Computers in Banking and Marketing

The technology is here, with promises and problems for both consumers and corporations.

F. E. Balderston, James M. Carman, Austin C. Hoggatt

Businesses and consumers in the financial industries and in retail trade engage in varied sets of transaction activities. Computers are modifying and will modify the organization of these activities. Just as in previous decades the telephone and the automobile changed consumer opportunity and patterns of search, so too may the computer. The automobile, for example, stimulated suburbanization and the subsequent concentration of large-scale shopping centers in outlying areas where car-borne consumers could buy a large variety of convenience and specialty goods at one time and could also visit a number of stores for comparison shopping. We will discuss computer applications that relate consumers to firms in financial industries and retailing, and we will look to major future trends in services.

Our subject matter includes (i) on-line service to depositors, (ii) electronic funds transfer systems, (iii) inquiry and verification systems for credit card transactions, (iv) reservation systems, and (v) point-of-sale electronic registers.

These applications have in common the property that they support activities at the point of sale, the point at which the business establishment and the consumer come together to engage in a transaction. This focus on the point of sale will, in turn, require us to take note of consumer attitudes and concerns as they may affect the design of computer-supported systems; many other types of business computing require no such sensitivity to the marketing interface.

Consumers may have much to say about which of these systems will endure; they may endorse and patronize the systems that give better service or reduce consumer costs, and they may resist and defeat systems that are irritating or too costly. Business organizations could probe the potential consumer response patterns by developing and offering new point-of-sale systems but they will make these investments with great uncertainty. It is nearly impossible to predict the outcome of this process.

The authors are faculty members of the Schools of Business Administration, University of California, Berkeley 94720. They shared equally in the preparation of this article.

Computers in Banks and Other Financial Firms

We will discuss five types of applications: (i) batch systems, (ii) on-line inquiry and teller assistance from terminals, (iii) automatic teller machines, (iv) electronic funds transfer systems, and (v) other financial services that are supported by computers.

Batch systems. In the sequence of interactions between the customer and the financial firm (commercial bank or savings institution), we distinguish conceptually between the stages of inquiry and verification and the stages of execution and recording of financial transactions. Many commercial banks, for example, use batch processing of each day's volume of checks and deposits to produce an updated listing during the night of each depositor's account status for the next day's banking activities. Tellers consult this listing during the day to determine whether withdrawals requested are within the balance limit and to answer customer requests for information on the status of their accounts.

Many commercial banks have progressed, since the late 1960's, to the point of operating on a batch basis several high-volume processes by means of multiprogramming. These may include not only the daily check processing and updating just discussed, but also preparation of the bank's trial balance and ledger accounts.

The large-scale, batch-process systems typically centralize account files of multibranch institutions and have been implemented with complex programming. An arrangement in New York City permits a number of commercial banks to settle financial claims with each other by computer. At the end of each working day, final balances are communicated to the regional Federal Reserve Bank for recording there, but the law still requires paper documentation to follow.

There has been success, however, in standardizing input requirements so that preauthorized payments (payrolls of large employers; entitlement payments of the Social Security Administration, and so forth) never enter the "paper" system: they are prepared on magnetic tape, and the bank credits the payment to each account by passing the tape input through special programs. These preauthorized, paperless payments, which have operated for several years, have grown to account for approximately one-tenth of the Social Security payment items, and they are helpful both to the payee in assuring prompt receipt of the payment due and also to the payment source by reducing claims for lost payments. These payment systems do reduce the "float" (several days of delay before a check clears) available to the payer's bank, and the bank cannot, therefore, reward the payer as it would if the payments stream occurred with the usual distribution of delays, resulting in the maintenance of the payer's account balance at a higher level for several days after each high-volume payment cycle.

