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# A chain store marketing information system: realizing Internet-based enterprise integration and electronic commerce

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**EXPRESS (a language used to define standard data models) is used to develop data models for products, categories, and chain stores allowing for ISO-integrated product data management. By applying EXPRESS to the task of managing product and market information, retail data are integrated in a central database and are accessible in real time by members of the distribution channel. Point of sales (POS) systems at the store level provide the streams of data from retail stores. These data are collected and kept in a central database used for dynamic sales analysis and merchandise planning. The decision models for automated shelf layout, continuous sales analysis, and real-time logistic management are incorporated into the marketing information system (MIS), which can be utilized by store managers through an easy-accessed Web-based interface. The WWW is the communicators' medium used to link the retail headquarters with the distributed retail chain. The central object-oriented database is based on the proposed EXPRESS data model and provides a means to manage large amounts of rapidly-changing information. Stores that implement retail information systems of this nature can easily expand to suitable and profitable economies of scale without loss of information and control.**

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## Introduction

The evolutionary trend of global retailing is to move away from disaggregate independent stores that sell a limited range products and toward an aggregation of stores (malls), larger stores (hypermarkets), or chain stores that provide wider assortments of products and economies of scale. With the continuing industrialization of countries and the increasing limitations on consumers' time, traditional and independent retail stores are ill-equipped to satisfy modern consumer demand. As a result, retailers are shifting from a singular focus on product distribution to a more complex emphasis on logistics and store management designed to satisfy the needs and lifestyles of the consumers.

A report published by Nielsen (1990) models problems with the traditional marketing channels as a deadlock in the flow of information. Communication becomes restricted when layers of manufacturer representatives and layers of retail buyers are used in the process of selecting merchandise for consumers. The use of traditional channels of communication results in the loss of data and negatively impacts customer satisfaction. When incomplete market information is used to select the target customers, to plan the merchandise assortments, and to evaluate the results of the marketing strategy, then incomplete product offerings and incorrect assortments are offered to consumers.

Point of sales (POS) systems provide a means to collect and transmit marketing channel information. However, by their very nature of providing a continuous stream of data, POS systems have a tendency to overwhelm retailers and manufacturers with too much information. The key to the effective use of POS data is to build data models to store and process the data. If data are integrated from manufacturer to retailer, and if an integrated communications environment is built, then buyers and sales representatives can use information for more efficient planning and negotiation.

The focus of this research is to build a marketing information system that can be used to communicate between stores and head-

quarters and demonstrate the competitive advantage of integrated data systems. The prototype information system is constructed based on an EXPRESS data model. The data model can represent much of the information related to the business of retail stores, including shelf layout and sales analysis. The system enables the retailer to trace product sales, evaluate promotion strategies, and plan product shelf layout across the chain stores. The system helps managers manipulate shelf space to attract consumers and to increase profits. Managers are better enabled to plan merchandise and to decide the inventory level of products in the store, reducing the costs of an unbalanced inventory.

## Background

In this research, current information about store products, promotion activities, and sales are placed in an object-oriented (O-O) database developed using ObjectStore (1993). Information schemes are constructed using STEP (1994), a means to develop standard market information models to represent data related to products, promotion and sales. The models are used to study changes in the market place and to develop market strategies. The objective of this research is to construct a chain store marketing information system (MIS). The system writes and retrieves data from an O-O database and communicates with users in remote sites by way of the World Wide Web (WWW). The ObjectStore database, in combination with the data models, forms a computer-aided marketing information and decision support tool. This section introduces the concepts of chain store management, retail POS systems, and the retail information systems. The standard data modeling and exchange technique, STEP/EXPRESS (ISO10303-1, 1994), is depicted in the second subsection. Finally, the concept of a common gateway interface (CGI) is introduced as a technique for Web-based system development.

## Chain store management

This section describes types of retail stores and the relationship of breadth and depth of merchandise to chain store management.

