Merchandise assortment planning:

Analysis through computer simulation

by

Dana Michelle Rupe

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INTRODUCTION

Quick Response (QR) is part of a recent initiative by U.S. apparel and textile industries to fight competition from foreign imports while battling the domestic challenges of running a leaner, more productive operation (Davis, 1989; Hunter, 1990; Simmons, 1989). QR has been recognized as a key to survival for domestic apparel industries (King & Poindexter, 1991). It has been defined as a business strategy based on consumer demand that drives the ordering and production of merchandise (Glock & Kunz, 1990). The strategy begins when a customer purchases a product. This purchase triggers the production of a replacement product. The manufacturing time of the product is condensed to the most efficient levels so the product arrives on the retail shelf only days after the order was triggered by the customers' purchase. This shortening of the pipeline between a consumer's purchase and the supply of raw materials requires being responsive to consumer demands and communicating among all levels of the supply chain (Kincade & Cassill, 1993; Knill, 1990).

The introduction of a QR system can result in many benefits for an apparel business. Among those most significant are increased inventory turns, reduced average inventory and improved sales and in-stock position (Hunter, 1990; Rouland, 1991). Other gains include reduced time needed for the creation, tracking, communication and handling of orders (Gilman, 1989). The success of the system and its benefits relies on accurate and timely information at the Stock Keeping Unit (SKU) level (Johnson, 1992; "Quick Response", 1991). This information provides support for effective merchandise planning and inventory management.

To realize such benefits a QR strategy requires many changes in the behavior of an apparel firm. Particularly, the role of merchandisers, those responsible for the planning, developing, and presentation of merchandise, is evolving (Kunz, 1993). Changes include weeks of sale replacing the traditional selling season, more participation in joint product development and style testing, and buying closer to the selling season in smaller initial orders with frequent reorders (Gellers, 1993; Kunz, 1993). One of the most fundamental changes centers around the merchandise planning process. Traditional merchandise planning focuses on dollar planning, a merchandise planning method based on the planned dollar value of stock, in contrast to planning with a QR system which requires planning at the unit level (Clodfelter, 1993). Unit level planning requires consideration of each individual piece of merchandise in the assortment, in contrast to the overall dollar value of a merchandise classification (Bohlinger, 1990).

In addition to the QR movement, many factors at the firm level have been responsible for the consideration of unit level planning: the escalating percentage of markdowns being taken at retail, high levels of stockouts, low gross margins, and increasing price competition (Mantrala & Tandon, 1994). Traditionally, the opening of more stores would be an alternative to trying to deal with these problems. However, in an already saturated market adding more stores may not be a viable option. Therefore, apparel firms are looking for other means of increasing sales (Troyer & Denny, 1992). Improved assortment planning and the use of newly developed technologies provides such options.

Although QR strategies and the development of new technology supply merchandisers with a great deal of information and allow decisions to be made closer to the point of sale, the success of the selling season is often primarily dependent on the assortment plan for the initial merchandise offering. The assortment planning function remains the responsibility of the merchandiser. In light of the importance of these decisions, merchandisers have few guidelines to help them determine the nature of successful assortments. The only research study to date on the subject of assortments concluded that the more "acceptable items the assortment offers and the fewer unacceptable items, the better the assortment" (Kahn & Lehman, 1991, p. 297). This study however, provides no specific or quantifiable indications of how to arrive at an assortment that is comprised of more acceptable items. There exists no guidelines for determining the appropriate mix of assortment factors or dimensions. One possible reason for this lack of guidance is the confusing and incongruous language used in the assortment planning process.

The most common and traditionally used definitions of assortment dimensions, breadth and depth (Brown & Davidson, 1953; Davidson & Doody, 1966; Gillespie & Hecht, 1970), are inconsistent and provide no quantitative meaning to merchandisers for planning profitable assortments. For example the following definitions of breadth have been used in merchandising literature: "characteristic of an individual assortment offering a large number of different categories" (Bohlinger, 1977, p. 369), "description of the different categories available in a store" (Jernigan & Easterling, 1990, p. 548), "the number of product lines carried" (Clodfelter, 1993, p.361), "the number of merchandise brands found in the line" (Dunne, Lusch, Gable, & Gerhardt, 1992, p. 475), and "the number of styles or colors within an assortment" (Cash, 1979, p. 541). Each of these definitions offers a slightly different meaning, while none provide any quantitative measurement of breadth.

Similar discrepancies exist for defining depth: "characteristic of an inventory assortment offering limited versions of proved styles" (Bohlinger, 1977, p. 368), "description of quantity of each item available in the assortment" (Jernigan & Easterling, 1990, p. 548), "number of units of each element in range of choices of a selection parameter" (Risch, 1991, p. 469), "number of choices offered within each brand" (Clodfelter, 1993, p. 362), and "average number of SKU's within each brand" (Dunne et al., 1992, p. 476). These preceding definitions demonstrate the incongruous uses of the assortment dimension words of breadth and depth, indicating the lack of guidance available to merchandisers in the assortment planning process.

Purpose

Because the effects of QR business systems can only be optimized if merchandisers are planning assortments effectively, the purpose of this study is to conduct controlled experiments to examine the effects of merchandise assortments of different dimensions on financial outcomes. Because no quantitative definitions of assortments exist, this exploratory study seeks to identify a functional relationship between assortments and financial performance related to the merchandising behaviors of the firm.

To date, this subject has been little explored since no method of analysis existed to control the many extraneous variables involved in studying the financial outcomes of assortments. Previous studies would have required the collection of sales information from past selling seasons in order to examine the financial productivity of assortments. This method however is not practical or feasible as industry data of past selling seasons would provide no control over variables such as pricing or delivery strategy, effectiveness of the retail presentation, and customer shopping behavior.

Recently, the Apparel Retail Model (ARM) was developed to assess the benefits of QR business systems. Included in ARM's capabilities is the capacity to perform rapid cost/benefit analysis of specific assortment situations (Nuttle, King, & Hunter, 1991). ARM is a computer simulation of the merchandising process that will allow the development of an assortment strategy, a pricing strategy, and a delivery strategy. The computer simulates customer demand and provides a financial analysis of the success of the chosen strategies. Measurements used to assess the success of the strategies include gross margin, adjusted gross margin, gross margin return on investment, lost sales, average inventory, and service level.

Based on the data analysis of assortments provided by ARM, relevant definitions of assortment dimensions can be developed. Results of this study will provide valuable insight about the relationship between merchandise assortment planning and the financial success of the firm. This will aid in planning appropriate assortments to effectively drive a QR business system.

LITERATURE REVIEW

Quick Response

The textiles and apparel industry operates in a constantly changing business environment. Factors contributing to the recent complexity of the industry include low wage rates in developing countries, the trade deficit, the Multi-Fiber Arrangement (MFA), currency fluctuations, the surge of leveraged buyouts and consolidations, and increasing global contention (Anderson consulting, 1994; Hunter, 1990). Additionally, retail markets are saturated with stores and merchandise, distribution channels are clogged with inventory, and customers are growing more demanding (Johnson, 1992). Stiffening global competition is forcing firms to compress lead and cycle times as a condition of competitive survival (Mooney & Hessel, 1990). In an attempt to combat and manage these factors Quick Response (QR) business systems are being developed and implemented.

The QR movement has transformed the way apparel is conceived, produced, brought to market, and sold. QR has been defined in a variety ways. Often it is defined by what it can accomplish, for example lower carrying costs, higher gross margins, etc. These accomplishments do not represent what QR is, but instead the "ends" are discussed. QR is also associated with the sophisticated technology that facilitates the process. However, this technology is the "means", not the definition of QR. For the purposes of this research, QR will be defined operationally as a business strategy, a new way of thinking about taking raw materials through production of finished goods to arrive at the retail shelf for consumption. The new strategy requires the establishment of different business practices, relationships, and procedures to speed the flow of information and merchandise (Anderson consulting, 1994). In a QR system, merchandise is "pulled" through the system in response to consumer wants. This is in contrast to traditionally "pushing" goods on consumers (Kurt Salmon Associates, 1994).

Working to implement the above strategies has dramatically changed the ways in which companies do business (Gillease, 1988). Kincade and Cassill (1993) identify three main concepts of QR implementation: a) responsiveness to consumers' demands, b) communication between suppliers and customers, and c) reduction of time between receipt of orders and final production (compressing cycle times).

Being responsive to consumer demands requires knowing what is selling over the retail counter today. This Point of Sale (POS) information is available through the use of Universal Product Codes (UPC) and retail scanning (Lovejoy, 1989). A UPC is a 12-digit code representing a unique product item (Anderson consulting, 1994; "Glossary of terms", 1994). It is a standard for "identifying merchandise to the lowest level of detail necessary for tracking and ordering merchandise" (Anderson consulting, 1994, p. 5). This code is electronically scanned, through optical reading of the barcode, at the retail counter when a consumer makes a purchase, providing up to the minute (real-time) sales information. The data can then be used for analyzing business and making future decisions on reorders and new product introduction, as well as forecasting and inventory management. Other benefits include increased speed and accuracy at checkout since manual entry of the information is eliminated.

The real-time sales data captured at POS, in addition to other information, can be transmitted electronically and shared throughout the apparel supply chain via Electronic Data Interchange (EDI). EDI is the computer-to-computer exchange of business documents, such as sales information, purchase orders or invoices, in a standard format (Kerch, 1994). Information is moved electronically in a structured retrievable format that allows the data to be transmitted, without rekeying, from one business or location to another. EDI's benefits include reduced order lead times, higher customer service, better accuracy, increased information availability, and timely information receipt (Hansen & Hill, 1989).

Once an organization has the information to be responsive to consumer demands and the necessary technology links with its' trading partners the compression of cycle time in the production process can begin. QR production takes advantage of several new technologies. Beginning with the design process, the use of computer-aided design (CAD) systems allows retailer and vendor to quickly and inexpensively alter designs prior to production and engage in joint product development (Bernard, 1987). QR manufacturing is modeled after the Just-In-Time (JIT) concept (Knill, 1990). JIT is "a business philosophy that focuses on removing waste from all the organizations' internal activities and from external exchange activities" (O'Neal & Bertrand, 1991). It requires organizing an operation to give timely response, deliver first quality, and get the order right the first time and on time (Tincher, 1989). Technologies inherent to this goal include computer integrated manufacturing (CIM) and flexible manufacturing in small lots (Becker, Knill, Rohan, & Weimer, 1990; Weston, 1990). After production trims cycle times, distribution is the next area of emphasis. Distribution, like retail sales, takes advantage of scanning, UPC, and EDI technologies.

The communication of financial information among apparel firms requires a new way of relating to trading partners. It has been termed strategic partnering. Partnership tactics include joint, up-front planning among raw materials suppliers, manufacturers, and retailers; timely sharing of sales and inventory information; optimizing logistics to ensure faster processing and transit time; and reducing total inventory by ordering more frequently (Rouland, 1991). The goal of partnerships (as is the overall goal of QR) is to optimize the entire supply chain, producing a win-win situation by cooperatively working together (Brousell, 1992; Johnson, 1991). Organizations must extend their narrow view of only buying and selling to a multifaceted view of the entire chain. It is crucial to understand all components involved in producing and moving materials and goods to the end consumer.

Not only are organizations required to rethink external relationships, but internal functions must also be reevaluated in a QR environment. Because QR requires several areas of the apparel firm to function as a whole - sharing, analyzing, and reacting to real time sales data - traditional functional barriers must be removed so that distributors, merchandisers, operations, executives, and stores work together toward a unified purpose ("It's all in", 1990). Many times this is accomplished through the use of multifunctional teams (Henricks, 1993; Moss, 1994).

One area of the firm seeing a great deal of change is the role of the merchandiser. The primary mission of merchandisers remains unchanged: they must still understand customer demands, analyze sales trends, and sell products. They continue to play an important role in the exchange process by providing products for consumer consumption (Anthony & Jolly, 1991). However, due to the competitive pressures previously outlined and the changes required under a QR system, this role is changing. As firms are looking to shave costs and improve profitibility in all facets of the organization, merchandise assortment planning is being targeted as an area of potential improvement. Merchandisers are becoming more accountable for managing bottom-line profitability, in contrast to the traditional measure of gross margin. This means being responsible for inventory turns, carrying costs, in-stock position, and distribution expenses. Therefore, ensuring an in-stock position for the consumer while reducing inventory is key, as is tailoring merchandise assortments to meet local demand (Troyer & Denny, 1992). To achieve these goals merchandisers are using the wealth of information available from technological innovations, such as UPC's, scanning, and EDI, to make decisions more accurately and timely. Such support systems allow merchandisers to react more quickly based on definite information, rather than relying on sales representatives, trade journals, fashion magazines, or instinct

(Shim & Kotsiopulos, 1991).

Fully implemented, a QR system can trigger a series of benefits. First and foremost is the increased sales due to an increased retail in-stock position. Simply stated this means having the product on the shelf when the customer wants it. These increased sales can be realized with lower inventory levels, that reduce carrying costs (Bravman, 1993). Due to fewer slow selling items, less markdowns and returns are needed. Therefore, more merchandise is sold at first price resulting in higher financial outcomes. Additional advantages include the accuracy of information, time savings due to less data entry, and increased distribution efficiency (Gilman, 1989). These benefits can be recognized throughout the supply chain creating a win-win situation for all partners involved.

Theory of the Firm

A theory of the firm acts as a conceptual framework to guide research development (Anderson, 1982). It expresses a set of general concepts and the critical relations among them (Cyert & March, 1963). Literature cites two types of theories of the firm, economic and behavioral (Anderson, 1982; Cyert, 1988; Kunz, 1994). Economic theories of the firm assume that the firm is operating in a perfectly competitive environment, with perfect information, and has the overriding objective of maximizing net revenue. Limitations of this type of theory include: profit maximization as the only goal; the absence of attention to the organization of the firm and how decisions are reached; and the unreasonable premise that a firm operates with perfect knowledge (Cyert & March, 1963).

In contrast, behavioral theories emphasize the coalitional nature of organizations and the role of human behavior, as opposed to economic elements, in explaining the activities of the firm (Anderson, 1982; Kunz, 1994). The behavioral theory recognizes the large, possibly multi-product firm, operating under uncertainty in an imperfect market (Cyert & March, 1963). Cyert and March (1963) propose three subtheories to use in analyzing the decision making process of the firm: variables that affect organizational goals, variables that affect organizational expectations, and variables that affect organizational choice.

In developing the three above subtheories, four relational concepts evolved as being fundamental to understanding the decision making process of an organization: 1) quasi resolution of conflict, 2) uncertainty avoidance, 3) problemistic search, and 4) organizational learning. Quasi resolution of conflict assumes that members of a coalition have different goals. These goals are a series of independent constraints imposed by the members of the coalition. The organization factors these conflicting goals and problems to subproblems and assigns the subproblems to subunits. This local rationalization of problems results in subunits dealing with a limited set of problems and a limited set of goals. The success of such specialization in decision making depends on whether the decisions of the subunits are consistent with each other and the external environment. The consistency of decisions is determined by acceptable-level decision rules and sequential attention to goals (Cyert & March, 1963).

Organizations avoid uncertainty by evading planning activities of uncertain events and instead focusing on planning where dissonance can be reduced through the use of some control device. One way to do this is, for those internal decisions that do not fall into a sequence (part of the quasi resolution process), to modify them so that they will. Similarly, organizations seek to negotiate their external environment so as to eliminate uncertainty and make it controllable as well (Cyert & March, 1963).

Problemistic search is caused by a specific problem and is focused on finding a solution to that problem. It can be distinguished from other types of searches in that it has a goal and is concentrated on understanding as it directly relates to control. It is assumed that search is motivated by a problem and terminated with the solution, is simple-minded until forced to a more complex model, and is biased in terms of the specialization, expectations, and communication of those solving the problem (Cyert & March, 1963).

Organizations adapt their learning over time using members of the organization as instruments. Adaptation focuses on three areas. First, the adaptation of goals occurs as a function of the organizations' previous goals and experiences and those of other comparable organizations. Second, the adaptation of attention rules determines what parts of the environment to give attention to. Finally, adaptation of search rules takes place as organizations experience success or failure with various search solutions (Cyert & March, 1963).

Building from the above behavioral theory of the firm and others, Kunz (1994) has proposed a behavioral theory specific to the apparel firm. (See Figure 1 for a representation of the Kunz (1994) model of a behavioral theory of the apparel firm.) The Kunz (1994) model is important to textiles and apparel research because it recognizes the change intensive nature of the industry and therefore the importance and diversity of the merchandising function. Additionally, it grounds firm decision making in the satisfaction of consumer wants and needs. The proposed model is based on five constituencies: merchandising, marketing, operations and finance, production, and executive management. The focus of the model is on these five constituencies, how they relate to each other, the firms' goals, and external coalitions. The format of the model includes concepts, constructs, and propositions.

The five constituencies of the firm form the constructs of the model. Four of the constituencies, merchandising, marketing, operations and finance, and production make up the functional divisions of the firm, while the executive constituency acts as the cohesive unit holding the others together. Unique to this model is the importance placed on the merchandising constituency. The merchandising constituency is responsible for the formulation of the product line, the apparel firms' primary source of revenue.