On-line inquiry and teller assistance from terminals. On-line teller assistance terminals now used by numerous savings institutions illustrate how the early part of the transaction sequence may be handled. The teller's terminal can address the customer's account in a central computer memory. All transactions are stored until the account holder's passbook or statement has been updated on the terminal printer. The teller has a limited series of available commands, each actuated by a single key. The terminal has provisions for on-line updating of any high-volume customer file, including savings accounts, collection accounts, passbook loans, and real estate loans. For any of these accounts it can deal with withdrawals or deposits, updating of interest and (if necessary) calculation of penalty interest, record changes to the master file, and teller totals for every transaction. The teller can also, by command, receive account status information on cathode-ray tube or printout before proceeding with any of the above operations. The system has printer capability so that the teller can audit the input information for accuracy before giving the command for the next steps of processing. The same system contains the

← *Courtesy Communications Satellite Corporation (COMSAT)*

general ledger of the institution, although hardware and programming controls are intended to restrict access to this system to authorized accounting personnel. For handling the institution's payable accounts, the authorized person can enter the appropriate name and accounting information and have a payment check printed on-line, with the updating of the ledger account also performed on-line.

In one well-established version of this type of system, several major operations are still batch processed overnight after each day's transactions: the transfers from savings account files into ledger accounts, the calculation of the daily trial balance of the institution, and the cross-checks and verification of accounts. The on-line system for one fairly large institution includes 400 terminals, most of which are in the branches that handle customer savings transactions; the institution's loan departments have their own display and transaction terminals, as do the general administrative departments of the headquarters. This large network of terminals is serviced by leased lines to a central processing unit operated by a specialized company with which the institution has a contract. Minicomputers scattered throughout the terminal network control the authorized access to different account files and provide message editing, buffer storage, and message concentration between the terminals and the main control processing unit (CPU) and storage.

Automatic teller machines and credit card systems. Automatic teller machines (ATM's) for commercial banking being developed are in various stages of pilot testing. The most inclusive concept of an ATM would be a machine the customer could use to accomplish any business that could now be done through a human teller. So far, the machines being tested are more limited.

One such machine is the cash dispensing machine. Chemical Bank of New York, among others, has installed these at street-side locations. The customer inserts a card, gives a password, asks for an amount of currency, and receives it at a slot.

Other ATM's are being designed to be used within a bank's branch location, either (i) as teller-assistance terminals to make deposits and withdrawals or to provide information concerning account status or (ii) to enable the customer to perform these functions alone with appeal to a bank employee if the operating instructions are too difficult to follow. It is much easier to design the terminal system if it is intended to perform only as teller assistance.

The ATM's designed to be placed at retail locations, with no bank personnel present, would offer the retail merchant a way to authorize credit or the consumer a way to acquire cash other than through the store's credit department.

Credit card transactions may now have automated support as well. One limited but useful function is that of verification and authorization of the card that is presented. At many retail establishments, this must now be done by telephone inquiry if the retailer does not wish to take the risk of defaulted payment. One system provides for negative verification of the card in the sense that its number does not show up on a list of "bad cards."

BankAmericard Service Corporation has a switching service for its member banks for card verification. An extension of the system, now being tested, allows the merchant to obtain verification either by phone call or by terminal inquiry. The merchant puts the customer's card and the sales draft into an electronic device. Then, the transaction amount is entered from the keyboard. The merchant's identification is picked up from the terminal's permanent storage. The message goes to the bank's computer. The originating bank that issued the credit card is then asked whether the card is good for the amount in question.

For inquiry and authorization as well as, potentially, for updating and transaction messages, terminal networks driven by minicomputer centers are being developed (*1*). The Bank of America's development will service, by means of 6000 terminals, inquiries concerning the status of accounts coming from its 1000 branches in California. This inquiry and message system is just one module of a series of modular arrays. Each will consist of a specialized machine configuration and operating system, designed for one set of purposes. This strategy is an alternative to that of adding more services and interactive tasks to an existing centralized and multiprogrammed system. It is not yet clear which of the two approaches is likely to win out in large financial institutions in which the capital and organizational choices are made centrally.

Electronic funds transfer systems (EFTS). The EFTS has long been discussed as a basis for the checkless and cashless society; development and pilot tests are now under way. To realize EFTS would require: (i) a terminal at each point of sale, which could not only request verification and authorization to debit the customer, but which could then begin to execute the transaction, crediting the retailer and debiting the consumer's deposit account; and (ii) a switching network to link all the financial institutions whose accounts would be affected by the flow of transactions. Such systems arouse important issues of public policy, such as privacy and security protection. Apart from these issues, widespread adoption of EFTS would affect the market structures of the financial industries and would tend to change the boundaries between retail trade and the banking system.