Cheesman and Wilkinson (1995) depict the current trend and development of Taiwan's retail stores, which can be viewed as the general pattern of retail evolution in Asia. Taipei City for example covers an area approximately 20 kilometers in radius. Within the city there are over two million people, five million cars and ten million motorcycles. Traffic is badly congested most of the time and particularly throughout the day when retailers attempt to replenish inventories. The demographics of this crowded urban environment necessitates the use of retail chains that allow consumers to buy products close to home and throughout the day and night. The transformation of the Taipei, Taiwan retail environment provides a leading example of the scale and rapidity of retail transition occurring across Asia. Particularly in China, the need for retail information systems is growing at an incredible rate. Even though the information needs are the same as the rest of the world, developing economies are at a disadvantage implementing costly MIS solutions seen in developed economies. Thus, the trend in Asia is to build flexible, adaptable, PC-based systems that can be applied across similar retail formats and merchandise assortments. The merchandise assortment (depth and breadth) serves as the means to classify stores into groups. Since stores within groups frequently apply similar merchandise planning and management strategies, decision support systems are customized according to retail group membership.

In order to assign stores to groups by the depth and breadth of merchandise, the following definitions are offered. The breadth of merchandise is determined by the number of categories; e.g. cereal, shampoo, and instant noodles, carried in the store. As the number of categories in the store increases, the breadth of the merchandise increases. The definition of the depth of merchandise is the number of product brands and types within a category. If the brands and types within a category are numerous, then the store carries a great depth of products. According to these definitions, stores can be classified into one of three groups:

- **Group 1:** Group one stores hold a broad range of merchandise with a large number of categories. The merchandise assortment not only covers food but also includes clothing and household items as well. The depth of each category is variable and is limited to brands and types with high turnover rates of sale. These stores have a large floor space that enables each store to hold large inventories and to reduce the number of stores in the chain. Group one consists of

wholesale clubs, hypermarkets, and warehouse stores.

- **Group 2:** Group two stores hold merchandise assortments with less breadth but greater depth than group one. For example, department stores focus on clothing categories with great depth and variety. Convenience stores focus on fewer categories but hold key categories with great depth. Convenience stores are typically set up as large chains. Since floor space is limited, only about 2,000 stock-keeping units (SKUs) are kept on hand. However, the drink or beverage category may be quite deep and hold as many as 500 SKUs.
- **Group 3:** The breadth of merchandise for group three stores is limited and with few categories. However, the depth of merchandise within a target category is extensive. This type of store is called a "category killer" and sells only one or a few categories of products in a very large store. For example, Tower Records focuses on the sale of recorded music and Toys 'R' Us focuses on the sale of toys.

Figure 1 illustrates the relative positions of each group by breadth and depth of merchandise. In this research, we focus on convenience stores that have moderate breadth and depth but the total inventory to be managed is large because the stores are set up as chains. The relative positions of store groups provide insight to the development of retail strategy and the management of inventory logistics. Group one stores depend heavily on the sales rates of items within categories whereas group three stores depend on the depth and variety within one or a few categories. Group two stores provide an interesting mix between groups one and three. For example, the convenience store drink category must be deep but the category for pet products may be very shallow. Finally, the relative position of a store in terms of breadth and depth impacts the design of the retail decision support system but not necessarily the data models. Thus, the data models used for a convenience store are very similar to the data models used for a hypermarket or a deep category store. However, a convenience store decision support system must focus more on the impact of product location and convenience in addition to turnover and delivery.

POS systems are popular in Taiwan and have been implemented in 76 per cent of the chain stores. However, only 19 per cent of stores use an infrared barcode number system (Cheesman and Wilkinson, 1995). These percentages indicate that the use of modern technology allowing for the continuous access of sales information is still in an early

stage of development. If a system is built to continuously integrate information from each store of a chain and support decisions, then ordering costs can be lowered, lead times decreased, and out-of-stock incidences limited. Just these improvements will substantially lower costs and increase profits of retail enterprises.

Lin and Liao (1997) describe a closed POS system built for Taiwan's China Oil gas station chain stores. The initial system covered several test stores and offered consumer receipt services and automatic gas refueling cards. To completely implement the POS system though, expensive hardware and software were needed to link all gas stations across Taiwan. The authors report that after the system was constructed, it was both expensive and difficult to add functions or to change data input formats. Thus, retail enterprises are finding little economic incentive to invest and implement this type of electronic commerce (EC) solution. For clothing retailers and category killers in particular, the consumer demand for variety necessitates the continuous introduction of products. If a traditional or closed POS system is implemented, its only benefit will be to provide basic accounting information. Managers will not be enabled to make the flexible and dynamic merchandising decisions necessary to survive in competitive consumer markets.