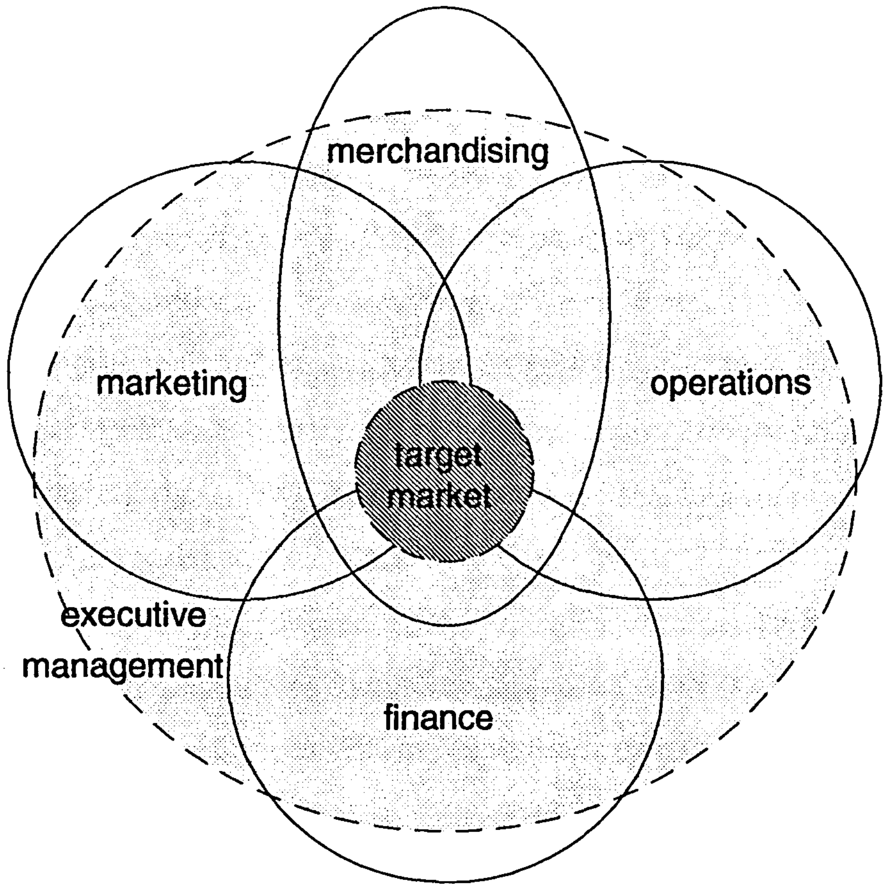

Figure 1. Interaction of the functional areas of specialization within an apparel firm according to the proposed behavioral theory of the apparel firm (Kunz, 1994).

The relationships among the constructs/constituencies and with their external environments form the decision making matrix for the firm. As previously discussed specialization induces each constituency to develop their own goals. However, common goals for the firm are established by the executive constituency which requires the interaction and coordination of all the constituencies. Conflicts stemming from specialization and differentiated goals are resolved through negotiation (Kunz, 1994).

The merchandising constituency negotiates differences in goals and priorities that exist internally in relation to product lines. Additionally, merchandising negotiates externally the acquisition and development of materials and/or finished goods. Anderson (1982) cites the internal constituency that negotiates the vital resource exchange as the most powerful constituency of the firm. Therefore, because the merchandising constituency negotiates the acquisition and/or development of materials and/or finished goods that are the firm's primary source of revenue, it plays a vital role in the firm.

The propositions of this model are derived from the relationships among the constructs defined above. First, the apparel firm is divided into five constituencies. Each constituency has goals and responsibilities that contribute to the firm but are not the same as other constituencies. These differences lead to conflict which is resolved through negotiation. The merchandising constituency negotiates conflicts among constituencies acting as an integrative function. Finally, a constituency's power is connected to the value of it's negotiations (Kunz, 1994).

In summary, behavioral theories of the firm propose that decision making in a firm is determined by the behavioral relationships among constituencies. This is in contrast to economic theories that postulate profit maximization as the primary goal pursued (Anderson, 1982). More specifically the behavioral theory of the apparel firm (Kunz, 1994) recognizes the importance of the product and the merchandising function in satisfying consumer wants and needs and therefore meeting overall goals of the firm. The Kunz (1994) model provides a framework for understanding how the merchandising function contributes to the larger organization.

Merchandise Assortment Planning

"Profit is not an accidental phenomenon" (Risch, 1987, p. 117). Profit essentially is the product of planned actions toward a definable and measurable goal. For the apparel firm the planned action is the merchandising plan with the measurable goal generally referring to financial productivity.

Merchandise assortment planning occurs at many different times and for various purposes in the apparel business. It occurs at the manufacturer during line planning and development. During this phase the designer, possibly in conjunction with a merchandiser, plans a group of coordinating styles to reflect a theme. Meanwhile, retailers are also engaging in their own line planning process. In organizing the line several factors are considered such as customer likes and dislikes, pricing issues, and offering a range of styles, colors, and sizes. This range or selection is referred to as the assortment (Tate, 1984).

After the designer has developed a line offering, it becomes the responsibility of the sales representative to communicate the line concept to potential retail buyers. Some large companies employ their own personal sales staff, while smaller organizations use independent sales representatives (Frings, 1982). Independent representatives may carry one or more different lines. As most sales representatives are paid on commissions, they must set their sales goals which requires planning merchandise assortments to be sold. Additionally, sales representatives often play a key role in planning assortments at the retail level. Research shows that when retail merchandisers are faced with uncertainty, they most often turn to sales representatives for aid in planning (Shim & Kotsiopulos, 1991).

As sales representatives report orders for merchandise, the manufacturer begins to plan production of the merchandise. As fabric can account for 50% of the total production cost, manufacturers are obviously concerned with maximizing materials utilization (Walfish, 1990). Therefore, when planning the arrangement of garment pieces to be cut the main priority is minimizing materials waste. Often the most optimum cutting plan does not exactly match the original merchandise assortment plan. But in the interest of materials utilization, the optimum plan is put into production. This then becomes the available merchandise to be shipped to the retail customers. In this manner the cut order plan often directly affects the retail assortment.

At both the retail and manufacturing levels merchandise planning requires both dollar planning in terms of budgets and unit planning in terms of specific pieces of merchandise (Bohlinger, 1990). The dollar plan translates financial goals into dollar realities, more specifically it is "designed to regulate inventories in accordance with preestablished financial objectives" (Risch, 1987). The dollar plan is often referred to as a six-month plan since traditionally merchandising plans usually spanned a time period of six months. The dollar plan determines how much money will be spent for inventory for a particular merchandise category. The dollar plan serves three purposes: 1) to provide an estimate of the capital required for a periodic inventory, 2) to give a reliable basis for the estimation of cash flow, and 3) to serve as a financial control instrument or measurement (Risch, 1987).

In the retail setting, dollar plans are prepared by classification and then assembled into departmental plans, with the store plan being the accumulation of the departmental plans. Included in the dollar plan format are the planned sales for the period, planned markdowns, planned purchases of goods, and level of inventory needed to achieve the desired level of sales (Jernigan & Easterling, 1990).

All dollar planning concepts must be translated into unit assortments (Risch, 1991). Basic stock or model stock plans are used to convert dollars into units. Basic stock plans, often referred to as basic stock lists, are composed of items that have consistent enough demand to warrant an in-stock position at all times (Jernigan & Easterling, 1990). These items have highly predictable sales with stable customer demand. To determine basic stock plans buyers generally consider the past sales history and trends of the merchandise classification (Clodfelter, 1993; Risch, 1991). The goal of basic stock plans is to provide a continuous supply of merchandise, but with a minimum of inventory. Today these plans are often computerized with automatic reorder functions.

The model stock plan is another method of preparing retail merchandise assortments. Model stocks are generally developed in reference to fashion items or those items that have a more dynamic sales nature and shorter selling season. The plan is broken down by predictable factors, such as price, color, size, or merchandise classification based on consumer demand (Bohlinger, 1990). Model stock plans address both the variety of merchandise to offer (how many unique pieces) and the volume of units to allocate across the plan. They differ from basic stock plans in that they are prepared and evaluated more frequently throughout the season.

The overall goals of both assortment planning methods are to: 1) provide the merchandise that satisfies customer demands, 2) time merchandise deliveries in line with customer demands, and 3) to plan purchases with some cash flow remaining to enable the merchandiser the flexibility to react to trends (Jernigan & Easterling, 1990). To achieve these goals assortment plans commonly have, but are not limited to the following concepts: the division of larger merchandise categories into subcategories or classes; the division of merchandise by assortment factors, such as style, color, and size; the number of units allocated to each assortment factor; the retail value of the stock, and a specific time frame (Risch, 1991). Given the importance and prevalence of planning assortments on the financial productivity of the firm throughout the apparel pipeline, there are few guidelines to help facilitate the assortment planning process. Therefore, investigation of assortment planning in order to provide merchandisers with insight concerning the process is needed.

Research Objectives

1. To examine the dimensions of assortments in relation to financial productivity and other measures provided in the Apparel Retail Model (ARM) simulation analysis.
2. To develop definitions of the dimensions of assortment based on financial productivity

and other measures, such as service level and inventory turn, provided in the ARM simulation analysis.

3. To test definitions of assortment on real data as merchandise might be presented at the small business, single specialty store or single department of a department store level.
4. To propose hypotheses about the relationship between assortments and financial performance of the apparel firm.
5. To contribute to the development of the behavioral theory of the apparel firm (Kunz, 1994).

METHODS

A Simulation Model for Apparel Merchandising

Although adoption of QR strategies has demonstrated significant improvements in the financial performance of apparel firms, the rate of adoption of QR has been slow. A contributing factor to this delay in adoption is the cost of carrying out full scale trials (Hunter, King & Nuttle, 1991). One way to economically evaluate new plans and strategies, such as QR, is through the use of computer simulation (Levy, 1990). The Apparel Retail Model (ARM) was developed to provide a financial analysis of QR strategies based on the simulation of a selling season. One of ARM's primary goals is to "quantify the potential benefits of QR supply systems for seasonal and fashion merchandise" (King & Poindexter, 1991, p. 2). The model explores the impact of assortments, ordering, reordering, pricing, and delivery on such financial measures as gross margin, gross margin return on investment (GMROI), inventory turns, and service level. The following is a description of how the model works.

ARM tracks a prescribed assortment of merchandise, at the SKU level, throughout a selling season. The simulation consists of two-menu driven programs, CHANGE and ARM, and a set of database files. Beginning with the CHANGE program, the user defines the simulation scenario to be evaluated. This is done by entering a series of inputs. See Table 1 for a list and description of the inputs. Any, all, or none of the input categories can be changed. If the user does not enter information for an input category the system uses the default setting for the simulations.

The model generates customer shopping behavior through a random flow of customers according to a nonstationary Poisson process (Kurt Salmon Associates, 1989). The arrival rate of the customers varies from week to week to reflect seasonality. Figure 2 shows the Customer Shopping Behavior Branching Diagram. When a customer arrives

Table 1. CHANGE program inputs.

CHANGE inputs
• the number of weeks of the simulated selling season
• the number of customers expected during the selling season
• the planned number of units to sell during the season
• the wholesale, retail, and joboff prices for the merchandise
• the inventory carrying cost, and the distribution expense specified as an annual % specified as a % of the wholesale cost
• the probabilities that customers will take different paths in the branching diagram
• the consumer demand profile for each style, color, and size,
• the buyer plan - the percent of total units allocated to each style, color, and size
• the customer arrival rate curve - what percentage of the total customers will arrive per week of the selling season
• the effect of markdown on customer response to stockouts - prior to each markdown the percentage of customers that alter their choice after a stockout or choose to leave can be changed
• the price elasticity of demand.

he/she either browses or has a specific product in mind. If the customer has a specific item in mind, he/she is randomly assigned a size, color, and style from the probability distributions which describe the preferences of the customer. The product is purchased if the preferred SKU is in stock. If the SKU is not in stock the customer either leaves or may

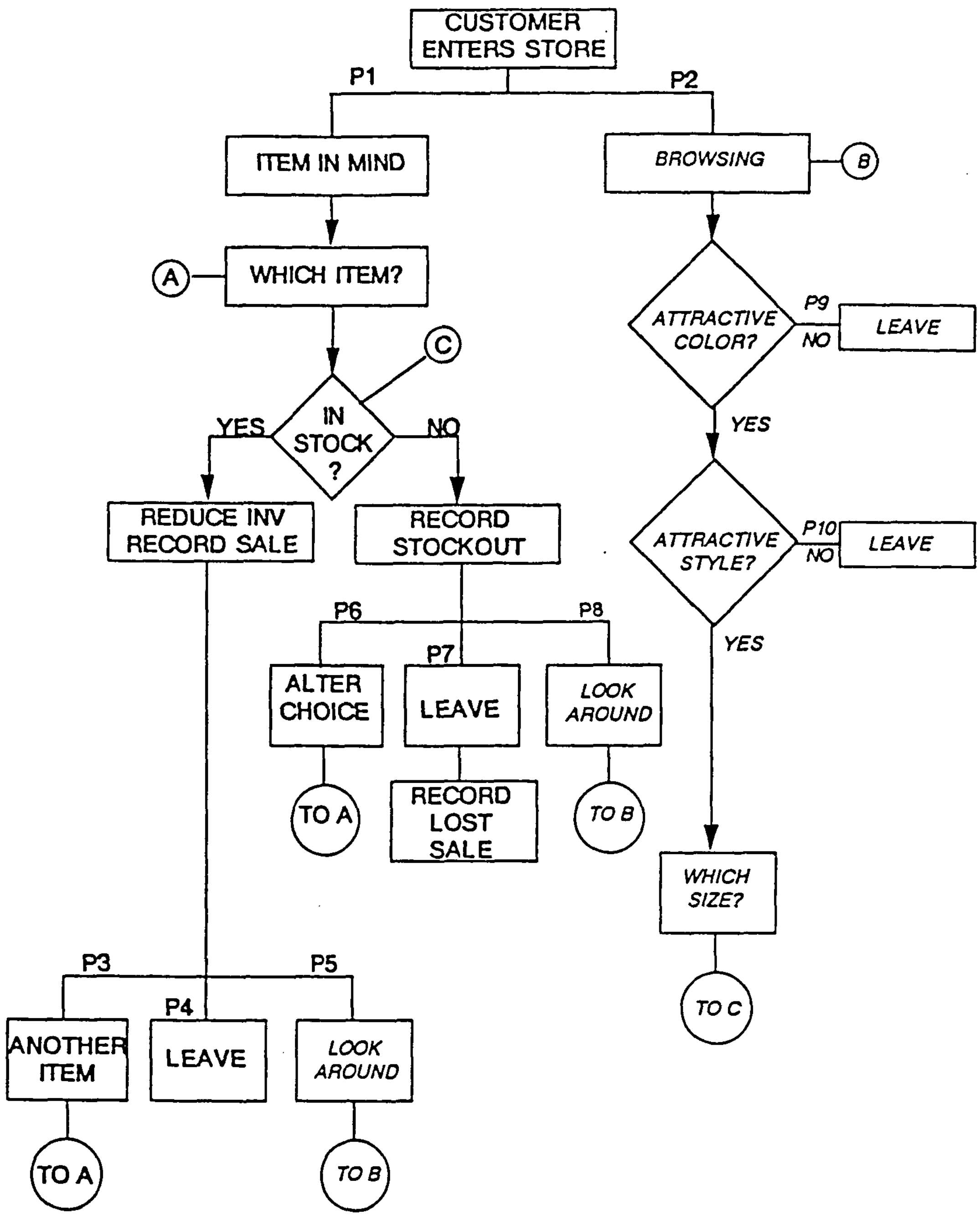

Figure 2. Customer shopping behavior branching diagram.

choose another item. If the customer follows the right side of the branching diagram and is browsing he/she can be attracted by a color and style with probabilities determined accordingly by the inventory level on the shelves. If he/she is attracted by both the color and style then the customer is randomly assigned a size. At this point the customer is treated similarly to the customer with a specific item in mind. If the item is in stock a purchase is made, if it is out of stock the customer may leave or choose another item. If the customer is not attracted by both color and style then he/she leaves.

The 'P' values in Figure 2 represent the probability that a customer will take a specific branch in the diagram. (See Appendix 1 for a list of the default percentages assigned to the 'P' values.) For example, P1 is the probability that a customer enters the store with a specific item in mind, while P2 represents the probability that a customer enters the store to browse. The values for the probabilities can be specified by the user or the default values can be used. Since little is known about in-store customer behavior the default settings are based on a study done of grocery stores that suggested the values for P6 and P7 of 26% and 74% respectively (Foxall, 1981). These values seem to be consistent with recent conclusions that consumers increasingly go shopping with a specific product in mind (Shopping the big centers, 1990). Todays' customer is most likely to engage in purposeful shopping to quickly and efficiently make purchases (Richardson, 1993; Weiner, 1992).

After the CHANGE program has been completed the information is imported into the ARM program through the database. The ARM program is the next step of the process. In this process the following categories are addressed:

1)1 of 4 modes of operation can be selected:

- non-interactive user specified consumer demand - the simulation uses the previously specified inputs of customer seasonality and number of customers.

