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Today there is a major emphasis within the business community on systems and procedures development. Why is this? Principally because of three factors: (1) increased clerical activity and its associated costs, (2) management's interest in more effective control reports, and (3) availability of powerful data-processing equipment.

Now let us look at the reasons for this particular session's being offered within the framework of this systems and procedures course:

- It should broaden your knowledge of one of the newer (and more glamorous) areas requiring application of systems and procedures effort—namely installation of electronic data-processing (EDP) systems.
- It will illustrate the manner in which the entire range of systems and procedures techniques is brought together and used in EDP work.
- It should acquaint you with some of the reasons for a high degree of management participation in the EDP project.
- Of most importance, it affords an opportunity for you to exchange some of your ideas on certain of the problems relating to the selection, design, and installation of an electronic data-processing system.

In proceeding, we shall first determine our objective. In this case it will be to decide what it is we are really trying to do when we start on an EDP project. Then we shall inquire as to why we are directing our attention to electronic data processing. Next, we shall review management's problems relating to this type of system so as to orient and confine our efforts within a proper scope. Then, finally, we shall examine some of the systems and procedures techniques peculiar to the installation of an electronic data-processing system.

OBJECTIVES OF DATA-PROCESSING SYSTEMS DEVELOPMENT

As systems analysts, our first consideration must be the objectives we desire from a machine installation. If we were to examine closely most of the installed electronic data-processing systems, we would gain the impression that they were installed for one or more of the following purposes:

- To take over functions already performed by punched card equipment, thus making a super-speed punched card system.
- To do some large-volume accounting job that offers possibilities of resulting in a net cost reduction.
- To acquire a special-purpose machine to do a particularly difficult "problem area" job. This usually results in a new crisis in some other area which needs a different machine for its solution.
- To experiment with a small system on a selected application with the intention of expanding the system to larger equipment later if the initial equipment is successful.

Each of these approaches to the use of electronic equipment constitutes a patchwork solution to the over-all data-processing problem. Furthermore, most of these approaches relate to fairly large companies that could afford medium or large-scale equipment, even though used on a partial solution basis.

This present use of EDP equipment has been misleading in that system development thinking has tended to be weighted heavily by it. The tremendous potential for utilization of EDP by smaller companies is yet to be realized. It will only be realized when EDP systems are developed under an engineered approach.

An engineered approach to system development is based on a frame of mind. It is a frame of mind that accepts the business enterprise as a high-order system composed of interdependent parts. These parts are people and their methods and procedures of sales, production, purchasing, accounting, etc., working toward a common goal. These parts are usually separated into departments for organizational reasons but not for data-processing reasons. In systems development, then, the organizational structure must give way to the data-flow structure.

The business system, being interdependent, acts like any servomechanical system. Just as a thermostat and a gas furnace operate

as a balanced servo-mechanism sensitive to temperature, so does a business system represent a structure of people sensitive to various economic and commercial forces. There is a balance of relative effectiveness of each part within the enterprise acting in relation to every other part to produce the performance of the whole system. As a matter of fact, strengthening one part of a business system may put stress on other parts so as to lessen over-all performance.

You can all picture the effect on the production department of a suddenly successful sales campaign of which the production manager had no knowledge; or the effect of extreme overproduction in one department on all other production departments on a processing line. These would be examples of system imbalance resulting from patchwork "improvement" within a system.

The objective, therefore, of the engineered approach to system development is to optimize performance within the enterprise through achieving the proper relations between the parts of the business system. How is this accomplished? Usually, it is accomplished by exercise of management control based on timely, proper, and accurate data.

As we learn more about EDP we realize that here for the first time is a machine system powerful enough to assist management in this control. So our question now is not, "How can I use this shiny new gadget?" but rather, "What is this particular enterprise all about and what does it take to manage it?" Perhaps the answers will include some use of electronic equipment.

Generally, there are two principal levels of management. At the top level, decisions are based on external as well as internal conditions; while at the lower level of management, concern is principally for control of conditions within the enterprise. Top management uses market analyses, projections, and predictions, while lower management uses operating reports.

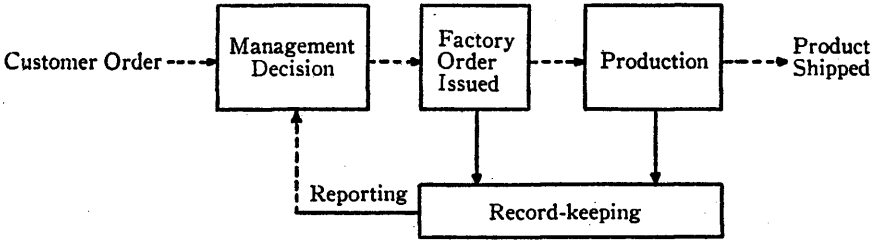
Much of the decision-making of top management is based presently upon intuition. A great deal of the necessity for this is due to lack of the proper data available on a timely basis. Those of you who have read Jay Forrester's recent paper on Industrial Dynamics (which appeared in Harvard Business Review for July-August 1958) are familiar with some of the research now being devoted to the development of a more professional approach to management through the use of scientific analysis and electronic computers. This paper suggested certain ways of thinking about management that should

be helpful to systems and procedures personnel as well as to executives in working on inventory control, production scheduling, advertising, sales, and other related problems. Presently, formal research on the subject of principles of scientific management is centered chiefly at Massachusetts Institute of Technology and at General Electric Company.

One of the basic aims of systems work in this field is the establishment of standards. These, in effect, are pre-decisions of what conditions should be. Exceptions to these conditions are subject to computer analysis for reporting to top management.

It is time now to look more closely at the data-flow structure and see what we mean by a business system and its control by management.

This chart is a generalized representation of an information system within a manfacturing enterprise:



The decisions as to production control and other operating matters are based upon reports prepared as a result of the entry of orders into the production cycle. In this business there are relatively few key factors necessary to determine to supply management's informational needs. These might include:

- Competitive product styling
- Effective marketing
- Lowest possible production costs

Factors of this type are fundamental in that their control should result in success for the business. Once the control measures matching these key factors are known, we are well on our way toward understanding the interdependence of the parts of a business system.

What are control measures?

Let us again examine our information system design. We have said that it acts like a servo-mechanism. By this we mean that a business is controlled by information fed back in a manner similar to

the way a missile is controlled by its radiated impulses acting within a guidance system. Inventory information affected by manufacturing and sales data can be fed back to management through reporting so that the minimum amount of capital will be required to be invested in inventories.

