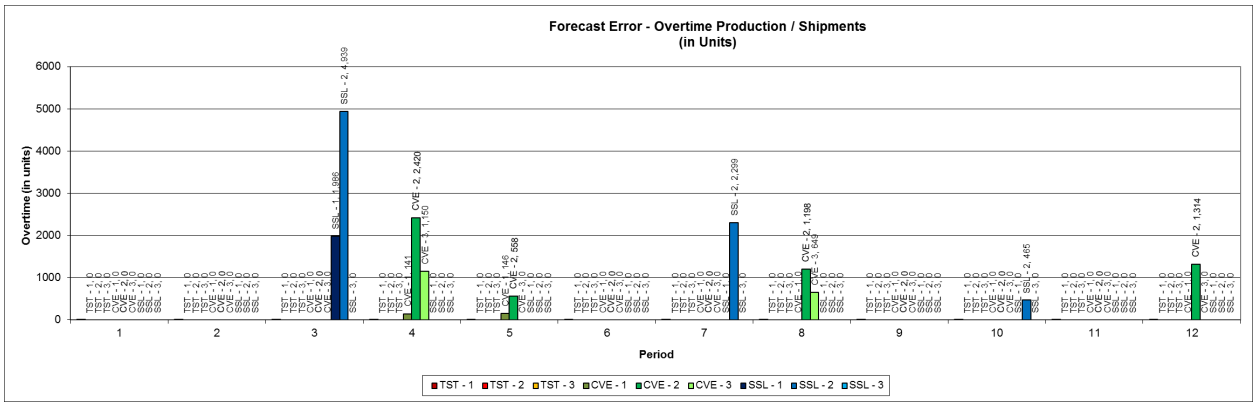
The competing participant teams are provided with access to online strategic market planning (Palia, 1995; Palia, 1996; Palia et al., 2002; Palia, 2010), positioning (Palia, 1997; Palia et al., 2003), sales forecast model-building (Palia, 2004), budgeting (Palia, 2007), market testing (Palia & Roussos, 2006), target profit pricing (Palia, 2008), strategic business unit analysis (Palia, 2009) and other performance enhancing tools (Palia, 2005) in order to facilitate user-centered learning (Palia et al., 2000).

FORECAST ERROR FLOW PACKAGE

The web-based Forecast Error Package Version 2.0 is accessible online to competing participant teams in the marketing simulation COMPETE. The Forecast Error Package Version 2.0 is a zipped folder "Forecast Error.zip" which consists of an Excel workbook "Forecast Error.xlsx" (with external links to each of x.xls COMPETE output files) and x.xls Excel version of sample COMPETE

Forecast Error – Overtime Production Worksheet (in Units)
Figure 1

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	0	0	0	0	0	0	0	0	0	0	0	0
TST - 2	0	0	0	0	0	0	0	0	0	0	0	0
TST - 3	0	0	0	0	0	0	0	0	0	0	0	0
CVE - 1	0	0	0	141	146	0	0	0	0	0	0	0
CVE - 2	0	0	0	2,420	558	0	0	1,198	0	0	0	1,314
CVE - 3	0	0	0	1,150	0	0	0	649	0	0	0	0
SSL - 1	0	0	1,986	0	0	0	0	0	0	0	0	0
SSL - 2	0	0	4,939	0	0	0	2,299	0	0	465	0	0
SSL - 3	0	0	0	0	0	0	0	0	0	0	0	0



output for all specified periods "x". This Forecast Error.xlsx workbook consists of three worksheets (a) Overtime Production worksheet, (c) Ending Inventory worksheet and (c) Consolidated Forecast Error worksheet.

The Overtime Production worksheet (see Figure 1) consists of external links to the quarterly COMPETE output files. This worksheet extracts the overtime production / shipments in units for each product in each region during each decision period from the quarterly results for the first twelve quarters (three years) of operation. A multiple bar chart graphically presents the overtime production / shipments for all nine SBUs in all twelve decision periods. Zero units of overtime production / shipments could either signify ending inventory (where shipments exceed demand) or instances where overtime production is not triggered. Overtime production in COMPETE is only triggered when 50 percent of the current stockout or 20 percent of the current shipping request, whichever is less, exceeds 100 units. While the initial stockout condition results in lost sales and potential lost customers, the overtime production, when triggered results in higher unit production costs. These unit overtime production costs are 15 percent greater than unit production costs during regular production hours. Consequently, the combination of stockouts and overtime production signify lower (lost) sales due to stockouts and increased unit overtime production costs which result in lower margins.