- non-interactive computer generated consumer demand - the computer chooses a consumer arrival pattern and customer volume from a set of representative patterns.
- interactive within a season user specified consumer demand - this is similar to the non-interactive user specified demand mode except the user is allowed to stop the simulation after each week to view the performance and change the reorder or markdown schedule if desired.
- interactive with computer generated consumer demand - this is similar to the non interactive computer generated demand mode with the capabilities of stopping the simulation after each week and making changes as discussed above.

2) initialize the buyer plan - the plan is broken down by unit for each style, size, and color (by SKU) and the user can alter the plan for an individual SKU,

3) consumer demand - the user may specify if they want to use the consumer demand profile created in the CHANGE program or if a % of error should be built into the estimation of demand for each style, size, or color,

4) initialize orders - this determines the number of orders to be received during the season and what % of the merchandise should be received in each order,

5) premiums - how much the initial markup % should be and how many weeks the merchandise should be sold at this first price, and

6) markdowns - how many markdowns to have during the season and what percentage of the first price should the markdown be.

After the input process has been completed the simulation can be run. Those input variables not specified in the ARM program will be imported from the CHANGE program to simulate the selling season. Upon completion of the simulation the system generates a number of output variables to aid in the analysis of the success of the chosen scenario. The success of the scenario hinges upon the reaction of the customer shopping behavior to the chosen strategies. See Table 2 for a list and description of the weekly and end-of-the-season outputs generated.

Assortment Definitions as Used in ARM

- Adjusted gross margin - calculated by subtracting the distribution costs and inventory carrying costs from gross margin (Poindexter, 1991).
- Assortment - the number of different styles in a classification and the sizes and colors in which the products are offered (Glock & Kunz, 1990).
- Assortment dimensions - breadth, depth, and volume.
- Assortment factors - style, color, size.
- Gross margin - the dollar difference between total cost of goods sold and net sales (Poindexter, 1991).
- Gross margin return on inventory - relates profit dollars generated to the dollar investment required to produce the profit, calculated by dividing gross margin by average dollar investment in inventory (Poindexter, 1991).
- Inventory turn - calculated by dividing total units sold by average inventory (Poindexter, 1991).
- Service level - how often the product a customer desires to purchase is in-stock (on the retail shelf).
- SKU - a unique item in the assortment identified by a combination of the assortment factors.

Table 2. Weekly and end-of-the-season outputs generated by ARM

Weekly outputs

- number of customers
- end of week inventory
- weekly sales in units
- cumulative sales dollars
- inventory delivered
- first stockouts - a SKU that is out of stock for the first time in the selling season
- total stockouts - a measure of all stockouts occurring during the week, this would include first stockouts plus any additional customers that arrived looking for the same SKU only to encounter the same stockout
- lost sales - any sales missed due to error in the buying plan or stockouts
- empty shelves
- retail selling price of the merchandise

End-of-the-season outputs

- % of orders sold
- %sell through - a measure of the % of total units sold at first price
- % jobbed off - % of the total units that were jobbed off at the end of the selling season
- % lost sales
- sales and job off revenue
- initial and delivered inventory
- cost of goods sold
- distribution cost
- average inventory level
- inventory carrying cost
- inventory turns
- gross margin
- % of maximum gross margin reached
- adjusted gross margin
- gross margin return on investment (GMROI)
- average sales price
- service level

Manipulation of the Apparel Retail Model (ARM)

Because the purpose of this study was to evaluate only the success of merchandise assortments, it was important to obtain results to be analyzed in a deterministic manner, that is, to control the influence of randomness as much as possible. This was achieved by using the default settings where appropriate and manipulating a minimum of items across all simulation runs.

In the CHANGE program the default numbers were used in all categories except number of customers expected during the season, planned number of units to sell during the season, the consumer demand profile and the buyer plan. Two initial sets of simulations were run using 100 and 1000 as the number of customers expected during the season and the number of units to sell during the season.

The approach to formulating a schedule of simulations to run was to hold the unit level constant (at 100 or 1000) and vary the level of the SKU's by changing the buyer plan in the CHANGE program. By varying the SKU's, the different relationships between the total number of units and total SKU's could be observed. The process of determining by how much to vary the SKU level was dependent on several things. First, was the ability to achieve the desired number of SKU's by the multiplication of three numbers, representing style, size, and color, under ten. Therefore, the range of SKU's was limited to 1-1000. However, when using 100 as the unit level, 100 would be the highest number of SKU's desired (since there would not be any merchandise beyond the 100 limit to allocate to any excess SKU's). Originally, the SKU level was varied by increments of 10 (10, 20, 30, etc.) from 1-100. This served as an appropriate method for evaluating the results of SKU levels from 20-100. However, under the 20 SKU level more refinement was needed in the schedule so further simulations were run, in addition to the increments of ten, to provide a better analysis of that region.

A similar approach was used in formulating the schedule for the 1000 unit level simulations. As it was desirable to study the same relationships as the 100 unit level (i.e., if the unit level is 100 and the SKU level is 10 this is a ratio of 10, then to achieve a similar ratio of 10 with a unit level of 1000 the SKU level must be 100) the SKU level was varied by increments of 100 from 200-1000. Under 200, additional simulations were run to provide further information of that range.

To account for the random flow of customer shopping behavior generated by the Poisson process, a total of 5 simulations were run for each SKU level. The number of 5 simulations was chosen based on recommendations by the ARM simulation developers and previous research conducted using ARM (King, 1994; Hunter, King & Nuttle, 1992; King & Nuttle, 1992).

After formulating the simulation schedule, the buyer plan was manipulated to reflect the variety of SKU levels chosen. This required altering the number of styles, sizes and colors. For example, if the desired total SKU level was 90 then an appropriate assortment to reflect this would be 9 styles, 10 colors, and 1 size. The 90 SKU level could also be achieved by 10 styles, 3 colors, and 3 sizes or 9 styles, 5 colors, and 2 sizes, etc. Therefore, every possible combination for each SKU level was run. The three numbers of the combinations could be input in any order. The combination of 9, 10, and 1 could be input as 1, 10, and 9. The simulation places equal importance on the three assortment factors of style, color, and size. Therefore, similar results are achieved for the same three numbers as inputs.

Within the chosen assortment dimensions the total number of units had to be allocated to each assortment factor. Two methods of allocation were used. The first method attempted to allocate the units as evenly as possible across each assortment factor. The second method consisted of a bell distribution with more units being allocated to the middle factors and less to the beginning and end factors. (See Appendix 2 for the allocation %'s for each method.) Each of the allocation methods was used for a set of simulations at the 100 level. As little differences were noted in the financial outputs between the two allocation methods, only 1 set of 1000 was run using the even allocation method. After altering the buyer plan, the consumer demand profile was altered to match the buyer plan. The same allocation method used in the buyer plan was then used in the consumer demand profile.

In the ARM program the non interactive mode of operation was selected because it was not the intent of the researcher to evaluate the weekly performance of the strategy and make markdown or reorder changes during the selling season. In order to ensure a consistent number of units for the selling season (100 or 1000) in some scenarios the buyer plan required editing. Due to rounding errors when translating the percent allocated into number of units, individual SKU's had to be changed to reflect the appropriate number of total units. If individual SKU's were altered an attempt was made to spread the excess or deficiency of units as evenly as possible across all styles, colors, and sizes. For simplicity's sake there was only 1 initial order of 100% of the merchandise received at the beginning of the selling season. Similarly, no markdowns were taken, therefore all merchandise was sold at the initial markup level or first price. (See Appendix 3 for a complete listing of all of the inputs used for the initial simulations.)

After the initial simulations, real data from two industry sources was collected and simulated. The first information was obtained from a small, men's apparel and furnishings, specialty store. The store provided the assortment dimensions, wholesale and retail prices, customer behavior shopping patterns, and length of the selling season for two different assortments. The customer shopping behavior patterns were derived from a brief survey completed by the owner and manager of the store. (See Appendix 4 for the survey and their answers.) The first assortment simulated was a name brand group of men's coordinating woven and knit shirts, sweaters, and pants. The second assortment was a group of men's ties. Due to the limitations of ARM all merchandise had to be simulated at the same price point. Although this was an issue of concern for the first assortment since not all of the merchandise was sold at the same price, the merchandise did have the same markup % so the simulation still reflected the reality of the desired margin.

Similar information was obtained from a single branch store of a major discounter. The discounter provided the assortment dimensions, retail price, and length of the selling season for three different assortments. However, the discounter did not provide the wholesale prices of the merchandise or the customer shopping behavior patterns. Therefore, this information was taken from trade publications that cite industry averages for gross margin and consumer shopping patterns of discounters ("The true look", 1993; Shopping the big centers, 1990). The assortments were of men, women, and boys' name brand T-shirts. Again, due to the limitations of ARM, pricing became an issue. This time the problem came in reference to achieving the desired markup percentage. ARM only allows whole numbers with no decimals. Therefore the wholesale and retail prices had to be altered to reflect whole numbers. However, the reality that a discounter has a lower markup than a specialty store or other retail organizations could still be effectively simulated. (See Appendix 5 for a list of all inputs used for the real data simulations.)

FINDINGS

Five financial outputs were chosen for analysis of the simulations: lost sales, adjusted gross margin %, gross margin %, gross margin return on investment, and average inventory. Lost sales serves as a measure of the number of stockouts. The adjusted gross margin % is the most realistic measure of performance as it subtracts distribution and inventory carrying costs from the gross margin. Adjusted gross margin % is a frequently used measure in QR business systems. Gross margin % is the total sales revenue minus the total cost of the goods. Gross margin % has historically been used to judge merchandising performance. Gross margin return on investment relates the profit generated to the dollar investment required to produce the profit. Average inventory is calculated in the simulation by considering the beginning and ending inventory for each week. Average inventory is also an important consideration in a QR environment. The above five financial outputs were chosen for analysis due to their traditional or recently developed importance as measurements of apparel assortment success.

After running all of the simulations and collecting the financial outputs the analysis was begun. (See Appendix 6 for a sample ARM printout.) First, all the simulations for a given SKU level, this would include the five simulations for each of the possible combinations of style, size, and color, were averaged together to get a single data point for each financial output at each SKU level.

Secondly, how to represent the relationship between the total number of units and total number of SKU's was considered. To address the issue a units per SKU relationship was derived for each SKU level. This relationship will hereafter be referred to as the "assortment multiplier". The name evolved from the fact that if the number of SKU's of the assortment is multiplied by the assortment multiplier it equals the total units in the assortment. The assortment multiplier definition is similar in nature to other studies that use the terminology "volume/SKU" (Hunter, King, & Nuttle, 1991). Both definitions serve as measures of how many units are allocated per each SKU. This is where traditional definitions of assortment dimensions have failed. They neglect to identify a relationship between units and SKU's. Under previous definitions, an assortment could not be defined without being compared to another assortment. They had to be defined as more broad than, less shallow than, more narrow, less deep, etc. than another assortment of comparison. However, by establishing an assortment multiplier any assortment can be meaningfully defined by merely determining the multiplier of that particular assortment.

Next, plots were created with the x-axis representing the assortment multiplier and the y-axis being the financial output. Five plots, one for each financial output, were created for each of the three data sets. (See Appendix 7 for a representation of all of the plots for all three data sets.)

Pearson correlation coefficients were run on the five financial outputs. Because the test showed all of the financial outputs to be highly correlated (see Table 3 for the correlation results) and all three data sets exhibited similar results, for simplicities sake only one financial output from one of the data sets will be used for discussion purposes of this report. The output to be explored for the remainder of this discussion will be the gross margin % of the 100 unit, even distribution data set. Gross margin % was chosen due to it's historical importance as a success measurement for merchandisers in the apparel industry.

Referring to Figure 3 it can be seen that as the assortment multiplier becomes smaller the gross margin % decreases. This means that as the total number of units and SKUs became closer to equaling each other (for example 100 units and 100 SKUs for an assortment multiplier of 1) the financial productivity of the assortment became less. An assortment with these dimensions has very few units allocated per SKU (in the above scenario there would be only 1 unit allocated per each SKU).

Table 3. Pearson correlation coefficients of financial outputs.

	Lost sales	Adjusted gross margin	Gross margin	GMROI	Average Inventory
Lost sales	1.00000 0.0	-.076436 0.0001	-.074512 0.0001	-.090475 0.0001	0.99167 0.0001
Adjusted gross margin	-.76436 0.0001	1.00000 0.0	.99946 0.0001	.96371 0.0001	-.74587 0.0001
Gross margin	-.74512 0.0001	.99946 0.0001	1.00000 0.0	.95625 0.0001	-.72522 0.0001
GMROI	-.90475 0.0001	.96371 0.0001	.95625 0.0001	1.00000 0.0	-.88470 0.0001
Average inventory	.99167 0.0001	-.74587 0.0001	-.72522 0.0001	-.88470 0.0001	1.00000 0.0

Conversely, as the assortment multiplier became larger the gross margin % improved. As the difference between the total number of units and SKUs became greater (for example total units of 100 and total SKUs of 10 for an assortment multiplier of 10) so did the financial performance. An assortment with these dimensions would have several units allocated per SKU (in the above scenario there would be 10 units allocated per each SKU). Similar results occurred with the other financial outputs and across the other two data sets. Adjusted gross margin % and gross margin return on investment decreased, while average inventory and lost sales increased as the assortment multiplier decreased.

This change in financial performance was attributed to the amount of stockouts. As the assortment has less units allocated per SKU the chances of not having the right

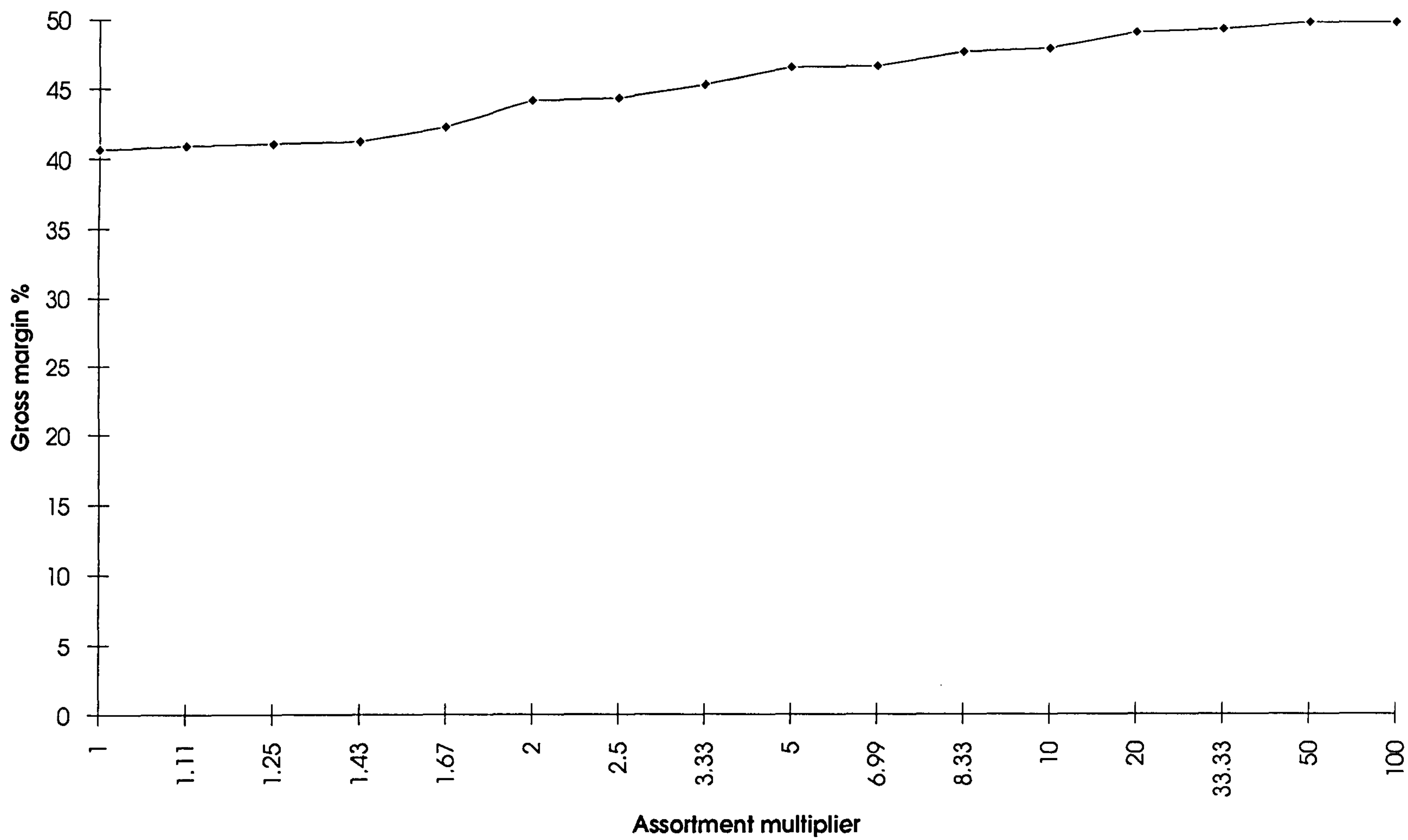

Figure 3. Gross margin percent for 100 units, even distribution.

merchandise for the customer, and therefore stockouts, increases. This is especially prevalent with an assortment multiplier of below 2 and a bell % allocation method. In such assortments it is highly likely that the assortment begins from the first day of the selling season with stockouts. As less customers find what they are looking for (i.e., more stockouts occur) and fewer purchases are made there is more merchandise left unsold at the end of the selling season. This merchandise must either be marked down from first price and sold at a lower selling price and/or jobbed off at the wholesale price (the latter was the chosen option in the simulation sets). In either case merchandise is sold at lower than first price resulting in lower financial performance. These findings seem to be consistent with other studies of assortments that suggest as the volume/SKU increases so does the financial outcome and that the more acceptable items and the fewer unacceptable items an assortment offers the better the assortment (Hunter, King, & Nuttle, 1991; Kahn & Lehman, 1991).