One basic question concerns the legal status of a payments terminal. Is it, in itself, a "branch" of the bank or savings and loan association to which it is connected? Much legal and economic analysis of EFTS will be required before this and related questions are resolved (*2*).

Widespread adoption of EFTS would, many believe, decrease the importance of branch offices of banks and savings and loan associations, which have provided services at convenient locations to their consumer customers; excess capacity and branch closings may well occur. Also, it can be presumed that the size of the capital investment required for EFTS will be discouraging to small banks and savings and loan associations and that some of them will not survive a large transformation in financial transactions systems. Some also believe that EFTS will further help the consumer allocate financial resources advantageously among types of accounts (for example, time deposits versus demand accounts), types of institutions (savings and loan associations versus banks) and ways of holding assets (treasury and municipal bonds versus accounts in financial institutions). The resulting increase in the fluidity and volatility of financial capital may well raise new problems of monetary control. Citibank, which has made a major developmental investment in the new technology, does not apparently believe that monetary instabilities will result (*3*).

The competitive equilibrium between banks and savings and loan associations may be modified by these changes in the technology of payments, reducing to some extent the importance of mandated interest-rate differentials (*4*). Many of the thorny public policy questions caused by EFTS are now being studied by a national commission on EFTS.

It is reasonable to predict, however, that competition among types of automated services will rage for some time, that competing EFTS mechanisms and switching systems will battle it out, and that, for many years to come, the present

paper-based payment systems (checks and credit card sales drafts) will continue in heavy use, coexisting with EFTS.

All of the schemes for EFTS that we have surveyed have the same fundamental cost structure—costs are largely fixed with only small variations in the cost of operation until capacity is nearly reached. At some point near capacity, these systems will display response degradation just as all other computer systems do. Unless new methods to maintain performance and security are developed, new forms of regulation will surely emerge. Overlaying such controls on the already stringently controlled banking system could produce interesting regulatory problems stretching into the indefinite future. A scheme to naturally limit growth of networks would be a valuable social asset.

Computers in Marketing

In this section we discuss the present and projected state of application of computers in the marketing of goods and services outside of banking. Discussed are applications in reservation services and retail trade. Not discussed in detail are four areas that we feel are necessary for a complete overview of our topic: computers in insurance, in securities markets, as consumer products, and in distribution of goods.

In insurance, computers are used to write new policies and process claims. This means that actuaries now have very current data on what populations are buying a new policy and how many claims are being filed on these policies. Thus, the actuary can now continuously monitor each type of insurance policy and the claims against it and detect and correct pricing mistakes much more rapidly.

The automated securities market raises an entirely new set of issues regarding exchange transactions. The goal now is to tie all regional markets into a system that functions as a single network, but another goal that may be technically possible is to replace all traders with a computer. Some research has been completed on the role of the market specialist in such a system, but many more intriguing and important research questions concerning public policy remain.

Similarly, the computer as a consumer product offers a yet untapped mine of ideas and problems. The pocket calculator is the standard example of such a product, but there are others. The electronic automobile diagnostic center, for example, is a service that has increased efficiency in a business field that has seemed in danger of being overtaxed. In contrast, the home video game and its future extensions may divert a major part of the problem-solving activity of the country to synthetic and perhaps irrelevant problems.

There have been computer systems for business purchasing and inventory management since the earliest applications of computers to business. Virtually all sellers in the industry offer some equipment and software to serve these needs. The major changes being made at this time are caused by the general availability of cathode-ray tubes and data communication networks.

Computerized reservation services. Remote terminals tied to a large CPU provided a basis some years ago for reservation services in airlines, hotels, automobile rental, and spectator entertainment events. These systems have been around long enough that it is now possible to develop some insights about their impact on the marketing of these services.

