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On Real-Time Systems

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It is this author's thesis that the management information requirements of larger organizations can not be met by batch methods of data processing. He reports a trend toward instantaneous processing in this review of

ON LINE-REAL TIME SYSTEMS–1964

by Richard E. Sprague
Touche, Ross, Bailey & Smart

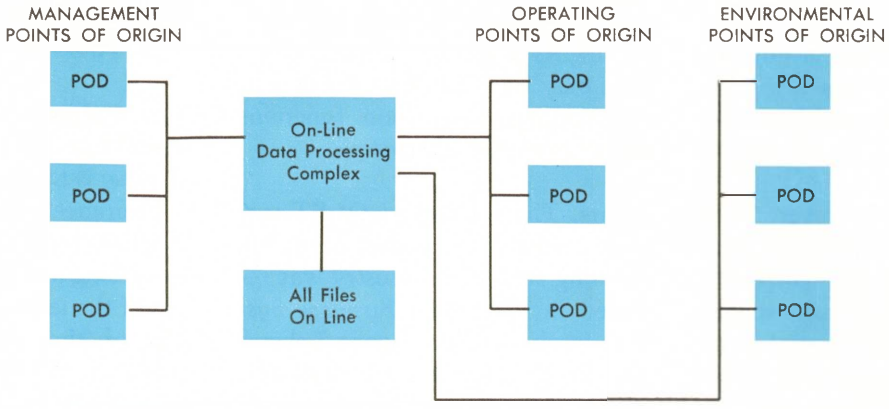
Two years ago Mr. Sprague predicted, "By 1970 nearly all electronic data processing systems will be of an on line-real time variety" (Electronic Business Systems, *Ronald Press, 1962). Today he still stands by that forecast. He tells why in this article, which reviews the evidence supporting his thesis in the light of the developments in equipment and in business systems that have occurred since his book reached the stage of final editing.*

TWO YEARS ago a prediction was made concerning on line-real time systems. Enough new evidence has been accumulated to examine the prediction and to test the thesis underlying it.

An attempt was made in *Electronic Business Systems* to formulate a thesis which would explain the trend toward On Line-Real Time (OLRT) systems. The skeptics and the economists when made aware of the trend usually comment on the high cost of OLRT mechanization and ask how any organization outside the military or airlines or savings banks would be able to justify the cost.

This is a very pertinent and legitimate question which every organization ought to ask itself before proceeding to an OLRT system. The answers, in general, do not begin to explain the trend. One must dig deeper into the very nature of data processing, business systems, and the way an organization is operated and managed to find the explanation.

The thesis, and the research work behind it, did just that. As a result, the trend toward OLRT can best be explained by reversing the skeptic's question to ask, "Can we afford *not* to have an OLRT system?" This should be expanded a little. The thesis implies that for most larger organizations to be managed and operated in the manner which most advanced business systems groups



Total OLRT System Diagram

Figure 1

advocate today, the information, storage, processing, communication, decision making, and display requirements *can not* be met by batch processing methods.

OLRT systems provide the only feasible solution to meeting the requirements available today.

For the smaller organization as well, OLRT systems are the only feasible type to meet the requirements generated by the necessity of sharing systems among small users in order to compete for business. In the long run, when enough subscribers share an OLRT service, the costs are bound to be lower and justification will be easier.

So, it is not sufficient merely to ask, "How can we justify an OLRT system?" It is essential that the basic pressures and reasons for the present trends be explored. *All* of the information needs for an *entire* organization should be determined. *Then* a decision can be made as to whether it is possible to accomplish the company's objectives over the next five years with batch processing techniques or whether the organization must go to OLRT.

After re-examining the thesis and evaluating new evidence, the author's prediction is still that batch processing will fall short of meeting the needs of most organizations and that nearly all business systems will be of the OLRT variety by 1970.

Definition. Before attempting to present and evaluate the new evidence and developments in OLRT, it seems desirable to orient the reader by defining the term, OLRT system, and by giving a short description of the thesis behind the prediction.

In a total OLRT system each and every person, machine or point (point of origin) in the organization using the system, having a true requirement to originate, retrieve or utilize information, is provided with a point-of-origin device (POD). These devices are connected to a central data processing complex by wires or other direct communication links (see Fig. 1).

Each device permits two-directional information flows at a point of origin of information such that the person or machine using it receives responses to his requests (when a response is required) in the amount of time desired. This, obviously, implies that all information with which every person or machine must deal is stored in some mechanized form immediately accessible to the data processing complex, and that all files of such information are connected *on line* to the complex.

The total nature of the system is brought about by the fact that *all* information for *every* person from the chairman of the board down to the lowest clerk is inserted and is available through the point-of-origin devices. This means that *all* information for all system functions is processed and stored by the system.