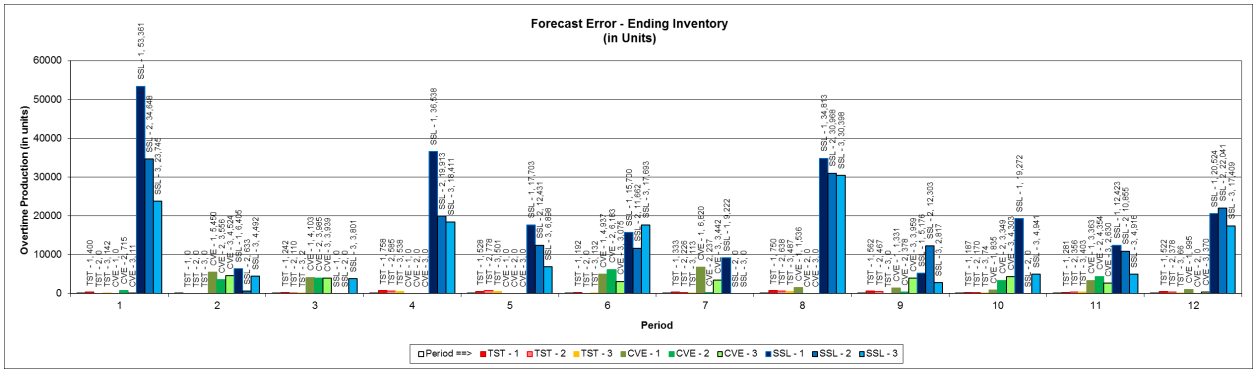
The Ending Inventory worksheet (see Figure 2) consists of external links to the quarterly COMPETE output files. This worksheet extracts the ending inventory in units for each product in each region during each decision period from quarterly results for the first twelve quarters (three years) of operation. A multiple bar chart graphically presents the ending inventory for all 9 SBUs in all 12 decision periods. Conditional formatting is used to signify instances when there is excess inventory with resulting high inventory carrying costs, storage charges, and potentially costly markdowns or clearance sales. Excess inventory is deemed to exist when there is an ending inventory of more than 100 units of the relatively high-priced TST, more than 500 units of the medium-priced CVE, and more than 1000 units of the relatively low-priced SSL.

The Forecast Error Package extracts relevant data via external links on overtime production / shipments and ending inventory for each SBU during each period from the Excel version of the COMPETE simulation results. First, this package extracts overtime production from the "Overtime Production / Shipments" table on the respective "Quality, Cost, OT, Shipments" worksheet for each decision period (quarter). Next, this package extracts ending inventory from the "Shipments and Inventory By Region By Product" table on the respective "Quality, Cost, OT, Shipments" worksheet for each decision period.

The relevant data are extracted from the COMPETE Results Excel workbook x.xls to the Forecast Error workbook as indicated in the Data Extraction Table (see Figure 3). The Excel worksheet (tab), page number in the Excel-version of the COMPETE results printout, and cell references for each account are shown in the COMPETE Results Workbook table (on the right). The corresponding cell references for each account are shown in the Forecast Error workbook table (on the left). For instance, the Over-

Forecast Error – Ending Inventory Worksheet (in Units)
Figure 2

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	400	0	242	758	528	192	333	750	562	187	281	522
TST - 2	0	0	110	585	778	0	226	638	467	170	356	378
TST - 3	142	0	2	538	501	132	113	487	0	74	403	66
CVE - 1	0	5,450	4,103	0	0	4,937	6,820	1,536	1,331	835	3,363	995
CVE - 2	715	3,556	3,985	0	0	6,183	237	0	378	3,349	4,354	0
CVE - 3	11	4,524	3,939	0	0	3,075	3,442	0	3,959	4,303	2,630	370
SSL - 1	53,361	6,405	0	36,538	17,703	15,700	9,222	34,813	5,176	19,272	12,423	20,524
SSL - 2	34,648	633	0	19,913	12,431	11,662	0	30,968	12,303	0	10,855	22,041
SSL - 3	23,745	4,492	3,801	18,411	6,898	17,693	0	30,398	2,817	4,941	4,916	17,409



time Production for TST in Region 1 (TST – 1) in cell B4 on the "Forecast Error – Overtime Production" worksheet in Figure 1 is extracted from cell G18 in the "Overtime Production / Shipments" table on the "Quality, Cost, OT, Shipments" worksheet of the COMPETE results workbook. Similarly, the Ending Inventory for CVE in Region 2 (CVE – 2) in cell B8 on the "Forecast Error – Ending Inventory" worksheet in Figure 2 is extracted from cell I28 in the "Shipments and Inventory By Region By Product" table on the "Quality, Cost, OT, Shipments" worksheet of the COMPETE results workbook.