In a business it is not alone the skill of management that determines the quality of management control. Good control depends also upon what information executives use and for what they use it. Management intuition must be fortified with proper, timely information if costly errors are to be avoided.

A proper goal in EDP system design work should be *profit improvement—not cost-cutting.* This implies that the system analyst be management-oriented in his thinking so that he can visualize the business as an over-all operation and not as a set of separate parts requiring cost reduction through mechanization.

So the first important consideration in applying systems and procedures techniques to electronic data processing is a matter of attitude. It is a matter of adopting a frame of mind equivalent to the viewpoint of management. It is only in this way that the eventual potential of EDP will be realized. The broad-scope objectives now possible of achievement must become the concern of people such as you since technical knowledge alone is not enough. It must be fortified with management abilities.

CAPABILITIES OF ELECTRONIC EQUIPMENT

Now that we have established the atmosphere for working in the field of EDP, let us inquire as to *why* we are directing our attention so forcefully to the utilization of electronic data-processing equipment. What are the unique capabilities of these machine systems that make them more powerful than former equipment? Perhaps it would be possible to determine this by first reviewing some of the points of difference from other business machines and then by giving some thought to the meaning of system integration. A working knowledge of these matters should be part of your background for work in this area.

As we examine the basic characteristics of non-electronic business equipment, we come to the realization that in most cases its use has required a change from normal manual data-processing procedures. Without going too far back into fundamentals, we might divide all data processing into six operational steps. These are: classi-

fying, sorting, calculating, summarizing, recording, and communicating. In the human performance of one or more of these six basic steps on business data it is usual to complete all necessary steps on one document before proceeding with the next. Hence, manual-recording is of a continuous process nature.

With the departmentalization caused by business growth, there has been a splintering of the recording functions into many segregations of specialized duties. Single-purpose machines have been developed to handle limited portions of these duties where there were similar operational steps in sufficient volume to justify the equipment cost.

The highest degree of development in this regard has been punched-card equipment. For this reason we might review some of the characteristics of this equipment so as to be able to make comparisons later with electronic systems. The principal features of punched card equipment may be stated to be as follows:

- Data is stored on a punched card which is capable of both human and machine reading. Card capacity is limited to 80 or 90 character records but the record can be extended over more than one card.
- To a certain extent, each machine in the system is a single-purpose one, usually performing just one of the six basic data-processing operations.
- There is a limited amount of automatic control within the system. This is accomplished to a large extent by control panel wiring.
- A high ratio of human participation is necessary—especially in moving the card records between the various special-purpose machines.
- The recording machines have a speed limitation of approximately 150 records a minute.
- A certain amount of system integration has been possible through the development of peripheral equipment capable of capturing data in a mechanized form at the time of original recording of a transaction.

The combination of these and other minor features of punched-card equipment has permitted a rather high degree of mechanization within selected portions of business data-processing systems. However, this equipment is customarily utilized within a limited scope

of operations and has usually been adopted for use in the handling of high-volume transactions.

Let us turn our examination to some of the characteristics of electronic data-processing systems and learn how these characteristics permit a higher level of mechanization than was previously feasible with punched card machines. Some features for comparison might be the following:

- Data is stored within the machine elements or within machine-accessible elements. Record lengths are not limited, although in some equipment, certain record lengths are more economical to use.
- All control instructions for complete processing of sets of data are stored within the machine system and can be modified automatically to suit special processing conditions.
- Storage, control, and processing machine elements all operate on compatible electronic principles which permit their intercoupling into a completely automatic system.
- No human manipulation of data is necessary during processing.

These characteristics of electronic data-processing systems are the principal factors that widen the scope for more extensive system development. Uninterrupted data processing is extremely fast and internal program control is extremely versatile.

Up to here we have spoken of the general characteristics of electronic and other systems. Of particular interest to us, however, is how the design features of electronic equipment affect the problems of system and procedure installation. What are the points of difference we should know about with respect to how the electronic system does things? To acquire this background we must start to talk about the equipment itself.

In the design of electronic systems there are certain limiting factors—just as there are in the design of a new system or procedure on any equipment. However, these factors differ somewhat in EDP and are usually somewhat more difficult to ascertain. Therefore, let us first look at some of these:

- Capacity to handle work volume. The approach to system design with respect to volume limitations has certain features under EDP not found in other methods.

The usual approach when installing bookkeeping machines or

tabulating equipment is to order enough machines to handle the work volume. This is not a recommended approach with EDP equipment since there are available complete systems within various ranges of capacities, each capable of handling certain work volumes.

Once work volumes are determined, it is necessary to give attention to equipment features of the various systems so as to select the range of electronic machine systems that would be capable of performing the entire work load.

Just a word of caution on accumulating work-load data. In EDP one of the most important features to consider when calculating equipment capacities is the time-demand curve of input. Most EDP systems will have a heavy daily work load. Accordingly, the time-demand for each hour of the day should be studied so as to provide machine capacity for the maximum hourly load necessary to be processed. Weekly, monthly, and annual volume fluctuations in the data flow should also be considered in establishing timing limitations.

There are also some unique features of EDP equipment that bear upon the matter of capacity. Some systems provide for overlapping of the input of data, internal processing, and the output of data. Where equipment does not perform in this manner, the input, processing, and output timing must be totaled. This equipment is also capable of utilizing a variety of input and output devices. Usually, many possible combinations of these devices must be considered in order to obtain the optimum operating condition for the system.

Capacity to handle working files. Most data processing consists of applying certain information from files to the daily transactions in order to prepare an output report. For example, the order from a customer may not contain standard shipping instructions, adequate product descriptions, credit terms, item cost, discounts, or allowances. This information must be supplied from files. In EDP systems, the simplest approach to processing is to store these files internally; that is, within the machine components.

There are many design problems relating to these files. Perhaps the most confining problem at this time is the size of file necessary. Even relatively simple business applications require vast files of data for their accomplishment. Data file

storage is relatively costly in electronic equipment, especially when there is usually low reference frequency to approximately 80 per cent of the file content. This would be in accordance with the 80-20 rule where 80 per cent of the activity falls within 20 per cent of the items.

Another design consideration with respect to working files is whether reference thereto can be on a sequential basis or whether it must be random. Since the sequential files have greater capacity and are less costly than random files, it is important to weigh these advantages against the disadvantages of placing in sequence all transaction data before processing can commence.

- Relative complexity of process. Because of the versatility of EDP equipment, the scope of applications possible, and the detailed information necessary, this type of systems work is the most difficult to perform. There is a superior challenge here that constitutes a barrier to acceptance because of lack of highly trained personnel. This has been a material factor in limiting the more extensive use of computers in smaller industries.
- Cost. Electronic data-processing systems represent the most costly office equipment yet offered for business use. Although there has always been a certain readiness to install expensive production equipment in the factory, extensive mechanization of the office is still a relatively new idea and meets with a certain amount of managerial resistance.