The EI/EC system constructed for this research is easier to build and less expensive than a closed POS system. We use PC-based Web technologies to facilitate the information sharing and communication between head-

quarters and retail stores. Even after its construction, the data models can be extended and applied to other decision support applications. The chosen information technologies are common and the requirements for hardware and software are PC based. Further, the Web interface costs less to develop and needs less manpower for maintenance. Thus, the system is developed using a more affordable approach that can be adopted by small or medium-size retailers as well as by large-scale retailers.

### Overview of STEP and EXPRESS

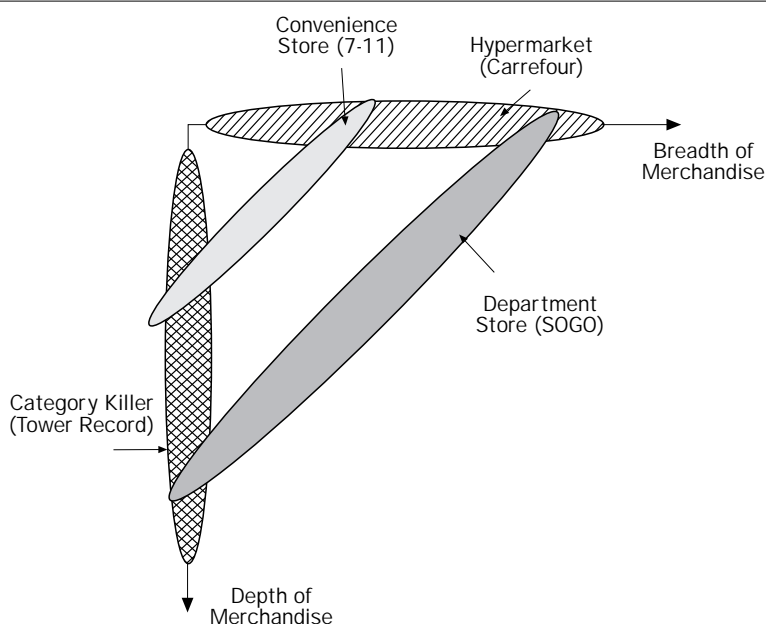
STEP is a product data representation and exchange standard that can model a variety of data types. STEP is developed to transfer product data between companies and departments (usually using different hardware and software systems) for information sharing and exchanges. In the following sections, the architecture of STEP, an overview of EXPRESS (the STEP data modeling language), and its graphical representation, EXPRESS-G, are introduced.

The Standard for Exchange Product Models Data (STEP) uses the EXPRESS language to describe a structure of product information (data model). STEP defines the different data on which the product model relies. The purpose of EXPRESS is to describe the assortment of data that is created in the complete product life cycle, and to process these data by computer. Therefore, EXPRESS is a general model language that aids computer-based management. The EXPRESS compiler compiles data models generated by EXPRESS and serves as the application language that reads, writes, and operates on the data. The object-oriented characteristics of EXPRESS extend the data model so that it is robust and reusable.

Since EXPRESS is a concept schema language, it defines the units and constraints of objects. EXPRESS has several functional units including an editor, a browser, standard STEP consistency and ENTITY constraints, schema detection and testing, and format transfers between IGES, DXF and STEP. An EXPRESS-formatted file is a software independent text file that consists of neutral data models as translation or transformation media. EXPRESS has no I/O functions and does not offer database formats, file formats, nor transfer syntax. Thus, another higher level language such as C++ or Visual Basics is used to assist the modeling process. The EXPRESS entities present information and related constraints or combinations of constraints and information. EXPRESS-G is the graphical representation interface of EXPRESS, transfers the data models into graphics and allows the user to browse or edit data models visually.

**Figure 1**

The relative position of stores by breadth and depth of merchandise



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### Basic Concept of Common Gateway Interface (CGI)

CGI is a standard for interfacing external applications with information servers, such as HTTP or Web servers. A plain HTML document that a Web client retrieves is static, which means it exists in a constant state as a text file. A CGI program, on the other hand, is executed in real time and can output dynamic information. CGI provides the middle-ware between World Wide Web (WWW) servers and external databases (or information sources). The CGI defines a method for the Web server to accommodate additional programs and services that may be used to access external applications or data sources from within the context of any active Web document. CGI allows a Web server to provide information from external databases to Web clients that would not otherwise be available to those clients in a readable form. This allows, for example, a WWW client to issue a query to an Oracle database and receive an appropriate response in the form of a custom-built Web document.

