1-1-1992

Catalog Forecasting System : A Graphics-Based Decision Support System

David V. Evans
Southern Methodist University

Uday M. Apte
Southern Methodist University

CATALOG FORECASTING SYSTEM
A GRAPHICS-BASED DECISION SUPPORT SYSTEM

Working Paper 92-061*

by

David V. Evans
Uday M. Apte

David V. Evans
Vice President and Director, Information Systems
JCPenney Company, Inc.
P.O. Box 2405
Dallas, Texas 75221
(214) 591-7810

Uday M. Apte
Edwin L. Cox School of Business
Southern Methodist Univesity
Dallas, Texas 75275
(214) 692-4102

* This paper represents a draft of work in progress by the authors and is being sent to you for information and review. Responsibility for the contents rests solely with the authors and may not be reproduced or distributed without their written consent. Please address all correspondence to Uday M. Apte.

ABSTRACT

JCPenney Company operates a $3 billion catalog business where avoiding excessive stockouts and overstocking is extremely critical for the financial and operating success. Improved forecast accuracy and the Quick Responses capability (i.e., the ability to respond to demand changes through continual updating of forecast) are naturally important here. In line with these goals, JCPenney Company has recently implemented a state-of-the-art Catalog Forecasting System. This graphics-based decision support system was especially designed and developed to support the catalog inventory control specialists in their forecasting and inventory control decisions.

In this paper, we present how this system is being used, its important features, the lesson learned in its development and implementation, and the strategic impact of the system. In addition to its easy-to-use graphical interfaces, the system's notable features include the use of advanced analytical capabilities and the process re-engineering that has accompanied its implementation. The realized strategic benefits of the system include continuous improvement in decision making, increased productivity, enhanced Quick Response capability and significant financial gains. Our system development and implementation experience indicates that the users' strong involvement in the design and development, the management's full commitment, and an extensive user training are required pre-requisites of the success of a decision support system.

Keywords: Decision Support System, Re-engineering, Implementing DSS, Graphical Interfaces, Forecasting

1.0 Introduction

Using information technology for improving the quality and availability of information throughout the distribution channel, improving forecast accuracy, and shortening the cycle time of activities for responding quickly to the demand change are critically important strategies in the apparel and retailing industries. In this paper we present the Catalog Forecasting System at JCPenney Company[1], a system targeted mainly towards the latter two strategies.

JCPenney Company owns and operates, in addition to its large chain of retail stores, a $3 billion catalog business renowned for its state-of-the-art distribution centers and sophisticated tele-marketing operation. Attractive pictures of apparel and other items presented in a catalog create customer demand for merchandise. To ensure high levels of customer service and satisfaction, it is important that customer orders be filled within a short time period through on-hand inventory. A stockout or an inordinate delay can be very damaging for future sales since a disappointed customer may decide never to purchase again using the company's catalog[2]. Avoiding stockouts (and overstocking) through accurate sales forecasts and effective inventory management are therefore critical for a catalog business.

The experience of retail industry confirms this criticality of forecasting and inventory management. For the last ten years or so, the apparel trade journals have noted a steady and disturbing increase in the percentage of apparel sold at discount prices. The cost to U.S. industry of non-promotional markdowns and sales lost

---

[1] This system received the 1991 Retail Innovation Technology Award, sponsored by Chain Store Age Executive and Digital Equipment Corporation (Fox, 1991).

[2] A comparison with a stockout situation in a department store is interesting. The stockouts are undesirable also in department stores; but the magnitude of the associated losses is relatively unknown. If an item in a department store is out of stock, the customers do not see the item on the rack. Consequently, the demand level for stockout item may arguably get somewhat depressed. Item substitution may also play an important role here. In any case, the bottom-line impact of stockouts are difficult to estimate for a department store in comparison with a catalog where the lost sales are precisely known.

because of stockouts are now estimated at tens of billions of dollars each year (Nuttle, et al., 1990). The Quick Response concept has emerged since 1985 as the centerpiece of industry's strategy for containing these losses.

Simply stated, Quick Response is a strategy for linking apparel and textile retailing operations to apparel and textile manufacturing operations, for providing the flexibility needed to quickly respond to the shifting market needs (Hammond, 1991). Quick Response consists of a combination of re-engineered business practices and technology applications that reduce the overall inventory level while simultaneously avoiding forced markdowns and stockouts. The changed business practices in Quick Response involve continual re-estimation of an item's demand over the season, and frequent small reorders to vendors so that the type and quantity of item being inventoried can be accurately matched with what the customers want. Penney's Catalog Forecasting System is specifically designed to support these changed business practices. Its primary goal is to support Catalog Inventory Control Specialists (ICS) in their responsibilities of forecasting, inventory control, and purchasing decisions.

In this paper, we present the Catalog Forecasting System at JCPenney. In particular, we discuss its important features, its development and implementation, the lessons learned, and the strategic impact that the system has had in terms of improved decision making, quick response capabilities and improved financial and operating performance. The paper is organized in four sections. This introductory section is followed by the description of the catalog forecasting and inventory control operation. The third section identifies certain important features of the system including an explanation of how the system is used by the inventory control specialists. The lessons learned in developing and implementing this system and some potential enhancements to the system are also presented in this section. Finally, the strategic impact of the system on the operating and financial performance is discussed.

2.0 Catalog Forecasting and Inventory Control

Starting with a single distribution center (DC) in the early 1960s, Penney's catalog business has grown to six DCs serving separate geographic regions in the country. Historically, the forecasting and inventory management functions for roughly 100,000 items, or stock keeping units (SKU), were carried out independently for each center. This approach necessitated making a very large number of forecasting estimates and inventory decisions. Moreover, filling a customer order when one DC was out of stock while another had the same item in stock, was generally time consuming, expensive and administratively cumbersome. Therefore, the need for coordinated decision making, and for improved efficiency and productivity led to the development of new forecasting and inventory control systems in the 1980s.

Forecasting for catalog business involves using historical experience and the knowledge of current factors for projecting demand for each item, for each week in a catalog's life. The catalog inventory control function is carried out by more than one hundred catalog inventory control specialists (ICS). On an average, an ICS controls sales and inventory for more than five thousand SKUs displayed in about forty catalogs published every year. The sales volume generated by the inventory controlled by each ICS can be as high as 30 to 40 million dollars. With this level of responsibility, the performance of an ICS has a major impact on the overall success and profitability of the JCPenney Catalog.