These matters of work volume and file capacity, processing complexity, and high cost are some of the systems and procedures design problems inherent in EDP work. The solving of problems of this type requires a high level of ability and a collection of all of the procedural techniques being discussed in this course.

In addition to a knowledge of how to accomplish an electronic data-processing installation, it is necessary for the installer to acquire a rather broad knowledge of all typical equipment available in this new field. He must also learn how this equipment works before he can start applying it to his problems.

In a short session such as this, it is possible only to point out various features of electronic equipment so as to indicate to you some of the system capabilities that make it so powerful. To do this, we

might scan the typical system components for input, storage, processing, and output.

In order to start processing business information within an electronic system, it is necessary to present the data to the equipment in a form of language readable by it. Although most equipment in use today requires a conversion of data from the business document to some other form, recently developed special-purpose machines are capable of reading directly from the original document.

Currently, the most widely used input method is punched cards. This is due to relatively low preparation cost, ease of verification, and development of fast card readers. Where extremely high input speeds are needed, the card may be transcribed to magnetic tape and this tape used for data entry into the system. There is some use of punched paper tape and direct key-board entry. This latter is confined to the smaller types of systems. All of these methods are customarily accomplished by a transcription of the original document, although in some instances the cards or paper tape are by-products of other recording processes.

Recently, most of the equipment manufacturers introduced electronic systems capable of reading directly from documents printed with magnetic ink. These systems are special-purpose inasmuch as they have been designed for banking operations.

Just as there are a variety of input devices and related speeds, so also are there a variety of internal electronic circuits in the processing equipment, each with its range of speeds. Older type of equipment utilized mechanical relays as well as vacuum tubes. Most of the newer designs incorporate diodes, transistors, or ferractors—all of which lend themselves to miniaturization. Additionally, the recently developed systems incorporate circuit elements that permit extremely fast access to all data being processed within the equipment.

One circuit element that is critical in the system design is storage. Here there is a wide range of capacities, speeds, and costs from which to choose. Some of the older systems utilized mercury-delay lines and electrostatic tubes. However, most current systems use magnetic cores, magnetic drums, tape reels, and, in some instances, magnetic disks or tape bins. Of these, the magnetic cores are the most rapid in operation and offer the greatest potential for future development. Presently, the high cost of core storage makes use of other devices economically desirable, especially where speed is not a prime factor.

After data has been processed, there are certain system design considerations related to the available output devices. Generally, there are advantages in using a combination of two or more of the types of available output methods. Some of the system output is usually in the form of updated records for future processing and is not meaningful in terms of the primary report requirements. Such records may be retained on tape or cards and only printed out in readable format at periodic intervals. Other data must be obtained in readable format as rapidly as possible.

Because of the system demands for a choice of output media, there are available, in most systems, magnetic tape, punched cards, paper tape, and a printer. Additionally, most systems provide for auxiliary equipment to handle output of the EDP equipment for purposes of preparing printed reports outside of the electronic system. This is termed "off-line" operation.

All of these electronic components have been combined in a variety of ways by the equipment manufacturers so as to offer machine systems that presently cover a wide scope of versatility and cost. Additionally, there are available many pieces of recording equipment designed to function as parts of the completely mechanized system. These recording machines act as links between the manual system and the machine system so as to permit a high degree of integration within the entire system.

Integrated data processing is not a new concept. To a limited extent we have always had some forms of integration in our recording systems. However, these recent developments of electronic data-processing machines have stimulated the parallel development of other machines designed as integrating devices.

Since integration of data processing is an important concept in the design of an EDP system, it might be well to review the meaning of this term.

As used in our work, integration has two facets: (1) unification of the system and (2) interconnection of the equipment. System unification has as its objective a design that includes on source documents sufficient information to permit use of these data wherever they are needed within the entire business structure. Interconnection of equipment encompasses the objectives of early recording of source data in machine media and the use of this machine media subsequently for all data processing. To put it more simply: The ultimate objective of integrated data processing is to have one manual recording of a

transaction at its inception and to accomplish all future recordings mechanically. However, we rarely achieve more than a partial success in approaching this objective.

The decision to integrate a particular portion of a system must be based on certain advantages. What are these? They should be lower cost, increased speed, and reduction of errors. So, as we consider machine components, we must keep these desired advantages in mind in order not to get lost in the fascinating hardware of the many ingenious gadgets for integration. It is often not feasible to push the application of integration techniques all the way back to the primary source of data.

Just as design features of electronic equipment were said to affect the problems of EDP installations, so do available designs of recording machines and recording media affect system integration. For this reason, we should approach this part of our work by becoming acquainted with the machine components and by learning how these components can be modified to meet our particular methods problem.

Although punched cards are probably the most-used medium for system integration, there is also extensive used of punched paper tape. Paper tape is especially useful where there are distance problems in communication between machines. Magnetic tape is rarely used for initial data capturing because of cost, but it is the principal recording medium within the electronic machines. Magnetic ink, either in coded form or in printed characters, is still in limited use. However, magnetic character-sensing seems to have passed through the experimental stage and now offers the systems technician a new field of exploration for use in integrating systems.

There is a large family of machines from which to choose in this field of IDP. Practically every type office machine can now be intercoupled to a card or tape punch. Flexowriters, add-punches, teletype equipment, cash registers, and ink imprinters are all machines capable of translating document language into machine language. Once translated, the machine language can be re-translated for use in other equipment where direct use is not possible or practicable. For this purpose there are card-to-tape, tape-to-card, and even tape-to-tape machines. There are presently few limits to machine compatibility. However, this matter of compatibility must be considered carefully by the analysts if minimum cost and maximum advantages are to be achieved.

Mechanization for aid to management decision, use of EDP for

business application, and integrated data processing can best be illustrated by using an example from practice. For this purpose please refer to the charts that appear following the end of this article.

These charts picture the types of jobs that might be done on electronic equipment. They bring out the interrelation of data pertaining to widely separated functions and how these data may be integrated by EDP.

CHART A

This chart combines the charts for six basic jobs which appear individually on the charts that follow. The rectangles represent the data processing machine and the circles represent one (or more) magnetic tapes. For simplicity, printed reports are not shown, although you might use your imagination as to possible reporting from the indicated output information. You will notice that some of the tapes are used in more than one operation and that output of some runs becomes input for others.