In addition to persons, machines, and points within the organization, it may be desirable in some cases to go outside the organization to the true original source of information generation and place point-of-origin devices in the environment of the organization (see Fig. 1).

Thesis. The thesis can best be described by referring to Figure 2, Thesis Diagram, which illustrates by arrows that fundamental economic and total-systems pressures lead to a set of requirements which, when coupled with technical developments, in turn lead to systems that have the characteristics of OLRT systems.

These pressures have existed since the beginning days of the data processing industry. The requirements have also existed. The technical developments have, however, just emerged since 1958 or 1959.

Long Range Planning. Returning to the discussion of how to decide whether an OLRT system should be considered, many companies have already been through the soul-searching, over-all business systems planning efforts implied earlier. Top

and middle managements have suddenly found themselves embroiled in their information systems executive's plans and vice versa. In almost any large company or government organization which has been through this soul-searching, the OLRT system has been talked about.

The "new look," however, is to consider OLRT as a potential long range goal for the entire corporate business system. The business system plan may involve several steps or phases along the way toward the goal. Some of these steps, as in the case of the airlines and savings banks, may include OLRT mechanization of selected functions. Included in the long range plan may be such functional areas as:

- Business Systems
- Manufacturing Process Control
- Communications Switching
- Central Information Retrieval and Library Systems
- Management Control Centers
- Centralized Engineering Computation Services

While these have traditionally been considered separate problems and systems, each of them generates a requirement for OLRT techniques. As a result, the long range plan may well incorporate two or three or even all of these functions in the same OLRT system.

Status. The number of OLRT systems installed, on order, or in the planning stages by industry was reported in *Electronic Business Systems* in chart form. Figure 3 shows the list of industries and indicates several new ones. The growth in OLRT systems in the last two years has been caused by both the increase in numbers in each industry and the addition of new industries.

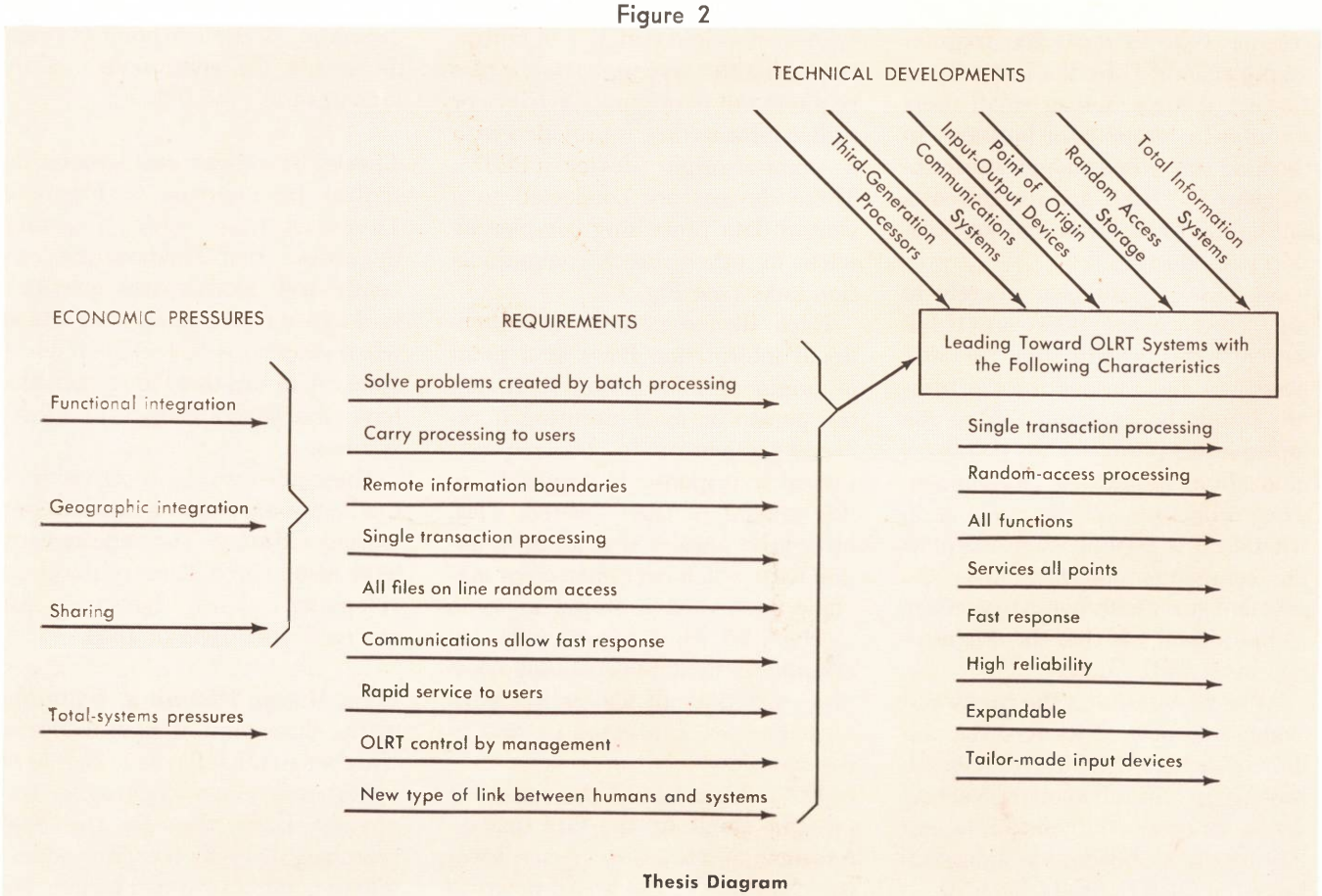
The column labelled Process Control in Figure 3 indicates those industries with OLRT systems installed for process control applications. *Control Engineering* magazine in the September 1963 issue listed 340 process control systems using digital computers installed throughout the world with 237 of them in the United States. For the purpose of this article, the process control situation is considered important because of potential relationships to business systems. This will be discussed later in the article.

