Faculty Working Papers

REAL-TIME INFORMATION PROCESSING
IN MARKETING

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#99

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"Improved customer service" has often been touted as a significant intangible
benefit of computer-based information systems. The basic idea is that, by applying
the computer to the marketing area, a company can greatly reduce the length of time
between placement of customer orders and delivery of the product, prepare more accurate
customer billings and statements of account, provide faster and more accurate responses
to customer inquiries, and generate more timely and complete information for marketing
executives. Such capabilities can generate a competitive advantage in the market-
place for those firms which are among the first to develop them, so the theory goes.
The result should be increased market share, sales volume and profits.

As many marketing executives would testify, levels of customer service are
not necessarily improved as a natural byproduct of computer application to the
marketing area. In some cases, the delays resulting from computerized batch
processing of customer orders actually lengthen the order-delivery cycle. And
everyone has heard stories about the customer relations blunders of which poorly
designed computer systems are capable. In short, many firms have damaged rather than
enhanced customer relations as the result of applying the computer to the marketing ·
area.

If better customer service is to be achieved as a result of using a computer,
the system has to be designed with that specific objective in mind. This requires
the involvement of marketing executives and staff personnel in the systems design
effort. As pointed out in a classic study by the consulting firm of McKinsey and
Company, "...the identification and selection of new computer applications are still
predominantly in the hands of computer specialists, who--despite their professional

expertise--are poorly qualified to set the course of the corporate computer effort."[1] The implications of lack of user involvement for marketing information systems in particular have been identified by Philip Kotler, "...few companies have taken the trouble to consider basic alternatives to their present marketing information arrangements. They are surprisingly slow to take advantage of new information-management concepts and technology."[2]

The purpose of this paper is to identify and describe a "basic alternative" to the way in which marketing information is presently being processed in most industrial companies. The system incorporates the advanced concepts of real-time information processing and data-base design. The foundation of the system is the real-time processing of customer orders -- an adaptation of the reservations systems which have been successfully used by the airlines, motel chains and others. The system is tailored to the general needs of industrial companies which utilize a sales force to market industrial goods to other producers, or consumer goods through wholesalers or similar channels. The primary objectives of this system are to maximize the level of service to customers and to provide a data base of current information for marketing decision making. Though the system may not be appropriate for all companies, there are surely many companies for which the system offers tremendous potential for giving a profitable direction to the application of computer-based systems in marketing.

<div align="center">Real-Time Systems</div>

A real-time system is basically a fast response data processing system which controls or influences a process or activity. An important concept in the definition is that of response time. The response time of a real-time system does not have to

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[1] McKinsey and Company Inc., "The 1968 McKinsey Report on Computer Utilization," reprinted in Management Information Systems, edited by T. W. McRae (Baltimore: Penguin Books Inc., 1971) p. 97.

[2] Philip Kotler, "A Design for the Firm's Marketing Nerve Center," Business Horizons, Fall, 1966, pp. 63-64.

be instantaneous, but simply fast enough to exert control. In real-time business

systems in which the work of people is the object of control, response times of

several seconds, or even a minute or two, are entirely adequate.

There are five basic elements of a real-time computer system. These are

(1) online direct-access files upon which the data base is stored, (2) a central

processing unit, (3) data terminals which provide the interface between the system

and its users, (4) a data communications network which links the processor with the

terminals, and (5) a software system, consisting of programs, documentation and other

user aids which enable users to operate the system effectively. A diagram of the

elements of a real-time system and their relationship to each other is shown in

Exhibit I. Though not specifically illustrated in the exhibit, the element of soft-