CHART 1

Chart 1 indicates how information on the sales budget might be combined with inventory requirements data to develop production requirements. The production requirements are translated into schedules in Chart 2 and compared with actual production for control purposes in Chart 3.

CHART 2

The standards tape shown in Chart 2 would contain data as to each product, such as bill of materials, labor requirements, power requirements, quality-control test requirements, standard unit costs, equipment requirements, and batch size. This information is used to explode the production requirements into various details.

CHART 3

Periodically, reports would be prepared in required detail showing where production is behind or ahead of schedule. As shown in Chart 3, the information is obtained by matching the production requirements against actual production.

CHART 4

Chart 4 pictures a typical inventory control job. The inventory of finished product, intermediates, materials, and supplies is updated by applying purchases, receipts, production, usage, and sales.

CHART 5

Chart 5 shows part of the processing to obtain cost and variance reports. At the same time, data as to sales quantities is processed and the cost of sales at standard is obtained.

CHART 6

The last chart, number 6, shows the processing of sales data for two purposes; first, together with cash receipts, to update the accounts receivable; and second, for sales analysis.

CHART A

If you will return again to Chart A, you will see how all six basic functions are integrated into an automatic system.

NEW PROBLEMS FOR MANAGEMENT

We have mentioned some of the objectives that should be sought after in the development of electronic data-processing systems and we have mentioned also the capabilities of the electronic and associated equipment. Because of the magnitude of the task of achieving these objectives with this equipment, many new problems have been created for the managers of the business enterprise. They are management problems because they require decisions to make major organizational changes, to use large amounts of capital, and to retrain and relocate many of the personnel.

However, these are not exclusively management problems inasmuch as the systems man is usually a key figure in their solution. For this reason, the systems man must understand the implications of his work in terms of the related management decisions necessary for the accomplishment of the systems job. Accordingly, we should examine some of the decision areas to understand better the rôle of the systems man.

Generally, the systems and procedures activity within the organizational structure is relocated when it encompasses the installation

of an integrated electronic data-processing system. Although data processing has customarily been assigned to the controller's department, the EDP systems group should be the responsibility of top management. It would be preferable to locate this group close to the executive vice president or someone of similar stature.

The reason for requiring a direct line to top level authority is founded on the necessity for disregarding the formal organizational structure in the new system design.

It is at this top level that the choice must be made as to how far away to go from a patchwork-systems approach and to what extent an engineered approach can be embraced. There is always a lesser immediate financial risk in the patchwork approach. A more imaginative approach requires both understanding and sanction by management.

One of the most difficult problems encountered in installing an EDP system lies in the selection and training of high caliber systems personnel. The success of the new system is dependent to a great degree on the quality of the systems work and the programming accomplished. Therefore, the program should be staffed with a blend of trained EDP specialists and experienced company personnel. The staff should be fortified with persons experienced in mechanized data processing, even though this may mean going outside the organization for such talent. A study of this size should be a team effort, and it is desirable to include in active participation an outside consultant specializing in this field as well as selected representatives from company management.

Top management must supply sufficient funds for preliminary study and installation. The budget for these phases must be prepared by the EDP group leader, so he must be acquainted with management policy in this regard and also must be adept at long-range planning.

It is not sufficient, though, for management to stop with financial aid. Top management must become genuinely interested in and give active support to the entire concept of EDP. This drive must carry middle management by influence and be extended to operational levels by education. Management must join in solving the problems of how to get information about the systems and their dynamics. If electronic systems are to be used for decision-making, only management can contribute the bases for those decisions.

Now, how can management participation be encouraged? One device that has proven successful in practice is to schedule an EDP

meeting at regular intervals. This may be every week or every second week. These meetings should start at the inception of the EDP program and should continue, at least, until the new system design has been tried successfully on the equipment. Participating in the meeting should be the key-system personnel, top management (especially the officer responsible for the EDP system function), the outside consultant, and representatives of the electronic equipment manufacturing company. Whenever system analysis work is being done in a certain area, department heads from that area should attend the current meeting. By using a device such as this, there is an opportunity for exchange of ideas and for management to be fully informed at all times concerning the status of the EDP project.

There are other problems requiring different devices for their solution. One of these is personnel relations. The start of an electronic system survey is usually no secret within an organization. Knowledge of this impending change gives rise to fear of job-loss by many of the clerical personnel. From the start of the project there should be a definite program for informing the personnel of what is being done. They should understand that all persons who might be required to do different work under the new system will have ample time to retrain. Usually, normal attrition within the work staff solves the problem of reduced personnel requirements.

In addition to allaying the fears of relocation, there should be positive attempts to inform all personnel of the nature of the contemplated change.

This can usually be done at a group meeting, or series of meetings, where, after a short description of what is being done, one of the sound film strips or movies available from the equipment manufacturer can be shown. Continuing information can be furnished through the company bulletin or by the department heads.

All management, down through the level of department heads, should attend executive-type courses so as to become acquainted with the equipment and how it works. This will permit them to do a better job when they sit in on the system meetings or participate in the design of a portion of the new EDP system.

A most difficult problem is that of the technical upgrading of key management personnel. In order to do a better job of management and utilize the electronic equipment to its greatest potential, it is necessary that each person give a high degree of attention to the problems of data processing. To become qualified in this regard de-

mands special effort on the part of the individual. This effort could be minimized through the adoption of a positive policy by management of seeking out beneficial seminars and courses at colleges and universities or sponsored by organizations such as American Management Association.

What all of this probably implies is that, in addition to needing management-oriented systems personnel, there is a real need for systems-oriented management personnel. It is evident, therefore, that these two groups come very close together at the higher levels of system development such as in the installation of an EDP system.

UTILIZATION OF SYSTEMS AND PROCEDURES TECHNIQUES

This discussion would be incomplete if we did not mention some of the ways in which systems and procedures techniques are used in the selection, design, and installation of an electronic data-processing system.

There are really just three principal areas of systems activity that might be said to be typical of an EDP system:

First—Determination of equipment needs—the feasibility study.
Second—Design of the data system for electronic processing.
Third—Installation of the equipment and conversion work.

Additionally, there are some minor areas of activity in regard to organizational planning, personnel procurement, staff and management education, and engineering problems relating to air conditioning, room lay-out, power requirements, etc.

The feasibility study is probably the best example of a combination of techniques since it incorporates practically all of the work scope of the installation. Actually, it is the gathering of facts and the construction of a model for future guidance. It is preferable to look upon the feasibility study as one to determine whether or not a new system concept is feasible—rather than whether or not it is feasible to use electronic data-processing equipment.