New Industries. Figure 3 lists a number of new industries. Typical of these is the insurance business.

Insurance companies were among the first to utilize electronic data processing and have continued to be one of the largest users of EDP outside of the Federal government. However, they had not taken an active interest in OLRT until 1962. In a cursory examination of insurance company data processing requirements, all activities seem to be inherently batch processing in nature. No requirement seems to exist for rapid response to inquiries.

However, the insurance company's more detailed analysis with over-all management and customer service considerations included shows a great justification and necessity for OLRT operation. As a result of this recent (last two years) re-examination of objectives and re-

Figure 2



Thesis Diagram

quirements, OLRT systems have suddenly become Topic A in the insurance field. Large numbers of companies are actively studying the possibilities, some have placed orders for equipment and nearly every insurance EDP conference has OLRT on its agenda. Allstate, Travelers, Equitable and Metropolitan have announced OLRT plans.

Among the old active industries are:

Airlines. The airline reservations market for OLRT is rapidly becoming saturated. Nearly every good sized airline has a system installed or one on order. The smaller carriers in the United States are examining various possibilities for sharing systems. Foreign airlines have recently contracted for systems, some of which will be world-wide in scope as will the new PANAMAC system of Pan American.

The larger airlines are moving ahead with plans for OLRT mechanization of related functions in the operations and accounting areas. At least one airline has announced that their system will encompass all functions on a world-wide OLRT basis.

While some problems and delays have appeared in the various passenger record systems under contract, the leading airlines fully expect to surmount them and to have reliably operating systems by the middle or the end of 1964.

Savings Institutions. This industry, which includes savings banks, savings and loans, and the savings departments of commercial banks, is also moving rapidly in its use of OLRT systems. The situation has been accelerated by several new developments. The first was the announcement of the availability of new lower cost equipment and services. (See section on Hardware Developments.) The second was the decision on the part of the Savings Bank Trust Company in New York to offer an OLRT savings service to savings institutions in New York City and State.

The third was the interest taken in OLRT by the Federal Home Loan Bank which is considering the possibility of offering OLRT service on a regional basis to its many savings and loan members.

The fourth factor has been the success of the first OLRT system at the Howard Savings Institution. The Howard's management use of the system and the effect on the methods of banking, floor design, branch planning, etc., emphasizes the point that fast response to inquiries, such as airline and savings bank customer queues require, is only one of many requirements met by OLRT systems. Far more important in the long run will be the improvement in management control of the entire organization and effects on planning through the use of an OLRT system.

The fifth factor has been the grouping together of smaller savings and loans in several metropolitan areas around the country to consider sharing OLRT services. Among the active communities are Minneapolis; St. Louis; Kansas City; Worcester, Massachusetts; Rochester, New York; Detroit; Pittsburgh; Los Angeles; Philadelphia; Seattle; and Dallas.

To take an industry by industry review:

Federal Government. The Federal Government's use of OLRT systems continues at an ever-increasing pace. One new trend is the interest on the part of the Department of Defense controller's office in an over-all total system for what is usually called the logistics side of the Department. Much of such a system would of a certainty be OLRT in nature.