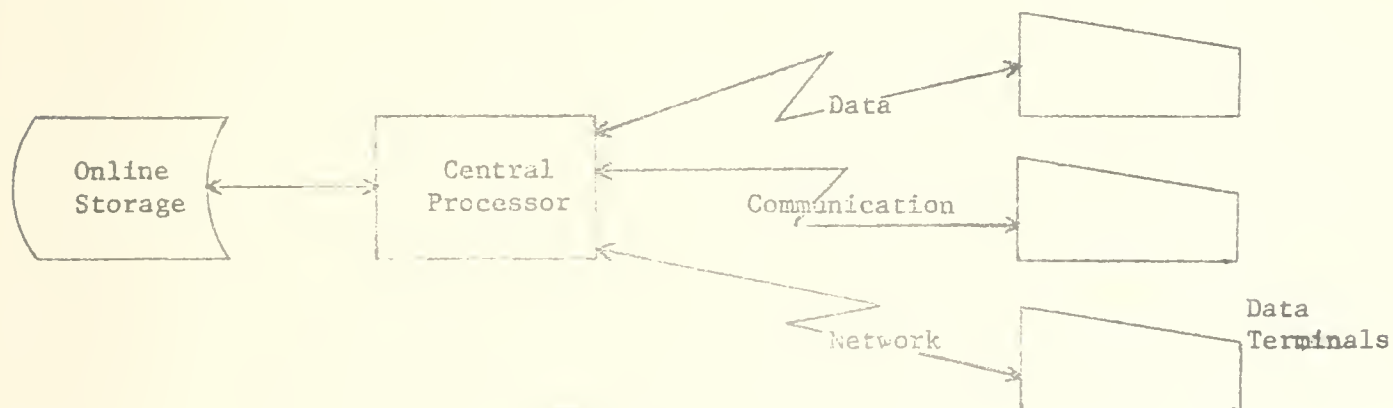ware is inherent in each of the other four elements of the system.[3]

Exhibit I

Elements of a Real-Time Computer System

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[3]For a thorough treatment of real-time systems, see the following books by
James Martin: Design of Real-Time Computer Systems (1967), Programming Real-Time
Computer Systems (1965), Telecommunications and the Computer (1969) and Introduction
to Teleprocessing (1972), all published by Prentice-Hall, Inc. of Englewood Cliffs,
N.J.

The Marketing Information Processing System

A real-time system for processing of marketing information includes each of the
five elements outlined above. The direct-access storage unit contains the marketing
data base, which has two basic dimensions---product and customer. The product
dimension encompasses for each product, (1) basic inventory data, such as units on
hand at various distribution points, units in production and their expected completion
date, and so forth, (2) price and incremental cost data, with incremental costs
classified as production, selling, transportation, and so forth, and (3) unit volume
data, both past and projected. The customer dimension encompasses, for each customer,
(1) a customer profile, (2) credit history, (3) accounts receivable data, and (4)
orders placed by the customer which have not yet been filled.[4]

The system also includes a network of data terminals distributed throughout
the company's marketing territory. Several alternative arrangements could be used
for entry of sales orders using the terminals. In a company in which salesmen
usually call on customers to obtain orders, each salesman might be provided with a
small portable terminal. This could be used to enter orders or inquiries directly
from a telephone outlet in the customer's office, using telecommunication lines
leased by the company. Another possibility would be that salesmen call in orders,
again using leased lines, to regional data collection centers at which terminals are
located. If customers usually initiate orders, each customer could call in orders
to regional data collection centers.

The system also includes, at each of the company's warehouses, teleprinter
terminals which are used to transmit shipping orders to the warehouses. In addition,
the system should include one or more display terminals available to marketing
executives, which could be used to retrieve product or customer profitability

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[4]For further discussion of data base concepts and their application in marketing,
see P. W. Kyle, "A Data Base for a Marketing Information System," European Journal
of Marketing, Summer, 1971, pp. 22-29.

analyses, performance vs. quota comparisons by salesman or product, and other

selected information on request. Finally, the heart of the system includes the

processing unit and related equipment, including one or more printers used to

prepare invoices, periodic profitability analysis summaries, and other necessary

documents and reports. An illustration of this system appears in Exhibit 2.

As mentioned above, the order entry terminals could also be used to answer

several forms of customer inquiries. For example, a customer might wish to know

whether a particular product is available and how soon it could be delivered.