In order to be specific, I shall present one possible approach to a feasibility study—without necessarily recommending the approach as the best.

There are three distinct stages to the feasibility study: (1) Fact-finding, (2) Analysis, and (3) Implementation.

Since the first stage is fact-finding for a particular purpose, let us review just what is done. First, there are two general areas that must

be studied—the clerical work, which is primarily manual, and the mechanized work, if any. This latter would usually be an existing punched card system.

The object of this study is to determine what data processing is being done and how much it costs to do it. However, we want this information in considerable detail so we shall plan to gather the data in a way so as to permit an analysis of the data by use of punched card equipment.

Each clerical employee is given a form on which he is requested to state his duties. Within each of the basic functions such as payroll, purchasing, inventory, and sales-order processing, the employee states the particular portion of the process performed by him. Processes are best described by such terms as sorting, classifying, filing, and computing. He shows, further, the percentage of his time devoted to each of these processes in a typical period of time, such as a month. He indicates any forms worked upon and in what volumes. He also attaches samples of completed forms to the statement of duties.

Once the statements of duties are completed and assembled by departments they are ready for processing. Codes are established for each employee, department, basic function, and process. Each process should also be analyzed as to whether or not it could be subject to some form of mechanization and it should be coded accordingly.

There should be obtained annual salary cost for each employee, including fringe benefits. These data along with statement of duty data are key-punched on cards.

Since we want to know the total clerical cost of each function and the processes within these functions, this can be our first tabulation. The costs are shown by mechanizable and non-mechanizable amounts. In this way the total cost of sales-order processing may be determined even though it occurs in the sales, traffic, shipping, billing, and accounting departments.

In order to know where the functions are within the formal organization, a second tabulation is made showing this information.

Where additional facts are needed about a certain phase of the work that seems particularly subject to mechanization, it is general practice to prepare flow charts for this segment. The two forms of flow charts most useful are the departmental chart showing processing steps and the document chart showing paperwork flow.

It seems that in the great majority of feasibility studies there are already highly mechanized applications using punched card equipment.

This, then, would be our second area for analysis. Here we would have two objectives: First, to ascertain what portion of functions are mechanized and their related costs, and second, to determine the degree of machine utilization. This latter information becomes useful in deciding the extent to which existing equipment can be retained or must be supplemented under the proposed EDP system.

The technique for a mechanical cost survey is based upon use of standards—both for costs and for processing efficiency. In developing the standard costs, each machine type is considered a cost center. A standard cost per hour is developed for each center, taking into consideration available working hours and percentages of standard utilization. The processing standards are based on machine speeds and are modified for the relative skill of the typical operator.

A daily record of units processed on each machine compiled for one month provides the information necessary to complete the study. Codes are established for employee, operation, machine, report, and department. This permits the key-punching of the daily record data and standard-cost and processing data.

The desired reports can now be prepared on tabulating equipment. These might show actual hours and costs and allowed hours and costs by machine, operation, report, and department. From these reports sufficient data are available to determine all necessary cost and utilization information.

This concludes the fact-finding stage of the survey.

The second stage of the survey is analysis. Where the fact-finding stage required technique, the analysis stage requires judgment. This is the point where all of the data are reviewed carefully. The objective at this stage is to select those functions that might be subject to integration with a corresponding reduction in duplication of effort; or to select functions where problems exist because of present system limitations; or to select functions where mechanization can be substituted for intuition. Whatever objectives have been set by management, these must be weighed in considering and analyzing the collection of system facts.

In analysis work the steps are methodical. Each function is examined in its entirety. For example, sales-order processing would be examined from the receipt of the customer's order, through the shipping order, invoice, inventory control, accounts receivable, and accounting. Associated costs would be identified with each of the processes of the function. Where an area of a function shows pos-

sibilities for mechanization, the cost of the clerical and punched card processes within that area are considered in relation to the cost to mechanize that portion on EDP.

Where some cost reduction or other advantage indicates that a possibility exists for use of EDP, that application is selected for inclusion in the study.

When all functions have been analyzed in this manner, they are gathered into a summary and a reasonable phasing schedule is generated for the entire project. If this analysis results in a practicable situation for application to some type of EDP equipment, the study proceeds to the implementation stage.

This third, and final, stage of the study has as its objective the development and evaluation of a preliminary system design.

The most satisfactory approach to this stage is to design simplified flow charts showing inputs and outputs to the system together with the volumes concerned. These charts should provide for all of the desired processing results and should give consideration to the file storage requirements necessary to accomplish each stage of the processing. From these charts tentative timing estimates are made for each of the selected sets of electronic equipment.

Probably the most critical area of this study is the cost estimate made during this stage. In addition to the obvious costs for equipment rental and personnel there are other costs of a material amount, often overlooked in the anxiety to come up with sizeable cost reduction. Some of these are such cost items as:

- Preliminary system study
- Detailed system study
- Training programmers
- Programming each proposed application
- Preparing physical facilities (partitions, floors, foundations, sound proofing, air conditioning, power requirements, etc.)
- Training operators and technicians
- Indoctrinating executives, supervisors, and workers affected by the computer installation
- Providing spare units of equipment
- Operating supplies such as magnetic tapes, tabulating cards, and multicopy forms
- Conversion of data before start of system
- Setting up and test-checking the program

- Parallel operation of two systems during changeover
- Learning period under the new system

These, and many other costs, are often critical factors in the overall consideration of the feasibility of a certain systems approach. Yet many of them are often omitted from the analysis.

At this point in the study it is possible to summarize the estimated costs and make a comparison with the cost reductions from elimination of clerical work. Although this is an interesting calculation and will certainly be influential in the final decision, it should not be stressed as the only argument in favor of electronic data processing. As a matter of fact, if all potential costs are considered, it is quite likely that the electronic system will be somewhat more costly than the punched card or other previous system. This should be true, especially, where a great many tasks are being assigned to the new system that were not performed at all under the old.

A summarization or tabulation should be made of all of the anticipated benefits to management of the proposed system. Although the eventual effect in dollars of improved management control may be difficult to estimate, we must assume that management itself might prefer to evaluate the controls in relation to the capabilities of the respective individuals concerned.

Upon the completion of a feasibility study it is necessary to communicate the results, conclusions, and recommendations of the study group to management. This should be in the form of a written report. Since this is probably one of the most difficult phases of systems work, we might mention some of the points that should be developed in the formal report.

A good report on a feasibility study should begin with a recapitulation of the factual material that will be included within the report. The reason for the study, the scope of the investigation, and the recommendation should appear in the initial section. Following this summary section, the report should be set forth in sufficient detail to permit a sound evaluation of the study by any qualified person.