One of the purposes of this study was to develop meaningful definitions to describe the dimensions of assortments. The assortment multiplier provided an important tool for this development. The plots of the financial outputs were analyzed in relation to the assortment multipliers. Based on the shapes of the plots and the raw data numbers, two ranges of assortments were outlined and defined initially. The two ranges were, an assortment multiplier of 5 or below and an assortment multiplier of above 5. The following words and definitions were developed to describe the two assortment ranges:

- a <u>diverse</u> assortment - an assortment with few units allocated per SKU, 5 or less, and therefore has an assortment multiplier of 5 or less (the assortment multiplier range of 1-5 exhibits an average change in gross margin of 5.81%).
- a <u>focused</u> assortment - an assortment with many units allocated per SKU, above 5, and an assortment multiplier of greater than 5 (the assortment multiplier range

of 5-1000 exhibits an average change in gross margin of 3.59 %).

Upon consideration, the two ranges were further defined. The diverse assortment range was broken down into two areas: a more diverse range with an assortment multiplier of 2 or below, and a diverse range with a multiplier of above 2-5. Similarly, the focused assortment was also broken down into two areas: a more focused range with a multiplier of above 20, and a focused range of above 5-20. To summarize, the final four ranges that were defined are:

- more diverse - an assortment multiplier of 2 or less.
- diverse - an assortment multiplier of 2-5.
- focused - an assortment multiplier of above 5-20.
- more focused - an assortment multiplier of greater than 20.

The data points of 2, 5, and 20 were chosen because at each of these points a change seemed to be initiated. When looking at Figure 3 it can be seen that prior to each of the three points there is a sharp increase in the slope of the line. This is especially evident when looking at the differences in the raw data numbers. (See Appendix 8 for the financial output numbers of all simulations.)

When looking at the performance of the ranges as a whole the most change occurs within the more diverse assortments, those with a multiplier of 2 or less. The average % increase in gross margin of the three data sets was 3.51 for the more diverse range. In this range, as the assortment multiplier increases and there are less SKU's and therefore more units allocated per each SKU, significant improvements in financial productivity are realized. Although in the focused range of assortments, financial productivity also improves as the assortment multiplier increases, the improvement is not as great. With assortment multipliers of between 5 and 20 the rate of gross margin increase is not as great as mulitpliers of below 5, but greater than multipliers of above 20.

In addition to the assortment dimension definitions discussed above, some other useful language for assortment planning emerged during this study. Following are the definitions of assortment planning that evolved:

- assortment allocation = the distribution of volume across assortment factors
- assortment volume = total number of units in the assortment
- assortment dimensions = number of SKU's, volume, assortment allocation
- assortment factors = style, size, color
- assortment multiplier = volume per SKU

To test these findings, real assortments were simulated and the assortment definitions applied to the outcomes. The two small, specialty assortments both fell in the very diverse range. One had an assortment multiplier of .81 (there were actually more SKU's than units of merchandise) and the other had a multiplier of 2. As expected the more focused assortment with the multiplier of 2 had better financial outcomes than the extremely diverse assortment with a multiplier of .81. Similar results were obtained with the discounters' assortments. The three assortments had multipliers of 3.3, 9, and 12.61. The focused assortment with the multiplier of 12.61 out-performed the other assortments. The moderately diverse assortment with a multiplier of 3.3 exhibited the poorest financial performance, while the moderately focused assortment with multiplier of 9 fell in the middle of the performance ranges. (See Appendix 9 for a representation of all the real industry outputs.)

Hypothesis for Further Research

Based on the findings of this study several hypothesis have emerged as deserving of further exploration. They are as follows:

1) As the assortment multiplier increases so does financial productivity.

2) An assortment with a multiplier of 5 or above will have higher financial productivity than

an assortment with a multiplier of below 5, holding all other variables constant.

3) An assortment with a lower assortment multiplier will require a higher markup % than an assortment with a higher assortment multiplier, to achieve similar financial outcomes.

4) The definitions of diverse and focused assortments are applicable to real industry assortment planning processes.

5) Most store level apparel assortments have an assortment multiplier less than 5.

6) Measurable definitions of assortment planning will contribute to the understanding of the merchandising constituency's importance in the apparel firm.

7) Fashion goods are presented in diverse assortments.

8) Basic goods are presented in focused assortments.

IMPLICATIONS

The findings of this study have many implications for merchandisers and educators. First, for merchandisers it provides an assortment planning language with quantitative definitions for planning assortments. Currently, assortments are generally based on an overall dollar value. Often little consideration is given to the number of SKU's in an assortment, while almost no consideration has been given to a relationship between the number of SKU's and total units. The results of this study provide general "rules of thumb" to follow when engaging in merchandise planning. The finding that a diverse assortment has lower financial performance than a focused assortment gives merchandisers incentive to plan assortments as focused as possible, as every SKU has an impact on the bottom line. When planning assortments merchandisers need only to calculate the assortment multiplier to determine which assortments would be most profitable assuming all other variables and strategies are held constant. This process could also work in reverse. If a merchandiser has determined that they wish to offer a diverse assortment, then they will need to take a higher markup on that merchandise (as compared to a focused assortment) to achieve the desired amount of profitability. This practice has often been inductively applied as discounters have traditionally taken lower markups on merchandise as their assortments are more focused, while specialty and department stores have taken higher markups due to their varied assortments. However, the reasoning behind this practice, in relation to assortments, has never been explored or documented.

The results also build a case against diversifying. When under financial pressure many businesses, particularly small organizations, add new and more product lines increasing the number of SKU's carried in an attempt to increase sales and profits. However, the results of this study would seem to indicate that this is not necessarily a strategically appropriate move, particularly in relation to profit. It may be wiser to focus on a smaller range of SKU's to ensure an in-stock position at all times and use product promotion to increase sales, rather than to offer a diverse assortment that increases the occurence of stockouts and does not adequately meet customer needs.

The findings of this study show, particularly in the varied assortment range, that the subtraction of every SKU (i.e., the more focused the assortment becomes) substantially improves profitability. It would appear that at the single store level most assortments fall in the diverse or more diverse ranges with an assortment multiplier of 5 or less. Even many of the apparel assortments of large discounters (as evidenced by the industry data simulated in this study) do not reach the focused range at the individual store level. Therefore, this would seem to indicate that it is important for all types of merchandisers to be concerned with the diversity of assortments at the store level. Additionally, in light of stockouts, all merchandisers should be concerned that when central organizational assortment plans are broken out for each store by percent allocation there is the potential for stockouts to occur early in the selling season, possibly even beginning the selling season with incomplete assortments. This problem escalates the more diverse the assortment is and with the use of bell % allocation methods. As most multi-unit organizations use central buying to reduce overhead expenses, it would seem that the above concerns would be very prevalent in the industry (Clodfelter, 1993). To address the problem, attention needs to be given to tailoring assortments to individual store needs.

As previously discussed, it appears that most apparel assortments fall in the diverse or more diverse ranges. This is particularly true of fashion merchandise as there are many SKUs offered but few units are allocated per SKU. This raises important issues about the applicabilityof QR in diverse assortments. QR is driven by customer purchases. Point of sale information at the SKU dictates what new merchandise should be replenished or developed. However, in a diverse assortment there is little opportunity for multiple sales of a SKU. Therefore, information is usually aggregated by assortment factor, for example at the style level. Thus, it is difficult for a QR system to synthesize SKU information meaningfully in diverse assortments. That is, it is difficult to quickly spot or act on trends, or to make future predictions or forecasts by locating a hot selling SKU. Based on the above premises it would seem that the fundamental assumptions of QR systems are inappropriate for diverse assortments.

Finally, these results provide educators a quantitative method with which to teach assortment planning to merchandising students. Previously, the inconsistent and confusing linguistics of the assortment dimension definitions were inadequate for instructors to communicate assortment planning. The definitions developed in this study provide a quantitative and more comprehensive way of studying assortment planning. Not only do they clarify the ranges of assortments, but they also directly relate assortments to financial productivity better preparing the student for entry into the textiles and apparel industry. Furthermore, this study also provided substantiation of the model of the behavioral theory of the apparel firm (Kunz, 1994). The successful direction of this research project demonstrates that the model provides adequate guidance for future research of this nature.

ISSUES FOR FURTHER RESEARCH

Using these preliminary findings of assortment planning and the derived definitions of assortment dimensions from this study as a point of departure, there are several potential areas for further research. First, the exploration of customer shopping behavior in relation to textiles and apparel would contribute to a more realistic functioning of the ARM system. This would include the investigation of customer reactions to stockouts. Similarly, the simulation places equal importance on each of the assortment factors of style, size, and color. This allows no interpretation of presentation or display. It would seem that in some scenarios one of these factors would be more important than another. Research in this area could also aid in the development of the simulation's reality.

The definitions developed in this study need further testing and possibly refinement. Further simulations could be run at more SKU levels to determine if the outlined assortment ranges still apply. Although the ARM system has the capability of simulating assortments with assortment multipliers of below 1, it was not undertaken as part of this study. Since many small stores have assortments that would fall into that very diverse range, particularly in the craft and gift categories as well as apparel, it could be an important area for further inquiry. As 1000 was the highest SKU level that ARM could run other methods/systems need to be developed to test above this level to determine if financial productivity continues to change or if at some point it levels off beyond an assortment multiplier of 20. The definitions developed in this study describe the assortment ranges using words such as more diverse or more focused. The language of the descriptions is ambiguous. Further development of these definitions and the words used to describe them could provide more clarity. The definitions could also be tested on a broad spectrum of merchandise types using methods other than the ARM system to see if the definitions were applicable.

An implication discussed in this study was the idea that certain assortments required higher markups than others to achieve similar financial productivity. This could be tested to determine by just how much higher the markup needs to be. For example, how much more does a diverse assortment need to be marked up to achieve similar financial outcomes as a focused assortment?

Additionally, the definitions could be used to define basic and fashion merchandise. As it would seem that most fashion assortments are more diverse than basic assortments it might be possible to use the definitions to further describe these two merchandise types.

Using the ARM simulation, a next step of research could be to test multiple delivery strategies to see if the financial productivity of the diverse assortments could be improved. As this research used an initial delivery of 100% for the merchandise, further studies could simulate multiple deliveries to determine by how much financial productivity could be increased. This would be particularly interesting in the diverse assortment range to determine if or by how much stockouts could be controlled.

As the real industry data simulated in this study seemed to have small assortment multiplier numbers in general (the largest one was 12.61), it brings up the question - what exactly are the nature of store assortments? Is it even necessary to define an assortment range of 20 or greater? Or should further breakdowns or definitions be developed in the smaller assortment multiplier ranges, as it would appear that this is where most store assortments may fall?

Finally, previous research (Hunter, King, & Nuttle, 1991) has suggested that the benefits of QR decline at an assortment multiplier of 20-25 and vanish at around 10. The results of this research study suggest most assortments fall below 20 (a moderately focused assortment) and many below 10 (in the moderately focused to diverse ranges of assortments). Assuming that both research studies are correct, most assortments are in the diverse to moderately focused ranges and the benefits of QR significantly decline in these ranges, then where or in what types of organizations and for what types of product categories is QR applicable?

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APPENDIX 1

DEFAULT SETTINGS FOR PROBABILITY VALUES ('P' VALUES) OF CUSTOMER SHOPPING BEHAVIOR BRANCHING DIAGRAM

P1 =	100% =	P(customer has specific item in mind)
P2 =	0.00% =	P(customer just looking, browsing)
P3 =	0.00% =	P(browing customer makes a purchase)
P4 =	100% =	P(after purchase, person leaves model)
P5 =	0.00% =	P(customers make multiple purchases)
P6 =	26.0% =	P(choice altered when stockout occurs)
P7 =	74.0% =	P(customer leaves when stockout occurs)
P8 =	0.00% =	P(customer makes purchase on impulse)
P9 =	0.00% =	P(browsing customer encounters stockout)
P10 =	0.00% =	P(SKU chosen on impulse, no purchase)

APPENDIX 2

THE % ALLOCATION METHODS

Even Distribution Method:

Number of the assortment factor	% allocated to each factor									
1	100%									
2	50%	50%								
3	33%	34%	33%							
4	25%	25%	25%	25%						
5	20%	20%	20%	20%	20%					
6	16%	16%	18%	18%	16%	16%				
7	14%	14%	15%	15%	14%	14%	14%			
8	12%	12%	13%	13%	13%	13%	12%	12%		
9	11%	11%	11%	11%	12%	11%	11%	11%	11%	
10	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

Bell distribution method:

Number of the assortment factor	% allocated to each factor									
1	100%									
2	50%	50%								
3	30%	40%	30%							
4	20%	30%	30%	20%						
5	10%	20%	35%	20%	15%					
6	5%	15%	35%	25%	15%	5%				
7	5%	10%	20%	30%	20%	10%	5%			
8	5%	5%	20%	35%	15%	10%	5%	5%		
9	5%	5%	10%	15%	30%	15%	10%	5%	5%	
10	5%	5%	10%	15%	25%	15%	10%	5%	5%	5%

APPENDIX 3

INPUTS FOR INITIAL SIMULATIONS

Variable	Setting
Number of weeks for the simulation	20 weeks
Number of customers expected during the season	100 or 1000
Number units planned to sell for the season	100 or 1000
Wholesale cost per unit of merchandise	$10
Retail price per unit of merchandise	$20
Job off price per unit of merchandise	$10
Distribution costs as a % of wholesale	8%
Inventory carrying costs (annual %)	20%
The price elasticity of demand	.700

Customer arrival rate curve - 20 periods

(# of periods must equal # of weeks)

Period	% of total customers arriving
Period 2 -	.04525
Period 3-	.04525
Period 4 -	.04525
Period 5 -	.05450
Period 6 -	.05450
Period 7 -	.05450
Period 8 -	.05450
Peroid 9 -	.05375
Period 10 -	.05375
Period 11 -	.05375
Period 12 -	.05375
Period 13 -	.05100
Period 14 -	.05100
Period 15 -	.05100
Period 16 -	.05100
Period 17 -	.04525
Period 18 -	.04525
Period 19 -	.04525
Period 20 -	.04525

Consumer demand profile and buyer plan:

SKU level	Possible combinations of assortment factors			
1		1X1X1		(i.e., 1 style, 1 color, 1 size)
2		2X1X1		
3		3X1X1		
5		5X1X1		
10		2X5X1	10X1X1	
12	2X2X3	4X3X1	6X2X1	
14	7X2X1			
15	3X5X1			
16	4X4X1	8X2X1	2X4X2	
20	5X2X2	4X5X1	10X2X1	
25	5X5X1			
30	3X5X2	3X10X1	6X5X1	
32	4X4X2	8X4X1	8X2X2	
40	4X5X2	10X2X2	10X4X1	
50	5X2X5	10X5X1		
60	6X5X2	3X4X5	10X3X2	
70	7X5X2	10X7X1		
80	4X5X4	10X4X2	8X5X2	
90	10X3X3	9X5X2	6X5X3	9X10X1
100	5X2X10	10X1X10	4X5X5	
125	5X5X5			
150	5X6X5	10X3X5		
200	4X5X10	10X2X10		
300	10X3X10			
400	10X4X10			
500	10X5X10			
600	10X6X10			
700	10X7X10			
800	10X8X10			
900	10X9X10			
1000	10X10X10			

APPENDIX 4

CUSTOMER SHOPPING BEHAVIOR SURVEY OF THE SPECIALTY STORE

Question	Answer
% of customers that have an item in mind	50%
% of customrs who browse on arrival	50%
% of customers who leave after a purchase	85%
% of customers who look for another item after a purchase	15%
% of customers who browse after a purchase	30%
% of customers who alter their choice after a stockout	15%
% of customers who leave after a stockout	85%
% of customers who browse after a stockout	15%
% of customers who find a style when browsing	50%
% of customers who find a color when browsing	65%

APPENDIX 5

FINAL SIMULATION INPUTS

Specialty store inputs	Assortment settings #1	#2
Number of weeks for the simulation	12	12
Number of customers expected during the season	87	80
Number of units planned to sell for the season	87	80
Wholesale price	$26	$26
Retail price	$55	$55
Job off price	$26	$26
Distribution costs as a % of wholesale	8%	8%
Inventory carrying costs (annual %)	20%	20%
The price elasticity of demand	.700	.700

Consumer demand profile and buyer plan:

Assortment #1

Styles 9 -	12%	5%	17%	12%	12%	5%	18%	5%	14%
Colors 4 -	48%	31%	14%	7%					
Sizes 3 -	32%	46%	22%						

Total SKU's = 108

Assortment multiplier = .81

Assortment #2

Styles 10 -	10%	3%	10%	10%	3%	3%	3%	28%	10%	20%
Colors 4 -	24%	24%	35%	17%						
Sizes 1 -	100%									

Total SKU's = 40

Assortment multiplier = 2

Customer arrival rate curve

Period	% of total customers arriving	Period	% of total customers arriving
1	.07645	8	.08495
2	.08570	9	.08495
3	.08570	10	.08220
4	.08570	11	.08230
5	.08570	12	.07645
6	.08495		
7	.08495		

Discount store inputs	Assortment Settings #1	#2	#3
Number of weeks for the simulation	12	12	12
Number of customers	3026	1080	264
Number of units to sell	3026	1080	264
Wholesale price	$4	$4	$4
Retail price	$7	$7	$7
Job off price	$4	$4	$4
Distribution costs as a % of wholesale	8%	8%	8%
Inventory carrying costs (annual %)	20%	20%	20%
The price elasticity of demand	.700	.700	.700

Consumer demand profile and buyer plan:

<u>Assortment #1</u>

Styles 4 -	25%	25%	25%	25%						
Color 10 -	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Sizes 6 -	5%	15%	35%	25%	15%	5%				

Total SKU's = 240

Assortment multiplier = 12.61

<u>Assortment #2</u>

Styles 3 -	33%	34%	33%							
Color 10 -	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Sizes 4 -	10%	30%	40%	20%						

Total SKU's = 120

Assortment multiplier = 9

<u>Assortment #3</u>

Styles 2 -	50%	50%								
Colors 10 -	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Sizes 4 -	10%	20%	40%	30%						

Total SKU's = 80

Assortment multiplier = 3.3

Customer arrival rate curve:

Refer to specialty store arrival rate curve.