The inventory control specialists work closely with the buyers. Building the best product line is the primary responsibility of a buyer. Thus, a buyer is concerned about aspects such as the fashion trends, customer taste, and the quality and construction of garments. In contrast, an ICS is responsible for quantitative or analytical aspects such as the sales forecast of an item and the desired inventory level. The inventory control specialists use the Catalog Forecasting System in making a variety of forecasting decisions prior to and during the selling season of a catalog which can for last for up to 35 weeks after the activation of a catalog. The responsibilities of inventory control specialists can be best described in terms of pre-season, in-season and post-season activities. We begin with a post-season analysis since, ideally, it takes place prior to a pre-season analysis and planning.

Post Season Analysis

Shortly after a catalog deactivates and before the ICS begins to plan for the next year's catalog, the ICS compares the original estimate with the realized demand to try to understand the reasons why the item sold the way it did. The ICS analyzes factors such as the selling pattern of the item, its presentation in the catalog, price, promotions, merchandise mix, supplier performance, overstock or shortage problems if any, and so forth. Post-season analysis provides the ICS with a wealth of information which helps increase the ICS's merchandise knowledge and continuously improve their future performance. Thus, a good pre-season plan starts with a thorough post-season analysis.

Pre-Season Analysis and Planning

Pre-season activities of the ICS include making a forecast of total sales and selling pattern (i.e., the weekly sales) over the selling season for each item included in the catalog. The process of arriving at the best estimate of total sales for each item begins with a meeting and negotiation between the ICS and the buyer. The purpose in involving both the buyer and ICS in estimation is to uncover assumptions and perspectives on estimated sales, to overcome possible biases, and to provide a system of checks and balances in arriving at the best possible estimate.

The task of making a forecast for more than 100,000 SKUs is simplified and systematized by arranging the items in a hierarchical manner. Such a hierarchy of items is convenient since it can also mirror the organizational hierarchy. As shown in Figure 1, this hierarchy consists of catalog (such as spring/summer, fall/winter, etc.) at top, followed by division (such as mens, womens, or childrens) at the next level, and so on through the category (such as casual dresses or sweaters), set, lot and the SKU at the bottom.

INSERT FIGURE 1 HERE

Actual forecasting is done either for an individual lot or for a group of lots, termed as "sets" within CFS. The process of assigning lot numbers or SKUs creates an artificial split of an item that the customers see as a single item displayed in the catalog. Thus a "set" is formed by combining lots that have a similar selling pattern and characteristics. For example, consider a lawn mower that comes in two varieties, a side-bagger or a rear-bagger. These two types of lawn mowers are assigned two different lot numbers but they are expected to have the same selling pattern and characteristics. Hence, these two lots should be combined to form a single set and then the forecasting should be done at this set level. The demand for each lot is then estimated as a percent contribution to the set estimate. The demand estimates for intermediate level, if any, and SKU are also prepared using the "percent contribution to the next higher level" method.

In arriving at the demand estimate, the ICS makes an extensive use of the graphical and analytical capabilities of the Catalog Forecasting System to access and analyze the previous five years of sales data. The previous years' total sales and the current merchandise mix and characteristics are used in preparing the current estimate. The system is especially useful in forecasting for items that are new. In these cases, inventory control specialists can analyze the past demand for items similar to the new item. The criteria used by the CFS in determining similarity are: item's use by customers, seasonality, price, style, fabric, number of colors offered, item's display in the catalog in terms of space allocation on a page or its placement, and so forth.

Once the total demand for a set is estimated, the next task for the ICS is to determine the selling pattern for a set. The concept of a "model", which denotes the shape of the curve representing the weekly distribution of sales over the selling season, is a key for this task. There are five basic models - Early, Early Average, Average, late Average, and Late - which are chosen depending on the time when the sales show a peak during the selling season. As an example illustrating the concept of a model, consider the selling pattern for a short-sleeve shirt displayed in a fall catalog. It might be expected to sell early in the season. Hence, it would be assigned an Early model that peaks early in the season. In contrast, a heavy sweater that is expected to sell late in the season will be assigned a Late model. Choice of a suitable model, also called a "plan model," is a very important pre-season decision as it helps ICS in the task of continual fine-tuning of forecast during in-season. After selecting the appropriate model, the ICS makes small adjustments to the shape of the curve to ensure that such factors as the holidays, events, promotions on specific dates and concurrent catalogs that affect the merchandise are reflected correctly in the peaks and valleys of the model.

Small mis-estimations or forecasting biases at the set level can have magnified impact when these forecasts are aggregated at the catalog level. Hence the concept of "Topdown Models" is used to mitigate this impact. Under this approach, topdown models are forecasted for levels higher than and including the category level in the forecasting hierarchy. These topdown models are defined based on the previous year's selling patterns modified by any changes in the timing of release of the catalog, or by any changes in merchandise mix, etc., at lower levels for the current year. Development of topdown models is accompanied by preparation of demand estimate for each level which is simply an add-up of all the item estimates at the next lower level. The use of topdown models, as explained later, allows control over the estimates from an aggregate, top-down perspective, and improves the stability and reliability of forecasts in season.

Other important pre-season responsibilities of the ICS are to develop inventory coverage & wholesale strategies. These strategies include decisions pertaining to initial orders and re-orders. The ICS's goal here is to control the level and flow of merchandise into the DC's on a periodic basis in order to cover the most immediate needs, without prematurely purchasing a larger percentage of the estimate than is necessary. The concept of model is again very useful here since it allows the ICS to estimate the pattern and level of sales during the coverage period.

<u>In-season Activities</u>

By putting a lot of time and effort into their pre-season decisions, the ICS greatly reduces the amount of work needed in-season while improving the quality of decisions. In-season is defined as the time period between the activation and deactivation of a catalog. Even when the ICS has well thought out the preseason decisions, the ICS still has to make many important in-season decisions. In season, the ICS reviews current demand trends and makes revised decisions about the estimate, model, and inventory coverage strategies.