### Approach

The system architecture of the Web-based marketing information system (MIS) is shown in Figure 2. Personal computers (PC) are implemented in the chain stores to transmit

store data and sales information to headquarters and to access data from the central database. In a Web environment, retailers transmit information by forms on Web pages to the Web server. The Web server sends the information as parameters of a CGI program and executes the program for database access. After processing the CGI programs, the results are translated for the Web server and the user receives results in the HTML format. A retail store only needs a PC with a Web browser to access the centrally managed database and decision support system.

The system organization allows headquarters to collect all the stores' data and analyze consumer trends across the chain stores. Remote store sites can also obtain a standard analysis of sales from headquarters, avoiding problems that might occur from the application of individual management practices without central control.

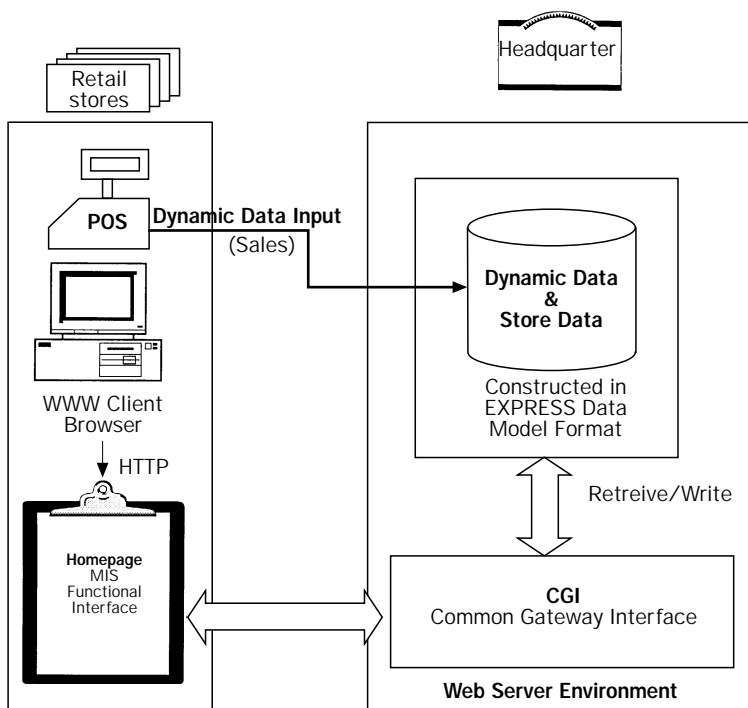
### Data modeling

Data modeling begins by defining the data requirements of the application. For re-ordering decisions, the model requires data about the inventory in each store. Second, it is necessary to define data for each product, the stock levels, brand names, product costs, and so on to determine when to ship and where to place each product in the store. Third, it is necessary to manage and rearrange the location of categories of products in each store, to identify sales trends, to introduce new products, and to track sales across the shelves and layers in the chain of stores.

