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The role of electronic data processing equipment in aiding and implementing inventory control for the steel distributor

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THESIS

THE ROLE OF ELECTRONIC DATA PROCESSING EQUIPMENT IN AIDING AND IMPLEMENTING INVENTORY CONTROL FOR THE STEEL DISTRIBUTOR

by

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I. INTRODUCTION

Inventory has often been referred to as the "graveyard of American business".[1] It does seem true that the few firms who owe their success to lucky inventory speculation are far outnumbered by those hapless souls who have been destroyed by price declines or changing markets and tastes. It follows, then, that when cash is converted into inventory, whether for manufacture or resale, far more comprehensive records must be compiled and maintained to keep management fully appraised of the size, cost, and condition of its investment. We become concerned in inventory control with the maintenance and use of such records not only because of their intrinsic "control" or accounting value per se, but because they serve as guideposts for management evaluation and action as well. Inasmuch as the average manufacturing firm will spend between 40 to 60% of its sales dollar for inventory, and the average steel distributor 60 to 80%,[2] it becomes quite apparent that even the smallest percentile savings effected through better methods of control will be reflected clearly and immediately in the net profit of the enterprise.

In establishing a conceptual framework for inventory control within which we can place many of the major arguments of this thesis, we must remember that there are a number of problems unique to inventory management. First, inventory is a heavy and a continual investment burden for the concern. Changes in the pattern of purchases will inevitably lag behind shifts in the trend of sales creating a deadly gap, especially where taste or style buying is concerned. Finally, inventory losses due to price fluctuations or excess waste can wipe out profits. This is quite significant for the firm working on tight profit margins as are the bulk of this nation's steel distributors.*

The causes of these problems are not hard to find. With the exception of the corporate giants such as General Electric or United States Steel, few firms have felt the immediacy of, or allocated sufficient funds to cope with the need for control programs. Furthermore, the responsibility for the control has remained somewhat indistinct, shifting uneasily between the sales, procurement, and finance functions depending on the management concept currently in vogue. The all too human trait of hoarding also enters into the picture. We overstock to meet growing sales to customers or lenghtening lead times from suppliers. The diversity of items to watch and study, the inadequacy of historical information, the difficulty of effective business forecasting all conspire to aggravate the work of inventory management.

In the midst of all these problems, our goals for inventory control remain relatively simple and clear-cut. We want inventory on hand for steady sales (or production) and good service to our customers. At the same time, we want this inventory lean enough to minimize the financial investment it will entail. Good vendor relations must be maintained and every effort should be made to avoid obsolescent stocks and excess scrap.

Where are the answers for effective inventory control coming from today? One of the newest developments stemming from our current technological revolution lies in the area of electronic data-processing. Computer equipment has added speed, accuracy, and long-term economy to many

*For the past four years, Joseph T. Ryerson & Son, a diversified industry leader, has averaged a 2.4% return on its sales dollar with 1960 seeing a scant 1% return.

of the most tedious and repetitive operations in the business firm. Basically, computers are devices designed to perform arithmetical calculations automatically at very high speeds. Remington Rand's Univac, for example, adds and subtracts eleven digit numbers at the rate of 1900 per second, multiplies them at the rate of 564 per second, divides them at the rate of 257 per second, and compares them at the rate of 2760 per second, and compares them at the rate of 2760 per second.[3] Operations can be programmed into one of these machines to allow it to proceed automatically from one step to another to a final solution without the need for human intervention.

The prospects for inventory control when handled by this type of equipment are quite bright. Certainly, the computer does not mean the end of the procurement and control function as distinct aspects of the firm's operation. Electronic computers do not make decisions, they can simply add and subtract, multiply or divide very rapidly. They cannot analyze, decide, and plot a course of action as can the human mind. This places more burden than ever on management to ask the proper questions and then be prepared to implement the necessary steps as indicated by the computer's findings. As Lewis and England point out:

> Data processing equipment permits the classifying, sorting, calculation, summarizing, and recording of information with a completeness and speed which enables decisions regarding order quantities, performance of suppliers, and related matters, to be made on up-to-the-minute, complete, and accurate information. [4]

This means, in effect, that the computer's long-run role will be that of helping the inventory manager do his job more effectively rather than supplanting his role _in toto_.

The steel distributor can and should consider the possibilities of adapting his control systems to automated electronic equipment. His problems are similar to those of any distributor carrying a multitude of items, sizes, and types. Indeed, this is a most crucial area of decision for the distributor since not only are effective inventory control and incremental profits wedded, but sales effectiveness as well. The steel warehouse in its pure form stocks steel for resale only. To the extent that its analysis of the market is correct, to the extent that management is able to develop a viable system of replenishing the significant items in the line and eliminating the slow, or non-movers, the distributor has accomplished the dual feat of cutting his costs of possession and furthering his sales effort.

The purpose of my research has a rather simple goal. I intend to show the direct advantages accruing to management from the adoption of automated data-processing systems in one of three basic categories: punch card, computer, or IDP, Integrated Data Processing, in controlling the myriad of items and sizes carried in stock by the modern steel distributor. Inevitably, there will be reflected in my discussion a good deal of groundwork necessary to define the steel distributor, data-processing equipment, and inventory control techniques. And certainly, no one approach or system is the be-all and end-all for every distributor since our subjects range from small, independent jobbers to national, multiplant operations.