The ICS follows the topdown approach for improving the accuracy of in-season re-estimation. The ICS starts at the top or catalog level and works down through the divisions, departments, subdivisions, and finally down to the category level. After the catalog activates, each week on Tuesday night the Topdown system calculates estimates for the catalog level through the category level by using each individual level's topdown model and its cumulative demand to date. After some initial warmup period, say about 10% of the season, all lower level estimates are forced to add up to the next higher level decision estimate by adjusting the lower level estimates. Due to a larger demand base and more consistent history at higher levels, the topdown approach provides estimates that are statistically more reliable.

After the topdown system develops its topdown models and level estimates, the system checks each level to see if there is any significant change between the percentage contribution of a level to the next higher level. If there are any significant shifts in percentage contribution, the topdown system presents on Wednesday such exception situations to the ICS. The ICS then reviews the models and estimates for that level, and for the levels above and below that level, and makes the necessary adjustments to resolve the exception.

Thursday of each week the Forecasting system uses all the current data available and calculates the most reasonable item estimates from the set level and down to the SKU/DC level. If the estimate does not meet the established criteria of being a reasonable forecast, it is again presented to the ICS on an exception basis for appropriate resolution. To resolve the exception, the ICS must first determine if anything has changed since the final pre-season plan, such as presentation, price, or promotion. If one of the merchandise characteristics that affect selling patterns has changed, then the ICS can select another model or estimate that would be more appropriate. For example, consider a silk blouse that was expected pre-season to sell 70,000 units, and that has begun trending at a seasonal selling rate of 110,000 units after three weeks of sales. The decision that the ICS needs to make in this case, in consultation with buyer, is whether to order additional 40,000 items. Using CFS for continual updating of forecast and purchasing decisions is what the Quick Response movement is all about which can indeed make a difference between a profit and a loss.

For determining the level of confidence the ICS has in plan model assignments, the ICS needs to interpret and analyze the various graphics screens in the Forecasting system which show current demand trends, how the actual demand varies from the expected demand, and the projected future demand trends for each item. If the ICS determines that a new model needs to be selected, he uses other CFS screens as tools to gather data and analyze other available models.

In summary, the main responsibilities of the catalog inventory control specialist, that are being supported by the Catalog Forecasting System, are: (1) pre-season forecasting of total seasonal demand and selling pattern for all items that s/he is responsible for, (2) in-season monitoring of actual sales and making the continual updating of the demand estimate and the model, and (3) making the periodic inventory/purchase decisions.

3.0 The Catalog Forecasting System

With the increased level of business volume and the increased number of distribution centers, it had become clear by the early 1980s that a centralized approach for inventory control, supported by information technology, was essential for improved efficiency and decision making. The methodology chosen for doing forecasting in CFS was to combine the power of analytical forecasting approaches such as exponential smoothing (Makridakis and Wheelwright, 1989), the computational and graphical interface capabilities of a computer, and the judgement and knowledge of an ICS. Given the semi-structured nature of the decisions to be made by the ICS, a portfolio of decision support systems (Keen and Scott Morton, 1978; Bidgoli, 1989) was planned and gradually implemented over the next decade.

The first milestone in that plan was the Catalog Responsive Inventory Management System (CRIMS), which was released in 1983. This system had both the forecasting and inventory control capabilities. Built-in triggers are used in CRIMS to identify items that show excessive demand or shortages of on-hand plus on-order inventory. These exception items are reviewed and analyzed in detail by the inventory control specialists to determine the necessary purchase order or expediting actions. Other systems that were implemented in phases, and are currently being used by the ICS are the Purchase Order Follow-up (POF) system, the On Line Exceptions (OLE) system and the Wholesale Inventory Control System (WIC).

CRIMS was and is an effective system, but it lacked the capability to do a corporate-level forecasting. A tabular format was used for the presentation of historical demand which made the analysis and uncovering of patterns difficult, and required the ICS to perform a number of hand calculations for performing both preseason and inseason tasks. Moreover, the support for performing any "what if" analysis was very limited. To overcome these limitations, the decision was made to create a separate graphics-based system that supported the forecasting decisions.

The work on Catalog Forecasting System (CFS), began in 1987 and after more than 100,000 person hours of development effort and $4 million of cost, the system was completed and installed on a pilot basis in 1990. It was fully implemented in time for the 1991 spring/summer catalog. The CFS currently runs in an IBM MVS/IMS mainframe environment with more than 100 users simultaneously interacting with the system using PS/2 machines linked in a local area network.

One of the most technically challenging aspects of CFS was its graphics capability. The mainframe technology as of mid 1980s required that certain IMS routines be modified to enable integration of IBM's GDDM (Graphical Data Distribution Manager) images with text data on screens presented to end users.

3.1 Graphical Interfaces

Use of innovative graphical interface for supporting forecasting decisions is the key design concept of the CFS. The system can graphically present data in various forms, including bar charts and graphs. The ICS also has a variety of choices in setting the scale and in selecting the data to be presented on screen from a rich database of historical demand. The system also allows the ICS to run four sessions simultaneously among which the ICS can switch easily by using a "hot key" feature. This adds another dimension to the analytical capability in that the ICS can simultaneously analyze multiple aspects of a decision.

All these features have combined to relieve the ICS of routine, computation-intensive, and time-consuming activities. The merchandise knowledge, judgement and skill that a inventory control specialist uses, however, are still the essential pre-requisites to success in forecasting and inventory management decisions.

The flexibility in accessing a vast quantity of data, in visually representing that data to suit individual taste, and the ease of use, are perhaps the most important innovations of the CFS. It also represents a significant improvement over the strictly tabular format used in the earlier system. The maxim that "a picture is worth a thousand words" has been found to be absolutely true. The graphics capability not only makes it easy to uncover the underlying pattern/s in data that may not be so evident when viewed as a table full of numbers, but it also takes only a fraction of time of what it used to take with the earlier system. This has allowed the ICS to spend much more time on conducting a variety of "what if" analyses, evaluating the reasonableness of various estimates, and improving the quality of forecasting decisions being made.

The design logic of the CFS and its innovative use of graphics can be better understood by considering some specific examples. Figure 2 illustrates a preseason model development run for a womens casual dress presented in a 1992 spring/ summer catalog. For clarity, the figure shows only the prior year's demand history and the projected model, although in practice the ICS can summon demand history for up to five previous years. Given the historical demand pattern, the system calculates the most suitable model (an average model in this case) and presents it to the ICS for possible modification and confirmation. In this preseason analysis, the ICS needs to set plan model after factoring in the impact of special holidays. The last year's demand shows a dramatic peak just prior to the easter weekend and hence, the projected model is also expected to have a similar peak. The easter weekend, however, is to take place a couple of weeks later this year and hence, the demand peak will need to be shifted accordingly. Figure 3 presents another example of preseason analysis where the prior year's distribution of a forecasting subdivision that consists of four categories is analyzed and modified to establish the distribution for the current year.