State and Local Government. Several state and local government agencies have taken an active interest in OLRT. Examples are: State of New York—Division of Employment, California and New Jersey Employment Divisions, New York State and California Criminal Intelligence Application, Central Indexing for Welfare in New York City and Alameda County California, New York City and State Racing

INDUSTRIES WITH OLRT SYSTEMS

INDUSTRIES	NEW IN LAST TWO YEARS	PROCESS CONTROL
Federal Government		X
State and Local Governments	X	X
Airlines		
Savings Institutions		
Commercial Banks		
Insurance Companies	X	
Radio and TV	X	X
Telephone Companies		
Service Centers	X	
Hotels		
Universities	X	
Hospitals	X	
Stock Brokerage		
Railroads		
Public Utilities		X
Retail and Wholesale		
Manufacturing		
Electrical		X
Cement	X	X
Petroleum		X
Chemical		X
Metal Industries		X
Large Equipment		
Paper		X
Aircraft		
Automotive	X	X
Publishing	X	
Doctors, Dentists, Lawyers, etc.	X	
Atomic Power	X	X

Figure 3

Commission Off Track Betting, and Process Control Systems for Auto Traffic Control in Detroit and Toronto.

Commercial Banks. A few commercial banks have installed OLRT systems for processing savings accounts, or handling inquiries on commercial accounts. Most notable among these are the Manufacturers Bank in Detroit and the First National Bank of Chicago.

However, the trends in commercial banking are taking some other interesting turns. First is the trend toward offering EDP services to depositors, correspondent banks and other customers. As systems and customer service requirements are examined by these banks, it becomes obvious that today's MICR, batch processing oriented, EDP systems are not able to do the job. This is especially true as applications and services get further and further away from the demand deposit and transit functions.

One current example is the U. S. National Bank of Omaha, Nebraska. It is providing doctors in the area with what amounts to a semi-OLRT service for patient accounting and billing. As far as the doctor is concerned, the service is OLRT because he is linked to the bank via Bell system Dataphone and his nurse can enter patient and treatment data at any time through a Dataphone card reader and keyboard in the doctor's office.

This type of service is also being offered by other organizations as will be described later.

A second trend in banking is the sharing of systems by groups of banks in an area. The same pressures mentioned in the thesis (and in more detail in *Electronic Business Systems*) will cause these groups to consider OLRT as opposed to shared batch processing systems.

A third trend is toward OLRT for over-all bank management and customer service reasons. The same requirements that stimulate the insurance company, namely, a need to handle all customer accounts and relations at one time while the customer is in the bank or on the phone, also push a commercial bank toward OLRT. In fact, almost any organization which has a multiplicity of relationships with its customers will find customer service greatly enhanced by this feature.

Finance companies, savings and loans, and eventually retail organizations will fall into this category.

Radio and Television. CBS and NBC both have OLRT process control computer systems installed for program switching. The toll TV companies have been interested in OLRT systems for measuring listener response, for collecting fees, for billing and advertising purposes.

Telephone Companies. Several of AT&T's subsidiaries have made great progress toward total OLRT systems. Most notable of these is Michigan Bell where OLRT mechanization is quite far along. As implied in *Electronic Business Systems*, the entire telephone network is a giant OLRT system for voice and data communications. The Michigan Bell system also places the customer billing, accounting and other business systems on an OLRT basis.

Hotels and Hospitals. Rather amazing trends are developing in hospitals. Not only patient services, accounting and accounts receivable are going on line. The patient himself is going to become part of an OLRT system at Children's Hospital in Akron, Ohio, and at the Veterans Administration. Measuring instruments will connect him to a central computer which alerts doctors and nurses when critical conditions develop or when it is time for specific action. Jefferson Hospital in Philadelphia is not going that far. However, they will install an OLRT patient accounting and billing system.

The hotel guest accounting and reservations systems discussed in the trade two years ago (which would seem to resemble the hospital system) have not progressed as rapidly as expected. Cornell University, the Statler Foundation, a group of seven hotels in New York and Sheraton Hotels have continued to investigate OLRT systems. Sheraton experimented with a new OLRT guest accounting system and to date has the only operating OLRT reservation system.

Stock Brokerage Field. Stock exchanges and stock brokerage companies moved rapidly toward OLRT services and systems in the past two years. Three types of systems are involved. The first is the stock exchange system itself. The second is a system employed by one or more national brokerage houses for customer accounts, and the third is the type of system providing information to brokers on stock prices and transactions.

No developments toward merging of these three types of systems have been detected to date.

There are three competing OLRT services being offered in the stock price display and inquiry area. Most large brokers have signed up for one of these and display techniques include quotation boards, lighted numerals, cathode ray tubes, printed strips of paper, and voice responses over a phone from a computer.