As is generally the case when dealing with a new concept or process, the relationship of inventory control to data-processing is generally touched in the closing pages of most new texts in the areas of purchasing or finance. The merits of electronic control systems are highly praised but very little, if any, developmental work is initiated. There are but few texts and fewer case histories for the student to draw upon. When we turn to potential sources within the industry itself, we find little suitable subject matter. The Secretary of the Steel Service Center Institute, the national data-collection agency and spokesman for the industry, could cite but a few distributors using, or contemplating using, electronic data-processing systems for inventory control. Our cases will be drawn from two of these firms as well as two firms outside the industry who have utilized the computer approach to inventory control.

We are quite grateful for the assistance and general background information representatives from the International Business Machines Corp. and Remington Rand Corp. were able to furnish as well as the personal assistance and guidance supplied by Mr. James Smith, former Office Manager of the Vinson Steel and Aluminum Co. of Dallas and Houston.

II. THE STEEL DISTRIBUTOR - AN ANALYSIS

It seems it requires a complete shutdown of basic steel mill operations to dramatize most effectively the significant role played in our economy by the steel distributor. The general and prolonged mill strikes of 1956 and 1959 proved what a vital link between the mills and the consumer the distributor has come to play. Some steel consumers were able to keep their plants running at close to full capacity by drawing on steel supplied them by their local steel warehouses. Up to 20% of the finished steel sold in this country arrives at the consumer's unloading dock via the steel distributor's truck. There are approximately 2,000 steel distributors located throughout the country. Some are associated with parent steel producers: such as United States Steel Supply and the United States Steel Corp., Joseph T. Ryerson & Son and the Inland Steel Corp. The majority, however, are small, independent organizations operating generally from a single location.

NINE MONTH MILL SHIPMENTS (IN TONS)

	Distributor	Total	%
CARBON STEEL PRODUCTS	6,067,031	36,581,139	16.6
ALL ALLOYS	421,643	3,557,178	11.9
STAINLESS	177,242	452,474	39.4
HEAT RESISTING	1,143	9,323	12.3
CARBON MERCHANT PROD.	1,707,271	6,752,522	25.3
SEMI-FINISHED & . . . . MISC. CARBON	547,847	2,261,327	22.9
GRAND TOTAL . . . . ALL PRODUCTS	10,208,286	57,612,825	17.7

TABLE I. TOTAL MILL SHIPMENTS AND MILL SHIPMENTS TO ALL SERVICE CENTERS AND WAREHOUSES. FIRST NINE MONTHS OF 1960. (5)

From the table we have listed above it is quite apparent that the distributor is represented in every major category of steel sales and, historically, will receive close to twenty per cent of all finished steel shipments from the mills. The nature of the business does not lend itself to simple classification, but it is safe to say that the industry can be broken down into five general categories. First, the General Steel Warehouse carries not only the so-called garden varieties of hot-rolled carbon bars, plates, sheets, and structurals, but specialty items as well. Second, the Specialty Warehouse carries from one to three products such as cold-finished carbon bars, mechanical tubing, boiler tubes, stainless steel, alloys, and sheets and strip. Third, the Combinations such as Heavy Hardware and Mill Supply Houses may have separate steel departments. Fourth, Structural Fabricating Shops may, on the side, do a warehouse business in plain material when their own business is not running at full capacity or when they become overstocked in certain types of steel. Fifth, the Marginal Operators, such as brokers and scrap dealers, appear on the market during a steel shortage and capitalize on their ability to find the special sizes and shapes in heavy demand.

The warehouse industry serves roughly ten times as many customers as the producing mills, selling to approximately 600,000 accounts, big and small. While the average mill rolling order is measured in tons, the average distributor order fluctuates around 1,000 pounds, and has been considerably smaller in recession periods when all buyers attempt to hold inventories at a minimum and order only what they plan to use from day to day. The mills aim for long production runs to achieve maximum profitability and hence are reluctant to handle small orders. This attitude and approach create the natural market of the steel distributor. Even the largest of mill buyers have occasional needs for items ranging from 10 to 10,000 pounds, and the steel distributor becomes the logical source to fill such special needs. The modern distributor's services range far beyond the simple storage of standard mill products and resale in small lots. Most distributors offer one day delivery service as well as cutting facilities designed to cut rapidly and accurately to the exact sizes needed by the customer. The demands of the consumer, as well as competitive pressure, have forced the modern distributor to offer more and more additional services in his sales package such as immediate delivery, cutting to exact requirements, special packaging and marking to protect and maintain the identity of the material in the customer's plant, free engineering, metallurgical and heat-treating advice, as well as very close and personal service from trained specialists.

In appearence the typical steel distributor bears little resemblance to the dark and dingy structure the word "warehouse" connotes to many of us. More and more money has been invested by distributors in heavy handling equipment such as cranes, lift trucks, banding and wrapping lines. The most modern types of cutting equipment have been installed to keep apace with the mushrooming demand for flat rolled products in coils, sheets, and plates. Coil slitting and flattening lines, plate shears, and flame cutting equipment ranging to the most expensive and elaborate electronic-eye equipment have been installed in an attempt to approach die-cut accuracy in steel plates cut with oxyacetyline or natural gas. Some distributors have burning equipment capable of cutting cleanly through plate as heavy as sixteen inches thick. A few distributors have seen a potential market in semi-finished parts and have added fabricating equipment such as press brakes, punches, and welding machines to their capital investment.