INSERT FIGURES 2 & 3 HERE

Figure 4 illustrates the inseason forecasting of demand for a set. This set forecasting is carried out on every Thursday using the actual demand through the previous demand week ending on Wednesday. First, the system calculates the "plan model" estimate for the set by dividing the cumulative demand for the set by the expected percentage of cumulative sales to date under the plan model already assigned to that set. The system also calculates a high and a low range which represents about 90 percent confidence interval around the plan model estimate. Early in the season, only a small percent of total estimated sales is actually realized and hence, the reliability of the plan model estimate at this time is considered low resulting into a wider confidence interval.

INSERT FIGURE 4 HERE

The system also develops a "balance to go" estimate based on weekly demand and expected weekly percent sales. This estimate naturally tends to be somewhat volatile, but it also gives early indication of unexpected changes influencing the demand. Next, the system calculates a "smoothed" estimate using the exponential smoothing method by giving appropriate weights to the last week's "option" estimate (that is provided by the ICS) and the current week's plan model estimate. The "option" estimate represents the ICS's final forecast decision for the set. The default for the option estimate is the smoothed estimate, but in certain instances the ICS may choose to override this default by creating his own option estimate. In setting the option estimate, the ICS makes reasonableness checks on the trial option estimates. For this purpose, the ICS uses Figure 5 to determine if the future demand pattern needed to reach the trial option estimate is reasonable.

INSERT FIGURE 5 HERE

The system finally uses this option estimate in making the coverage and purchase calculations. As a part of these calculations, the option estimates are adjusted in such a manner so that all set option estimates within a category add up to category estimate created in earlier topdown system analysis.

3.2 Other Salient Features

The other innovative features of the CFS are its use of advanced analytics and more importantly the process re-engineering (Hammer, 1989; Davenport and Short, 1990) that accompanied the introduction of the system:

- o *Use of advanced analytical methodology*: The analytical routines and graphical interfaces that fit naturally into the way inventory control specialists think and analyze are made possible only through the use of powerful analytical methodologies. These include sophisticated forecasting methods such as exponential smoothing, automatic selection of appropriate models, and the complex calculations that the system needs to perform to graphically represent the data. All these analytical tools now allow inventory control specialists to perform in-depth analyses of historical data and extensive "what if" analyses in a very small period of time.

- o *Process re-engineering*: Making a single all-DC forecast instead of individual forecasts for six DCs has dramatically reduced the number of decisions that a inventory control specialist needs to make. In addition, aggregation has reduced the variability of underlying sales data and consequently improved the reliability and quality of the forecast. The ability the make continual updating of demand forecast has strengthened the Quick Response capability since it now allows the company to keep the suppliers abreast of changed demand forecast.

Another important instance of changed business practice is the change in the forecast week. Previously the forecast week ended on Thursday with the forecast data being available to the ICS for analysis and action on the next Monday. This resulted in purchasing actions being taken only on the weekend following that Monday. In the new system, the decision was made to change the forecast week so that it ended on a Wednesday. Now the ICS has the data available by Thursday morning. With the advanced graphics, what-if, and analytical capabilities made available by the CFS, the ICS can make the necessary decisions by Friday noon allowing the purchasing actions be taken on the weekend. Thus, effectively, one week has been saved in being able to respond to demand changes.

3.3 Development and Implementation Experience

Partnership of users and system professionals in system development is the most significant element that has led to the success of the system. During the entire system development period and pilot testing, the user department representatives worked very closely with the systems professionals. It is only through this partnership that a system has evolved that provides the best possible support to the inventory control specialists. Several elements of this partnership deserve special mention:

- *User's Involvement and Ownership*: In developing any system, it is necessary that the actual users who know and understand the true needs are involved throughout the development life cycle. It is also important to ensure that the users takes pride in and ownership of the system, and not see the system as something that has been foisted on them by the senior management or the information system staff. This is critical for implementation success of any system.

- o *Involvement of Seasoned Systems Veterans*: The project team should contain one or more systems staff who really understand the needs of users, who have gone through several generations of similar systems, and who can choose the right technical solutions.

- o *Management Commitment*: Although the importance of this factor is well known, it is surprising to see how many systems projects get started which lack the real commitment by senior management. This required management commitment takes many forms: the willingness to fund the project and the necessary technological infrastructure, and the patience to wait till the right system is developed.

A significant pre-planned activity in implementing the system was the training of users. However good a system may be, its ultimate impact is dictated by whether or not the users can and do use of the system in an effective manner in performing their jobs. Hence, training is very important. As our experience indicates this training is ideally provided by the user department itself. This way the system's use can be explained in the language and the context that the users can easily understand and appreciate. This training was especially important for the CFS since it involved a change from a tabular format to a graphical format of data representation. This change is undoubtedly beneficial but it also necessitated a dramatic change in the way ICSs were accustomed to in thinking about and analyzing the data. Some ICSs were faster that others in adapting to new system but after a year of training, all have started to effectively use the CFS. During the past year a total of 86 hours of training was provided to each ICS, 23 hours using computer based training[3] and 63 hours of

---

[3] This training program has also received an award as the best computer based training program.

classroom training. This training program has continued with about 1 to 2 hours of training being provided per week.

It is interesting to note that our experience in successfully developing and implementing the CFS matches very closely with the conclusions of the meta-analysis of DSS implementations reported by Alavi and Joachimsthaler (1992). As in their analysis, we find that the users' strong involvement in the design and development of a system, the management's full commitment, and an extensive user training are critically important for the success of a decision support system.

4.0 Strategic Impact

The Catalog Forecasting System has had a significant strategic impact on the catalog business operations. Though a systematic bench-marking study for measurement of benefits is still under way, initial analysis indicates that the systems has already paid for itself several times over in just one year of use. The main benefits of the system include:

- o *Continuous Improvement in Decision Making*: As evidenced by the financial gains discussed below, the graphical interfaces and analytical capabilities of CFS have led to significant improvement in forecasting and inventory management decisions. An unexpected bonus has been the role of CFS as a learning tool that enriches an inventory control specialist's understanding of the selling patterns. This has opened an opportunity for continuous improvement in decision making.