Alternatively, a customer might wish to inquire into the current status of his

account, or of an order which he has placed. These and other similar types

of information could be retrieved from the marketing data base by a salesmen

within only a few seconds after such a question is posed by the customer.

The software element of this system has two basic components, (1) an order

entry and order processing system, and (2) an information retrieval system for

use by marketing executives. Each of these systems is described briefly here.

The entry of a customer order into the order processing system initiates

a series of operations. First, a variety of validation and accuracy checks

(described subsequently) are performed to assure the accuracy of each item of

data entered. Second, the customer's credit status is checked on the basis of

credit history and current accounts receivable data available from the data base.

If credit for the transaction is approved, the next step is to check the avail-

ability of each item ordered according to product inventory records in the data

base. For those items, if any, which are temporarily out of stock, a backorder

notice is written onto the inventory record in order that shipment may be initiated

immediately upon replenishment of the item. For those items which are in stock,

shipping order data is transmitted to the appropriate warehouse (or warehouses),

where shipping orders are typed on the teleprinter. Warehouse personnel may then

Sales Order
Entry Terminals

Product-Customer
Data Base

Marketing Department
Terminal

Marketing
Information
Processing
System

Warehouses'
Terminals

Invoices
and other
Documents

Profitability
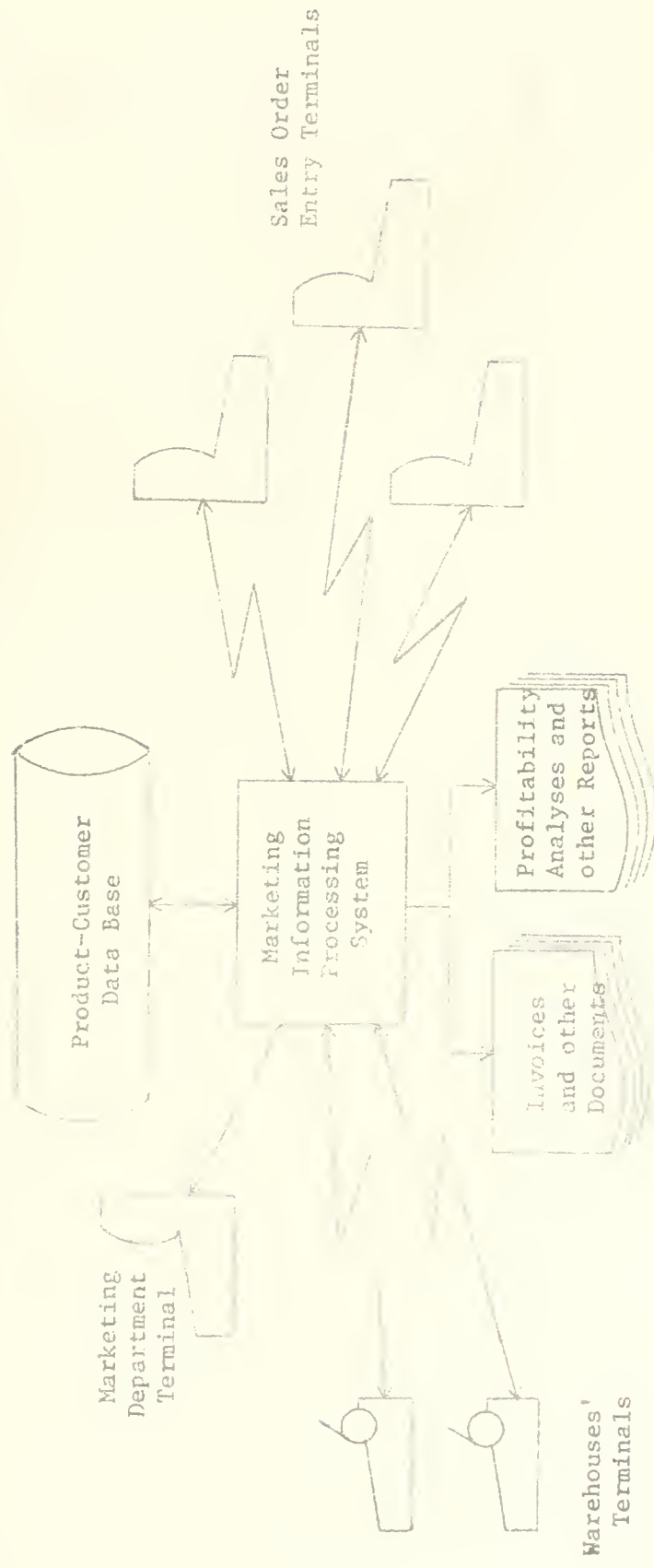Analyses and
other Reports

Exhibit 2

The Real-Time Marketing
Information Processing System

assemble, package and ship the goods with a mimimum of delay.

The next step taken by the system is to display the status of the order on the order entry terminal so that the salesman or operator may confirm the placement of the order to the customer. This should take place within a few seconds of the entry of valid order data. The system also prints customer invoices for the order, writes all data pertaining to the order on a transaction log stored on a disk or tape file, and updates all of the appropriate records in the data base to reflect the placement of the order. Finally, if the sale has caused the inventory balance available to fall below the reorder point, the system may initiate a purchase requisition or other action to replenish the stock.

The marketing information retrieval system offers vast potential as a useful tool of marketing management. Using online terminals to access the marketing data base, marketing executives may request information in a variety of forms. For example, profitability summaries by product line or region may be obtained, or detailed revenue and cost analyses by product item or customer may be generated. Requests may be structured in a variety of ways to obtain information for management by exception. For example, the system can provide a list of all customers, products or salesmen for which sales volume to date is 20% or more below quota, or a list of all territories in which total sales volume to date is below quota for a particular product. Since this information is kept current at all times, marketing executives may obtain up-to-the-minute information on sales trends, thus facilitiating management control of the sales function.