Ironically enough, steel distributors sell a homogeneous group of products for which marginal differentiation can be at best contrived. The level and quantity of competition, the influx of foreign steel, the popularity of competing products (such as aluminum or plastics) has forced profit margins down to the point where it has become difficult to maintain, let alone expand, investment in the industry. In 1953, one of the best years in the history of the steel business, the producing mills made 5.7%

net after taxes on their sales dollar. During the same period, 80% of the members of the steel Service Center Institute (then known as the American Steel Warehouse Association) reported earnings under 5%. This was a record year for the industry which only 1956 again approached. The bar graph which we have reproduced on the following pages illustrates the negative profit trend the industry has been experiencing over the past few years. Now in the midst of our second nation-wide recession in three years, there can be no safer comment than that the efficiently managed distributor is the successful distributor.

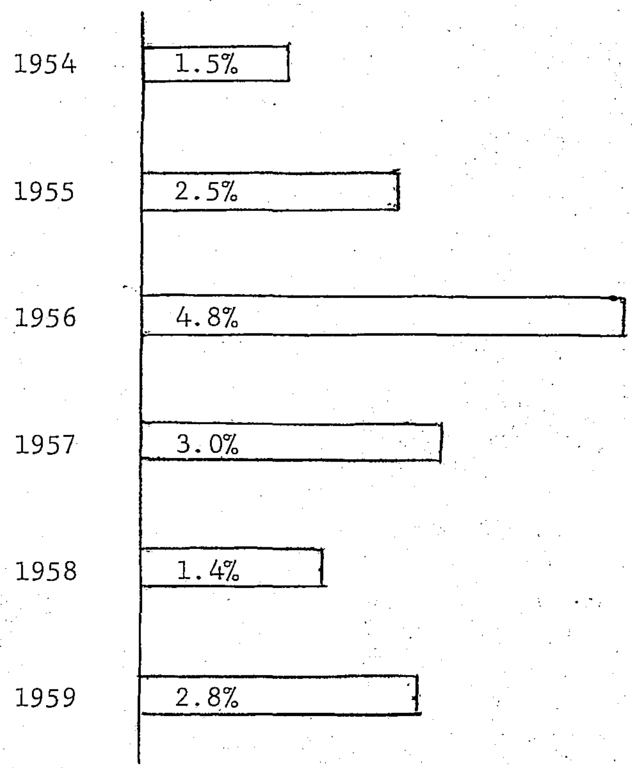

CHART I. STEEL SERVICE CENTERS - PERCENT RETURN ON SALES AFTER TAXES (6)

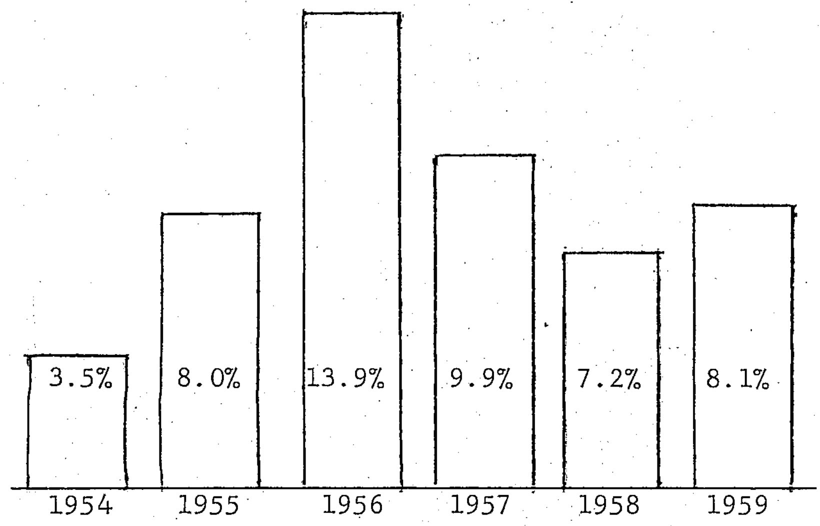

CHART II. STEEL SERVICE CENTERS -
PERCENT RETURN ON BOOK NET ASSETS AFTER TAXES (7)

The distributor must take on many of the burdens he offers to remove from the shoulders of his customers. He provides storage space, invests heavily in plant and equipment as well as a special inventory. The successful operation of such a firm becomes as much a study of finances and financial controls as sheer sales technique. It is to one aspect of the financial control of such a firm to which we have addressed ourselves.

Inventory control for the steel distributor is generally an item of concern for the purchasing agent, the sales manager, and the chief financial officer of the firm. Decisions made in this area are so crucial to total sales, dollar turnover, and the overall health of the firm that many cooks must attend the broth. And yet, this very fact of mutual concern and interest becomes a weak point. In only a few instances is a specific "inventory control" function vested solely with a specific individual. Another problem area, especially for the General Steel Warehouse, comes from the pressure which each product specialist applies in an effort to add to his line and bolster his sales effort. It is quite difficult for a purchasing agent to become a clearing house for such diverse requests and treat them knowingly.

The problem of physical accounting is also quite pertinent. The distributor buys in carload quantities and is constantly receiving and unloading mill shipments. Since these shipments can vary within permissable mill limits, significant discrepancies between actual and expected inventory levels will occur unless a constant tension is maintained between the plant and the office. Most firms maintain some type of perpetual inventory against which incoming and outgoing shipments are recorded. Since these figures are posted by hand and the new totals are determined by a clerk, there is always present the risk of human error. Such errors can jeapordize sales and reorders with the mills since both rely on the perpetual inventory records so heavily.