The New York and American Exchanges are both installing OLRT systems and others are actively interested. Several national brokerage firms have studied OLRT systems for customer service and accounting. F. I. duPont & Company is installing a system for switching messages from offices around the country to the floor of the exchanges, to the customer data processing center in New York, or to over-the-counter operations. Automatic logging of accounting and billing will be part of this system which in effect puts a customer directly on-line to the trading floor.

Railroads. A few of the railroads, notably the C&O and the Pennsylvania, have been experimenting with communications-oriented informations systems for some time. The key to breaking the log jam in railroad EDP systems for freight accounting has been the development of a reliable, inexpensive method for detecting the location

and identity of cars. The jam may be about to break as the Association of American Railroads has agreed on a car reading technique and is entertaining proposals for its mechanization in an on line-real time fashion.

The concept is that optically scanned plaques fastened to the sides of cars will feed identity data into systems allowing both car location and inter-road accounting, as well as operational controls to be realized on an OLRT basis.

Public Utilities. The bulk of OLRT interest on the part of public utilities has been in the use of process control systems for the control of electrical and atomic power. Certain utilities would like to see a low cost point of origin device developed for OLRT meter reading and utilizing existing power lines for data communications. The resulting customer accounts receivable and billing system can be visualized as having many advantages over current systems. This still appears to be a long way off.

Retail and Wholesale. Only one type of system has been developed for retail stores using OLRT techniques. Only two stores have put it into operation, Robinson's in Glen Burnie, Maryland, and Kaufmann's in Pittsburgh. The rest of the industry seems to have adopted a "wait and see" attitude. It is not a complete computer-based system, which may account for some of the waiting.

Meanwhile, grocery chains, mail order houses, and other types of retail chains have been studying OLRT techniques. None has made any announced commitments to date.

Manufacturing Industries. Possibly the third or fourth greatest level of progress (after airlines, government, and savings institutions) toward OLRT systems in the past two years has been in the manufacturing industries. Some of the impetus has been caused by the influx of process control systems and some by each of the general factors yet to

Depositors get split-second service at Union Dime Savings Bank, New York, one of the first savings institutions to use on line-real time computer systems for deposit accounting.

Here's the way in which the Union Dime's Telefile system works:

A depositor presents his passbook. After checking the signature a teller enters the account number in his window Teller-Register. Immediately the system prints the current balance on the teller's proof tape and reports any unposted items or hold notices that must be cleared before the transaction can continue.

The teller enters the deposit or withdrawal. The system records it; updates the account in the passbook; and simultaneously prints the same data on the proof tape, on input to a magnetic drum in the headquarters center for the computer's memory storage, and on a magnetic transaction tape for permanent record keeping. A monitor unit in the executive suite displays on demand an up-to-date total of deposits and withdrawals any time during the banking day.

Telefile's elimination of manual posting, ledger cards, and reference files reduces back-office clerical work and (in combination with a separate optical signature verification device) makes it possible for a customer to bank at any window or branch. That not only speeds service but also gives management more flexibility in the use of personnel and space. The freed clerical time has gone into promotional effort and new money-making services. The result has been an accelerated rate of growth of deposits, loans, and other services, exceeding that of some larger competitors.

Union Dime's system is now processing more than 166,000 savings accounts. In the nearly two years the system has been operating, account transaction volume has risen more than 4%, banking hours have been extended 15%, and a fully staffed new branch is ready to open—with no increase in personnel. Yet employees go home sooner after bank closing, sometimes half an hour afterward.

Figure 4

be discussed. In any event, electrical, petroleum, chemical, metals, paper, aircraft and aerospace, automotive, and other process industries such as glass, cement and rubber manufacturing have all taken a very active interest in OLRT systems.

The list of companies includes: Westinghouse, Socony Mobil, DuPont, U. S. Steel, Mead Corporation, Lockheed, and Chrysler, just to name one from each industry. Applications usually include production and inventory control, scheduling, customer order processing and quotations, factory data collection and management, and general management controls. Not one of the manufacturing companies involved would claim to have a total OLRT system installed. Too many links are missing in point of origin devices and much, much work yet remains in systems design and programing. However, the most advanced of the companies *would* claim that OLRT fits into their long range planning picture in goal form as outlined in the introduction.

Figure 5

Three General Trends

Three new general trends are creating pressures for OLRT in manufacturing industries as well as certain other organizations. They are: Management Control Centers, Combined Process Control and Business Systems, and Remote-Shared Engineering Computation.

Management Control Centers. Most of the computer manufacturers are developing or have developed display devices or techniques for military use which are now beginning to be applied (or at least sold) for commercial use in what has come to be known as a *Management Control Center* (Fig. 4). One aerospace company has included a description of an MCC and a mock-up design in a movie made about its own management information systems.