- o *Increased Productivity*: The tools available to the ICS have improved substantially. Instead of working with paper and pencil on single lot forecasting, the CFS can work on a "set" of lots using the advanced graphics and what-if capability provided by the system. By one estimate, the analysis that previously took about one-and-half day takes only about half a day. Another reason for increased productivity is due to all-DC forecasting. For example, consider a shirt available in two sizes and seven colors at six Dcs. Historically, the forecasting of this item involved 84 estimates and model decisions. In contrast, the current system requires only one estimate and model decision, with the corresponding improvement in productivity. The actual improvement in productivity, however, is not directly visible since now the ICS has more time to do better and more comprehensive analysis. Thus, the ultimate result is a moderate shortening of the time it takes for the ICS to arrive at a forecast accompanied by improved forecast accuracy. As per a preliminary estimate, the introduction of the CFS has led to a net productivity gain of about 15% to 20%.

- *Aid to Quick Response capabilities*: The capabilities to make continual adjustment to demand forecasts and the reduced cycle time for analysis and decision making in forecasting and inventory management are important contributions to the Quick Response strategy. Specific examples are the ability to respond one week sooner to the demand trends and the ability to continually inform suppliers of any changes in the total estimated demand for each SKU.

- *Impressive financial returns*: The most visible financial gain has been the tens of millions of dollars of reduction in omissions (i.e., lost sales due to out-of-stock conditions). Thus, during the year since the system was introduced, the system has paid for itself several times over. There are two other important gains: (1) dramatic reduction in the use of paper - about 4.2 million pages per year of computer printout has been eliminated, and (2) significant reduction in inventory carrying costs - frequent review of on-hand inventory has allowed smaller levels of safety stock and overall inventory.

The Catalog Forecasting System and the associated systems described in this paper illustrate perhaps the most advanced and state-of-the-art approaches being used in the retailing industry. The efforts to improve this portfolio of systems, however, continue as the opportunities to introduce analytical approaches to inventory management (Nahmias and Smith, 1991) and advances in information technology, such as expert systems, become more real.

Bibliography

Alavi, M. and E. Joachimsthaler, "Revisiting DSS Implementation Research: A Meta-Analysis of the Literature and Suggestions for Researchers," MIS Quarterly (16:1), March 1992, pp. 95-116.

Bidgoli, H., Decision Support Systems: Principles and Practice, West Publishing, St. Paul, Minnesota, 1989.

Davenport, T. H. and J. E. Short, "The New Industrial Engineering: Information Technology and Business Process Redesign," Sloan Management Review, Summer 1990, pp. 11-27

Fox, B., "Penney Wins Top RITA: Judges Impressed by Forecast Systems' Ease of Use and Graphics," Chain Store Age Executive, September 1991.

Hammer, M., "Re-engineering Work: Don't Automate, Obliterate," Harvard Business Review, July-August 1990, pp. 104-112.

Hammond, J. A. and M. A. Kelly, "Quick Response in the Apparel Industry," Harvard Business School Publication #9-690-038, Boston, Massachusetts, 1991.

Keen, P. G. W. and M. S. S. Scott Morton, Decision Support Systems: An Organizational Perspective, Addison Wesley Publishing Co. Reading, Massachusetts, 1978.

Makridakis, S. and S.C. Wheelwright, Forecasting Methods for Management, J. Wiley & Sons, New York, NY, 1990.

Nahmias, S. and S. A. Smith, "Mathematical Models of Retailer Inventory Systems: A Review," Unpublished Manuscript # 91-014, Santa Clara University, Santa Clara, California, September 1991.

Nuttle, H., R. King and N. Hunter, "A Stochastic Model of the Apparel Retailing Process," Unpublished NCSU-IE Technical Report #90-11, North Carolina State University, Raleigh, North Carolina, 1990.