First, they are obviously efficient and powerful. Airline systems have provided more efficient aircraft use, better customer service, and a comfortable way to meet federal restrictions on the overselling of space. Still, these systems appear to have unused capacity. Most airline computers will now add seat selection, car rental, and hotel reservations to the information they store and transmit. Specialized printers at terminal sites now write tickets so efficiently that they have replaced what has historically been a major inefficiency affecting both the buyer and the seller. The end of the benefits for the traveler is still not in sight. For example, one hotel had an on-line system to keep accounts of charges incurred by its guests; it used this system to provide a wake-up service, thus relieving switchboards of a time-consuming daily task. The computer calls the room at 10-minute intervals until the phone is answered.

Buyers of hotel and airline systems now have multiple vendors to select from. National Cash Register's "Inn-Tak" is a typical modular system for hotels and motels with more than 500 rooms. The innkeeper can buy either the reservation module, the guest-accounting module, or both. Each costs approximately $60,000.

Second, some car reservation services provide insights into the demand-stimulating value of computer systems. The computer has all the paper work completed when the traveler arrives at the counter. The customer need not even produce a driver's license, because the computer already has that information. The "instant service" is a way to hold customers.

Hotel and motel reservation services provide an interesting example of another kind of promotional and competitive impact of computer reservation systems. Hotels have found that reservation services help to build customer loyalty. They have therefore formed—by integration, franchising, or cooperative arrangements—chains of hotels or motels to provide service to the traveler at every stop on his or her trip. These chain organizations use either their own in-house reservation systems or contract reservation services. Multifirm reservation services like the American Express "Space Bank" are no longer advertised. There are, in fact, only three "cooperative" reservation services left. Two of these are supplementary to systems already operated by major motel chains for their own guest reservations. These three service companies do not advertise to the public at all. The individual motel or travel agent simply advertises that it can provide reservation services to individual customers.

Computers in retail trade. Perhaps the greatest impact of computers in marketing in the 1970's is the point of sale (POS) terminal. These computers are exciting because of their potential for efficiency in retail operation, because of their potential for still further innovation, and because they bring the customer so directly into contact with the computer.

The simplest innovation a retailer can make in this area is simply to replace his mechanical cash registers with electronic ones. There are about seven suppliers in this field, with National Cash Register having about half of the market. Sales of these registers now total more than $800 million per year and are growing at an annual rate of about 28 percent. The electronic register that requires no connection to the CPU costs less than mechanical registers, reduces cashier training time by as much as 80 percent, processes a sale in one-half to two-thirds the time of old registers, and records more information concerning transactions. Thus, even the small retailer is going electronic.

The next step is to convert the POS register to a terminal tied to other terminals. In the days of the large CPU's, each POS terminal transmitted all information to a central computer, usually not even in the store. The present design concept, however, is to process the data on minicomputers at the level in the orga-

nization where the data are to be used. Cash payments are completed at the register; departmental sales analysis is done at the branch store; only summary information leaves the branch store. This practice, its advocates claim, provides more timely information where it is needed and reduces data transmission by 20 to 40 percent. Decentralization of computing also has an advantage over giant centralized systems with regard to data security. A fire will not destroy all the records of a firm; downed telephone lines will not put a store out of business for hours or days. However, the advocates of centralized data processing have not surrendered yet.

The POS terminals can next be tied to credit verification centers. The store that accepts both company and bank or travel cards might be tied into a number of credit verification centers, some in the store and some hundreds of miles away. If EFTS becomes a reality, the POS terminal stands ready to deduct your bill at the store from your bank account and add it to that of the store.

The automated service station is an example of credit verification and self-service both controlled by a minicomputer. In a typical configuration, the terminal will accept $1 bills or a company credit card. When the credit card is inserted into the machine, it triggers a phone inquiry to a distant credit verification center. If the card has been reported stolen, the terminal will capture the card and not return it. If credit is approved, the terminal will instruct the customer on how to pump his own gasoline. Of course, the terminal will also provide a summary of all transactions at the end of each working day.

The next addition that the POS terminal can accept is the laser optical scanner that can replace manual entering of information. The problems here are twofold: universal product coding (UPC) and consumer acceptance. The grocery industry worked for many years to achieve UPC. Even without optical scanning, UPC has increased efficiency. The achievement of UPC was a major accomplishment for cooperation within the industry between manufacturers and distributors.