The first details should explain the areas of study and the results of this examination. Weaknesses of present methods should be stated together with proposed methods for accomplishing the work. Here it should be brought out why electronic data-processing equipment is necessary. After each section of proposed applications has been covered the entire new system should be summarized. Where the proposed change is an extensive one, a step-by-step accomplishment

might be recommended. Included in this part of the report or referred to in an appendix should be a time schedule for the entire program of system installation.

A summarization of costs should appear next in the report. This should be in sufficient detail to show what items have been included. Also shown should be the areas in which the clerical cost offsets might be expected.

After setting forth these factual data, it would be advisable to include some material as to the expectations of the new system as to improved management control. Here the material summarized in the study could be expanded to fulfill the particular requirements of this job.

The report should close with some statement of what action is now necessary from management if the suggested program is to be started. This section can usually be stated in a forceful manner by placing it in the style of an action program. This would show each of the required management actions, when the action should take place, and who should take the action.

The feasibility study has been explained in some detail because it incorporates almost all of the techniques of the systems man. Implied also in the ability to do this type of work is a knowledge of how electronic equipment works.

There are many other areas of electronic data processing that require the special talents and techniques of the systems man. During the design of the machine system and its installation there are many situations that arise to challenge both ingenuity and patience.

It will be found that in a new integrated system design as much as 75 per cent of it may relate to policy. This means that a high contribution of management time will be required. After the general block-diagramming stage has been reached there will be a necessity for many meetings with the respective department heads for the purpose of selling the system. The highest level of diplomacy is needed in this phase because we are usually talking to the people who designed the system we are trying to replace.

As the work progresses into the intermediate detail-diagramming and final machine-language programming there must be a constant effort to maintain a fresh approach. There is always a temptation to follow present methods and forms. This should be resisted and counteracted by frequent staff meetings and discussion sessions so that the over-all objectives will not become obscured in the mass of detail.

It is well to control a system design through complete documentation. There should be constructed a complete time schedule of accomplishment showing estimated and actual time for each major subdivision of the work encompassed by the project. There should be a programmers' handbook specifying the symbols, automatic programming commands, and programming conventions to be used by all personnel on the project. This constant demand for uniformity conserves many hours of personnel time as the design work progresses through its various stages.

As the new system design approaches completion all procedures under the new system should be developed and written into a form suitable for guidance of operation personnel.

This operating procedures manual should be loose-leaf in form so that system modifications can be reflected in it more easily. Concurrent with procedure writing should be the forms development activity. Forms design should be assigned to someone on the installation team who is adept at this technique so that it can avoid the pitfalls of inexperience. All forms should be tested in a draft form to be certain they reflect the output formats programmed into the new system.

The conversion from the present system to the electronic one will not "just happen." This is a matter for careful planning and constitutes an extremely important phase of the installation. This is due, principally, to the magnitude of the change and the many persons concerned. For this reason, the planning must be in the form of a written schedule. It should include, also, complete instructions for each person affected by the changeover so that no portion of the task will be overlooked. All persons participating in the conversion should be given an opportunity to review the entire plan at one or more group meetings with the system-design team.

SUMMARY

So you see that throughout the work of installing an integrated electronic data-processing system there are used practically all of the typical systems and procedures techniques. These are usually brought together in the form of the talents of many persons, welded into an installation team.

This team must retain its objectivity and its management-oriented attitude. It must become thoroughly acquainted with the mechanics of processing data on the new equipment, which is being improved con-

stantly. Additionally, this team must work so closely with management that management will feel that it is is practically part of the installation group.

By including this type of thinking in your management or systems work, your business enterprises should have an increased chance of being successful.