In the midst of the myriad of detail involved in maintaining a going business operation, where is time to be found by management to meet its forecasting needs? Forecasting often becomes a mental process performed in the mind of the owner or manager of the firm. When the concern becomes larger and procedures more formalized, the problem grows for then it must intrude upon the time of managers and personnel who tend to be wrapped up in the day's current business. One of the goals of any transition to electronic data-processing equipment should be the addition of systems offering more effective and immediate information for management. This information can be of many types and varieties: current stock levels, the sales of a given product line or specific item, a review of past promises and actual deliveries from mill suppliers. In addition, electronic equipment must meet the challenge of supplying a means for the regular accumulation and transmission of data for reports, the entry of new orders and the maintenance of perpetual inventory records.

The potential dividends for the distributor are many and rich. Among the more obvious we can cite the fact that electronic controls will mean optimum personnel utilization. Clerical work of the most tedious nature will be eliminated and, along with it, many concomitant errors and discrepancies. Cost reductions can be effected through grouping and design of work loads, less time wasted on repetitive operations, and more accuracy. The distributor can face the most pessimistic of market conditions with full flexibility and the lag between sales and purchases can be cut to a minimum. Data-processing means better control through the principle of "management by exception". The effective manager wants to know when his operations are out of line. He needs, therefore, what electronic experts call feedback, immediate and frequent reports for him to appraise the results he has obtained from his efforts to improve deviations from anticipated norms. Data-processing equipment will implement the exception principle through continual feedback. The manager's skills can thus be devoted to controlling and improving the areas of his responsibility which need the most improvement.

Let us continue to set the stage with a simple analysis of what electronic data processing means with a generalized discussion couched in the terms and imagery of the layman, not the engineer or electrician.

III. THE ELEMENTS OF ELECTRONIC DATA PROCESSING

There are three types of data-processing which we intend to outline and discuss. The technical aspects of each are available for perusal and study by the engineer and mathematician elsewhere. Our goal here is as much to point out what is available as to explain how it works.

The Punch Card: This technique of data-processing is used extensively and effectively in cutting down the level of routine clerical operations for the firm. It often forms the basis or background for some of the newer techniques employing high-speed computers. Some of the jargon developed around the use of punched cards should be pointed out and discussed since it will recur again and again, even in the most sophisticated systems of data-processing. The punch card itself is a rectangular cardboard tab in which certain openings are punched. These openings are significant and represent specific elements of information depending upon their location on the card, generally referred to as "field" - the columns set aside for specific types of data. The key punch is a machine ressembling a typewriter on which the punch cards are slotted. The operation of the key punch requires a good deal of training and is an area in which skilled technicians are in great demand at the current time. A tub file is a container which contains batches of pre-punched cards and simplifies office procedure when cards containing identical information are used frequently. For example, a sales firm which uses punch cards to carry customer information which is applied to sales orders might use a tub file containing pre-punched cards for all of its regular customers. Punch cards can be read on the proper translating equipment for counting and sorting. An electric typewriter mechanized to read punch cards could take customer data cards as mentioned above and type all the pertinent information on the face of the sales order with only a minimum of human control.

Punch cards permit an entire sequence of operations to be performed on the proper type of machines. They also can serve as a repository for data needed frequently or at intervals in the routine of the office. They offer a good deal of flexibility at low unit cost. It is possible to merge new data with significant information from old cards to establish a historically current set of cards. Punch cards finally serve as the media by which information may be transmitted from one piece of equipment in the office to another without midification since each machine can be preset to search for and analyze only a particular field or sets of fields.

Inevitably, there are limitations to this the forerunner of the more sophisticated electronic systems. The punch card is not a suitable vehicle by which to transmit information over considerable distances. The cards must be physically handled from one piece of equipment to another in order to reproduce all the information they contain. This may seem insignificant at this stage, but we should remember that the "input" problem must be met and solved if we are to utilize the fantastic speeds at which today's modern computers are geared to operate. In all, the punch card system has not been able to meet the demands of the large business office handling vast quantities of data in a single day.

This is not to say there is not a place in the office of the steel distributor for the punch card and its accessory equipment. Many helpful services can be performed through this medium such as the transmission of customer information to orders as we have already discussed. We shall see later in one of our case histories that a major steel distributor has had good success in analyzing current stock levels, monthly sales, and reorder points with a modification of the simple punch card system. Primarily, however, we have introduced the lowly punch card at this stage of our discussion to pave the way for the pure electronic systems which have entered the market in the past decade.

Electronic Data Processing Machines: As we indicated in our closing comments on punch cards, the need for faster means of data handling has been a current problem in the field. The computers, originally an electrician's daydream, were broken in during their application to defense needs. They have been instrumental in speeding up the processing of data problems. Basically, all these computers operate on the principle of counting and storing electronic impulses. These impulses, in effect, become the language of the machine. Of course, this creates something of an input problem since the data being fed into the machine must be translated into units decipherable by the machine. Furthermore, the machine must be given a set of orders, programmed, in order to take the input and give us meaningful answers. Both steps require the use of skilled technicians. In addition to its calculating abilities, the computer can also serve as an immense storage bin which retains records of these magnetic impulses or dots in individual cells assigned to particular elements of information. The computer's operator can program the machine to compare, store, and recall this information from the storage cells at tremendous speeds.