Of the two major software systems, the sales order entry and order processing system is the basic foundation upon which the marketing information retrieval system and other subsystems are built. As such, it must be fully implemented and operational before the other systems can be implemented. On the other hand, the marketing information retrieval system may be implemented gradually, becoming increasingly more sophisticated as marketing executives develop a greater under-

standing of the computer's capabilities. Ultimately, the system may be used as the basis for a marketing intelligence network. Information obtained by salesmen or marketing executives is entered into such a system as it is acquired, and then immediately disseminated to those within the organization for whom the information is considered essential. Such information may also be stored for future reference, indexed according to key words to facilitate its retrieval whenever a subject is under study to which the information is relevant.

Extension of the marketing information retrieval system might also take the form of the development of simulation models. Such models enable executives to experiment with various decision alternatives under consideration by simulating the implementation of each decision via the model, and then observing the likely effects upon volume, profit, market share and other relevant variables.

System Feasibility

A question which should have occurred to the astute marketing executive by now is, "Could this system be feasible for our company?" McKinsey and Company suggest three tests of feasibility for any proposed system: (1) technical feasibility (2) economic feasibility, and (3) operational feasibility.[5] Technical feasibility refers to the attainability of the system given the existing state of technology. Economic feasibility characterizes a system which generates economic benefits which exceed its costs. Operational feasibility involves the question of whether the system will be successfully used, and not resisted or ignored, by those persons within the organization for whom it is developed.

With respect to the real-time marketing information processing system, it may be stated unequivocally that such a system is within the limits of existing technology

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[5]McKinsey and Company, Inc., op. cit., pp. 103-106.

Most of the essential hardware elements have been on the market for a decade or more, and are now available with a wide variety of optional features. The software and design techniques have been in use by the airlines and others for a period of several years. Adaptation of this technology to fit the needs of the typical industrial firm should be within the capabilites of any competent staff of computer specialists.

With respect to economic and operational feasibility, no specific answers may be given without a thorough analysis of the unique needs and characteristics of the organization in question. However, it is possible to make some generalizations. For example, with respect to economic feasibility, specific categories of cost and benefit may be identified even though it would be inappropriate to quote precise figures. Therefore, each of these two remaining aspects of feasibility is examined briefly below.