APPENDIX 6

SAMPLE ARM PRINTOUT

END OF WEEK	WKLY CUST-OMERS	IN-VEN-TORY	# OF WKLY SALES	CUM SALES $	INV RE-PLACE MENT	WKLY FIRST STOCK OUTS	WKLY TOTAL STOCK OUTS	WKLY LOST SALES	WKLY EMPTY SHELF	SELL PRICE
0	0	0	0	0	1831	0	0	0	0	0
1	297	1534	297	7128	0	0	0	0	1	24
2	287	1254	280	13848	0	11	11	7	9	24
3	298	981	273	19308	0	26	26	25	19	20
4	282	746	235	24008	355	60	67	47	12	20
5	344	779	322	30448	330	33	36	22	10	20
6	348	783	326	36968	317	31	33	22	6	20
7	322	784	316	43288	290	7	7	6	4	20
8	307	781	293	49148	289	16	17	14	3	20
9	320	758	312	55388	287	13	13	8	4	20
10	289	765	280	60988	284	10	11	9	4	20
11	296	760	289	66768	277	9	9	7	7	20
12	340	706	331	73388	266	14	16	9	8	20
13	326	661	311	79608	250	19	19	15	8	20
14	304	618	293	85468	247	15	15	11	9	20
15	305	584	281	91088	268	30	30	24	9	20
16	300	562	290	96888	287	15	15	10	5	20
17	264	594	255	101988	296	12	13	9	9	20
18	314	586	304	106548	0	13	13	10	23	15
19	300	316	270	110598	0	49	63	30	47	15
20	340	108	208	113718	0	165	226	132	79	15
TOTALS	6183	108	5766	113718	5874	548	640	417	167	

--------------------- OVERALL SEASON STATISTICS ---------------------

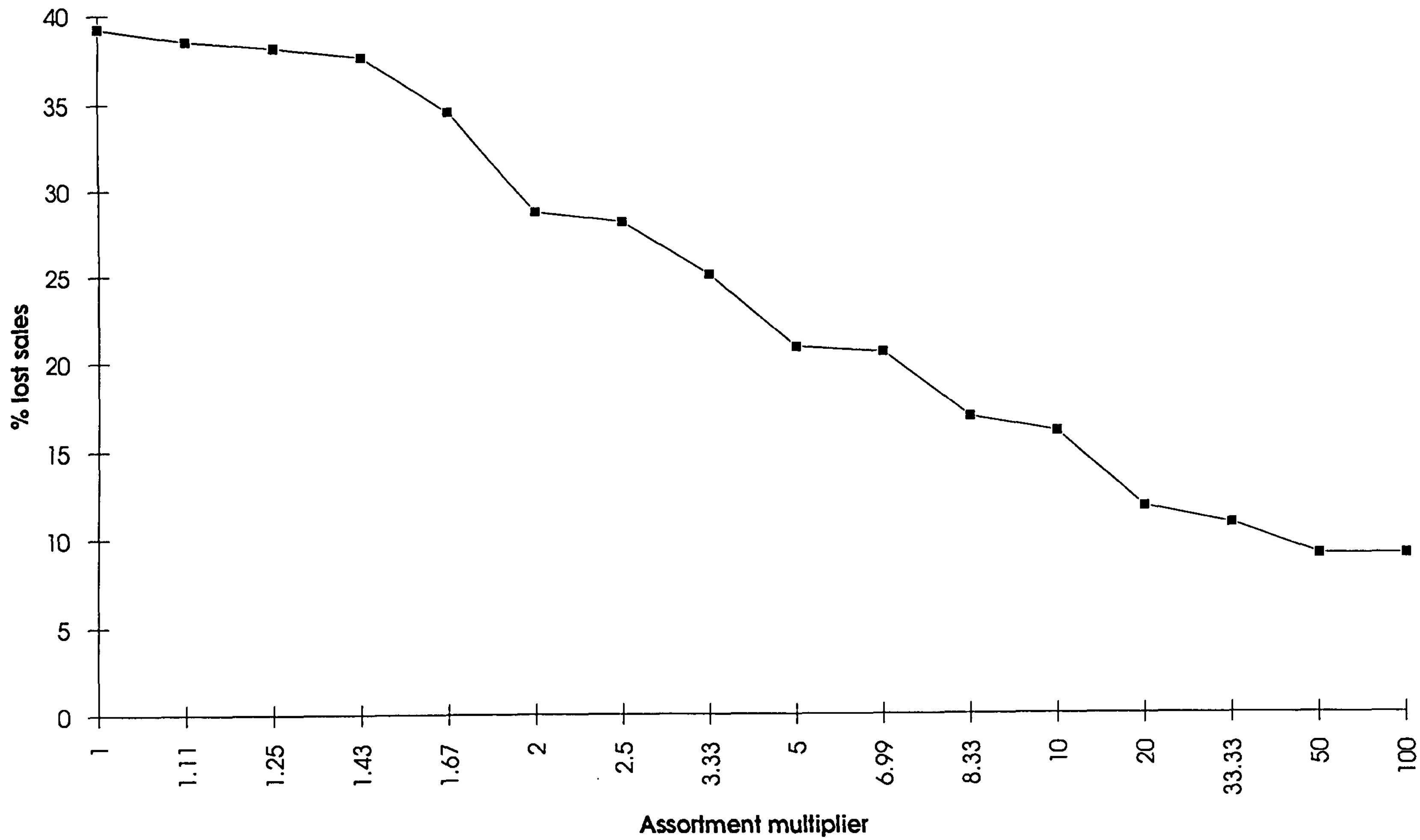
TOTAL NUMBER OF CUSTOMERS = 6183

% OF ORDERS SOLD	= 98 %	GROSS MARGIN	= $ 56058
% SELL THRU	= 85 %	MAX GROSS MARGIN	= $ 58740
% JOBBED OFF	= 2 %	% OF GM POTENTIAL	= 95 %
% LOST SALES	= 7 %	GMROI	= 6.39
SALES REVENUE	= $ 113718	COST OF GOODS	= $ 58740
JOBOFF REVENUE	= $ 1080	DISTRIBUTION COST	= $ 4701
TOTAL REVENUE	= $ 114798	AVG ACTUAL SALES PRICE	= $ 19.54
INITIAL INVENTORY	= 1831	AVERAGE INVENTORY	= 877
RECEIVED INVENTORY	= 4043	INV CARRYING COST	= $ 674
TOTAL INVENTORY	= 5874	INVENTORY TURNS	= 6.57
ADJ. GROSS MARGIN	= $ 50683	SERVICE LEVEL	= 91 %

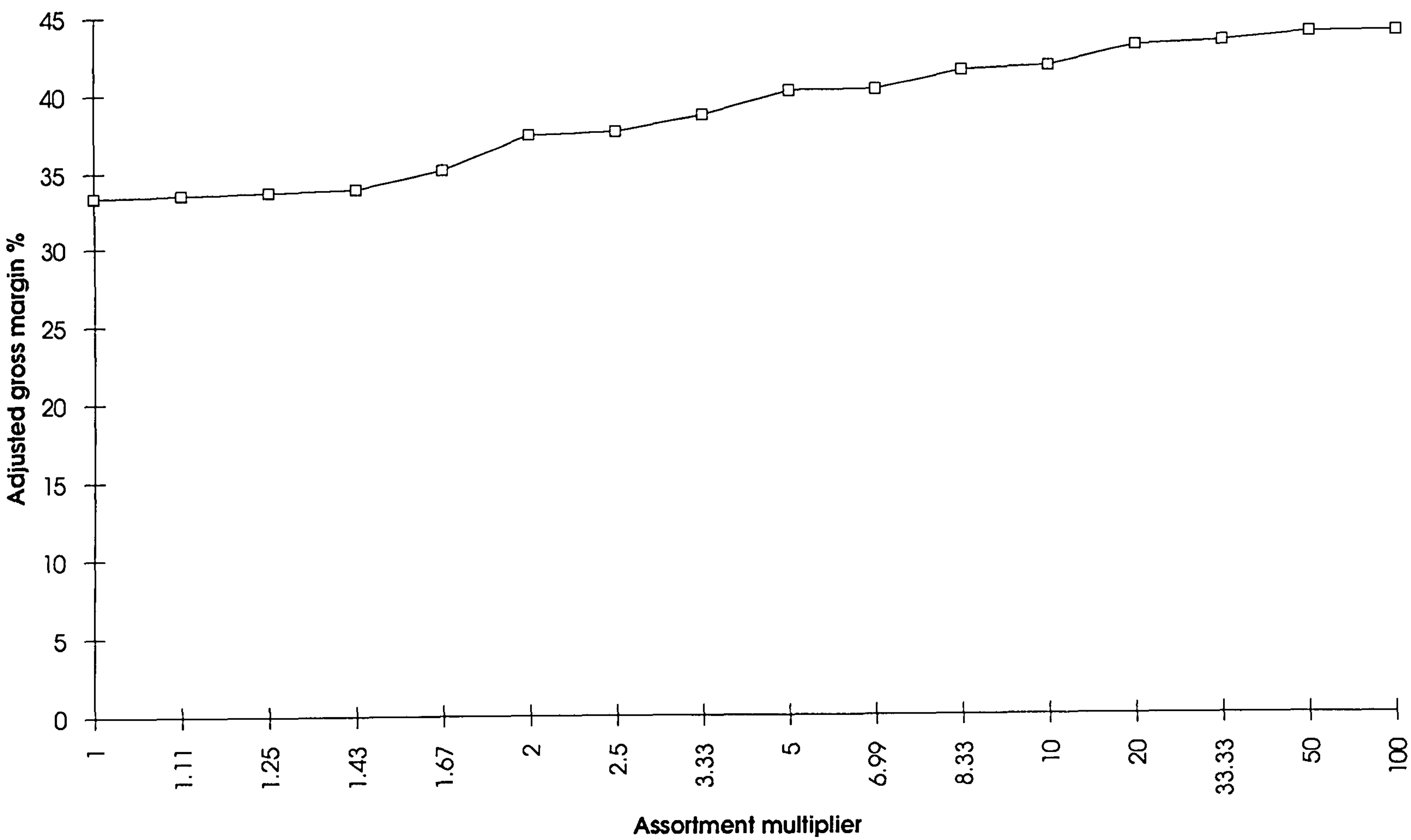
APPENDIX 7

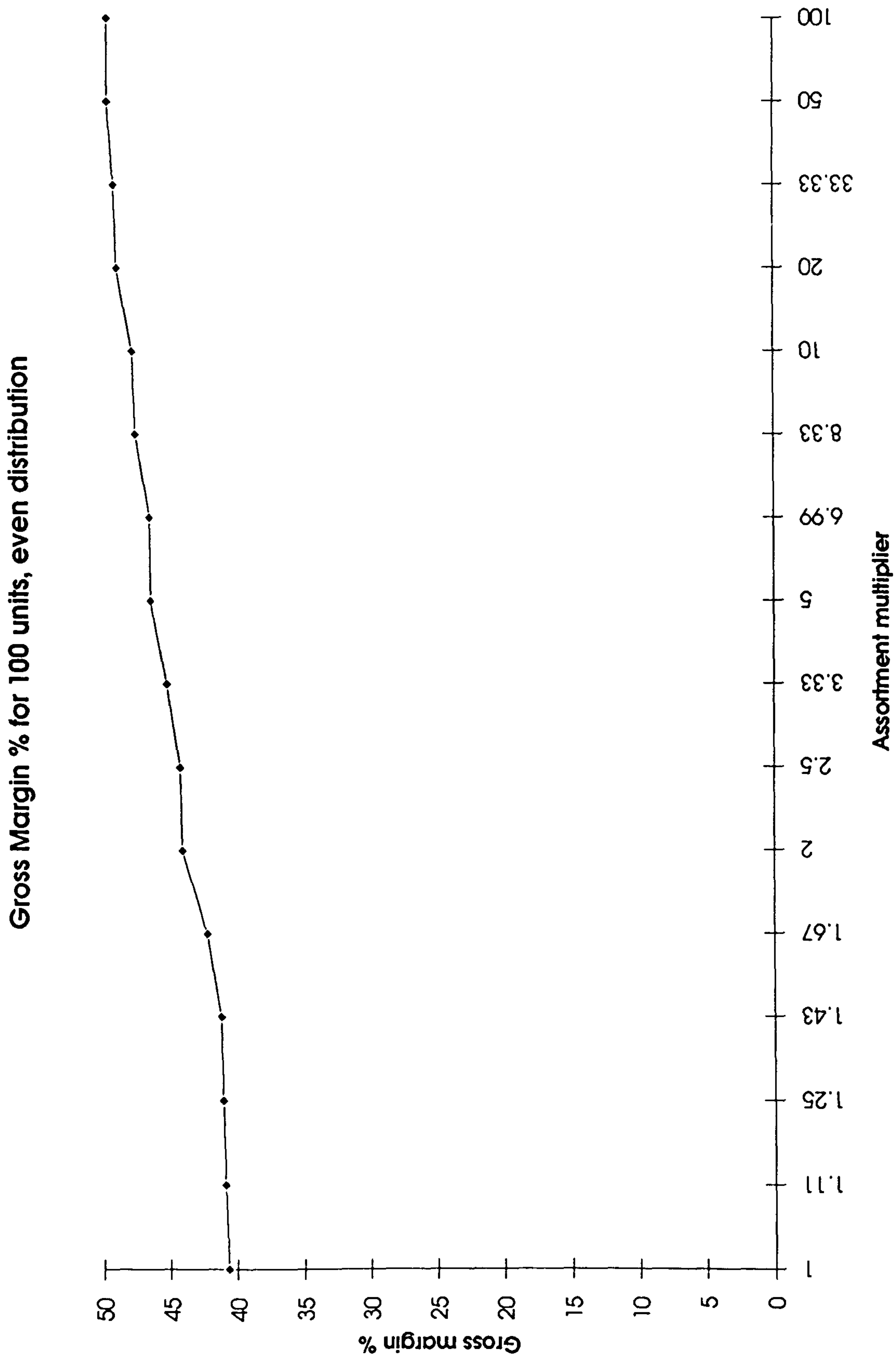
FINANCIAL OUTPUT PLOTS FOR ALL DATA SETS