Although we are simplifying, there are basically two types of computers. The analog computer requires its input to be converted into measurable units, such as impulse lengths, voltages, or the like. It requires highly trained operators and has found its main use in scientific work where its extensive use of feedback principles can be best applied. The digital computer, on the other hand, relies on basic arithmetic for its operation. It is a general purpose machine using magnetic impulses as its language and has been found quite adaptible to general office applications. The input data must be programmed by trained operators, but the machine can be adapted to functions required uniquely by the firm employing it. In some cases, the computer may be purchased from the manufacturer with certain types of repetitive data pre-programmed into its circuitry.

Leaving the niceties of linear programming and quadratic equations to the engineers, it is interesting to note some of the particular characteristics of this type of machine. As we mentioned, the input function is the outside world's means of communicating its demands to the computer. Magnetic tape has proven a far more rapid method of getting programmed data into the machine than punched cards. Tape input has been calculated to exceed a card input of 10,000 cards per minute. When we consider the amount of punching, sorting, and handling involved in punched card systems we realize that a 10,000 card input is quite impossible and begin to see the significance of tape. The magnetic tape itself is originally made up from punched tape or cards. It is read by a special translating device within the computer. The magnetic impulses carried by the tape are magnified at this reading stage and begin to activate operating circuits within the machine. There are a number of different tapes identified as to the type of purpose they serve. Instruction input tapes serve to give the computer a series of "do" commands. They guide the machine through a sequence of routines which, in turn, may be broken down on the tape into sequences of sub-routines. These instructions are stored in the memory section of the computer and are carried out in order and automatically as long as information is fed into the machine for analysis. It is apparent how important accurate programming is in the instruction tape. Since the machine cannot think for itself, it will not evaluate the commands fed into it. Thus, if the commands are incorrect in any detail or step, the error will be present in any work the machine may perform while under the instruction of that particular instruction tape.

The transaction input tape serve to carry the data required for analysis to the computer. It is often used with a history tape to bring balances forward or to bring the history tape itself up to date.

The output units at the delivery end, so to speak, may be found in a number of forms. Output may be new tapes, punched cards, punched forms, checks, or envelopes. Again, the computer usually has completed its calculations far more rapidly than its printer can type or punch its results. Often the computer is designed to place its answers in a special section of its memory file and feed them back to the printer as rapidly as that piece of equipment can handle them.

While simple forms of punch card techniques and equipment have been in existence for upwards of fifty years, the computers are relatively still in their infancy but have already proven their merit in high speed calculating, sorting, and filing for many involved operations punch cards could not begin to solve. Certainly the demanding nature of the programming required for these machines is more than offset by the valuable services they perform. Yet, for the short run, there is a distinct lack of personnel trained to initiate involved programming. Office management, generally, is not yet prepared to draw upon the full benefits offered by this equipment because they themselves have not yet had the opportunity to "grow up" to the machines held up for their consideration in the marketplace. Taken alone, the computer is a difficult piece of machinery to relate to the operation of the business office. It requires a special location and controlled atmosphere. Special tapes, meaningless to the other machines in the office are required to make it function. Its answers must be decoded into numerical statements or punch cards to permit them to be integrated into the operation of the rest of the office.

We can see now a distant but distinct connection between the computer and inventory management for the steel distributor. Just as there are threads of similarity between applications for different firms, there are common problems to be shared. The problems of personnel, data-programming, and translation remain true for the distributor as for any other firm. The computer offers management for the first time a rapid and accurate device for digesting vast quantities of information at arriving at meaningful answers. Let us proceed one step further.

Integrated Data Processing: IDP is designed to permit the computer to operate at its maximum efficiency. It can tie a single office together in common language as it were and via teletype can communicate with and operate equipment at distant points throughout the country.

> "Integrated Data Processing is a plan for mechanizing the recording, transmission, and re-use of necessary business information. Its goals are designed to surmount the major objections to computer mechanization, eliminate the frequency of human entry into the analytical process, and, at the same time, have the requisite information constantly on hand, ready for immediate extension and tabulation," 8

The problem of handling and rehandling data is inevitable when we consider the proliferation of specialized data-processing equipment found in even the smallest office. The heart of IDP lies in the "common language tape". This tape eliminates the need for decoding and repunching of computer information. In the fully automated office, every important machine will be capable of reading and operating from the common language tape. Furthermore, these tapes have been designed around the five channel communication code to enable them to be hooked up with communication equipment for transmission to other offices.

For a moment, let us stop to consider the many types of business machinery such a system could extend to. The teletype - or basic communication instrument between distant points, electric typewriters for converting data into tables and reports, adding machines, addressograph-plate machines, bookkeeping machines, cash registers, calculators, convertors (devices to convert punched tape to cards or vice versa). Indeed, the old tub file can find a new lease on life, this time to store tapes rather than cards.

Many of the same arguments about initial cost, obsolescence, need for specialized skills may be raised when contemplating investing in the automated office as when the computer itself was first analysed. And yet the logic of equipping the office to travel in the same company with the computer is sound and cannot be denied. The peculiarities and needs of any given firm make generalizations difficult and out of place. Firms which face masses of calculations and summaries in their operations, such as insurance companies, were among the first to visualize and grasp the benefits automation held for them. Cost is certainly a factor here, cost not only in the strict sense of outlay for new machines, but the cost of converting records, developing new forms and procedures, revamping the internal paper flow generally to meet automation with a minimum of friction and inconvenience. A conversion to IDP cannot be taken lightly nor can it come rapidly. A good deal of study and project analysis should be completed before management can feel at ease in its decision one way or the other. Systems and forms currently employed may be unadaptible to IDP and hence must be scrutinized closely. The major firms selling computer equipment offer a package service which often can include such appraisals. However, one must not forget that they are attempting to sell their own system. Management would do well at this point to call in outside advice. The consultant can render service far beyond his fee with a dispassionate analysis designed to dampen somewhat the hopes of the ardent automationists and perhaps encourage some of the more reluctant fundamentalists.