Economic Feasibility

The relevant cost of any proposed system is its incremental cost. Since a real-time marketing information processing system would be replacing some other order entry and information processing system, it is necessary to make some assumptions about the system replaced. It is assumed here that the system to be replaced is a fairly modern, computer-based batch processing system. In such a system, orders are filled out by salesmen or order clerks and sent in batches to a computer center, where they are entered onto punched cards or magnetic tape and verified by means of keyboard devices. The order records are then sorted and processed on the computer to update accounts receivable, inventory, open order, and sales analysis files stored on magnetic disks. This processing probably includes credit checks and inventory balance checks as well as data validation routines. Customer invoices are prepared, and one copy of each invoice is used to initiate shipment of the order.

Several elements of the cost of a batch processing system for sales order entry are eliminated if this system is replaced by a real-time system. The most substantial of these is the cost of keying the data onto cards or tape and verifying it. Both the personnel cost of operator salaries and the hardware cost for the machines would be eliminated. The personnel and hardware utilization costs of sorting the records and reading them into the computer would also be eliminated. In addition, the time required for salesmen or order clerks to fill out order forms would be approximately offset in the real-time system by the time necessary to enter order data over a terminal or phone in orders to a regional data collection center.

Of the additional costs incurred in the real-time system, one of the most substantial is likely to be the cost of developing the system software. Several man-years of programming effort may be required to adequately prepare, test and document a complex system of this sort. In addition to the main file update and dispatch program, several other inquiry processing, information retrieval and support programs must be developed. The other main area of cost is hardware, and includes the cost of the display and teleprinter terminals required,[6] the cost of data transmission services between the terminals and the computer center,[7] and the cost of additional main storage within the central processor. The cost of magnetic disk files is not included under the assumption that the system replaced also used disks. If regional data collection centers are used, a third major area of cost includes the labor and overhead costs of operating such centers.

While the additional costs of a real-time system appear to be substantial,

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[6]For a "product profile" of the features and prices of most of the data terminals presently available, see the following issues of Modern Data: May, 1971, June, 1971, and July, 1971.

[7]The best sources of information concerning the cost of data transmission services are the communications carriers, notably the Bell System.

the cost savings it generates may also be fairly significant. When compared to the potential benefits for the market-oriented company, the incremental cost of the real-time system may seem much less substantial. Ultimately, of course, the project must be evaluated relative to alternative investments of systems development resources before the decision is made that such a system is economically feasible.

Operational Feasibility

Unlike technical and economic feasibility, operational feasibility is not entirely a constraint on the development of a new system. Instead, operational feasibility is best perceived as a variable which is dependent upon the way in which the development effort is planned and carried out. If the real-time marketing information processing system is imposed upon a company's marketing staff and sales force, it is unlikely that such a system can be made operationally feasible. On the other hand, if the development effort is conducted giving due respect to the pyschological and sociological factors involved in a major systems change, operationa. feasibility is unlikely to be a barrier to the success of the new system.

The most substantial factor affecting the operational feasibility of the marketin information processing system will probably be the degree of involvement of salesmen, marketing executives, and marketing staff personnel in designing and implementing the system. For example, salesmen should participate in identifying the kinds of information which are most useful to them in serving their customers. Furthermore, marketing executives must participate in identifying the most common forms of inquiry which they will address to the system, and the most useful types of responses in terms of content and format. Participation of this sort nurtures an attitude of identification with the project and its goals. In turn, such an

attitude contributes substantially to the success of the new system.[8]

Data Security

In a real-time system, it is essential to protect the data base from either (1) unauthorized access to confidential data, or (2) loss or destruction of data. Techniques for accomplishing these objectives in the real-time marketing information processing system are briefly described here.