% Lost Sales for 100 units, even distribution

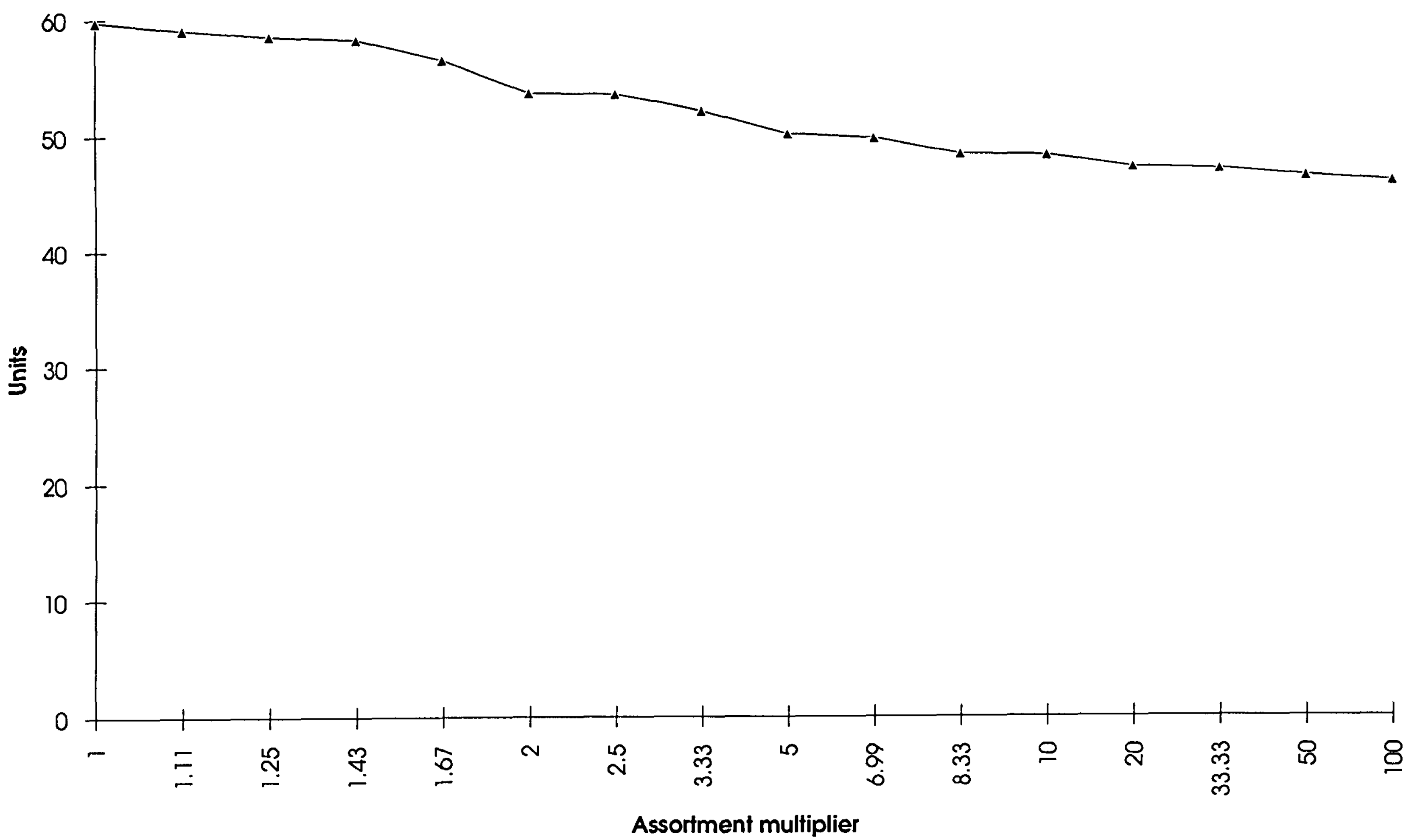


Adjusted Gross Margin % for 100 units, even distribution

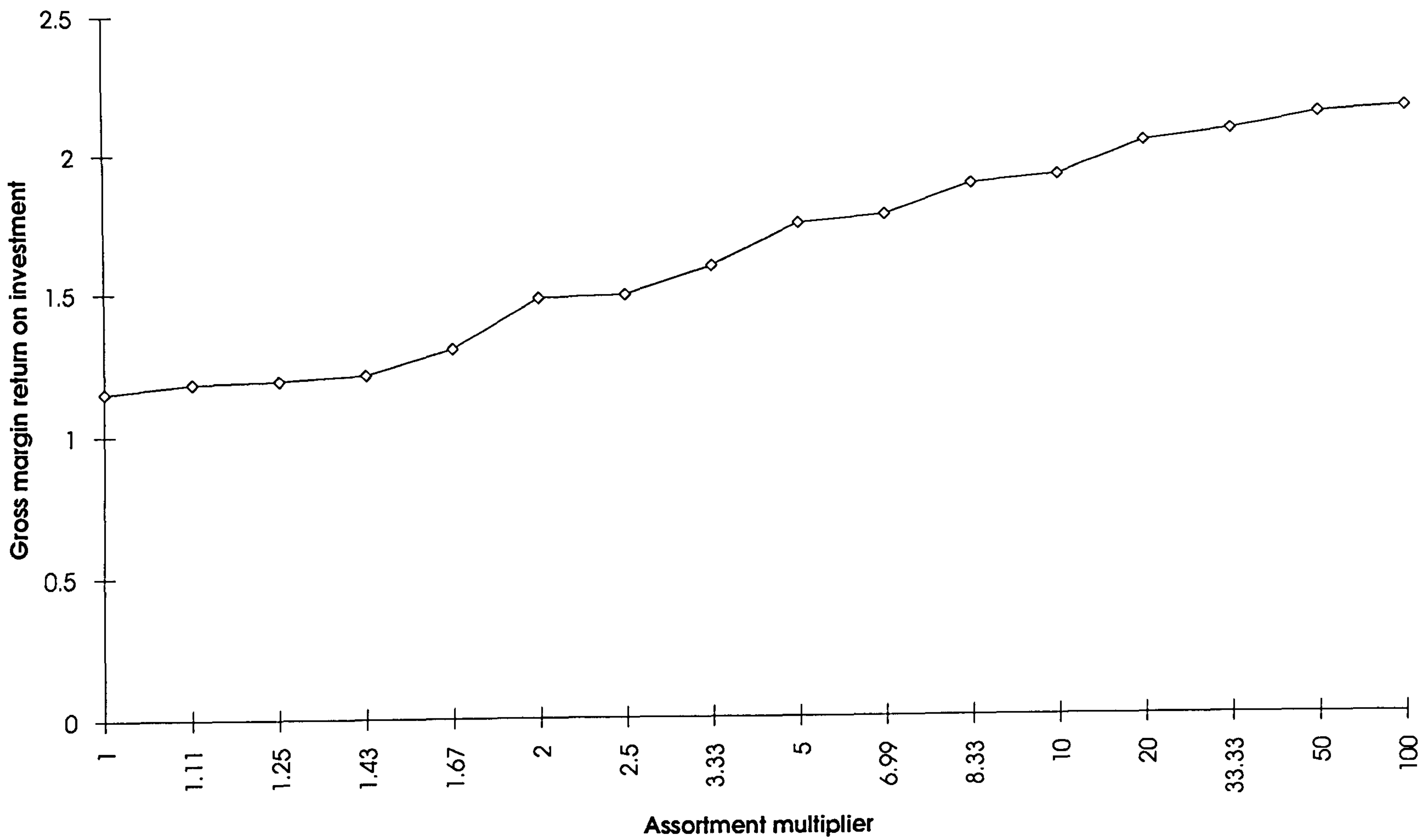


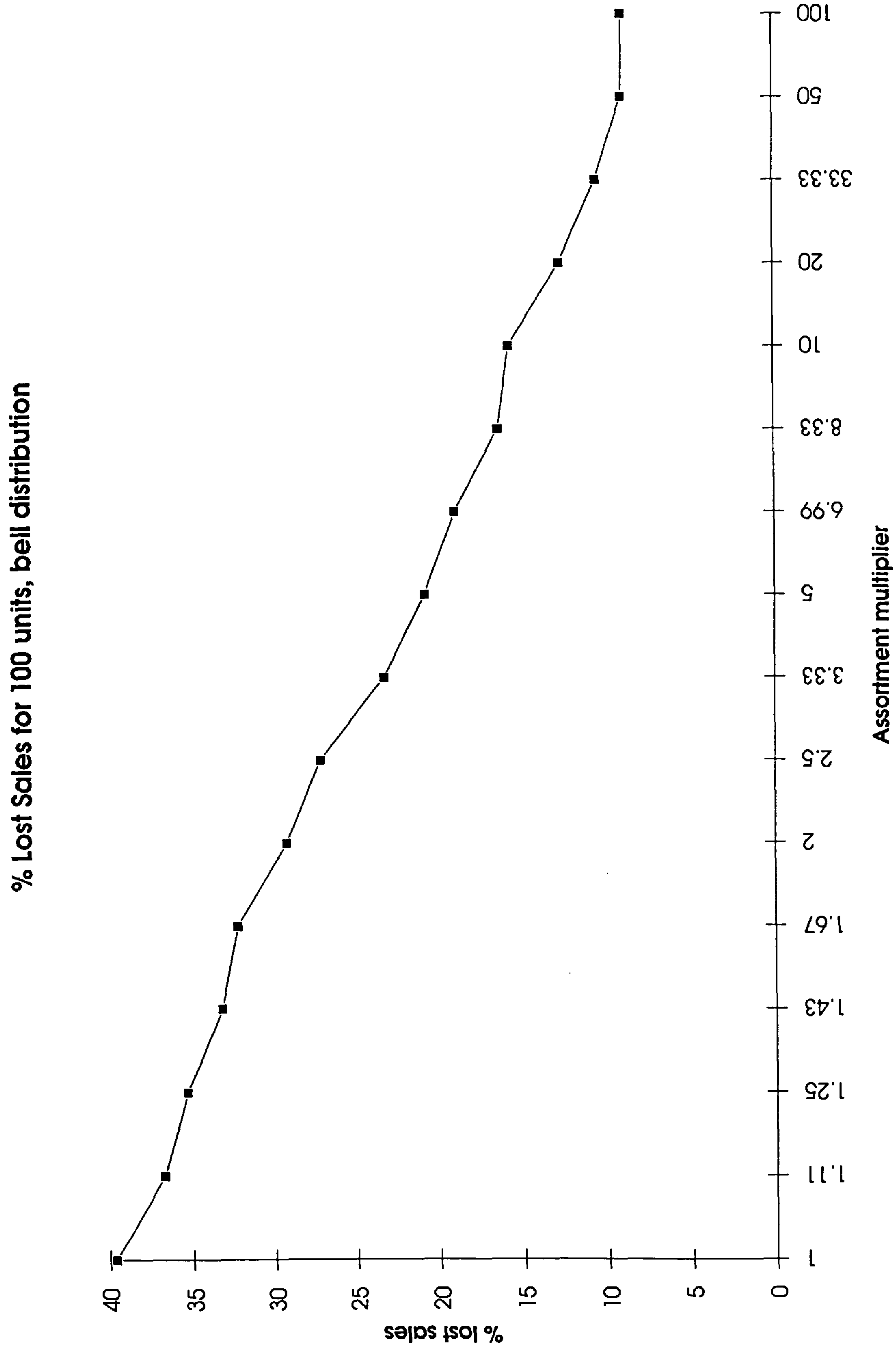

Gross Margin % for 100 units, even distribution
Gross margin %
50
45
40
35
30
25
20
15
10
5
0
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
8.33
10
20
33.33
50
100
Assortment multiplier

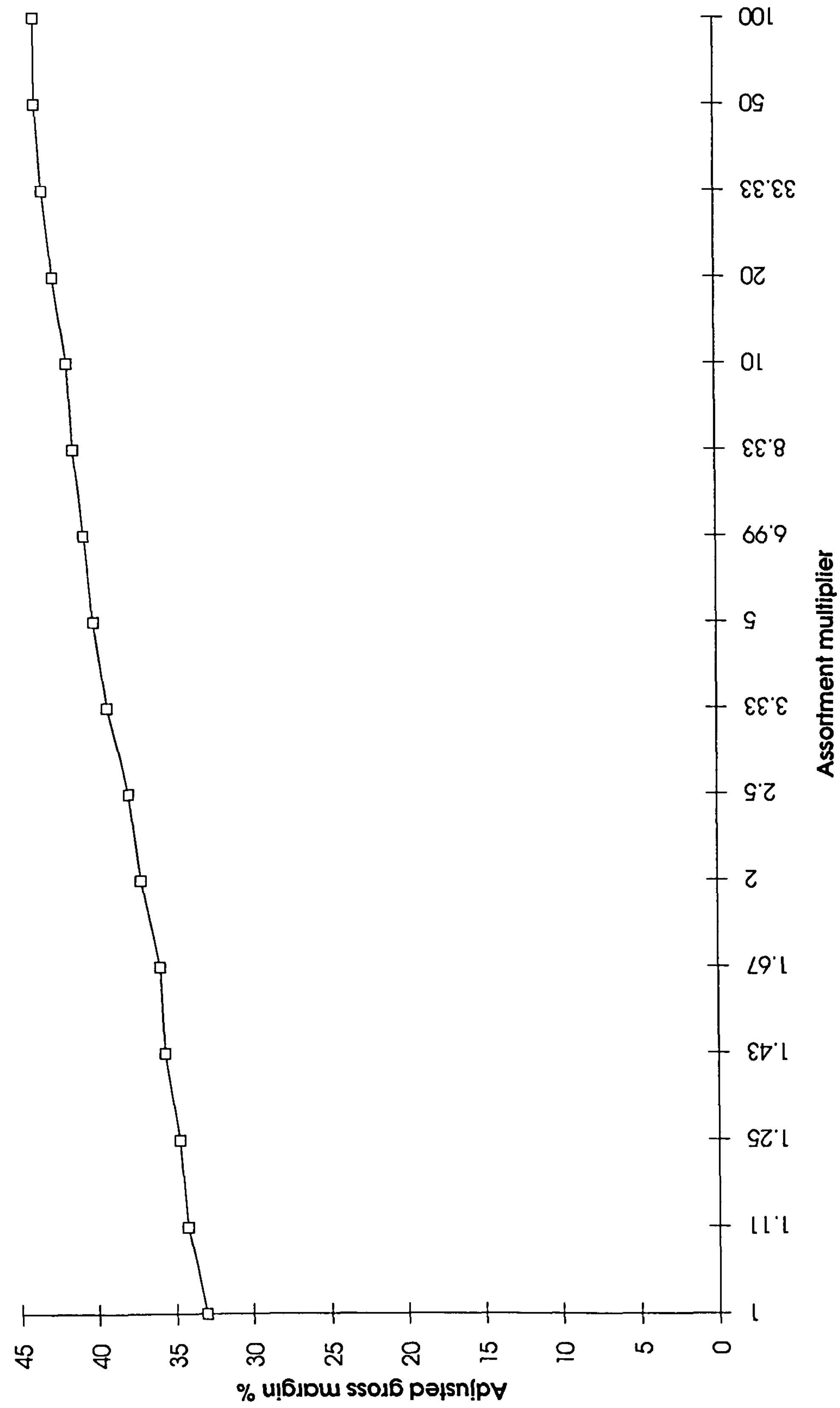
Average Inventory for 100 units, even distribution



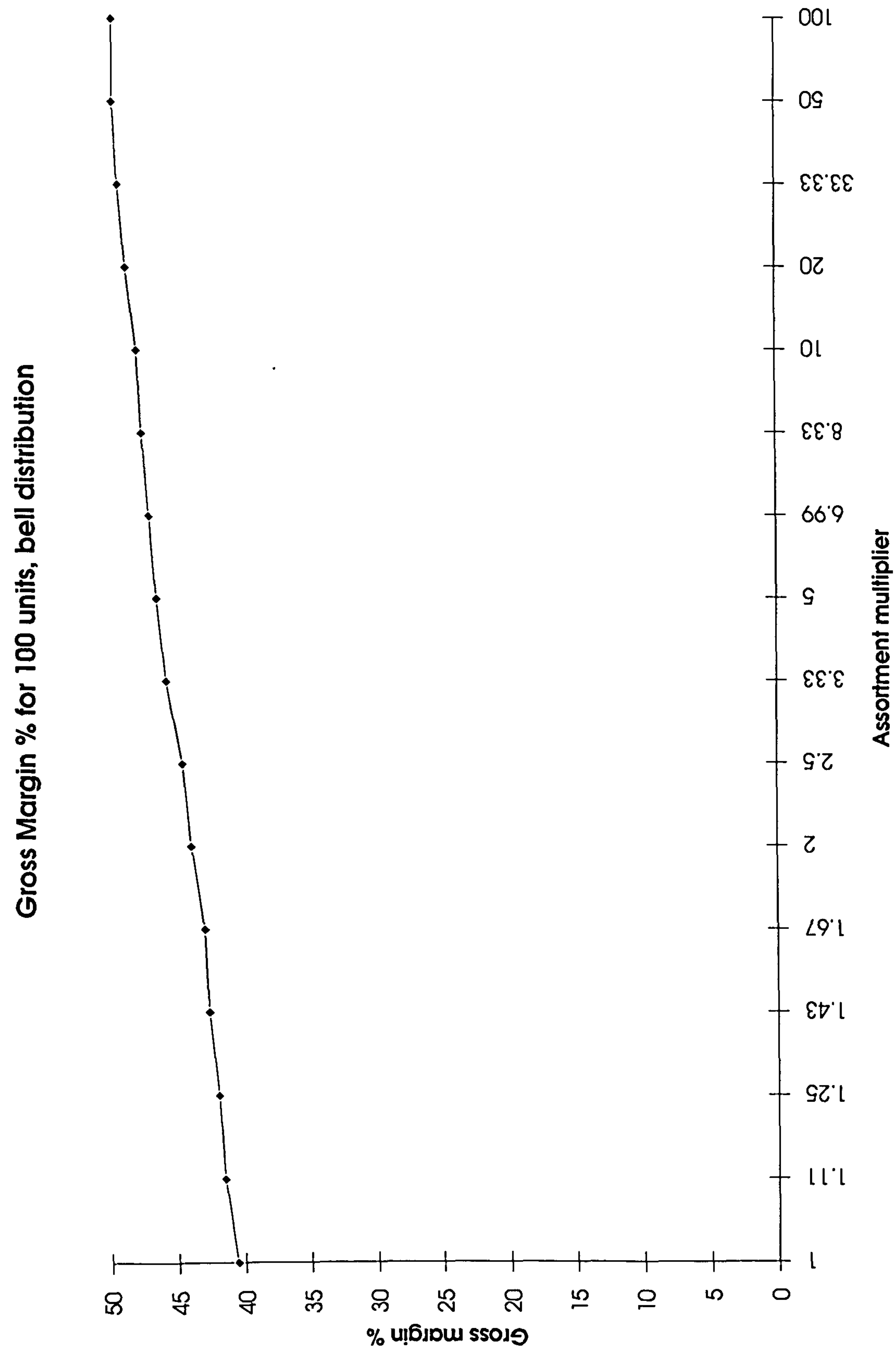
Gross Margin Return on Investment for 100 units, even distribution