The Consolidated Forecast Error worksheet (see Figure 4) consolidates, color-codes and presents forecast errors due to stockouts, overtime and ending inventory for all products in all regions during all 12 decision periods. In addition, the worksheet presents the number and percentage of instances of stockouts, overtime, excessive ending inventory, and reasonably accurate forecasts for all nine

Data Extraction Table
Figure 3

Data Extraction from COMPETE Results Workbook.xls To Forecast Error Workbook

COMPETE Forecast Error Workbook			COMPETE Results Workbook x.xls (x = Period Number)			
Account	**Cell Ref.**		**Worksheet (Tab)**	**Page #**	**Account**	**Cell Ref.**
Overtime Production Worksheet (Tab)	Period 1					
TST in Region 1 (TST - 1)	B4	from ==>	Quality, Cost, OT, Shipments	7	TST - 1 Overtime Production	G18
TST in Region 2 (TST - 2)	B5	from ==>	Quality, Cost, OT, Shipments	7	TST - 2 Overtime Production	G19
TST in Region 3 (TST - 3)	B6	from ==>	Quality, Cost, OT, Shipments	7	TST - 3 Overtime Production	G20
CVE in Region 1 (CVE - 1)	B7	from ==>	Quality, Cost, OT, Shipments	7	CVE - 1 Overtime Production	H18
CVE in Region 2 (CVE - 2)	B8	from ==>	Quality, Cost, OT, Shipments	7	CVE - 2 Overtime Production	H19
CVE in Region 3 (CVE - 3)	B9	from ==>	Quality, Cost, OT, Shipments	7	CVE - 3 Overtime Production	H20
SSL in Region 1 (SSL - 1)	B10	from ==>	Quality, Cost, OT, Shipments	7	SSL - 1 Overtime Production	I18
SSL in Region 2 (SSL - 2)	B11	from ==>	Quality, Cost, OT, Shipments	7	SSL - 2 Overtime Production	I19
SSL in Region 3 (SSL - 3)	B12	from ==>	Quality, Cost, OT, Shipments	7	SSL - 3 Overtime Production	I20
Ending Inventory Worksheet (Tab)						
TST in Region 1 (TST - 1)	B4	from ==>	Quality, Cost, OT, Shipments	7	TST - 1 Ending Inventory	F27
TST in Region 2 (TST - 2)	B5	from ==>	Quality, Cost, OT, Shipments	7	TST - 2 Ending Inventory	F28
TST in Region 3 (TST - 3)	B6	from ==>	Quality, Cost, OT, Shipments	7	TST - 3 Ending Inventory	F29
CVE in Region 1 (CVE - 1)	B7	from ==>	Quality, Cost, OT, Shipments	7	CVE - 1 Ending Inventory	I27
CVE in Region 2 (CVE - 2)	B8	from ==>	Quality, Cost, OT, Shipments	7	CVE - 2 Ending Inventory	I28
CVE in Region 3 (CVE - 3)	B9	from ==>	Quality, Cost, OT, Shipments	7	CVE - 3 Ending Inventory	I29
SSL in Region 1 (SSL - 1)	B10	from ==>	Quality, Cost, OT, Shipments	7	SSL - 1 Ending Inventory	L27
SSL in Region 2 (SSL - 2)	B11	from ==>	Quality, Cost, OT, Shipments	7	SSL - 2 Ending Inventory	L28
SSL in Region 3 (SSL - 3)	B12	from ==>	Quality, Cost, OT, Shipments	7	SSL - 3 Ending Inventory	L29

