as paper but infinitely reusable (Platt, 1997). Jacobson is considering the production of a "prime sheet of paper with millions of tiny, two-toned particles" (Platt, 1997, p. 165). The so-called "paper" is coated with a grid made up of thousands of lines of flexible, transparent, conductive ink. Text and images come into focus by applying controlled electronic charges. However, Jacobson does not expect the paper-thin electronic display to replace conventional paper within the next 20 years.

In Europe, a prototype for a new ink that will not harm the environment is being tested (Imhoff, 1996). The ink is polymerically encapsulated and held in place with a bonding agent that comes off the paper at 130 degrees Fahrenheit. According to Imhoff (1996), the dye never touches the paper, and when an item is no longer needed, the ink goes back into a solution to be shipped back to the printer so it can be reused. Moreover, paper treated with this ink will be 12 to 13 times more recyclable because there is no breaking up of the fiber by chemical bleaching.

In many fields of the graphics industry, emerging technologies offer new solutions that safeguard the environment. Universities and schools, where tomorrow's printers and graphic communicators are being educated, have the compelling task of fostering an environmentally conscious attitude among their students in order to ensure responsible graphic production decisions for the future. Vice President Al Gore highlighted the need for environmental education saying: "The most dangerous threat to our global environment may not be the strategic threats themselves but rather our perception of them, for most people do not yet accept the fact that this crisis is extremely grave" (Ortbal et al., 1996, p. XVIII). The educational aspect should not be limited to creating awareness about possible pollution through printing processes, use of hazardous materials, and the impact of paper production and consumption on existing ecosystems. More importantly, environmental education includes making ecologically sound and economically viable options available and known to students and professionals. In the graphics industry, environmental awareness combined with state-of-the-art technological know-how is no longer a matter of choice; it is rather a strategic necessity to stay competitive in an increasingly global market.

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4. A Customer Feedback Information System

by Ke Wang, Ping Liu, and Mahyar Izadi

In the competitive global economy, every organization needs to continuously improve the quality of its products and services to meet the needs of ever more sophisticated customers. Prompt response to customer feedback is a critical step toward achieving world class quality. Today, consumers demand high quality and reliability in goods and services at a fair price. The quality of products and services can no longer be taken for granted. Even industries that once enjoyed a monopoly over domestic products now face competition from foreign products. More than ever industrial companies realize that quality is vital to their survival, and industrial technology faculty and graduates can play a significant role in quality improvement and customer satisfaction.

All activities for quality improvement must be performed with customers in the principal position. Both manufacturing and customer service divisions should focus on fulfilling the needs and expectations of customers. Processes including design, manufacturing, and service begin with customer needs and expectations and end with what the customer sees and believes concerning the quality of the product. Managers must continuously understand customers' needs and provide

products and services that meet those needs (Shores, 1992).

To understand the statement that quality is meeting or exceeding customer expectations (Evans & Lindsay, 1993), we must understand the meaning of customer. Many employees think of a customer as the ultimate purchaser of a product or service. For instance, the person who buys an automobile, the guest who registers in a hotel, and the patient in a hospital are external customers. In education, employers of graduates, taxpayers (in state-supported institutions), and graduate schools may be considered external customers (Izadi, Kashef, & Stadt, 1996). Clearly, meeting the expectations of external customers is the ultimate goal of any enterprise. Also, failure to meet the needs and expectations of internal customers can result in a poor quality product. For example, a poor design for a computerized hotel reservation system makes it difficult for the reservation clerk to do his or her job, and consequently affects the customer who stays in the hotel. Likewise, every employee in a manufacturing company has internal customers—the individual or department which performs the next operation. In education, parents, alumni, and students are internal customers (Izadi et al., 1996).

Organizations must invest time, effort, and money to learn what their customers want and expect. According to Orme, Parsons, and McBride (1992), there are three major reasons to establish a customer feedback information system (CFIS). First, an organization should eliminate the duplication of research efforts and time, thereby reducing costs. Second, an organization should ensure that information about customers, products, and services is properly collected and interpreted throughout the organization. Third, an organization should provide decision makers access to better and more reliable quality information. In their research, Orme et al. discussed concepts regarding how to establish and manage a customer database and how to collect, archive, and access customer information. They believed that organizations that have begun a quality improvement program would understand the advantages of setting up a CFIS, which makes the quality transformation easier by improving the efficiency of project teams and by providing managers access to more information to make important decisions. In all business activities including manufacturing and service, organizations that manage information more efficiently than their competitors can meet their customers' expectations better. As they consistently satisfy all of their customers' expectations, these organizations will be better prepared to survive and prosper in future competition (Orme et al., 1992).

A CUSTOMER FEEDBACK SYSTEM

We set out to design an original conceptual CFIS. It included the elements of system concepts and design approach, data analysis, decision making, user interface design, and program implementation. Customer feedback was managed with a centralized database. The analysis results were used to make recommendations regarding corrective actions for various departments in an organization.