For nonfoods, the problem is more complex. The suppliers are less consolidated and the assortment of products is much broader. Also, retailers of nonfoods realize that characters must be readable by humans as well as machines. Most items will have to be marked at the store with both code number and price in a system that has optical character recognition (OCR). A few OCR systems are in operation today, but there is a catch. Item marking plus OCR scanning for the wide variety of goods that department stores must handle pushes their cost to perhaps 500 percent of the cost to the grocery store. It is doubtful that such a system can be justified in terms of the costs, at least in stores where check-out queues are not a problem.

But even in grocery stores, optical scanning is not sweeping the country. Scanners are now found experimentally in perhaps 100 stores throughout the nation. These tests show productivity gains of about 25 percent at checkout. However, if item pricing is required, about one-third of the cost savings disappears.

We have now developed the POS terminal with the capabilities to analyze sales, to control inventories, to transfer funds, and to optically scan data. Perhaps we can replace the whole store with such a device. But we are probably not very close to the day when two-way closed-circuit cable television tied to the POS terminal will replace the store. Catalog selling by means of the printed book and the telephone is growing and is very efficient. More important, it is not clear that consumers will stand for more automation in the name of efficiency alone.

Assets and liabilities of the use of computers in promoting retail sales. The history so far of computers in direct contact with consumers provides some lessons on just when computers have positive promotional value and when they have negative promotional value. In addition, we suggest that there may be a third category in which consumers are neutral about computing in the short run but may become negative in the long run.

Computers can have positive promotional value when they yield an obvious consumer advantage. In this case, sellers are well advised to make promotional hay while the sun shines. Avis Wizard is a good example of a way the computer can improve service.

Optical scanning in food stores provides the classical example of negative consumer response. Consumers like the additional speed at the check-out counter, but they are not willing to give up item pricing. Consumers do not trust supermarket pricing anyway. Removing prices from items in the name of efficiency has not met with enthusiasm. In fact, the legislators of four states (California, Connecticut, Massachusetts, and Rhode Island) quickly passed bills prohibiting the removal of item prices.

Some other new technologies may or may not encounter long-term consumer resistance. Computerized banking systems could be simpler if consumers did not insist on the return of their canceled checks; but, so far, consumers want to keep this form of personal record for their own audit control. Fearing that consumers would refuse to give up possession of the printed account record, savings and loan associations also seem to be hesitating to eliminate the savings account passbook. Besides resisting loss of control over their own paper records, consumers may not adapt willingly to changes in the timing of payments. For instance, checks now require a few days to clear, and many credit card transactions are not settled for several weeks. Will consumers resent compression of these payment cycles?

Consumers are likely to be either indifferent to the new systems or mildly hostile to them as one more new, depersonalized system. Why should consumers be interested in paying for the new payment services? If consumers do not care enough to finance the new schemes, this creates a struggle between the retailers and the financial institutions over who will bear what costs.

Some Possible Social Responses to Pervasive Computer Systems

The growth of information networks with memories raises issues of security and individual privacy. Large investments may be made to protect the privacy of individuals and the integrity of systems from breaches of security, but both theory and practice tell us that such investments can, at best, reduce but not eliminate the probability of harm. At some point, the marginal investment cost will exceed the value of the marginal improvement in security. These large-scale interconnected financial and marketing systems, since their control programs are merely information having special meaning to a computer, will be vulnerable to the terrorist or thief.

Realizing that complete security is not possible, we could perform an interesting social experiment. Suppose two electronic funds transfer systems were offered with identical financial systems capabilities. System 1 is very secure and devotes much of its effort to protecting the privacy of customers; this expense is passed through in-service charges to the users. System 2 has easy access for people or organizations who may use the data in the files for any purposes they wish (since the blackmail potential for this information is nil, presumably the users would be doing marketing research). Customers are paid a premium for using system 2 and the commercial

interests pay the costs of operation. This scheme has the interesting prospect of allowing a market choice for consumers with regard to privacy. It also has the potential for cost reduction, as many a type 1 person could be transformed into a type 2 person when the costs were made explicit.

The quality of service is also important. While an information bit is binary, complex systems that handle and deliver information are subject to response degradation ranging from minor response delay to information "brownout" or even collapse. There is also a risk of irrecoverable losses of stored information.