CHART A

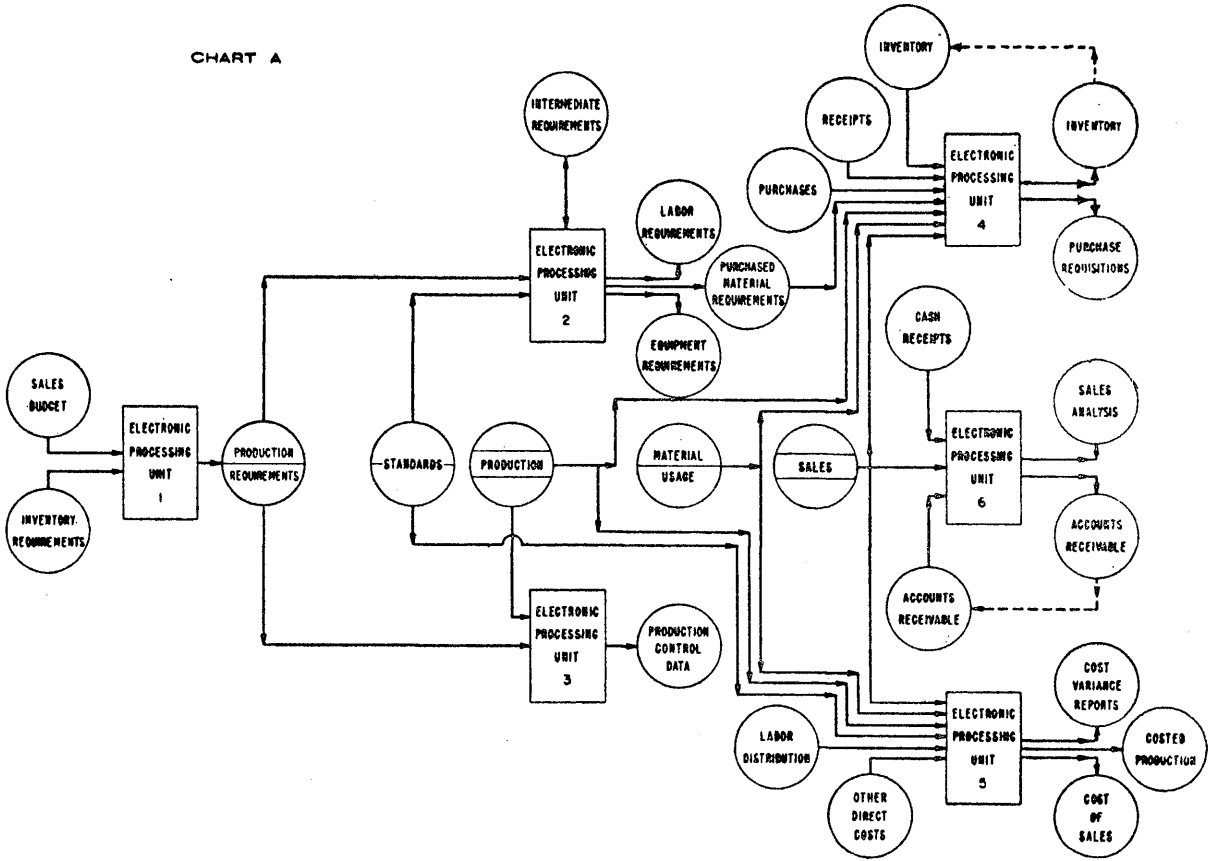
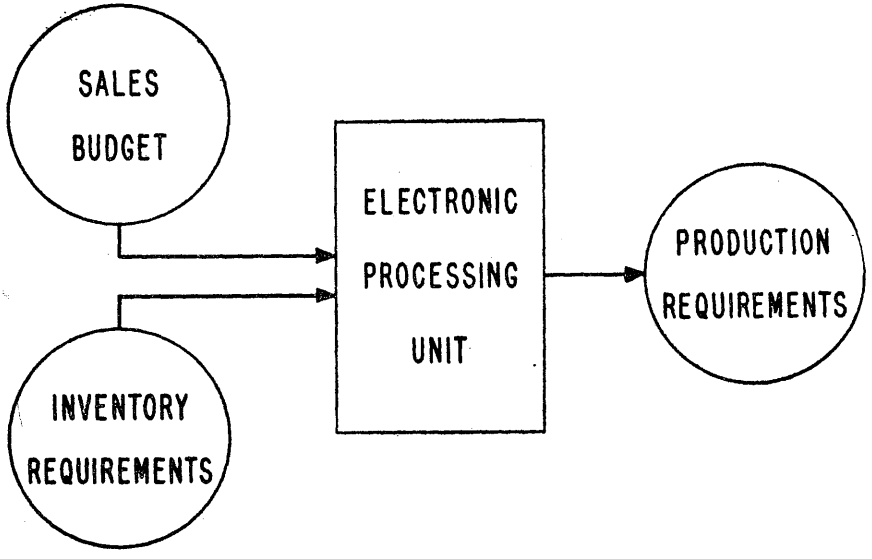
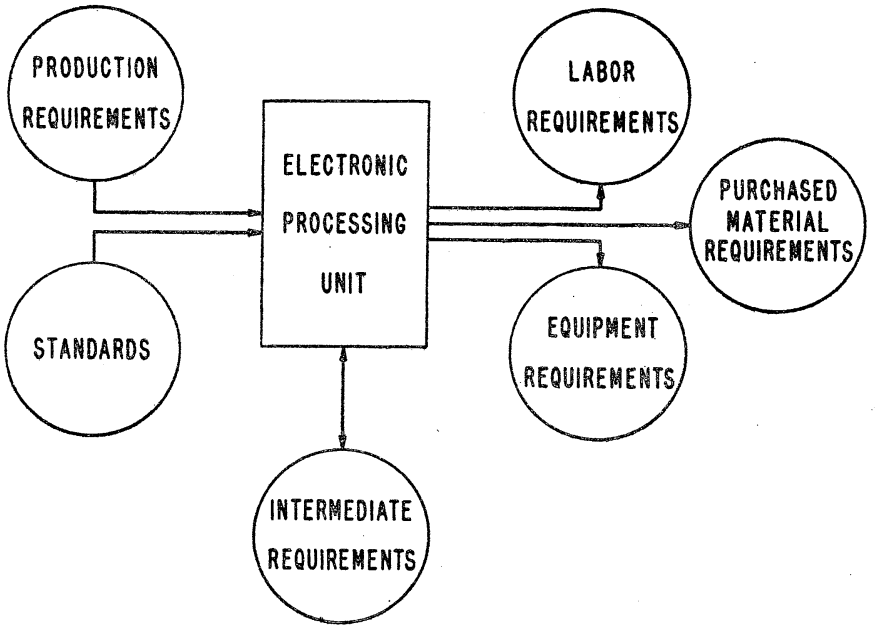

SALES BUDGET
INVENTORY REQUIREMENTS
ELECTRONIC PROCESSING UNIT 1
PRODUCTION REQUIREMENTS
STANDARDS
PRODUCTION
INTERMEDIATE REQUIREMENTS
ELECTRONIC PROCESSING UNIT 2
LABOR REQUIREMENTS
EQUIPMENT REQUIREMENTS
PURCHASED MATERIAL REQUIREMENTS
ELECTRONIC PROCESSING UNIT 3
PRODUCTION CONTROL DATA
MATERIAL USAGE
SALES
INVENTORY
RECEIPTS
PURCHASES
ELECTRONIC PROCESSING UNIT 4
INVENTORY
PURCHASE REQUISITIONS
CASH RECEIPTS
ELECTRONIC PROCESSING UNIT 6
SALES ANALYSIS
ACCOUNTS RECEIVABLE
ACCOUNTS RECEIVABLE
LABOR DISTRIBUTION
OTHER DIRECT COSTS
ELECTRONIC PROCESSING UNIT 5
COST VARIANCE REPORTS
COSTED PRODUCTION
COST OF SALES