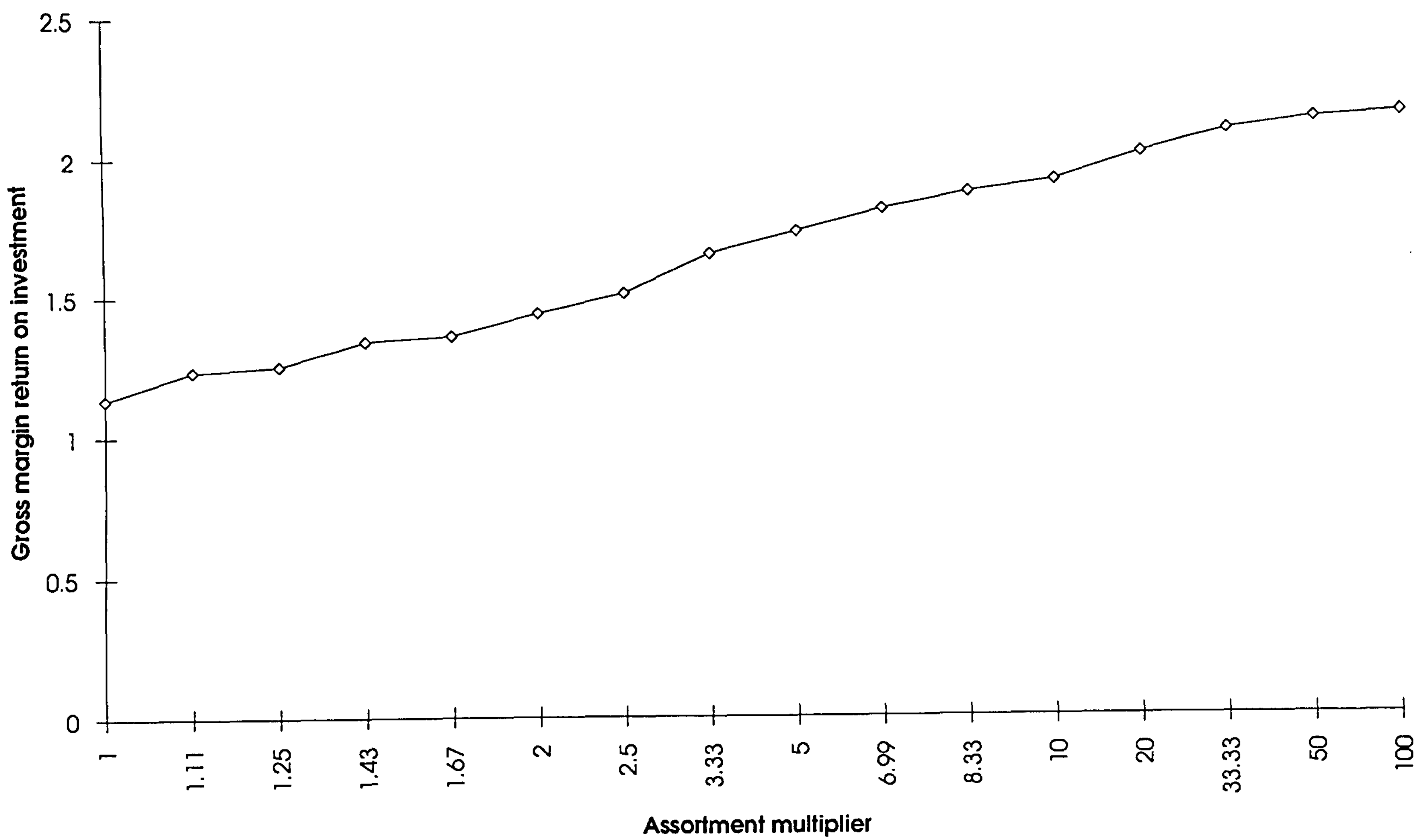

% Lost Sales for 100 units, bell distribution
% lost sales
40
35
30
25
20
15
10
5
0
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
8.33
10
20
33.33
50
100
Assortment multiplier



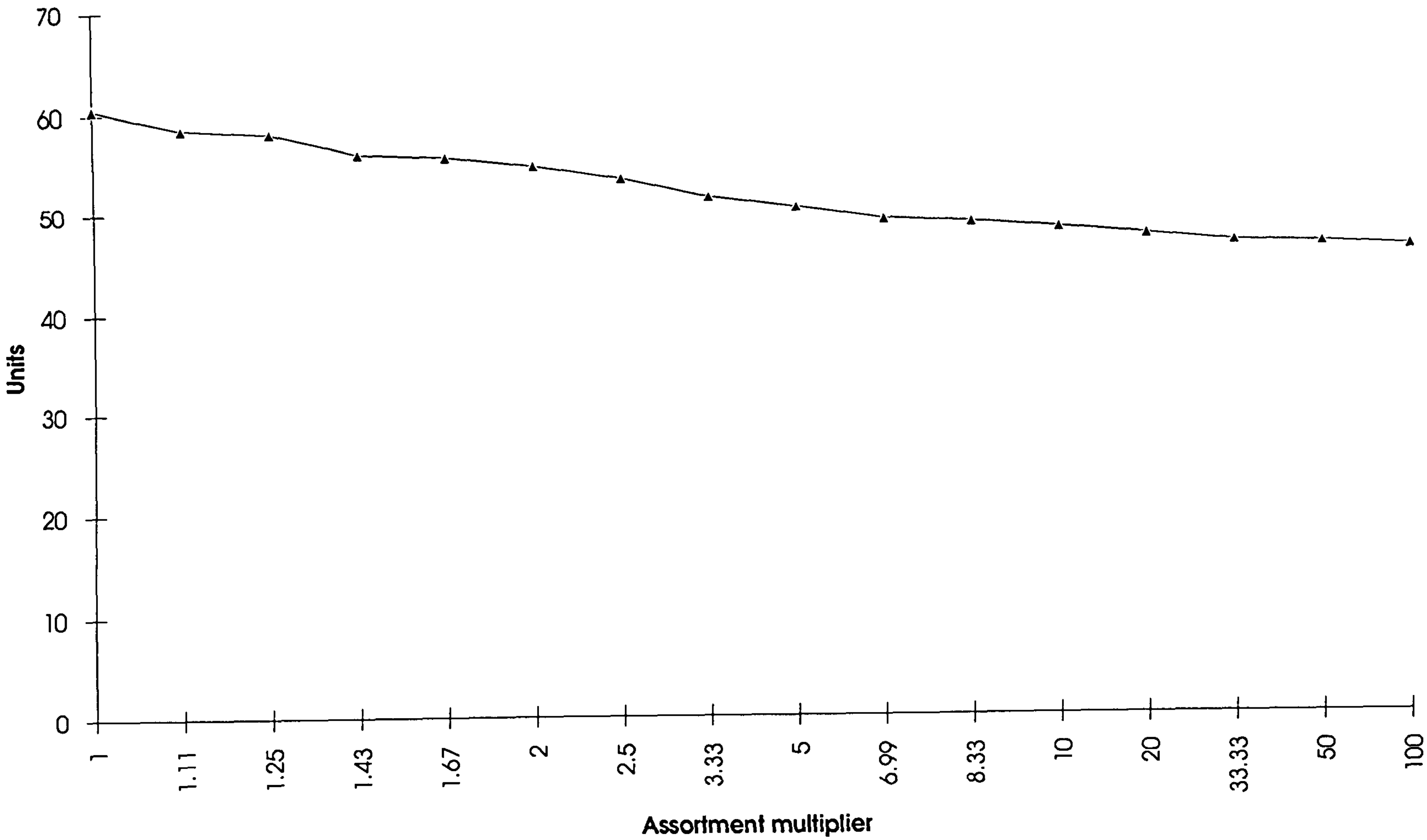
Adjusted Gross Margin % for 100 units, bell distribution

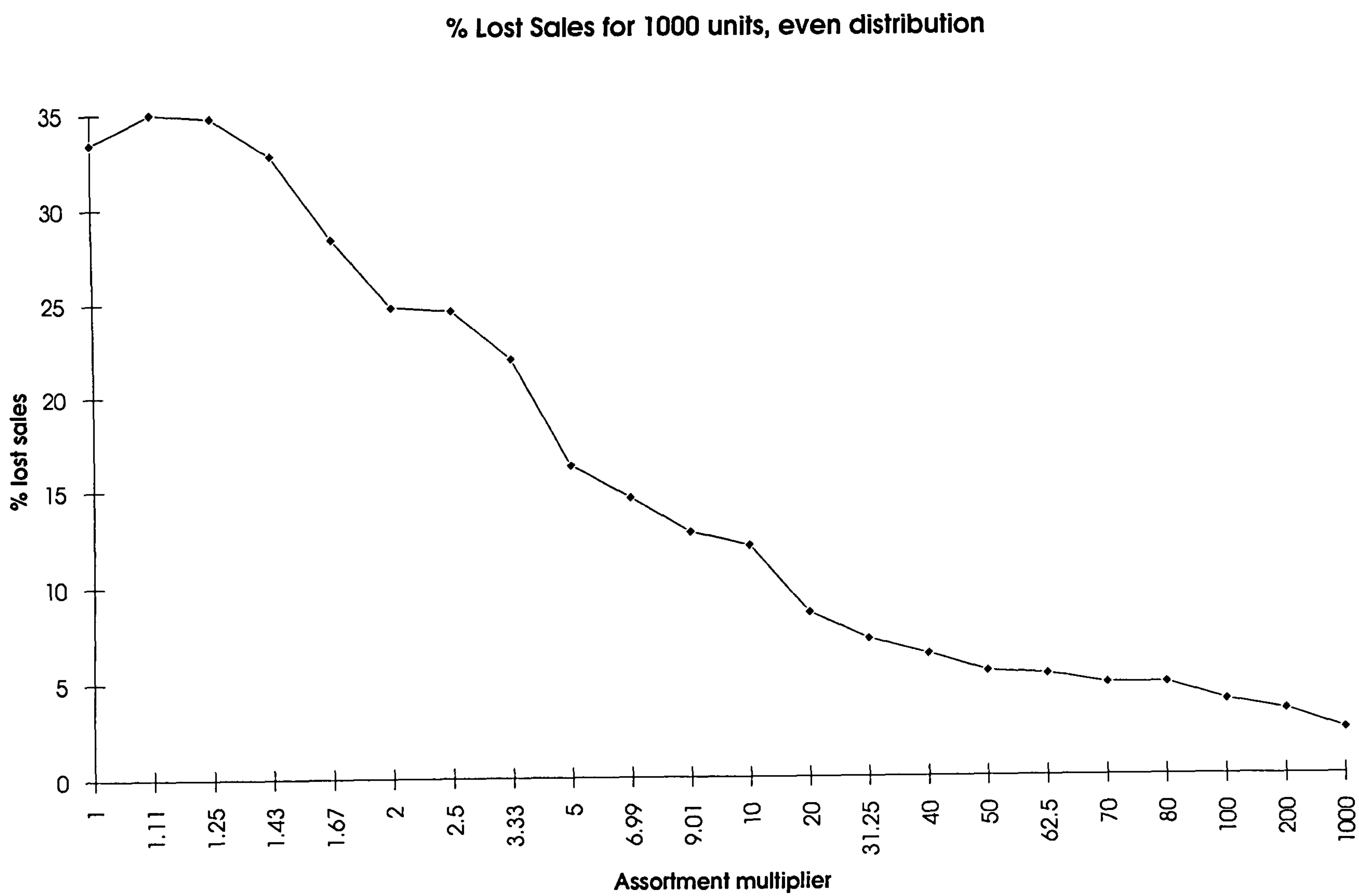

Gross Margin % for 100 units, bell distribution
Gross margin %
50
45
40
35
30
25
20
15
10
5
0
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
8.33
10
20
33.33
50
100
Assortment multiplier