The first essential security feature of this system is the assignment of a unique user code number to each salesman, executive or other person authorized to use the system. Each user's code number should be known only to him. Each time the user desires access to the system, his code number is the first item of data he must enter over the terminal keyboard. The system should check the validity of the user code number before accepting further instructions or data from the terminal. Furthermore, each user's code number should be changed periodically. The purpose of this control procedure is to prevent unauthorized users, such as competitors or customers, from obtaining access to a company's files.

As an extension of this procedure, each user's code number should contain an internal code which defines the transactions he is authorized to initiate and the types of records to which he is authorized to have access. For example, a salesman's user code number should restrict him to initiating only sales orders and to inquire only into records of accounts receivable, open sales orders, and finished goods inventory. The system is thus programmed to check the validity of each instruction or transaction it receives relative to the internal code of the user's code number. This prevents a salesman from manipulating payroll, accounts payable, or other records which he has no authority to examine or revise.

[8]For further discussion of the sociological and psychological factors in systems design, see Enid Mumford, "Implementing EDP Systems – A Sociological Perspective," The Computer Bulletin, January, 1969, pp. 10-13; and James B. Bower and J. Bruce Sefert, "Human Factors in Systems Design," Management Services, November-December, 1965, pp. 39-50.

Data security also requires that provision be made for reconstruction of the data base in the event that its contents are partially or wholly destroyed. The most common procedure is to prepare one or more duplicate versions of the data base periodically, such as at the end of each day. Magnetic tape files would probably be used for this purpose. Then a log of all transactions affecting the data base should also be separately maintained. If reconstruction becomes necessary, the most recent duplicate version of the data base, together with the log of all transactions processed since the duplicate was prepared, may be processed together to restore the data base to a current and accurate state.

The contents of each day's transaction log should also be printed out and retained as an audit trail of sales transactions. Furthermore, a separate log should also be maintained of requests for information from the system, including both those which were filled and those which were rejected as unauthorized. Careful review of this log could detect any effort to achieve unauthorized access to confidential data before its perpetrator accomplishes his goal.

System Reliability

Frequent breakdowns of the marketing information processing system, causing loss of real-time service, could become a source of frustration for marketing executives and salesmen. However, a trade-off must be made between system cost and the desired level of system reliability. If the system is designed under the assumption that it is not essential to maintain real-time service 100% of the time, then marketing executives must be made aware of the possibility of an occasional loss of service, and manual bypass procedures involving preparation of sales order documents must be devised for use by salesmen until such system malfunctions are corrected.

If it is considered essential to maintain a 100% level of system availability, system components which are prone to fail may be duplicated. In this way if a component fails the system can switch to the duplicate component and continue providing real-time service even while the failed component is being repaired or replaced. This is referred to as duplexing of system components. This can be quite costly, such as when the central processor is duplexed, and so the choice of this approach should carefully weigh cost factors relative to desired system performance levels.

Controlling the Accuracy of Input Data

Also essential to the success of the marketing information processing system is a high level of accuracy of input data. In a real-time system, there is only one point at which the accuracy of data input can be controlled--the point of entry of data into the system. If the system accepts an inaccurate item of input data, the chance to discover and correct the error before it contaminates all files, documents and reports is lost. This means that control of data accuracy must be focused at the point of origination and entry of input data. Since all subsequent processes are automated, prevention of input errors virtually eliminates the possibility of inaccurate data in a real-time system.

Simplicity of operator data entry procedures is one feature of a real-time system which facilitates accuracy of input data. In the order entry system, this may be accomplished by displaying an invoice or sales order format on the terminal for the salesman to fill in by typing the required data into the appropriate locations. Alternatively, the terminal might simply print a request for each data item required. The system thereby guides the salesman through the data entry process, checking that each and every required data item is entered. This helps to minimize the possibility of erroneous data entry and eliminates the chance of omission of required data by the salesman.

One major form of data control in a batch processing system which cannot be used in a real-time system is the batch total. Since sales orders are entered one at a time as they occur, there is no such thing as a batch of input records. Primary responsibility for controlling the accuracy of data input in a real-time system therefore shifts more heavily to data editing routines programmed into the system. These include validity checks, redundant data checks, closed loop verification, field checks, and reasonableness tests.