Two peripheral questions which we have touched upon but not discussed in detail are among the most significant of the overriding factors management must consider in its approach to electronic automation. The first is that of relating costs to results. The initial investment in a computer and its accessories is certainly not a figure which can be absorbed in a yearly budget. It is a distinct piece of capital investment which for some firms may become an expensive plaything if purchased unwisely. The steel distributor, depending on the size and scope of his operations, is faced with a number of functions such as accounting, inventory control, and purchasing as well as a need for reports on such subjects as shipping costs, manpower allocation, employee insurance and benefits which lend themselves to faster and more efficient handling through computer techniques. The second factor to be resolved is that of the effect of automation on the current office staff. It takes a long time and many dollars to train people to handle the internal workings of a business concern. They must be treated with understanding when as radical a shift as this is under consideration. Perhaps the best generalization we can make is to keep the office staff as informed as possible. Let them know of management's feelings on the subject of automation. If they understand the role the new equipment will play in the office, they will undoubtedly give it a far better reception than a change presented to them as a *fait accompli*. In many cases, the new equipment will eliminate only the most undersirable kinds of clerical work and probably aid the skilled personnel in performing their work more rapidly.

We now begin the process of bringing electronic data processing together with the most advanced concepts of inventory control, constantly relating the union to the problems and challenges of the steel distributor.

IV. RELATING DATA PROCESSING TO INVENTORY CONTROL

Inventory control for practically any firm boils down to balancing the advantages to be derived from stocking various additional quantities of different items against the advantages resulting from not stocking them at all. So many unrelated factors must be weighed in establishing effective inventory controls that it seems best to initiate our discussion with a brief listing of those we consider most important.

Stock on hand	- material in our plant ready for production or resale.
Turnover	- the anticipated time period which will elapse before the stock on hand is sold.
Storage cost	- includes labor cost of handling plus rent, insurance, utilities, etc.
Obsolescence	- This is not a particularly acute problem for the steel distributor, but the need to keep his material in a condition suitable for resale certainly is.
Special handling problems	- any physical or personnel problems which will prevent the firm from purchasing in the most economical quantities, lengths, etc.
Transportation costs	- the distributor's proximity to the mill will reflect directly in his costs of raw material.
Investment costs	- based on the current rate of interest, this factor represents a rate of return which will not be received over the period our money is tied up in inventory.
Order cost	- usually a factor only in small dollar purchases.
Lead time	- time required for delivery to our plant site once order is placed with mill.

These factors we have listed above, among others, are as significant to the inventory manager as the purchasing agent (usually one and the same individual in most distributor organizationsl charts). They must be all given their relevant weight in any system which sets out to define standards of performance for inventory management. A number of yardsticks may be applied, even within the same firm for different classes of inventory. We find them expressed in terms of minimum-maximum levels, as ratios to sales in the form of turnover, or number of day's supply, or they may be in the form of dollar levels established for certain types of inventory. Return on investment can also be used to measure performance, although it is generally tied into some more tangible yardstick such as turnover or day's supply.

Minimum-maximum quantities are one of the most common standards for the control of inventory. For each item a minimum and maximum limit is set for the guidance of the purchasing department. These limits are usually intended as a general guide rather than definitive criteria. Closely related to this approach is the slightly more sophisticated and up-to-date concept of "working" and "safety" stocks. This concept springs from the fact that our inventory has two distinct personalities. The first and major portion of our inventory is ordered to cover anticipated usage and takes the title "working inventory". It is represented, for the steel distributor, by the actual quantities of a size or item he purchases from the mill, i.e. a 40,000# carload of 3" x 4.1# structural channel in random mill lengths. If lead time from the mill, usage, and the other factors we listed earlier were constants, the carload of channel could arrive, be placed in stock, and sales could commence against that stock. At a certain point, based again on lead time, usage, etc., a new order would be placed for that size with the mill and would arrive in our plant just when the last of the channels from our original order were being sold. Again we point out that this could be the case only if we were dealing with constants. However, lead time, usage, and the rest are the most flighty of variables and we must inevitably be faced with the unpleasant prospect of going "out of stock" in our stock before the channels arrive from the mill. This is the justification for the second part of our inventory which has been labelled "safety stock".

Effective inventory management dictates that we order at some point in advance to guarantee that our new stock will arrive before we are in absolute need of it. The safety margin we establish in terms of a certain number of stock lenghts of channels becomes our safety stock. Again, to finalize our point, we establish our safety stock to drop the possibilities of a complete "stockout" from 50% to some more comfortable percentage. The size of our safety stock will determine just how comfortable we shall be. The larger the margin, the less the danger of ever running out of 3" x 4.1# channel completely. And yet, we cannot permit too large a margin since it means tieing up dollars in unproductive inventory. When we recall that even the humblest general steel warehouse will carry upwards of 1,000 different sizes and items, we gain some insight into the dilema of the inventory manager. There is a unique set of factors which must be weighed for each item and size to arrive at a realistic level for our working and safety stock. Furthermore, we face a continually shifting economy. Changes in attitudes, designs, and manufacture mean that once these levels are established, management cannot become complacent and assume it has a "perfect" system. Working and safety inventory levels will bear constant scrutiny to insure maximum turnover with minimal dollar tie-up in nonworking inventory.