The concept of an MCC is that top level management meeting in small or large groups in the center can have displayed before them in various forms current operating and financial information. Selections are made from a management console (see Fig. 5) and information concerning decisions as well as inquiries can be inserted as the meeting progresses.

The assumption that must be made if an MCC is planned is that an OLRT lies behind it. The data and management information to be useful must be retrieved while managers are in the center. The greatest advantage of such a concept is the tightness of control which can be exercised by management and the conserving of management's time.

It is possible that an entirely new science may be emerging which combines the informational and psy-

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chological fields. It is the science of presenting information to executives, making them understand it and retain it and finally allowing them to communicate decisions which they understand back to an organization *through* a system.

Much work remains to be done to develop this new science, if it can be called that. More is implied here than that which industrial designers and military systems planners have called man-machine relationships.

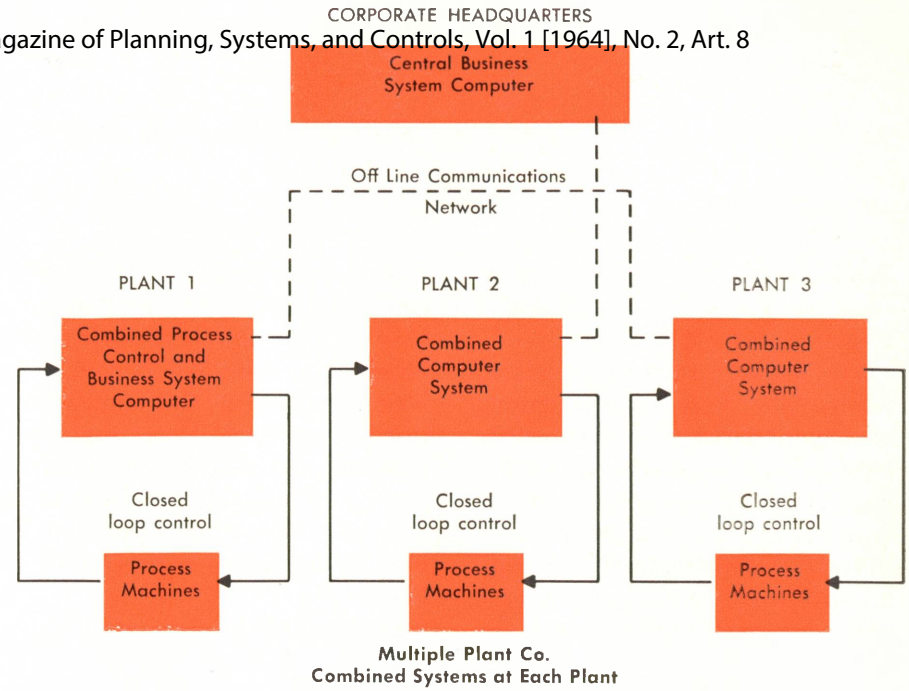
Combined Process Control and Business Systems. The second general trend is just beginning to emerge. It is the concept that digital process control systems and computer-based business systems have enough inter-relationships between them to begin considering combined systems designs. Two possible relationships are worth considering. First, if a single central computer complex is capable of handling both a process control application and a major part of the business system of an organization, it may be more economical to use it than two separate computers.

The answer to this depends on the geography of the organization, i.e., number of process control plants and where located with respect to the corporate center, on data communications facilities and costs, on the type of process control involved, and on the amount of business system data processing to be done at each plant location. Figure 6 shows a multiple plant company with combined systems at each plant and Figure 7 shows one large central computer doing the entire job.

The second relationship is more subtle and depends on the nature of the manufacturing process. It is the probability of system overlap between the two areas at two points. The production scheduling and control output of the business system is bound to affect the input and environment of the process control system.

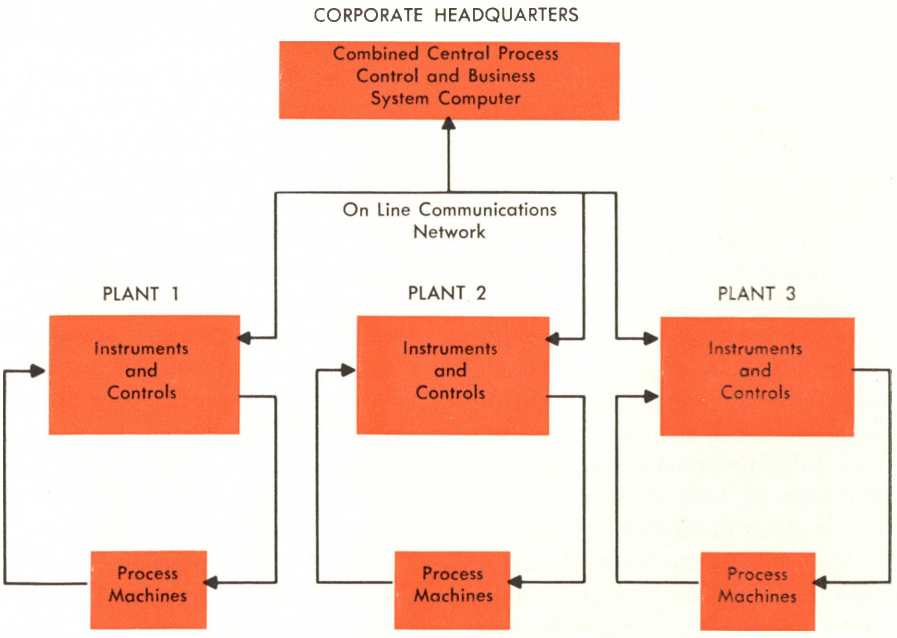
Also, the outputs from the process control system will probably form some of the raw production status data for the business system. These relationships can become quite complicated depending on the products being made and the ways in which they are produced, packaged and sold.