Consolidated Forecast Error Worksheet (in Units)
Figure 4

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	400	0	242	758	528	192	333	750	562	187	281	522
TST - 2	0	0	110	585	778	0	226	638	467	170	356	378
TST - 3	142	0	2	538	501	132	113	487	0	74	403	66
CVE - 1	0	5,450	4,103	141	146	4,937	6,820	1,536	1,331	835	3,363	995
CVE - 2	715	3,556	3,985	2,420	558	6,183	237	1,198	378	3,349	4,354	1,314
CVE - 3	11	4,524	3,939	1,150	0	3,075	3,442	649	3,959	4,303	2,630	370
SSL - 1	53,361	6,405	1,986	36,538	17,703	15,700	9,222	34,813	5,176	19,272	12,423	20,524
SSL - 2	34,648	633	4,939	19,913	12,431	11,662	2,299	30,968	12,303	465	10,855	22,041
SSL - 3	23,745	4,492	3,801	18,411	6,898	17,693	0	30,398	2,817	4,941	4,916	17,409

Condition	Instances	Percent	Implications
Stockouts	9 instances	8.33%	Bare shelves, lost sales, and lost customers
Overtime	12 instances	11.11%	Bare shelves, lost sales, lost customers, & overtime costs
Excessive Ending Inventory	79 instances	73.15%	Inventory carrying cost, storage charge, & clearance sales
Reasonably Accurate Forecasts	8 instances	7.41% only	Increased sales, lower costs & higher margins
Total Number of Instances	108		

Legend:
Stockouts
Overtime
Excessive Ending Inventory
Reasonably Accurate Forecasts

Excess Inventory Condition:		
SBU		
TST	>100	units
CVE	>500	units
SSL	>1000	units

SBUs over all twelve periods. Conditional formatting is used to highlight instances of stockouts (in green color), instances of overtime production (in brown color), instances of excessive ending inventory (in yellow color), and instances of reasonably accurate forecasts (in white color) for specific products in specific regions during each of the twelve decision periods. Conditional counts are used to determine the number and percentage of instances of stockouts (when both overtime production and ending inventory are zero), overtime production, ending inventory, and reasonably accurate forecasts. The instances of reasonably accurate forecasts are the remaining instances calculated by subtracting the sum of instances of stockouts, ending inventory and overtime from a total of 108 instances (12 decision periods x 9 SBUs). No data entry is required.

The use of external links ensures relevant data are extracted from relevant sources (statements) in the simulation results and precludes data entry error. Cell comments clarify variables extracted from the COMPETE results to both the Overtime Production and Ending Inventory worksheets (see Figures 5 & 6). In addition, cell comments clarify functions used to identify, count, and color code each type of forecast error in the Consolidated Forecast Error worksheet (see Figure 7).

Forecast Error – Overtime Production Worksheet With Cell Comments (in Units)
Figure 5

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	0	0	0	0	0	0	0	0	0	0	0	0
TST - 2	0	0	0	0	0	0	0	0	0	0	0	0
TST - 3	0	0	0	0	0	0	0	0	0	0	0	0
CVE - 1	0	0	0	141	146	0	0	0	0	0	0	0
CVE - 2	0	0	0	2,420	558	0	0	0	0	0	0	1,314
CVE - 3	0	0	0	1,150	0	0	0	649	0	0	0	0
SSL - 1	0	0	1,986	0	0	0	0	0	0	0	0	0
SSL - 2	0	0	4,939	0	0	0	2,299	0	0	0	0	0
SSL - 3	0	0	0	0	0	0	0	0	0	0	0	0

TST-1 Overtime Production extracted from Overtime Production / Shipments Table for Period 1.

CVE-1 Overtime Production extracted from Overtime Production / Shipments Table for Period 5.

SSL-1 Overtime Production extracted from Overtime Production / Shipments Table for Period 9.

Forecast Error – Ending Inventory Worksheet With Cell Comments (in Units)
Figure 6

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	400	0	242	736	328	192	333	750	562	187	281	522
TST - 2	0	0	110	585	778	0	226	638	467	170	356	378
TST - 3	142	0	2	538	501	0	0	0	0	74	403	66
CVE - 1	0	5,450	4,103	0	0	4,937	6,820	1,536	1,331	835	3,363	995
CVE - 2	715	3,556	3,985	0	0	6,183	237	1,198	378	3,349	4,354	0
CVE - 3	11	4,524	3,939	0	0	3,075	3,442	0	3,959	0	0	0
SSL - 1	53,361	6,405	0	36,538	17,703	15,700	9,222	34,813	5,176	19,272	12,425	20,524
SSL - 2	34,648	633	0	19,913	12,431	11,662	0	30,968	12,303	465	10,855	22,041
SSL - 3	23,745	4,492	3,801	18,411	6,898	17,693	0	30,398	2,817	4,941	4,916	17,409

TST-1 Ending Inventory extracted from 'Shipments and Inventory By Region By Product' Table in Period 1.