Figure 1

Forecasting Hierarchy

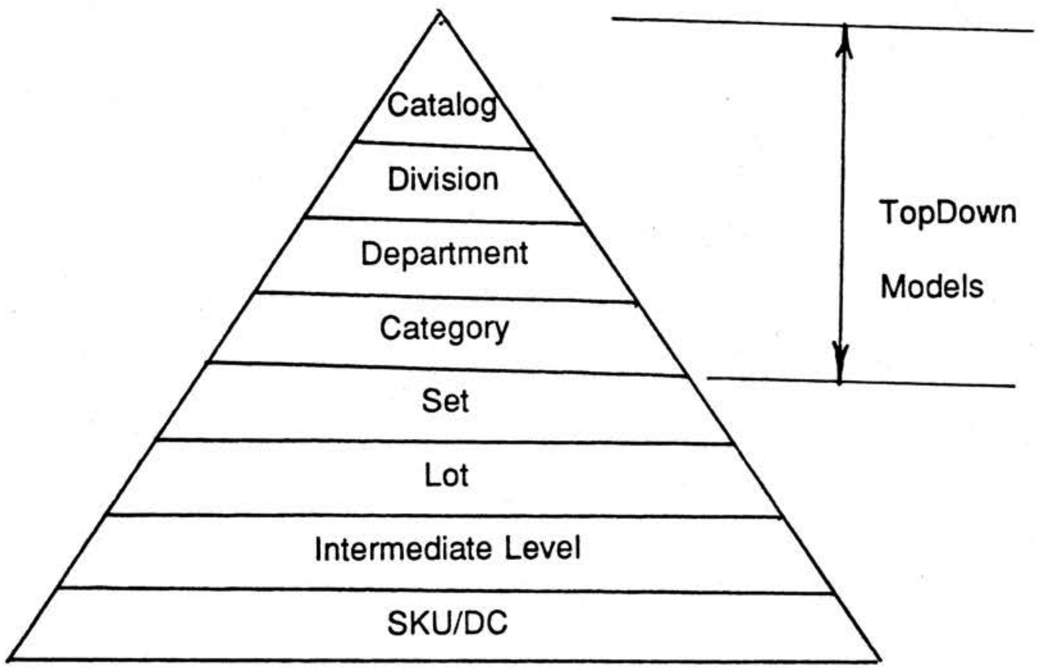
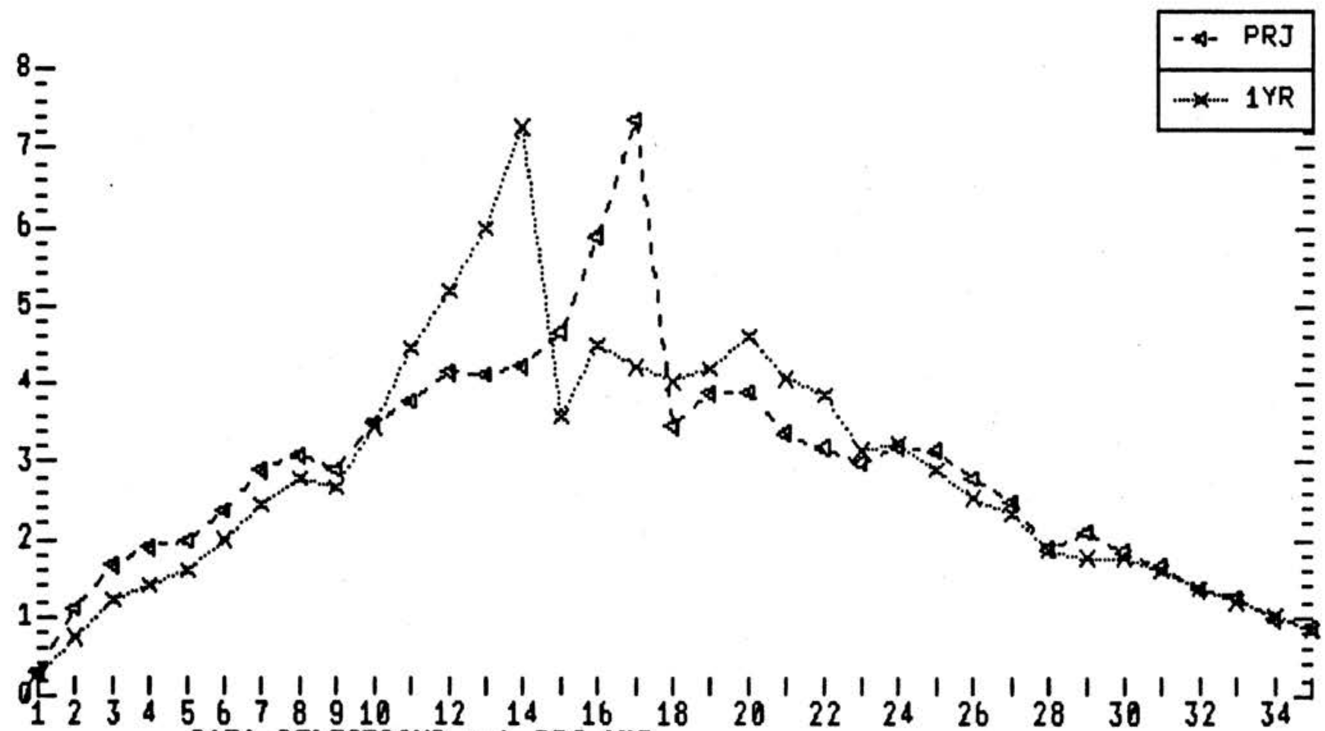


Figure 2

Preseason Model Run

```
CHSSIN0D                     MODEL
SCREEN MEDIA DC   FDIV FDPT FSUB FCAT   MDL
 MDL    A 92  COM  4    22   222   22
```




```
DATA SELECTIONS ==> PRJ,1YR
SELECT TRD MODEL ==>
UNIT% % ADJUST GROUP MDLS Y
```