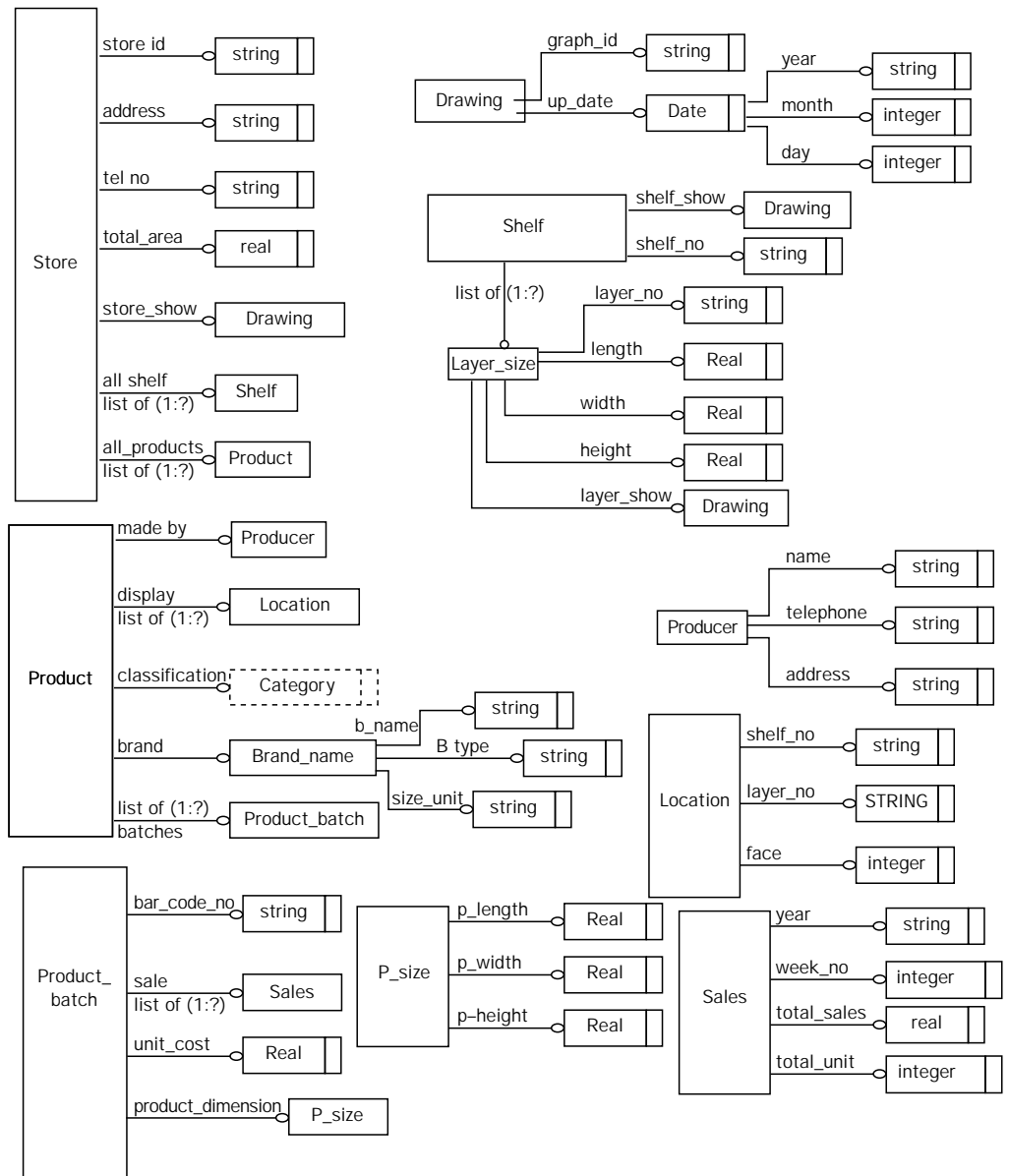
EXPRESS-G and EXPRESS language is used to specify the shelf layout schema and organized information into two main data models — the store data model and the product data model. EXPRESS-G provides representations for all entities as shown in Figure 3. The store data model includes <store\_id> to identify the store, <address> and <tel\_no> to record the location and telephone number of the store, <total\_area> to indicate the total area of the store, and <drawing> to contain the store layout graphic. Finally, <shelf> includes data about shelves in the store and <product> describes products in the store. In the store data model, the attributes <drawing> <shelf> and <product> are entities. A drawing entity includes the <graph\_id> and <up\_date>. A shelf entity has <shelf\_no>, <drawing> list and <shelf\_size> as its attributes. <Layer\_size> is defined with <layer\_no>, <length>, <width>, <height>, and <layer\_show> as the descriptive attributes.

The second data model called <product> is also an entity. The <product> entity defines its attributes such as <producer>,

**Figure 2**  
A chain store marketing information system



**Figure 3**  
Merchandise planning model created with EXPRESS-G



<category>, <brand\_name>, and <product\_batches> of the goods sold. Additionally, the entity indicates where the product should be placed using <location>. The most important attribute of the product data model is the <product\_batch>. In a retail store, there are often thousands of products. Each product may also have different purchase prices depending on its batch shipment. This case is modeled with an attribute that lists the batches, <product\_batch>, and accounts for different batches with different unit costs. For example, if the batch was purchased during a promotion period, the unit cost will be lower. However, the product may be sold during a non-promotion serial and earn larger profits. Thus, the unit cost is an

attribute of <product\_batch> and not an attribute of <product>. The attributes of <product\_batch> include <bar\_code\_no>, <sales>, <unit\_cost>, and <product\_dimension>. Frequently, the barcode numbers on products in a store are attributed to different batches. The POS system records product data such as bar\_code\_no and unit cost whereby the bar\_code\_no serves as a reference point for products that have different unit costs. By aggregating products using the barcode number, it is possible to calculate the profit of the different batches (sales price minus unit cost). For shelf layout management, different batches may also have different size packages. As an example, during a promotion period, the manufacturer