With respect to sales order data entry, the first editing routine should be a validity check on both the customer account number and the inventory stock number of each item ordered. This routine simply checks to see if the numbers entered do exist in the data base, and if so it reads the data for each record into the central processor from the data base. For new customers the validity check of account number may be bypassed, with the provision that the system does not initiate shipping papers until a credit check is performed.

To assure that the salesman does not provide a valid but incorrect account number or stock number, a redundant data check may be used. This would require that the salesman also provide the first few letters of the customer's name and of the item description. The system could then check whether the number and letters entered match with those in the customer account record and inventory stock record. For example, if the salesman enters stock number 123456 and item description CAPACITOR, and the system finds the item description TRANSISTOR under stock number 123456, an error in data entry is indicated.

Closed loop verification is another possible way of verifying the accuracy of customer account number and item numbers. Using this approach, the salesman would provide only the numbers themselves. The system would then retrieve the corresponding customer name and item descriptions from the files and display these back to the terminal. The salesman should recognize whether these data are correct.

Another type of edit routine in this system would be a field check to assure that the data entered in such fields as quantity ordered and price contain only numeric characters. In addition, if the salesman provides item prices, the accuracy of the prices entered may be tested by comparing them to the list prices on file in the data base.

A variety of reasonableness tests may be performed upon input data in a real-time sales order entry system. First, the reasonableness of the product relative to the customer may be tested. For example, it would not be reasonable for a men's clothing store to order women's underwear. Similarly, the reasonableness of the quantity ordered relative to the product might be tested. An order for a large quantity of a large product, such as 500 drill presses, would not be reasonable. Conversely, an order for a very small quantity of a small product might also be unreasonable.

If any of these editing routines detect a possible error, the salesman is requested to re-enter the item in question. After all data have been entered and have passed the various edit routines, the system may transmit critical data back to the terminal, requesting verification by the salesman of its accuracy. This serves as an additional check on data entry, and also should detect transmission errors where the data were entered correctly but were incorrectly transmitted to the system.

The design of a system of editing routines requires ingenuity and care. All of the techniques described here would not necessarily be appropriate for a given company, and some additional tests might have to be included for additional input data unique to each company's sales order procedures. The design of data editing routines must balance cost and risk factors to arrive an an appropriate set of controls for the unique attributes of the user organization.

Summary

Real-time systems may provide the key which will unlock the door to profitable computer usage in business organizations. One potentially profitable application of real-time systems is the area of marketing information processing. The dream of improved customer service through application of the computer to the marketing function may be achieved by real-time processing of customer orders. Advantages of such a system include immediate response to customer inquiries, elimination of the "paperwork" delay from the order-delivery cycle, and reduction of the likelihood of errors in sales order data entry. Furthermore, the data base developed for this purpose serves as a foundation for implementing a marketing information retrieval system to support decision making for planning and control of the marketing function.

Two relevant considerations with respect to the real-time marketing information processing system are its feasibility and the data security and control provisions which are used. Technical and operational feasibility should not present any problems, but economic feasibility may be a major obstacle for many companies. Surprisingly, however, the incremental cost of the system may be less than many executives might expect, since the system will replace some of the hardware and personnel costs incurred in batch processing of sales orders. Data security requires that user code procedures be implemented to control access to the data base, and that provisions be devised for reconstruction of the data base in the event of its partial or complete destruction. Control of data accuracy must focus upon the point of data entry, which requires that careful attention be given to sales order entry procedures and routines for validation of input data. Prevention of errors at the point of data entry virtually assures error-free processing of sales order data and its byproduct marketing information.

The future success of computer-based information systems in business organizations depends upon the involvement of executives and other system users in the identification, selection and development of new computer applications. In turn, this requires "bringing managers to a fuller awareness of the computer's vast potential."[9] This paper represents an attempt to contribute toward this goal by describing a new approach to the application of computers in marketing.

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[9]McKinsey and Company, Inc., op. cit., p. 110.