There are two more concepts basic to our explanation of scientific inventory control: order quantity and reorder point. Both have been known and discussed for many years as subjects of concern for purchasing, but they affect inventory control as well. Our more modern analysts place heavy reliance upon mathematics in formulating and solving special equations in an attempt to condense these problems into measurable phenomena within an overriding algebraic formula. Without delving too deeply into the mathematics involved, we can point out that establishing order quantity (how much of a given item and size we will buy at one time) involves weighing those costs that will increase as we augment the size of the order versus those that will decline. In defining the various cost factors, we note that the costs immediately concerned with the inventory itself will increase with the size of the order. Such costs are interest, insurance, taxes, obsolescence, depreciation, storage, and utilities. They are directly connected with the size of our inventory and the smaller our average inventory, the lower these costs.

On the other hand, the costs of handling a specific order will not fluctuate <u>per se</u>, but will increase as the number of orders rises.* This holds true because of the constants we face when place any order, constants in terms of paperwork, expediting, and handling. In addition, there is an intangible error factor which will be present as the order frequency mounts. This factor will also serve to increase our order costs. Finally, we must establish some kind of arbitrary cost factor for the loss in sales, good will, and customer standing when we have a complete "stockout". It is not a simple one to arrive at since we can only guess at the orders we did not receive, or the customers we alienated with a stockout. Of course the steel distributor must analyze the peculiarities of what he is ordering, as must any distributor, in arriving at a final order quantity decision. Quantity price differentials, packaging extras, length, guages, width, thickness, straightness extras conspire to give the mill price book the appearence of a dense forest in which any turn we make will result in a higher invoice for our material. Equations have been developed, however, to help guide management through the order quantity miasma. The calculations required, however, make computer application almost essential since so many factors must be weighed an inventory clerk would scarcely know where to begin. In any attempt to define order quantity it is imperative that we use some type of outside check point to measure our results, such as past and anticipated sales, since it would be all to easy to arrive at a situation in which our calculations told us to order 1,000 lengths of channel but find our annual sales have rarely touched 800 lengths.

Order quantity is, of course, responsible for establishing the level of working inventory. The reorder point is instrumental in defining the amount of safety stock we shall have. It relates to the "when" of the ordering program. Let us outline briefly the factors important in determining reorder points. Lead time from our suppliers is of great importance. We must predict lead time accurately or else we shall find our safety stock far too small or too large. We should anticipate, wherever possible, changes in lead time and adjust our reorder point accordingly. Apart from unexpected breakdowns, the steel mills are able to present accurate rolling schedules well in advance. Since related sizes are commonly rolled in sequence, the distributor's problem is further simplified. For example,

* Or to state this another way, order handling costs will increase as the quantity diminishes.

Inland Steel's 28" Structural Mill may be rolling 10" Wide Flange beams the first week in May. We can plan all our 10" beams with Inland for that rolling. The rub comes when we examine our inventory and find that perhaps only one of the four or five weights of 10" beam we stock has reached a reorder point. This is one reason why constant review of all our inventory is so essential. Only automated techniques will give us the speed and consistency we require.

One recent and interesting approach to inventory control which touches upon this area should be mentioned before we consider the record keeping function of inventory control. The approach, in a sense, summarizes many of the concepts we have been outlining. It is termed a "practical" approach, and does appear to be one.[9] It consists of three basic facets; the cost to procure, the cost to hold, the cost of capital. The cost to procure reflects those indirect costs we pay in obtaining an item for stock. It depends on the cost of ordering an item and the frequency of procurement. Ordering costs are assumed to hold constant for all items and are determined by the indirect expense of the purchasing function plus allocated overhead divided by the number of orders processed during a given period. The cost to hold reflects our cost in storing an item and may be applied to that item in a number of ways. Storage area or volume required for the item intrigues us as a method of relating this system to the steel distributor's problem. The cost of capital in this set of concepts is taken to mean the expense involved when too much of the working capital is tied up in inventory. The difference between the amount of money tied up when yearly requirements are secured by a single purchase order versus numerous purchase orders can mean dollar savings for the firm.

The amount of "capital released" with frequent orders is weighed against the cost to hold and procure on a frequent basis. The result is what the authors call an optimum stock turnover factor, i.e. there is a point at which stock turns over rapidly to release the optimum amount of capital for other purposes. Significant savings can be made by close control of the items with high unit costs and large sales. The approach we have presented can offer a reduction of total inventory as well as indirect expenses. If the use of this analysis shows that a reduction in order volume is justified, the sheer work load and cost of order entry can be reduced. We have seen a number of the most important concepts in what has been called scientific inventory control. Mathematics and mathematical calculations have been integral in the application of all of them, and the "practical approach" we have been discussing is no exception. Although the need for adopting these equations to computer solution is quite important, let us dwell briefly on one other time-consuming element in inventory control, records-keeping.

For the steel distributor, the maintenance of accurate records of what items are in stock, the quantities available for sale, what widths, lengths, and thicknesses the items come in are elements of information essential to the overall effectiveness of sales personnel both inside and outside. Indeed, some distributors have discovered that they can minimize their costs of outside solicitation by maintaining an alert inside sales force in daily contact with their customers by phone and equipped with any sales tool deemed essential, especially a current stock list. The distributor's business is based on prompt deliveries, and knowledge of what is on hand and in transit can often mean the difference between an order and a near miss.