may add 20 percent volume to a product package. If the size is different, then the location arrangement relies on the new product size. The location entity includes the <shelf\_no> to indicate which product will be placed on what shelf. The <layer\_no> indicates the layer of the shelf that the product will be placed on and the <face\_width> describes the shelf frontage that will be given to the product. The sales entity is defined to collect the sales of the product and the sales record in weekly periods. Shorter time periods, such as daily or hourly sales are also possible via the data model. To identify weekly sales, the entity uses <year> and <week\_no> attributes. During the assigned week, <total\_sales> and <total\_volume> of the products sold are described. In order to analyze the shelf layout, the area of the shelf layer and the size of the product must be determined. By defining <layer\_size> as a shelf entity and defining the product size as <p\_size> entity with attributes such as <p\_length>, <p\_width> and <p\_height>, the shelf layout is analyzed.

### Implementation

First, an object-oriented database containing information about the retail store, products, shelves, and sales is built on an NT server. The database is built using the data models described in the previous section. The steps taken to build an object-oriented (O-O) database are introduced in this section. The O-O database includes retail information such as store data, product data, shelf data and sales data that are built into directories. The decision system can write and retrieve data from the database to perform shelf and sales analyses. In the following paragraphs, an overview of the application system, the requirements of the environment and the requirements of the software for the system implementation are described.

#### Overview of the system

The decision support for the retail marketing information system focuses on shelf layout and sales analysis. The decision rules and correlation programs are written in the C++ language that interface with the ObjectStore database and the World Wide Web browser environment.

ObjectStore is a high performance object-oriented database (OODBMS) for storing large, complex data structures, and provides functions such as data integrity, version control, and query processing in a complete multi-client/multi-server architecture. The objective of the system is to deliver basic

decision support needed by retailers to manage shelf layout, perform sales analysis, and develop marketing strategies. The decision system consists of five functions for shelf and sales analysis.

#### System functions

After the central database collects data from retailers' POS systems, the shelf and sales analysis system is ready to run. The system consists of five functions. These functions include store data retrieval and display, product search, sales analysis, shelf layout and shelf rearrangement (Figure 4).

##### (a) Store Data Retrieval and Display

Store data retrieval and display is a basic function to depict individual retail store information. In the main homepage of the system, there is a two-frame interface to show functions and results. When the pointer is used to click on a chain store in the table, the basic data of the store (store area, address, telephone number, and the floor plan) are shown in the viewing frame. The result of clicking on the icon is that the environment identifies that store's parameter values and uses this information to execute the home.htm file. Using the query string of the ObjectStore DBMS in the executable file, the query will find database objects in line with the values of the parameters.

##### (b) Product Search

After assigning a store, the functions accept the "store\_id=store\_value" parameters. The process and programs used in the product search function are shown as Figure 5. A search of store products by category, brand name, or supplier is provided. The operations of product search by category are illustrated in the next paragraph.

When the product search item in the left frame is clicked, the product search interfaces with the category item, the brand name item, or supplier item and the result is displayed in the right frame. When the user clicks on "search by category," the system transfers to the page product\_find\_c.htm in the right frame. There are 11 categories in the store, so by clicking on the "H\_C\_B\_A" category, the environment gets the parameter, "classification", and its value "H\_C\_B\_A" to execute the product\_c.exe file. The query strings in the product\_c.exe file find the products in the ObjectStore database that fit the "H\_C\_B\_A" category and send the result back to Web server in HTML format.

##### (c) Sales Analysis

If the sales analysis item is clicked, the page of sales.htm is shown allowing users to choose a detailed function to execute. In this

function list, there are two objectives. The first is to calculate the growth rate of sales, units sold and profits of identified product in a given period of time. The growth rate is estimated from a simple regression. The second objective is to rank sales, units sold and profits by category. The process for this sales analysis function is shown as Figure 6.

For example, clicking on the "calculate growth rate of sales" icon, the query interface of sales\_1.htm displays the sales frame. Choosing one product and time period (e.g. March), the environment sends four parameters and their values. These parameters are brand\_name=brand name of the product, year=1997, month\_1=9 and month\_2=12, month\_1 and month\_2 are represented in week number. Thus, the sale growth rate of the product in March is calculated and the results are shown.