For example, postulate a paper manufacturer with several paper machines, several cutters and packagers in one plant, all under control of a digital process control computer. The production scheduling and control part of the company's business system must keep track of what paper (grade, color, size, etc.) is being and should be made on each machine, and how it is being and should be cut and packaged. But, so must the process control computer do all of these things in this



Multiple Plant Co.
Combined Systems at Each Plant

Figure 6



Central Computer Combined System

Figure 7

Attractive to small business: the ability to eliminate clerical help

hyper-system. It is apparent that in these circumstances, one combined system is dictated.

The *pressure* referred to earlier, which may bring manufacturing companies in the process industries to OLRT systems earlier than otherwise, is that of economic considerations such as the ones given above plus the tendency to place all digital computers in the organization under the same type of systems design structure.

Remote-Shared Engineering Computation. The third development affecting manufacturing companies is in the engineering and scientific sphere. In most large companies where research and engineering play an important role, electronic computers have been in use for several years. The trend in the past has been toward the use of smaller and smaller scale machines by individual engineers or groups of engineers and scientists. This is primarily due to the nature of problem solving using a computer. It is a trial and error process in which the engineer communicates back and forth at more or less nonscheduled times with his computer. Program as well as data changes are made as the solution progresses.

Now, it has long been established that the larger and faster the computer, the more efficient it becomes and the less expensive is the unit of computation per unit of time. The economic pressure then exists for engineers and scientists to share a large computer rather than use many small ones. The problem has been how to share and still retain the kind of personal relationship an engineer develops with his own little computer.

M.I.T. and Systems Development Corporation have been experimenting with OLRT solutions to the problem. By providing an engineer with a properly designed console connected on line over communications facilities to a large scale computer, the equivalent of his own little computer in the same room can be provided. Many engineers can time share a large scale computer on this basis, provided a suitable executive control program is used in the computer on an OLRT basis.

SDC and M.I.T. demonstrated the feasibility of such a system in November 1963, when an engineer at M.I.T., using a teletypewriter linked by telephone lines to SDC's large scale computer in Santa Monica, California, shared the machine with six other engineers in California, all working on their own programs. To each one it appeared as though the entire computer facility was at his disposal. In this first trial program changes were required to be entered by a consultant at the computer site.

As this concept spreads among larger manufacturing companies, another pressure will be created for OLRT systems. Socony Mobil Oil Company already utilizes its business system computer center in New York for remote-shared engineering computation on an OLRT basis from locations as far away as London and Seattle.

Also, the concept should lead to the establishment of OLRT service centers for engineering and scientific computation. It is possible that some of these will be owned and operated by universities and nonprofit organizations like SDC.

Doctors, Dentists, Lawyers

One new "industry" trend, if it can be thought of as an industry, is the offering of OLRT service to small businessmen such as doctors, dentists, lawyers, small stores, etc., who do business on a credit and billing basis. The earlier section on commercial banking mentioned this type of service as being offered by a midwestern bank.

Organizations of other types are springing up all over the country with similar OLRT services. In Alvin, Texas, a public accounting firm[1] handles doctors and other clients located in medical centers in the community. In Los Angeles a newly formed service company[2] offers OLRT service using Dataphone to doctors and dentists. Also, Bank of America in California and some other banks provide this service.

In Boston, another OLRT service bureau[3] is doing work for small manufacturing companies, a hospital and a factoring company.

The economic attractiveness of OLRT services for small business lies in the ability to eliminate any need for clerical help and to enable the doctor or dentist to concentrate on his patients without worrying about accounts receivable, billing and collecting.