Automobile recalls for safety, environmental impact, and consumer satisfaction are good examples of the far-reaching changes which are in store. In such systems statistical quality control is not enough. Records must be kept initially on the product identity and on the seller's identity and location. Records are also kept over time; as defects become apparent in use, the consequences are determined, and some subset of already sold items is called in for warranty repair. Indeed, with the built-in computer monitoring systems necessary to meet the stringent environment controls of 1980, it is possible that the decision to recall could, for some conditions, reside in the control computer of the individual car and be evoked when failure was detected in use.

This raises an interesting possibility for decentralization. As miniaturization continues and more powerful devices with memory become available, it will be possible to place monitors in all sorts of equipment (home appliances, and so forth) and to keep a log of activity. A record of demands and performance available to manufacturers and consumers would be a useful basis for warranty decisions, and it might relieve a burden of centralized data storage and retrieval.

A common thread in these examples is growth toward more complexity. We have mechanisms at hand that permit great expansion of bureaucratic regulation (public and private) and that may induce us to choose organizational forms of increasing complexity. We should be cautious about embracing these possibilities. Automobile recall requires considerable information. A matrix of interactions between dealers and owners extends over time and requires storage that increases at least linearly with time. Cost accounting for such information systems is not yet well developed, and storage without retrieval has been with us ever since man invented librarians, so it is unlikely that these systems will be well run.

Random isolated failures of complex information systems are expected and accepted. The social consequences of the general failure of such systems are less acceptable and less understood.

Any EFTS should be designed to be robust against general system collapse. Experiments with parallel systems should include careful tracing of costs and benefits. These systems should not be imposed on society before they have been thoroughly tested.

References

1. J. D. Foster, *Datamation* **22** (No. 7), 54 (1976).
2. W. P. C. Baxter and K. E. Scott, *Retail Banking in the Electronic Age: The Law and Economics of Electronic Funds Transfer* (Allanheld Osmun, Montclair, N. J., 1977).
3. CitiBank monthly economic letter (December 1976).
4. K. J. Thygerson and K. Reich, paper presented at the 2nd Annual Conference of the Federal Home Loan Bank, San Francisco, Calif., 10 December 1976.

The Impact of Integrated Electronics in Medicine

Robert L. White and James D. Meindl

Health care presents a singular opportunity to improve the quality of life in our society through electronics. In modern medical practice the premier diagnostic and monitoring tools are electronic instruments as illustrated by the x-ray and electrocardiograph. An electronic prosthesis, the implantable cardiac pacemaker, is essential to life for many patients. In medical research, a myriad of electronic instruments ranging from electron microscopes to pinpoint-size microelectrodes contribute enormously to the prevention, identification, and treatment of disease.

During the past 16 years the monolithic integrated circuit has had a revolutionary impact on electronics. Throughout this period the number of elements per chip, or the functional complexity of integrated circuits, has doubled annually. Today 64,000-element chips are commercially available. Because of their low cost, excellent performance, high reliability, and small size, integrated circuits have made possible whole new industries, and their impact pervades our lives. In particular, the unique capabilities of integrated electronics can be applied to medical instruments with enormous benefit to the quality and availability of health care. The purpose of this article is to illustrate through a number of examples how health care has been expanded through the new diagnostic, monitoring, and prosthetic instruments now possible through integrated electronics.

Diagnostic and Monitoring Instruments

The ideal diagnostic instrument provides definitive data on the patient's condition, causes him no harm or discomfort, and is convenient, reliable, and economical for the physician or his medical associates to operate. A monitoring instrument imposes the additional stringent requirement of virtually total freedom from the need for a human operator. Because of their noninvasive character, transcutaneous instruments such as computer-aided tomographic x-ray scanners, electrocardiographic monitoring units with automatic arrhythmia detection, and ultrasonic imaging and blood flowmeter systems offer the greatest possibilities of fulfilling these idealized specifications. However, in view of the limita-

Dr. White is a professor of electrical engineering and materials science and is director of the Institute for Electronics in Medicine in the School of Engineering, Stanford University, Stanford, California 94305. Dr. Meindl is a professor of electrical engineering and director of the Stanford Electronics Laboratories in the Stanford School of Engineering, Stanford University.