*(d) Shelf layout*

The shelf layout function is used to show the sales trends of merchandise on individual shelves in the store. The processes and pro-

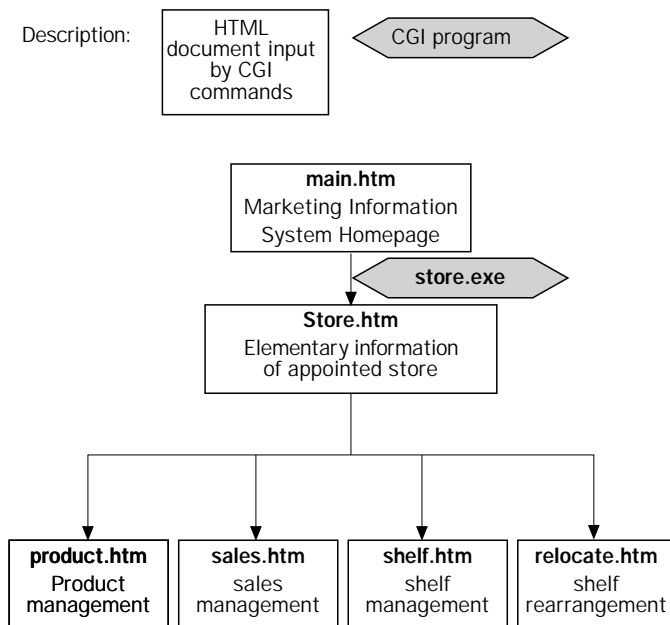
grams of the function are shown in Figure 7. Users click on the shelf that they want to analyze and a graphic of the shelf and its products is displayed. If users want to see a detailed layout of products on a shelf layer, then they click on the layer\_no.

*(e) Shelf reallocation*

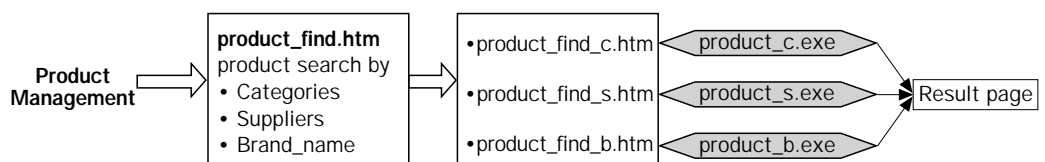
This is the rule for rearranging the display of products in a store by analyzing the sales data. The method can be separated into two stages - across categories and within each category. The process flow of rearranging the shelf layout is shown in Figure 8.

In the first stage, the store space allocated to each category is analyzed using category sales information. First, the algorithm calculates sales in the store and the proportion of sales for each category in the assigned period. Second, the growth rate of sales in the time period for each category is calculated. Finally, the proportion of shelf space for each category is rearranged according to the proportion of sales and the growth rates of categories in the store. In the second stage, a similar approach is used to allocate space to brands within categories.

**Figure 4**  
Structure of the system functions



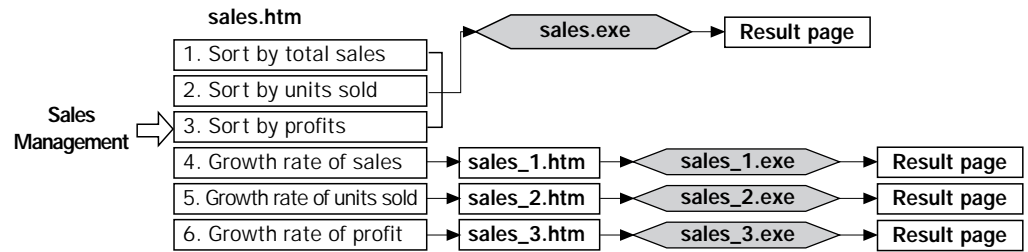
**Figure 5**  
Process of the product search function