B - SESSION1

Figure 3

Distribution of a Subdivision into Four Categories

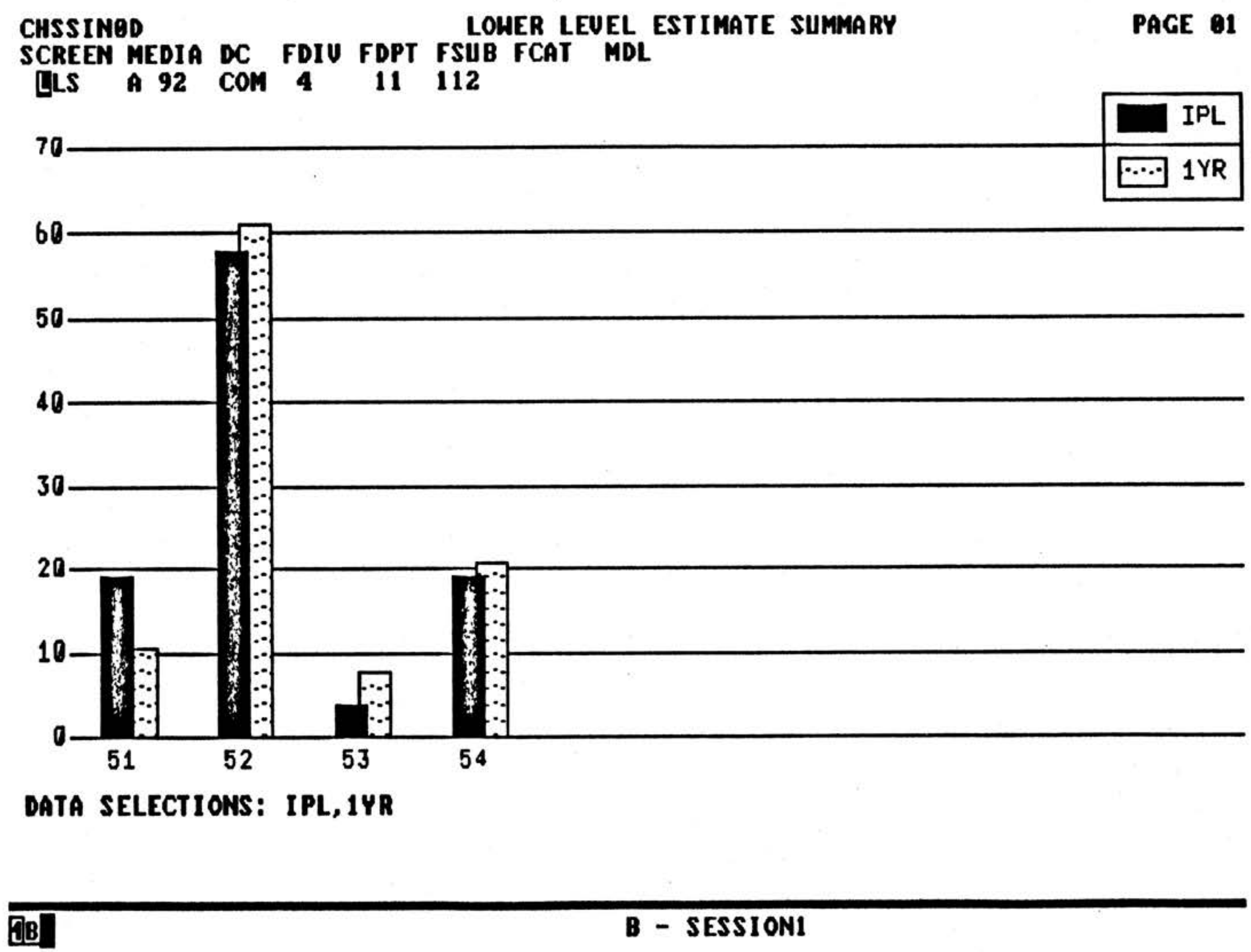


Figure 4

Inseason Set Forecasting

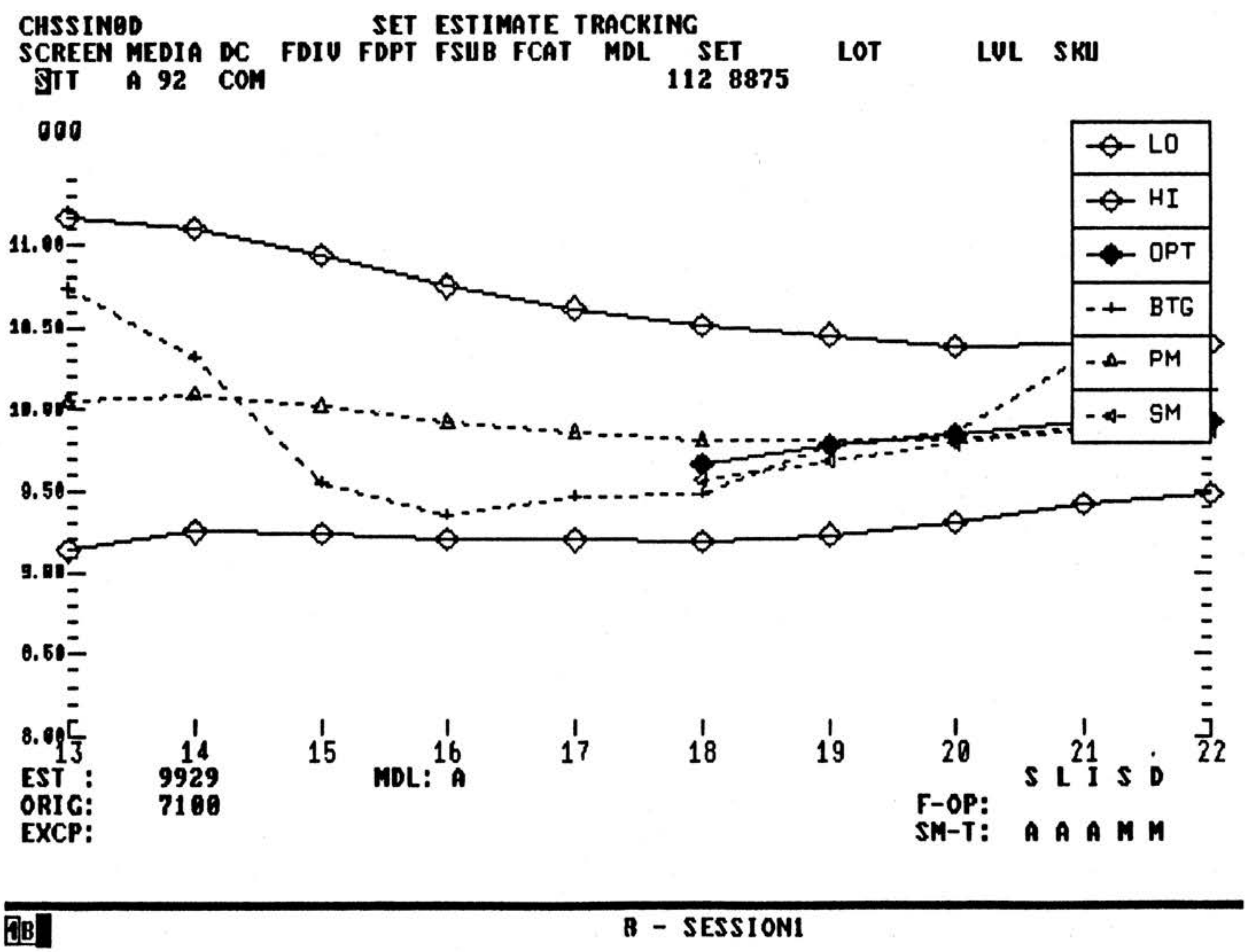
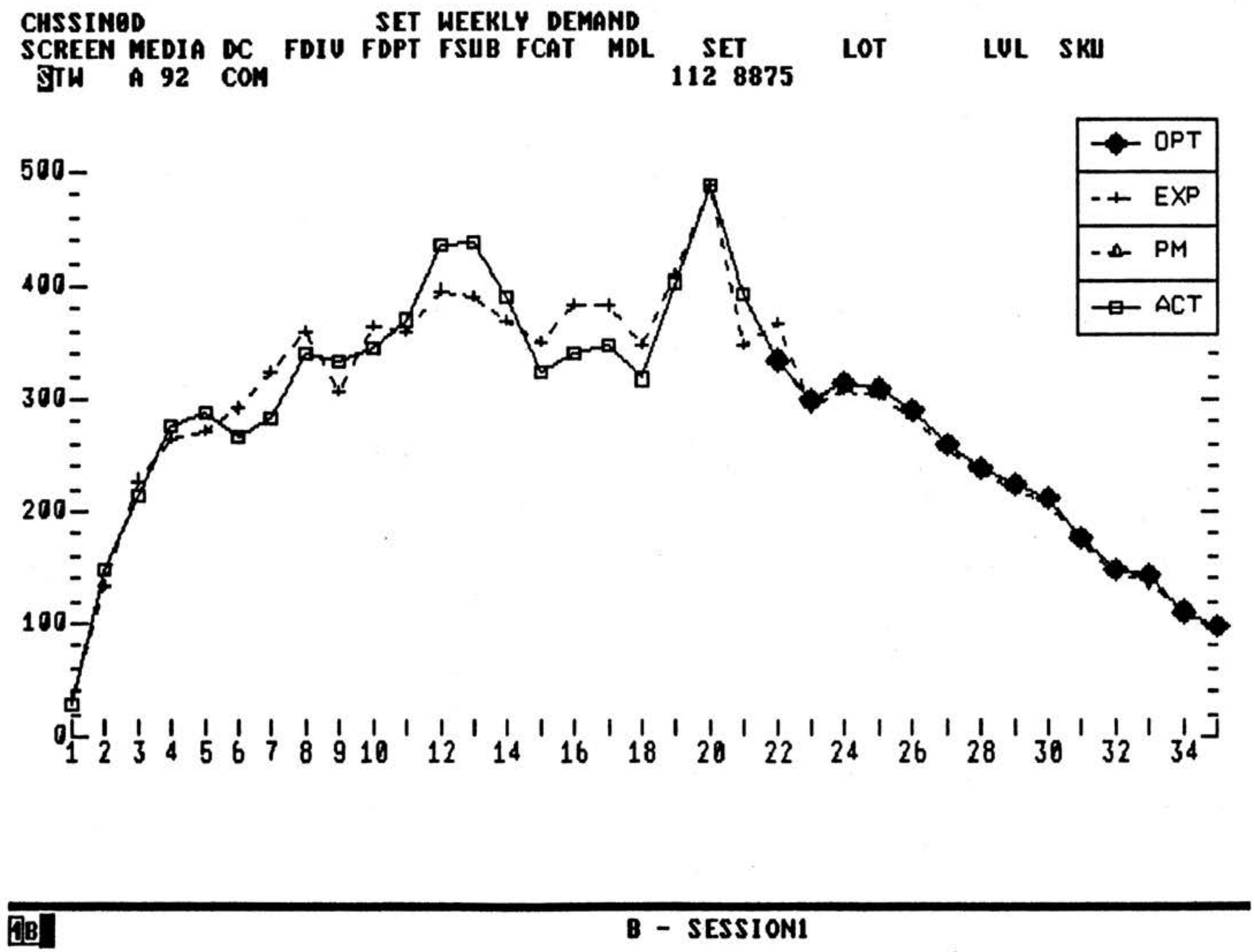