CHART I



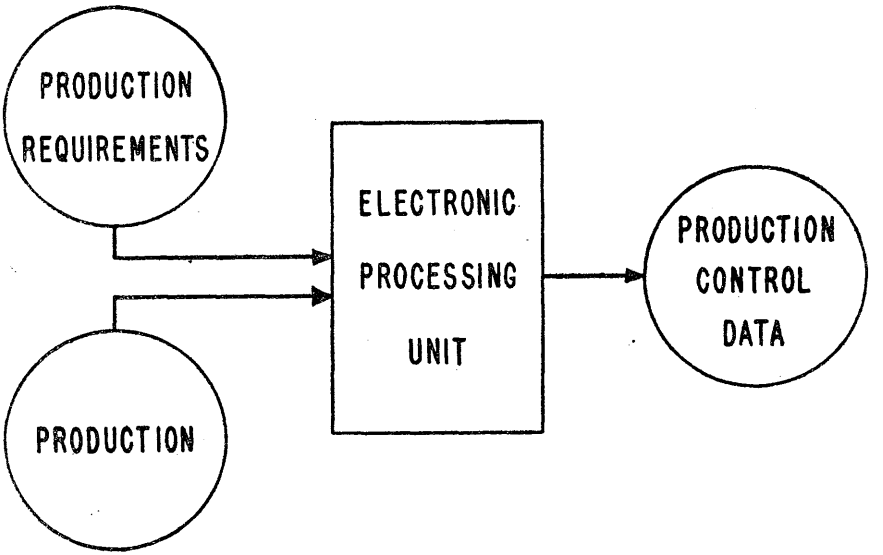
FINISHED GOODS PRODUCTION REQUIREMENTS

CHART 2



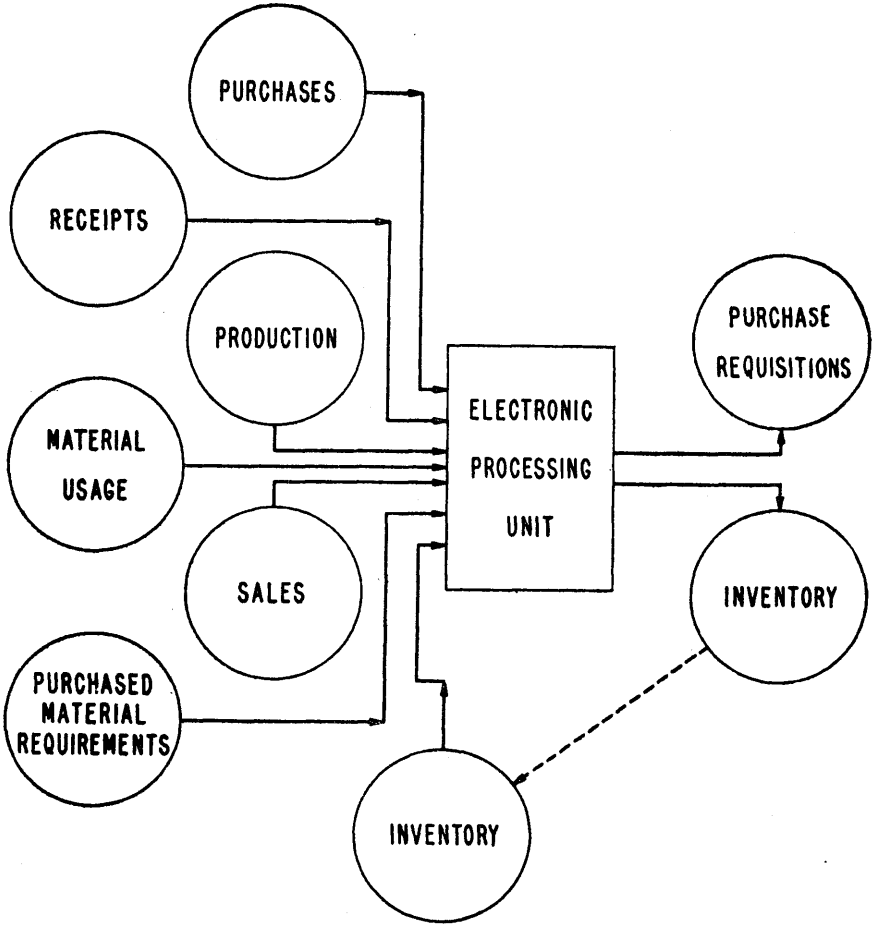
PRODUCTION REQUIREMENTS

CHART 3



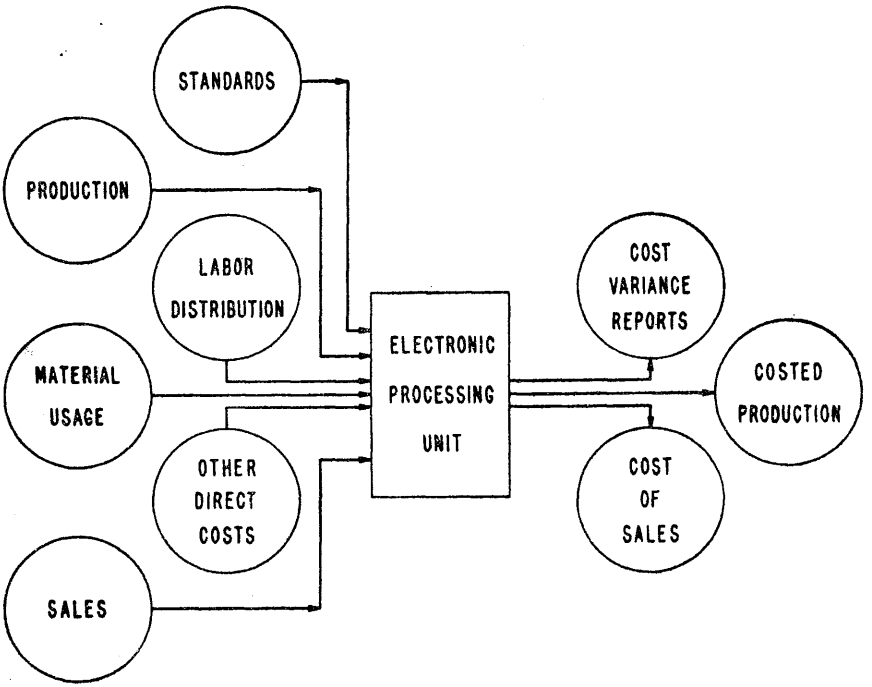
PRODUCTION CONTROL

CHART 4



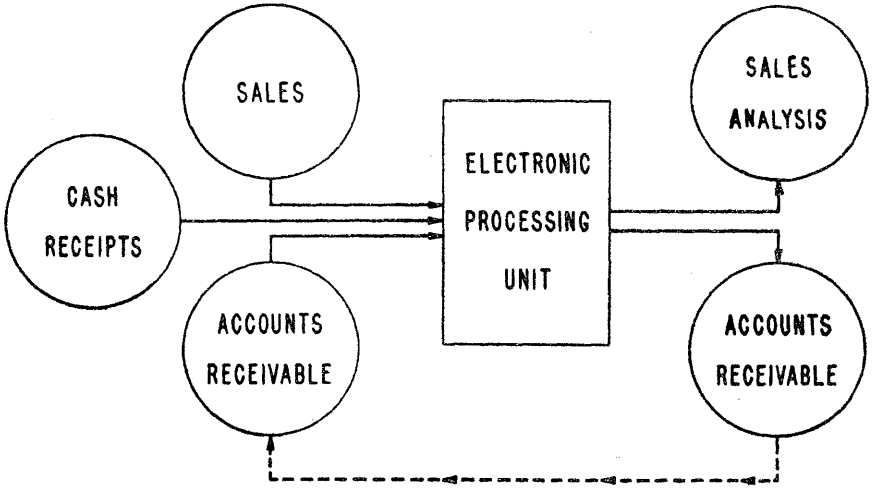
INVENTORY CONTROL

CHART 5



COST OF SALES AND VARIANCE REPORTS

CHART 6



RECEIVABLES