Description of the System

An effective closed-loop CFIS is an essential part of the quality information system in an organization so that customers' feedback receives prompt responses. To do this, customer satisfaction and expectations must be continuously monitored and measured (Ward, 1994a, 1994b). A typical closed-loop CFIS is illustrated in Figure 1. In this system, customer feedback is continuously collected and processed in the information system. After processing and analyzing, recommendations are promptly forwarded to various departments within an organization, including research and development, design, manufacturing, vendor relations, sales, and services.

For our purposes, the structure of customer, product, and vendor tables (explained in the Database section) was defined and constructed. This system was developed under Microsoft Windows Version 3.0 (1985) or higher operating environment and Microsoft Visual FoxPro Version 3.0 (1995). In addition, the CFIS was established to effectively measure the quality of products and services. The major technique includes a database management system, which records all relevant information on customers, products, and vendors, and structured program design. The system can analyze customer feedback, continually assess their needs and expectations, and recommend corrective actions to various departments in an organization.

A typical structure of a CFIS is illustrated in Figure 2. The system consists of five modules, including data collection, data operation, evaluation and analysis, decision making, and reporting. Customers' data are collected through various channels such as customer surveys, registrations, correspondence, communications, and returned

Figure 1. **A closed-loop customer feedback system.**

goods. Data input can be accomplished using keyboard, bar-code scanner, automatic reader, or other input devices. Data management operations include appending, browsing, deleting, indexing, searching, sorting, and updating. These operations can make data easily retrievable. Customers' data can be evaluated by various statistical tools such as control chart, bar diagram, Pareto chart, and so on. Data reporting sends corrective action recommendations to various departments, for example, research and development, design, manufacturing, sales, shipping, and customer service.

The Database

In the CFIS database, three two-dimensional basic tables were defined and constructed: customer table, product table, and vendor/manufacturer table. The three tables are independent in structure, but they can be related to each other. By keyword, common field, or relational expression, new tables can be derived from the basic tables.

In the CFIS, a product table is a bridging table. It includes common fields such as product code and vendor/manufacturer code for linking customer and vendor/manufacturer tables. In a product table, using product code as the keyword, customers' purchasing and returning activities can be searched and summarized. Similarly, using vendor/manufacturer code as a keyword, related information about vendor/manufacturer can be accessed.

With the three basic tables, other tables can be easily created as shown in Figure 3. Using keywords or common fields, new tables such as quality rating score table, quality feedback table, and customer/vendor contact table can be derived.

Elements in Design

The following steps are involved in the system design: planning and programming environment, design of a user-friendly interface between database and users, mechanisms for control, report design, customer satisfaction summary, and realization of object linking and embedding.

Planning and programming environment. Two major factors must be considered at this step. The first is to design

***Figure 2*. Structure of customer feedback information system.**

***Figure 3*. The relation between three basic tables and derived tables.**

the data flow related to data structure. Due to the entry of thousands of records about customers, products, and vendors in the CFIS, storage of the same data in multiple records or tables will be redundant and lead to waste of computer resources, especially the storage space. In addition, it also causes complicated problems for data management such as poor data integrity and extra computer processing time to retrieve these redundant records. To avoid this problem, only three basic tables were created. These tables contained the primary data required by the system and keywords as a linkage between tables. A derived table can be created through keywords such as customer code, product code, vendor code, and relational or logical expression.

Programming environment is another factor that should be considered in designing a database management system. Currently, there are many database management systems (DBMS) available. In this research, FoxPro, a relational database system, was used as the DBMS of the CFIS. FoxPro is an ideal tool for developing applications for cataloging, tracking, and processing information. Like most other database management systems, FoxPro allows the system to work with various types of data, such as numbers and character strings. Data can be stored in tables, arrays, variables, and files. FoxPro provides a rich set of query language commands and functions that can be programmed to perform data querying and processing. The advantage of the query language is that it has flexibility for application development and it is easy to use. Moreover, FoxPro has a built-in charting software, Microsoft Graph. Microsoft Graph can insert charts directly into an application's report or document.

Design of a user-friendly interface. Ideally, an application should provide an easy-to-use interface for users to make requests with valid and accurate data (Kroenke & Dolan, 1988). Availability of a user-friendly interface significantly reduces the users' burden. With the interface, users no longer need to master the environment of FoxPro and query language commands. When menus including submenus are designed in Windows format, users can easily establish a relational or logical expression to complete their desired operations by clicking the mouse on pop-up menus, push buttons, radio buttons, or spinners.