Dataphone. The role of AT&T's Dataphone service in these small client OLRT service centers cannot be overlooked. Every doctor, dentist or lawyer has a telephone. The same phone will be used for his OLRT service. A small card reader is attached to it. The line charges are negligible if he is in the same metropolitan area as the center, since they are based on the use of the same lines as his voice calls and the same rate structure.

It is the attractiveness of the Dataphone concept which seems to be stimulating many of the OLRT service centers. The doctor never leaves his office for reporting or record

[1]Kennedy, Sheppard & Co.
[2]Telecredit, Inc.
[3]Key Data, Inc.

keeping purposes. His nurse can enter the data in her spare time. The bills go directly from the center to the customers so the doctor never sees them unless he wants to. Even the payments and deposits in the bank to the doctor's account can be handled without his attention if he so desires.

Hardware Developments

As pointed out in the thesis, new hardware developments have a strong influence on the rate at which OLRT systems can progress with economic justification.

Developments in the past two years have accelerated OLRT systems in several industries and applications.

Lower Cost OLRT Computers. The most general new hardware development has been the announcement of the availability of lower cost computers with OLRT characteristics. Nearly every computer manufacturer has now announced at least one OLRT oriented computer and the majority of new machines are equipped with some OLRT features.

The new computers include the IBM 1440, 7040, 7044, Univac 1050, NCR 315-100, Honeywell 1400, G.E. 400 series, RCA 3301, and SDS systems. In addition, standard lower cost computers such as the H 200, the B 200 series, the RCA 301 and the G.E. 200 series have been adapted for OLRT use.

The new IBM System/360, which was just introduced last month (see p. 5.), is specifically designed for total On Line-Real Time Systems. The computing equipment, communications equipment, point of origin terminal equipment, and a hierarchy of on line storage devices were announced along with the system. This array of hardware should focus the attention of many IBM customers on the possibilities of On Line-Real Time operation.

Process control computers and communications switching computers with OLRT characteristics were also announced for sale in large numbers.

New Random Access Memories. The cost of large volumes of random access storage has been a limiting factor in economic OLRT systems for many applications. The introduction of RCA's RCA 3488 memory with a per character cost lower by an order of magnitude than prior mass memories should have drastic effects on the economic situation. The 3488 memory uses magnetic cards for storage, can be as large as 5 billion characters and has a cost per character lower than magnetic tape.

A second limiting factor has been the rather high access time of mass memories for a reasonable cost. The new Burroughs disc file with 20 millisecond (a factor of five below others) access time and costs comparable to prior memories provides a solution to this problem.

Other new memories include the IBM 1440 disc pack, and the 1302 disc file and the Univac Fastrand.

Point of Origin Devices and Displays. New data gathering equipment for manufacturing companies has been brought out by several computer suppliers. These include RCA's EDGE, G.E.'s Datanet, IBM's 1050 series, NCR's offering of Stromberg Carlson's equipment and Data Trend's MIMO (a handwriting device).

NCR, G.E., RCA, Ramo Wooldridge (now Bunker-Ramo Company), Burroughs, IBM, and Univac have all developed new types of management displays ranging from complete wall projection or image retention types (NCR) to consoles like the one in Figure 5.

Teleregister has also announced two new data display devices, one for use in the stock market inquiry field, and the other for general purpose inquiry and display applications. Both use inexpensive cathode ray tubes.

Except for specific industries such as airlines and savings institutions, no pattern seems to be emerging in the use of Point of Origin devices or displays.

Communications. The majority of the communications services and facilities for OLRT available today were also available two years ago. AT&T's services, Dataphone, WATS, Telpac, and Dataspeed WADS, have had the major impact on OLRT systems planning. However, Western Union, RCA, IT&T, Collins Radio and others have also provided data communications facilities for OLRT systems.

Education. Orienting, training and educating engineers, programers, systems designers and management in OLRT systems lagged behind developments until the last two years. Now, special courses and seminars are conducted at many universities and companies on the subject. In addition to the computer manufacturers, notably IBM in its Systems Research Institute, M.I.T., University of Pennsylvania, Carnegie Tech., American University, University of California and University of Chicago all hold OLRT courses.

Software. The software gap in OLRT systems was described recently[4] in an article by a former OLRT systems engineer and programer. What most organizations with experience in the field have learned the hard way is that OLRT programing and software are very different from batch processing. "Old timer" batch processing programers sometimes make the worst OLRT programers because of the major differences in philosophy required.

Today a small cadre of OLRT programers coming out of military, airline and savings institution areas form the best knowledgeable core of experience available. Unfortunately, until education and training catch up, this number is pitifully small.

Systems and programing talent may well be the greatest limiting factor in the growth of OLRT systems.

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[4]R. V. Head, "The Programing Gap in Real-Time Systems," *Datamation*, February 1963.