CVE-1 Ending Inventory extracted from 'Shipments and Inventory By Region By Product' Table in Period 5.

SSL-1 Ending Inventory extracted from 'Shipments and Inventory By Region By Product' Table in Period 9.

Consolidated Forecast Error Worksheet With Cell Comments (in Units)
Figure 7

Period ==>	1	2	3	4	5	6	7	8	9	10	11	12
TST - 1	400	0	242	736	328	192	333	750	562	187	281	522
TST - 2	0	0	110	585	778	0	226	638	467	170	356	378
TST - 3	142	0	2	538	501	0	0	0	0	74	403	66
CVE - 1	0	5,450	4,103	141	146	4,937	6,820	1,536	1,331	835	3,363	995
CVE - 2	715	3,556	3,985	2,420	558	6,183	237	1,198	378	3,349	4,354	1,314
CVE - 3	11	4,524	3,939	1,150	0	3,075	3,442	649	3,959	0	0	0
SSL - 1	53,361	6,405	1,986	36,538	17,703	15,700	9,222	34,813	5,176	19,272	12,425	20,524
SSL - 2	34,648	633	4,939	19,913	12,431	11,662	2,299	30,968	12,303	465	10,855	22,041
SSL - 3	23,745	4,492	3,801	18,411	6,898	17,693	0	30,398	2,817	4,941	4,916	17,409

=SUM('Overtime Production'!B4,'Ending Inventory'!B4)

=SUM('Overtime Production'!B4,'Ending Inventory'!B4)

=SUM('Overtime Production'!B4,'Ending Inventory'!B4)

Condition	Instances	Implications
Stockouts	9 instances	Bare shelves, lost sales, and lost customers
Overtime	12 instances	Bare shelves, lost sales, lost customers, & overtime costs
Excessive Ending Inventory	79 instances	Inventory carrying cost, storage charge, & clearance sales
Reasonably Accurate Forecasts	8 instances	Increased sales, lower costs & higher margins
Total Number of Instances	108	

=COUNTIFS(Overtime,"=0", Ending_Inventory,"=0")

=COUNTIF(TST,">100") +COUNTIF(CVE,">500") +COUNTIF(SSL,">1000")

Legend:
Stockouts
Overtime
Excessive Ending Inventory
Reasonably Accurate Forecasts

Excess Inventory Condition:		
SBU		
TST	>100	units
CVE	>500	units
SSL	>1000	units

FORECAST ERROR PACKAGE PROCESS

First, the participant teams download and unzip the Forecast Error.zip folder. Next, they login to CODES and download, rename and save the Excel version of results for all twelve periods (quarters) "x" in the unzipped "C:\Forecast Error" directory. Then, they update the Forecast Error.xls workbook with team data. For instance, to update the Forecast Error worksheet with team data, they first open the unzipped Forecast Error folder, then open the Forecast Error.xls workbook, and finally click "Update file" in the pop-up menu that appears.

The overtime units are extracted from the Overtime Production / Shipments table on the Quality, Cost, OT, Shipments page of the Excel version of the COMPETE results for the first twelve periods (quarters) of operation. The ending inventory in units is extracted from the Shipments and Inventory By Region By Product table on the Quality, Cost, OT, Shipments page of Excel version of the COMPETE results for the twelve periods (quarters) of operation.

The Consolidated Forecast Error worksheet consolidates, color-codes, and counts the number of instances of stockouts, overtime, excessive ending inventory (defined as 100 or more units of the relatively high-priced TST, 500 or more units of the relatively average-priced CVE, and 1000 or more units of the relatively low-priced SSL), and the remaining instances of reasonably accurate forecasts.