Mechanisms for control. Once the database has been accessed, processing the database must be controlled. Such controls are primarily intended to reduce the inadvertent errors. Menus and pop-up windows are two forms of mechanisms for processing control. Figure 4 shows a two-level menu structure used by the CFIS. In the main menu, a user is given the operational options of DATABASE, RECORD, ANALYSIS, REPORT, and EXIT. All optional items are represented in icons. The structure of the menu and the allowed options provide one important means of processing control. Another mechanism for processing control is the pop-up window. A pop-up window can be placed in the screen, with full or decreased size. In a submenu, if a processing option is chosen, an associated pop-up window is defined and displayed. After the desired operations are completed, users can exit the window. Since pop-up windows can be nested, they make the system levels transparent.

Report design. Printed tables, summaries, graphs, and charts represent the major outputs from the CFIS. The readability of any report, which presents the results of analysis and decisions to be carried out, is very important in the

Figure 4. **Menu structure.**

system design. Figure 5 shows various report formats, including tables, summaries, and graphs. Graphic functions present data using pie, bar, or line charts.

Customer satisfaction summary (CSS). In the analysis process, CSS was used to show the satisfaction degree of products that customers purchased or returned. In the CSS report, product name, code, rating scales, and customer satisfaction index (CSI) are included. In rating scale columns, a 5-point Likert scale was used (Bragar, 1992).

Realization of object linking and embedding. In the CFIS, the task of graphic processing is submitted to Microsoft Graph. Thus, how to realize object linking and embedding (OLE) or to combine text with graph to produce quality analysis reports was one of the tasks in the system. OLE is a set of features supported by Microsoft Windows operating system that allows users to embed or link data from one Windows application into another application. OLE objects can be stored and displayed in fields of general type in a database table. Once an object is stored in a general field, the object can be displayed or edited into tables, screens, or reports. In the system, if the GRAPH button is clicked in the ANALYSIS pop-up window, the system will work under the Microsoft Graph environment. In the Microsoft Graph environment, different graphs such as pie charts, bar charts, or line charts can be chosen to display on the screen or printed report. The charts of analysis can be stored in the general field of the relevant database file by clicking the SAVE AS button.

RESULTS: PROGRAM DESCRIPTIONS

System Requirements

Hardware and software requirements. The CFIS requires an IBM 80386SX or higher hardware system. It requires a mouse, a printer, and a 6-megabyte RAM if virtual memory is set to none or a 4-megabyte RAM if virtual memory is set to temporary or permanent. It is recommended that a VGA or higher resolution monitor be used. The hard disk should have at least a 100-megabyte storage space. The system requires Microsoft Windows version 3.0 (1985) or higher including Windows 95 in 386 enhanced mode.

System Functions Descriptions

CFIS was written using FoxPro commands and functions to realize the interface between DBMS and users. The program is divided into main program, subprogram, and procedures in structure according to their different functions. The main program is divided into three sections. A flowchart of the CFIS main program is shown in Figure 6. The first section is initialization, which sets up the CFIS environment, initializes global variables, and defines arrays. In this section, SET SYSMENU SAVE was programmed to save the FoxPro environment when users exit from the CFIS environment and the FoxPro window can be restored. The main menu definition section defines, establishes, and displays the main menu and waits for the user's choice. The third section controls the flow of the program according to the user's choice. DO CASE conditional statement was used to execute a set of commands based on a logical condition. It controls the flow and invokes associated procedures. In the system, there are four major procedures to complete database maintenance, records operations, data analysis, and reports output. They are implemented by DATABASE, RECORD, ANALYSIS, and REPORT subprograms.

Subprograms. The DATABASE subprogram consists of a series of procedures to complete operations such as OPEN, CLOSE, BROWSE, PACK, or SORT. These operations are used to manipulate tables in the database.

The RECORD subprogram includes APPEND, CHANGE, DELETE, GOTO, LOCATE, UNDELETE, and REPLACE procedures to perform operations such as adding, changing, selecting, deleting, and positioning records.

The ANALYSIS subprogram consists of customer purchase and return analysis (CPRA), product information analysis (PIA), sale and cost analysis (SCA), product and vendor summary (PVS), and customer satisfaction summary (CSS) procedures.

The function of the REPORT procedure is to generate various reports and print the data reports in tables in a desired format. In the system, 14 format files with FAX extensions were defined. Information such as text, pictures, fields,

Figure 5. **Methods of reporting data.**

lines, or rectangles about the reports is stored in these format files. Users can create other report formats according to their needs.

USING THE SYSTEM

In using the CFIS we learned the following:

1. The CFIS is an effective tool to collect, access, summarize, and respond to customers' feedback for continuously improving quality of products and services of an organization.
2. The closed-loop feedback system is emphasized to constantly improve quality by promptly responding to customers' needs and expectations.
3. The CFIS includes the functions of data input, storage, database maintaining, processing, analysis, and reporting.
4. The CFIS uses FoxPro and the Windows environment for data management. Microsoft Graph is incorporated to produce graphs for report output.
5. A limited number of data tables are needed to maintain data integrity and reduce redundancy. Users can create their own tables and report formats for analysis and summary reports according to their needs.

Figure 6. **Flowchart of CFIS main program.**

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