Figure 5

Inseason Set Forecasting: Reasonableness Check



Note: The following is a partial list of papers that are currently available in the Edwin L. Cox School of Business Working Paper Series. When requesting a paper, please include the Working Paper number as well as the title and author(s), and enclose payment of $2.50 per copy made payable to SMU. A complete list is available upon request from:

Business Information Center
Edwin L. Cox School of Business
Southern Methodist University
Dallas, Texas 75275

90-011 "Organizational Subcultures in a Soft Bureaucracy: Resistance Behind the Myth and Facade of an Official Culture," by John M. Jermier, John W. Slocum, Jr., Louis W. Fry, and Jeannie Gaines

90-021 "Global Strategy and Reward Systems: The Key Roles of Management Development and Corporate Culture," by David Lei, John W. Slocum, Jr., and Robert W. Slater

90-071 "Multiple Niche Competition - The Strategic Use of CIM Technology," by David Lei and Joel D. Goldhar

90-101 "Global Strategic Alliances," by David Lei and John W. Slocum, Jr.

90-102 "A Theoretical Model of Household Coupon Usage Behavior And Empirical Test," by Ambuj Jain and Arun K. Jain

90-103 "Household's Coupon Usage Behavior: Influence of In-Store Search," by Arun K. Jain and Ambuj Jain

90-121 "Organization Designs for Global Strategic Alliances," by John W. Slocum, Jr. and David Lei

91-011 "Option-like Properties of Organizational Claims: Tracing the Process of Multinational Exploration," by Dileep Hurry

91-071 "A Review of the Use and Effects of Comparative Advertising," by Thomas E. Barry

91-091 "Global Expansion and the Acquisition Option: The Process of Japanese Takeover Strategy in the United States," by Dileep Hurry

91-092 "Designing Global Strategic Alliances: Integration of Cultural and Economic Factors," by John W. Slocum, Jr. and David Lei

91-101 "The Components of the Change in Reserve Value: New Evidence on SFAS No. 69," by Mimi L. Alciatore

91-102 "Asset Returns, Volatility and the Output Side," by G. Sharathchandra

91-121 "Pursuing Product Modifications and New Products: The Role of Organizational Control Mechanisms in Implementing Innovational Strategies in the Pharmaceutical Industry," by Laura B. Cardinal

92-101 "Management Practices in Learning Organizations," by Michael McGill, John W. Slocum, Jr., and David Lei

92-031 "The Determinants of LBO Activity: Free Cash Flow Vs. Financial Distress Costs," by Tim Opler

92-032 "A Model of Supplier Responses to Just-In-Time Delivery Requirements," by John R. Grout and David P. Christy

92-033 "An Inventory Model of Incentives for On-Time Delivery in Just-In-Time Purchasing Contracts," by John R. Grout and David P. Christy

92-034 "The Effect of Early Resolution of Uncertainty on Asset Prices: A Dichotomy into Market and Non-Market Information," by G. Sharathchandra and Rex Thompson

92-035 "Conditional Tests of a Signalling Hypothesis: The Case of Fixed Versus Adjustable Rate Debt," by Jose Guedes and Rex Thompson

92-036 "Tax-Loss-Selling and Closed-End Stock Funds," by John W. Peavy III

92-041 "Hostile Takeovers and Intangible Resources: An Empirical Investigation," by Tim C. Opler

92-042 "Morality and Models," by Richard O. Mason

92-051 "Global Outsourcing of Information Processing Services," by Uday M. Apte and Richard O. Mason

92-052 "Improving Claims Operations: A Model-Based Approach," by Uday M. Apte, Richard A. Cavaliere, and G. G. Hegde

92-053 "Corporate Restructuring and The Consolidation of U.S. Industry," by Julia Liebeskind, Timothy C. Opler, and Donald E. Hatfield