Based on the extracted data, the Forecast Error Package calculates the percentage of instances of stockouts, overtime, excessive ending inventory and reasonably accurate forecasts during the twelve periods of competition. The use of external links ensures relevant data are extracted from relevant sources (statements) in the simulation results and precludes data entry error. Cell comments (see Figure 5,6 & 7) clarify variables, cell formulae and functions used. Color-coded cells specify where data are extracted and differentiate among instances of stockout, overtime, excessive ending inventory and reasonably accurate forecasts.

STRENGTHS AND LIMITATIONS

The Online Forecast Error Package is used to track and present the type, frequency and magnitude of forecast error during the twelve periods (quarters) of competition. The consolidated forecast error matrix consolidates, color-codes, and counts the number of instances of stockouts, overtime, excessive ending inventory and reasonably accurate forecasts during the twelve periods of competition. This matrix is presented at the end of the insightful and revealing "Errors Made and Lessons Learned" section of the team presentation at the end of the semester. The consolidated forecast error matrix demonstrates the pervasive nature of forecast error. In addition, this matrix highlights the need for more accurate forecasts in order to reduce ending inventory, inventory carrying charges, storage charges, and clearance sales when forecasts are overly optimistic, and the need to avoid stockouts, lost sales, costly overtime production and lost customers when forecasts are overly pessimistic. Finally, the consolidated forecast error matrix provides a smooth transition to the use of a linear unrestricted single-equation multiple regression model to more accurately forecast sales.

Positive anecdotal student feedback was received at the end of the Spring and Fall 2010 semesters. Some students reported that the decision support packages were very useful and helpful. They indicated that the automatic extraction feature saved a lot of time that would otherwise be necessary to identify, enter and compute the necessary figures. They hoped that it would continue to be used in the future as it definitely made a difference. Other students indicated that they did not make full use of the DSS.

Admittedly, sales forecasting is a complex and critically important task that requires considerable effort, judgment and experience. The user needs to select and use suitable sales forecasting techniques that are either quantitative and objective or subjective and judgmental depending upon the availability of past data, changes in the market and marketing mix, and relative stability of product life cycles. Next, the user needs to corroborate the results in order to derive confidence in the forecast. Then the user needs to determine the level of shipments based on the level of ending inventory, the sales forecast and the level of safety stock. In order to improve forecast accuracy, the user needs to track the type, frequency, and magnitude of forecast error, understand the underlying reasons, and take corrective action.

Despite these limitations, the Forecast Error Package is a simple yet powerful web-based user-centered learning tool that extracts relevant data from the simulation results, precludes data entry error, and saves considerable time involved in identifying and entering relevant data. Yet, in order to maximize learning about sales forecasting, and actualize the potential of Forecast Error Package, the instructor needs to (a) explain the purpose, significance, assumptions, usage, and limitations of this DSS package as well as sales forecast model building, (b) require inclusion of a sample analysis and subsequent sales forecast in a team report and/or presentation, and (c) test students on their understanding of the underlying concepts at the end of the semester.

CONCLUSION

The Online Forecast Error Package is a user-centered learning tool that helps to prepare students for sales forecasting and marketing decision-making responsibilities in their future careers. This package enables users to apply sales forecasting, monitor the type, frequency and magnitude of forecast error, and thereby assess the accuracy of their forecasts and their impact on team performance. Former researchers have identified sales forecasting error (the

primary "driving variable") and profits (the primary "end result" as important simulation performance criteria (Hand & Sims, 1975). They have concluded that forecast accuracy affects ROE significantly (Gosenpud et al, 1984)., and that there is a positive correlation between forecast accuracy and simulation performance (Teach, 1987, 1989, 1990, 1993a, 1993b, 2007). Other researchers have found no consistent relationship between learning and forecast accuracy (Washbush & Gosen, 2002). More recently, scholars have determined that forecast accuracy correlates with simulation performance (Washbush, 2003), and that forecast accuracy explained 40.75% of the variance in company performance (deSouza, Bernard & Cannon, 2010).

Given the importance of forecast accuracy to simulation performance, participants can use the Online Forecast Error Package to (a) determine the type, frequency and magnitude of forecast error for each of their nine SBUs over the 12 periods (quarters) of competition, (b) better understand the significance of accurate forecasting, (c) learn different forecasting techniques, and (d) improve their forecasting skills. Further, this online Forecast Error Package may be used to empirically test the relationships among sales forecasting, simulation performance and enhanced learning. In addition, the package facilitates the integration of computers, the Internet and the World Wide Web into the marketing curriculum.

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