Gross Margin Return on Investment for 100 units, bell distribution

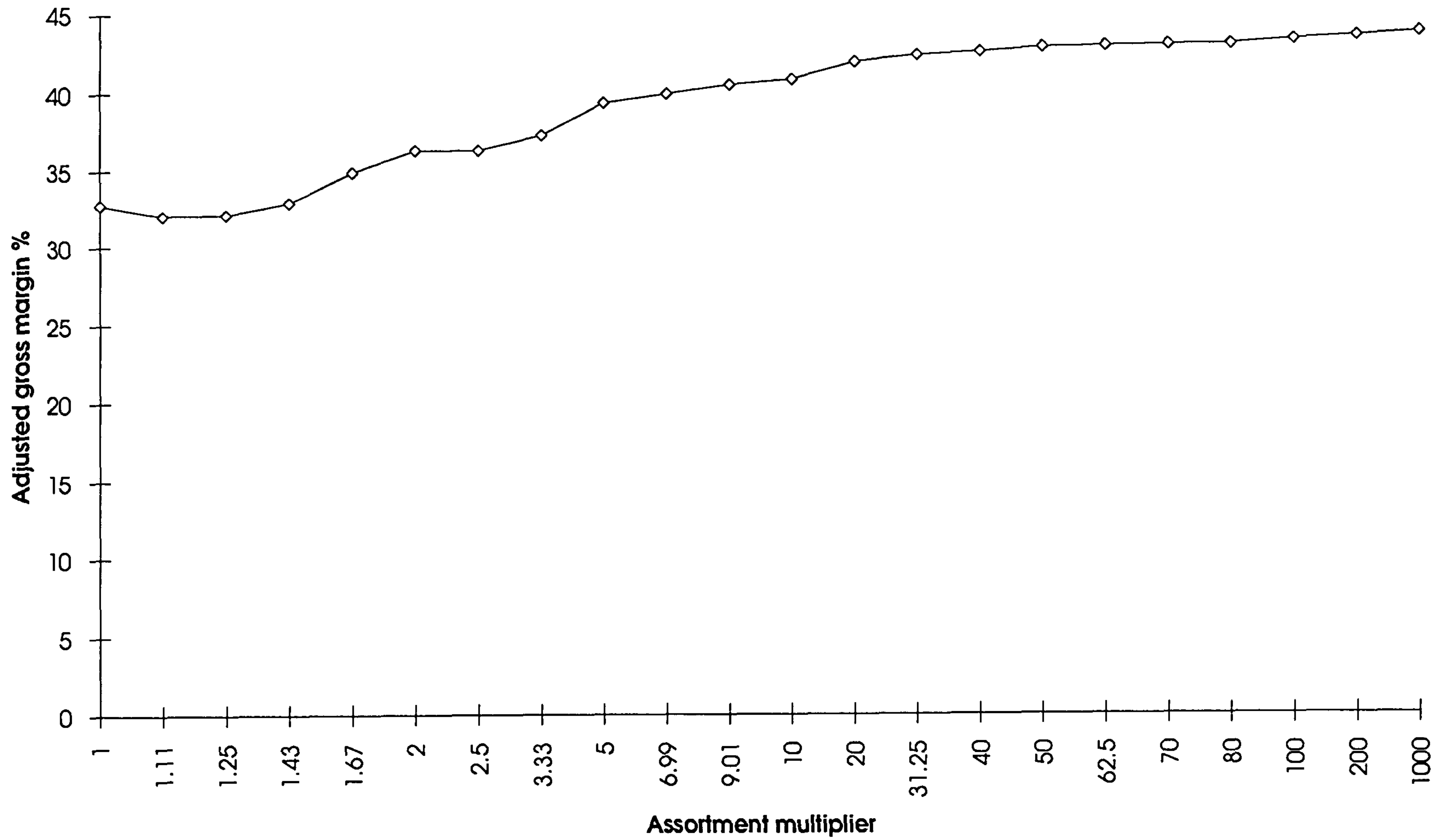


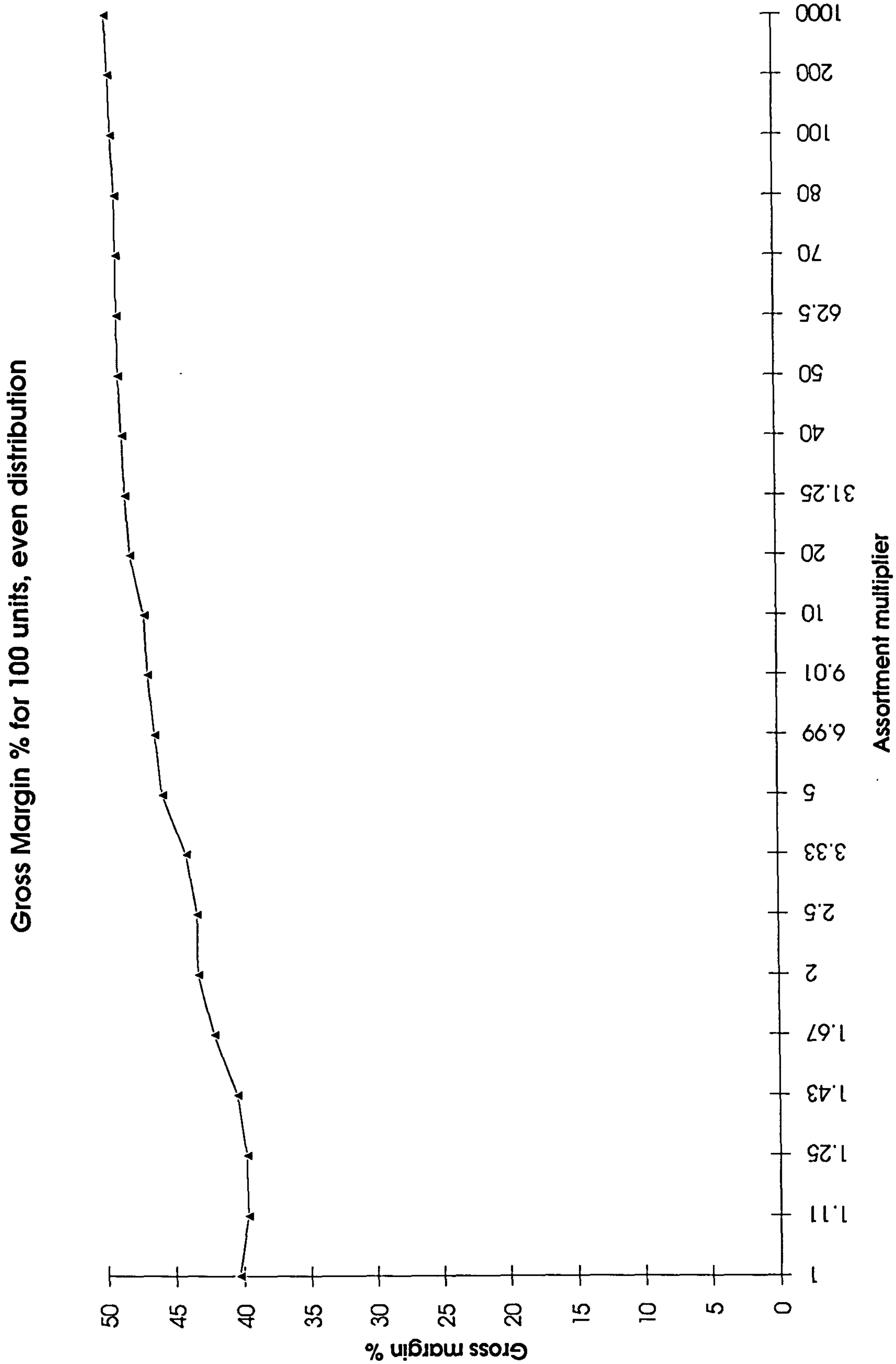
Average inventory for 100 units, bell distribution

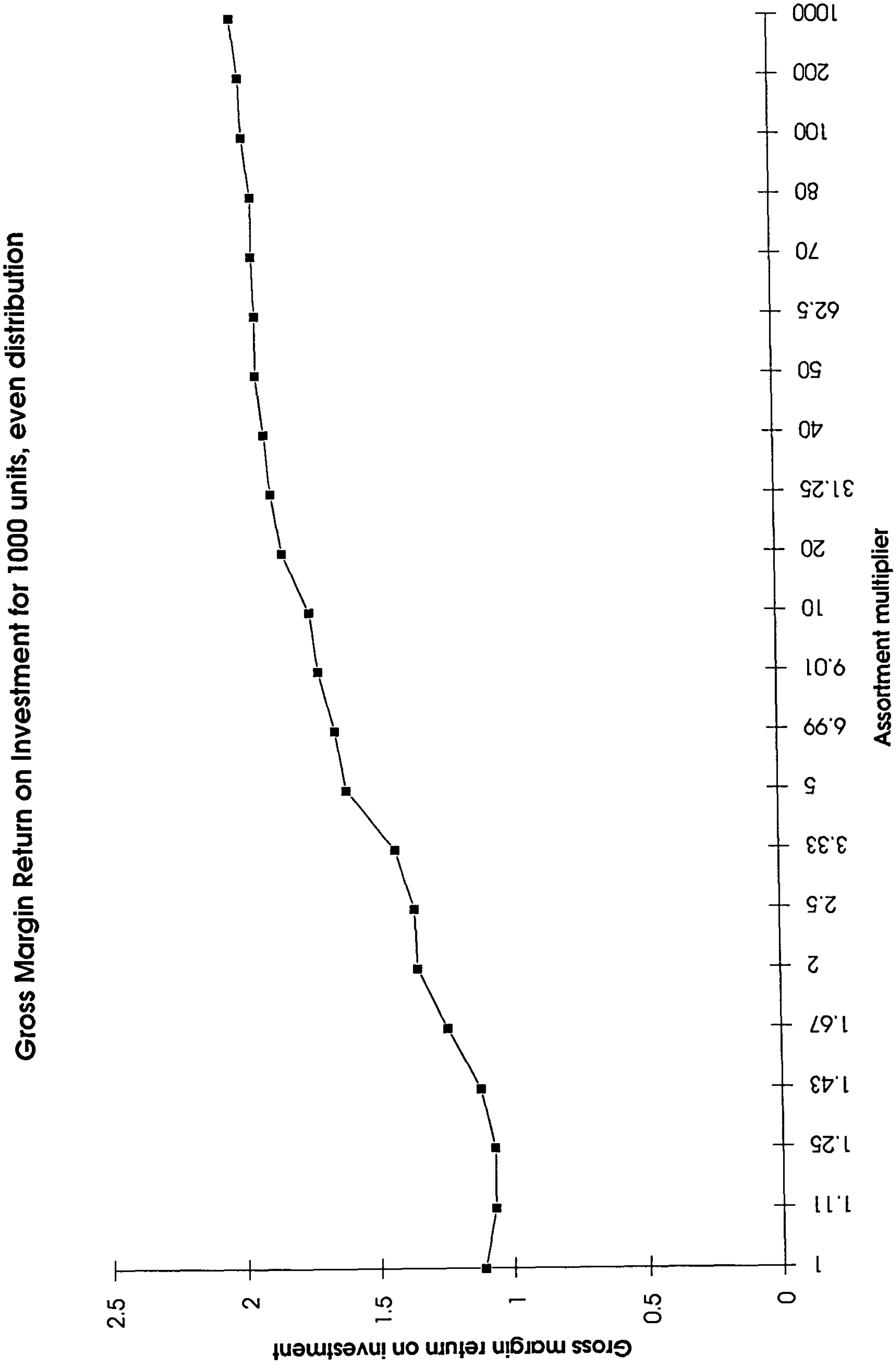


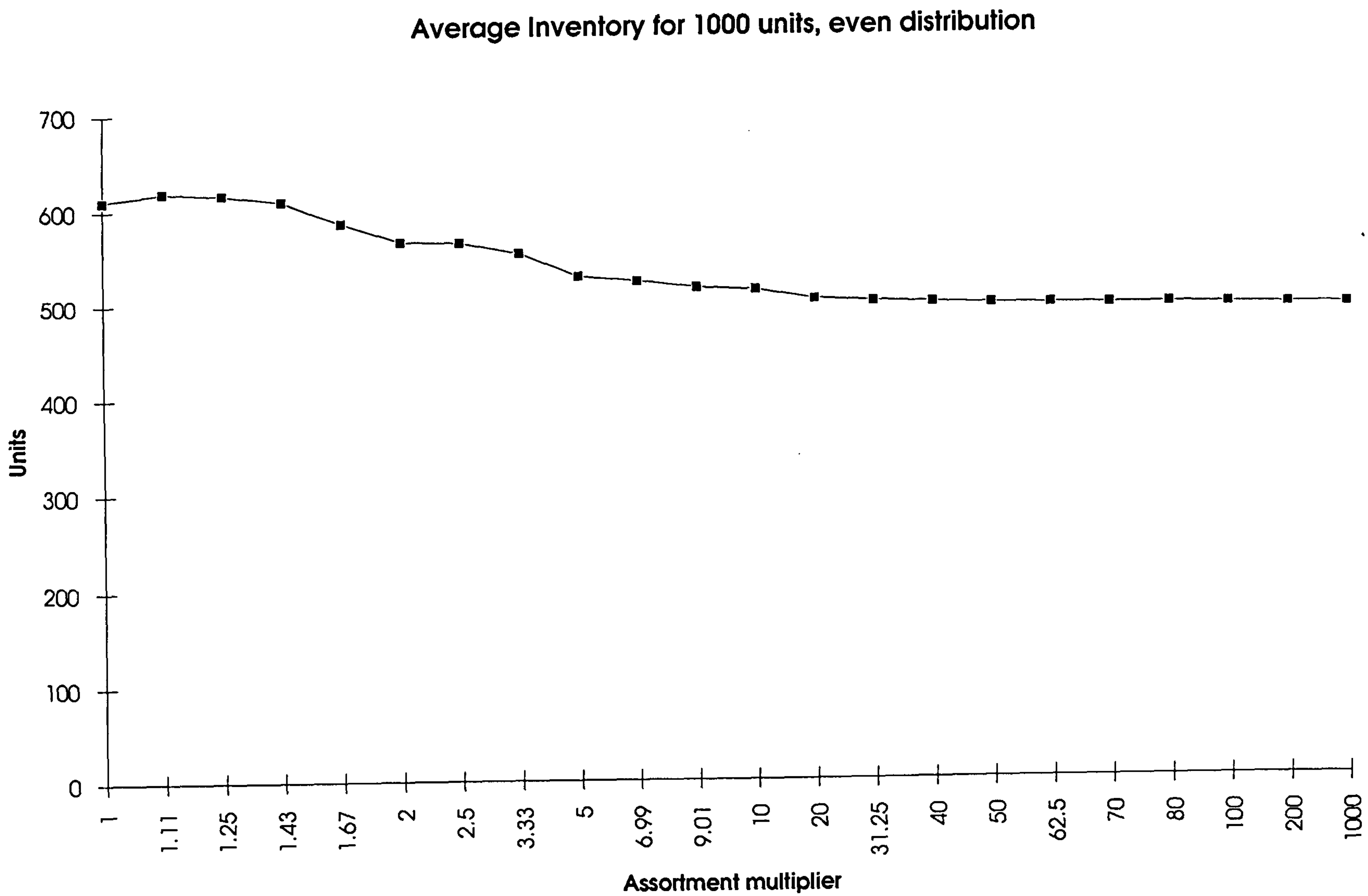

% Lost Sales for 1000 units, even distribution
% lost sales
35
30
25
20
15
10
5
0
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
9.01
10
20
31.25
40
50
62.5
70
80
100
200
1000
Assortment multiplier

Adjusted Gross Margin % for 1000 units, even distribution




Gross Margin % for 100 units, even distribution
Gross margin %
0
5
10
15
20
25
30
35
40
45
50
Assortment multiplier
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
9.01
10
20
31.25
40
50
62.5
70
80
100
200
1000


Gross Margin Return on Investment for 1000 units, even distribution
Gross margin return on investment
0
0.5
1
1.5
2
2.5
Assortment multiplier
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
9.01
10
20
31.25
40
50
62.5
70
80
100
200
1000


Average Inventory for 1000 units, even distribution
Units
700
600
500
400
300
200
100
0
1
1.11
1.25
1.43
1.67
2
2.5
3.33
5
6.99
9.01
10
20
31.25
40
50
62.5
70
80
100
200
1000
Assortment multiplier

APPENDIX 8

FINANCIAL OUTPUT NUMBERS

100 Units, Even Distribution

multiplier	LS	AGM	GM	GMROI	AV IN	SKU's	
1	39.2	33.34	40.67	1.15	59.73	100	
1.11	38.5	33.53	40.91	1.18	59.1	90	
1.25	38.13	33.69	41.04	1.19	58.6	80	
1.43	37.6	33.91	41.22	1.21	58.3	70	
1.67	34.53	35.16	42.26	1.3	56.53	60	
2	28.7	37.4	44.15	1.48	53.7	50	
2.5	28.13	37.6	44.33	1.49	53.6	40	
3.33	25.07	38.67	45.25	1.59	52.2	30	
5	20.87	40.16	46.49	1.74	50.2	20	
6.99	20.6	40.25	46.55	1.77	49.8	15	
8.33	16.93	41.46	47.59	1.88	48.53	12	
10	16.1	41.73	47.82	1.91	48.4	10	
20	11.8	43.05	48.97	2.03	47.4	5	
33.33	10.8	43.33	49.23	2.07	47.2	3	
50	9	43.87	49.69	2.13	46.6	2	
100	9	43.89	49.69	2.15	46.2	1	

Change in GM% of the defined assortment ranges:

Assortment range	Change in GM%
below 2	3.53
2-5	1.81
5-20	3.04
above 20	.72

100 Units, Bell Distribution

multiplier	LS	AGM	GM	GMROI	AV IN	SKU's
1	39.6	33.04	40.53	1.13	60.47	100
1.11	36.7	34.25	41.53	1.23	58.55	90
1.25	35.33	34.76	41.97	1.25	58.13	80
1.43	33.2	35.68	42.7	1.34	56	70
1.67	32.27	36.01	43	1.36	55.67	60
2	29.3	37.15	43.96	1.44	54.8	50
2.5	27.2	37.93	44.61	1.51	53.47	40
3.33	23.33	39.31	45.77	1.65	51.53	30
5	20.87	40.15	46.49	1.73	50.47	20
6.99	19	40.79	47.02	1.81	49.2	15
8.33	16.47	41.44	47.58	1.87	48.87	12
10	15.8	41.84	47.91	1.91	48.3	10
20	12.8	42.73	48.69	2.01	47.6	5
33.33	10.6	43.41	49.27	2.09	46.8	3
50	9	43.87	49.69	2.13	46.6	2
100	9	43.89	49.69	2.15	46.2	1

Change in GM% of the defined assortment ranges:

Assortment range	Change in GM%
below 2	3.43
2-5	2.53
5-20	2.2
above 20	1

1000 Units, Even Distribution

multiplier	LS	GM%	AGM%	GMROI	AV IN	SKU's
1	33.4	40.3	32.73	1.11	610	1000
1.11	35	39.7	32.01	1.07	618.6	900
1.25	34.8	39.75	32.08	1.07	616.2	800
1.43	32.8	40.43	32.87	1.12	608.8	700
1.67	28.4	42.09	34.85	1.24	585.6	600
2	24.8	43.28	36.28	1.35	565.2	500
2.5	24.6	43.3	36.29	1.36	564.4	400
3.33	22	44.09	37.25	1.43	553	300
5	16.3	45.84	39.31	1.61	528.2	200
6.99	14.6	46.32	39.87	1.65	522.7	150
9.01	12.8	46.82	40.46	1.71	515.6	125
10	12.1	47.07	40.75	1.74	512.8	100
20	8.6	48.05	41.89	1.84	502.6	50
31.25	7.2	48.39	42.28	1.88	499.53	32
40	6.4	48.58	42.5	1.9	498.2	25
50	5.45	48.83	42.78	1.93	496.4	20
62.5	5.3	48.88	42.85	1.93	495.93	16
70	4.8	48.95	42.91	1.94	495.6	14
80	4.8	48.99	42.97	1.94	495.33	12
100	3.9	49.24	43.25	1.97	494.4	10
200	3.4	49.4	43.44	1.98	493.4	5
1000	2.4	49.65	43.71	2.01	492.8	1

Change in GM% of the defined assortment ranges:

Assortment range	Change in GM%
below 2	3.58
2-5	2.56
5-20	2.21
above 20	1.6

APPENDIX 9

FINANCIAL OUTPUTS FOR INDUSTRY DATA SIMULATIONS

Specialty store results:

			Financial outputs		
Markup %	Assortment Multiplier	Lost Sales	Adjusted gross Margin	Gross Margin	GMROI
53%	.81	23.4%	30.87%	37.75%	.88
53%	2	12%	36.73%	42.93%	1.2

Discounter results:

			Financial outputs		
Markup %	Assortment Multiplier	Lost Sales	Adjusted gross Margin	Gross Margin	GMROI
43%	12.61	0.6%	25.58%	32.99%	.74
43%	9	0.8%	25.21%	32.67%	.73
43%	3.3	4.0%	25.19%	32.60%	.72