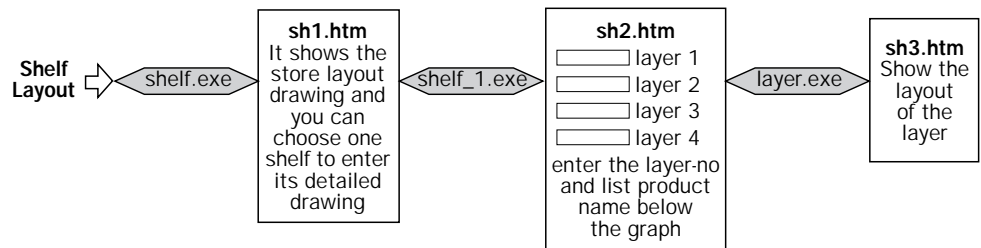
**Discussion and conclusion**

This paper offers a new approach for developing a chain store marketing information system between headquarters and retail stores. The development of the system is inexpensive and speedy. The system is not constructed in a close environment but in an open, common environment and is divided into two main efforts. First, this research defines a standard and organized data representation format for the construction of the headquarters' marketing databases. The format keeps the marketing data of the chain of retail stores consistent. The other effort is the transmission and communication of data to a central decision support system. The research enables two-way (closed-loop) communication to overcome the shortcoming of formal POS systems commonly used in the retail sector. The system uses Web technology for communication between headquarters and retail stores. The information about

**Figure 6**  
 Process of the sales analysis function



**Figure 7**  
 The shelf layout function



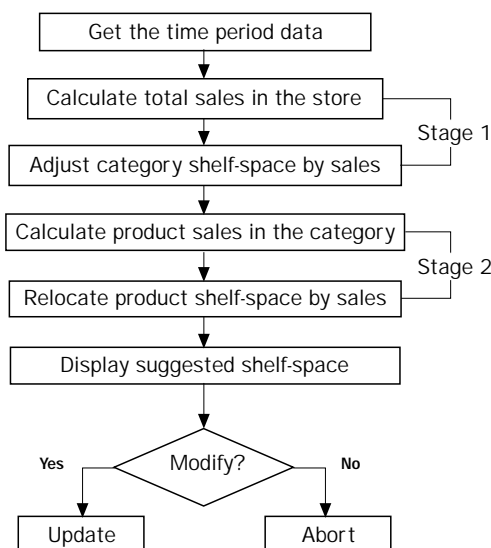
the chain of stores flows into the central database of the headquarters' computer. The headquarters' system accumulates data such as management sales history and store layout data to provide higher quality analysis and management support online through the Web. The system and its concept is easily adapted to retail enterprises because the environment, technologies, and equipment for system development are prevalent. Thus, retail enterprises can devote their efforts on developing sophisticated decision models that satisfy their business needs. The

retail MIS system architecture matches the structure of the retail business. Therefore, retailers can continue to build on the system with their modularized analytical rules without major restructuring of the information system.

There are two future directions for future research. First based on the current system developed in this research, the retail data models can be enlarged and, thus a more sophisticated decision support system (DSS) or expert system (ES) can be deployed. To enlarge the data models, the research can develop data models relevant to other marketing strategies. For instance, consumer data models can be added to collect information about buying behavior; or, enhance the inventory data model to facilitate an automatic ordering system. Second, the research may be directed toward the development of knowledge-based decision support system (DSS). Such a DSS would require knowledge acquisition and validation before incorporation to the existing system. In summary, the practical contributions of this research are:

- The research presents a standard and systematic format to collect and store a variety of marketing information. The maintenance and collection of information is therefore more consistent and can be used and translated into common data formats.
- The research offers an easy method to develop a two-way communication marketing information system. Retail enterprises can easily develop a decision support application system that is based on this structure.

**Figure 8**  
 Process for shelf rearrangement





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- The marketing information system developed facilitates electronic commerce (EC) and electronic data interchange (EDI) in the distribution channel, helping to achieve the goal of EI/EC implementation.

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### References

Cheesman, N. and Wilkinson, M. (1995), *Food Retail 2000, Food Retailing in Taiwan, Developments, Future Directions & Opportunities*, Agribusiness Marketing Service, Department of Primary Industry, Queensland.

ISO10303-1 (1994), *Industrial Automation Systems and Integration – Product Data Representation*

*and Exchange – Part 1, Overview and Fundamental Principles*, Subcommittee 4 of Technical Committee 184, International Standard Organization, Geneva, Switzerland.

Lin, M.W. and Liao, G.L. (1997), "POS system of gas station", POS Technology and Application Conference, Taipei.

Nielsen, A.C. (1990), *Category Management: Positioning Your Organization to Win*, NTC Business Books.

*ObjectStore Tutorial* (1993), Object Design, Inc., Burlington.

STEP Tools (1994), *ST-Developer, ROSE Library Reference Manual, STEP Programmer's Toolkits*, version 1.3, STEP Tools Inc.