Some type of perpetual inventory system is quite common to distributor inventory control. It is generally kept on a cardex file to which a clerk will post all relevant data for an item; orders placed with the mill, expected delivery. The other half of the item card will show a running balance in units to show how much of the item is on hand. At Joseph T. Ryerson & Son, the loading and cutting papers for each order are passed through the inventory records department (called the Merchandise Department). The quantity of each item sold is deducted from its running balance and a new balance is posted. Since each sales order processed may contain up to four different items, there is a good deal of paper handling required to keep the records up to date. Incoming shipments are posted to the item cards by the stock clerk as well. The chance for errors remains quite high with so many numbers to be read, copied, added, or subtracted in the proper columns. Such a system makes forecasting a rather time-consuming chore as well. The chance for errors remains quite high with so many numbers to be read, copied, added, or subtracted in the proper columns. Such a system makes forecasting a rather time-consuming chore as well. The item cards are broken down by monthly periods. The clerk marks the card with a symbol alongside the closing inventory total for that month. To find our sales for the month, the clerk must go back over his records and summarize his deductions for the month. Assuming the original documents the balance was made from were correct, and that the clerk never duplicated his deductions nor missed a sale, the record should be correct. This type of perpetual inventory system cannot hope to guarantee any close degree of accuracy without the most painstaking type of review and audit.

As cumbersome as this system may seem, few are in existence which can utilize clerical labor more effectively. Inadequacies appear in virtually every system administered by clerical personnel. Regular checks must be made to see that the office records match the physical inventory in the plant as closely as possible. One solution has offered partial success, at least for small items. Two inventory records are kept, one at the general inventory file, the other with the parts in question. Each stock deduction is noted at both places and this, of course, offers the basis for an immediate recheck if any discrepancy develops between the two records. Electronic data-processing appears to be a logical solution to the record-keeping problem. Let us now discuss the methods by which data-processing equipment can assist the steel distributor in all phases of his inventory control.

We shall discuss first the more or less standard mechanical operations and later the special, analytical services which computers can perform for the steel distributor. In the initial steps of conversion to computer controls a detailed physical inventory of the stock is preferred much more than simply relying on the old stock records. The individual items in the inventory can then be transferred to punched cards. Once the initial cards have been verified against the source documents, they will be reproduced, calculated, and extended without any deviation from their description or coding. A good deal of the accuracy of our machine will depend on how reliable were our original sources of information.

An important step which takes place in time actually before the punched cards are made up is the adoption of a method of identification. Like sizes and analyses should be grouped together. Descriptions must be accurate and yet circumvent the detailed and lengthy descriptions which can be kept as part of a printed or handwritten register. The use of symbols has been widely adopted as the basic form of short hand needed to solve the problem. The symbols may either be numbers, letters, or a combination of both. They permit concise item definitions and yet are easy to use. An identifying symbol is broken down by basic material, special alloying elements, if any, physical form or shape, physical size with the key *dimensions* being spelled out. Coding methods have become highly specialized since they must be adapted to many industries. The IBM booklet, Modern Coding Methods, Form 32-3793, offers a good deal of light on the subject. The cards punched for inventory can serve more than one purpose. If the descriptions are clear enough, the cards may be used for the preparation of purchase orders, with the entire process handled on machine equipment. This in itself is of significance to the small distributor as well as the large. The great number of items and sizes they carry require a good deal of clerical time in simple order entry when stock reaches reorder points. A mechanical system capable of preparing the entire purchase order automatically at high speed could do much in helping rationalize the initial costs of the transition. In yet another application, the punched cards could be used to produce a materials catelog listing significant data for each item carried in stock. This catelog could be kept up to date as new punch cards are made up and, with minor modification, could also carry relevant data about stock on hand and on order.

Once the initial transition to punch cards has been made, there still remains a good deal of latitude in the selection of the procedural approach which best fits the firm involved. We will list and discuss the three most common approaches although not each one of them affords equivalent value for the steel distributor.

Balance Forward: This system is often employed by manufacturing firms. Complete information about the status of each coded item of inventory is kept on a punched balance card. Any transaction involving a coded item is reviewed at the end of the day and a new balance card is made up by summary punching the corrected total. The advantages of such a system are numerous. Stock status reports are always available for review to assist sales and purchasing. A historical record of stock movement is also readily available as well as a record of work-in-process for the manufacturing firm. Balance forward helps make possible minimum inventory levels and, conversely, helps reduce excess overhead resulting from overstocked situations. Concise and current records are always available for statistical reports as a by-product.

Unit Inventory Control: While the balance forward approach seems adequate to handle inventory control for the manufacturing firm, certainly the system would be cumbersome if adopted by the jobber or distributor. With myriads of items in stock, it would become a gigantic task to administer the special cards which would have to be processed daily to keep inventory figures correct and current. Unit inventory control establishes a prepunched file of cards which serve, in effect, as a pseudo warehouse. Each represents a saleable unit of merchandise ready for shipment somewhere out in the physical plant of the firm. The system permits a perpetual inventory in the firm's office which will be correct. Each stock item is represented in a tub file by a separate section identified with a divider bearing the item number and description. Item cards are added to or subtracted from the file as receipts and shipments occur. One problem which immediately comes to mind is how does the firm with large quantities of separate items avoid the bulky files entailed in the unit inventory plan. A common approach is to use "set-up" cards for each item on which all receipts can be noted. The balance shown on the set-up card is reduced as sales are made against the item.

Another problem which a arises in unit inventory is that of handling sales of less than the defined unit, or "split cases". The split case problem for the steel distributor might arise when he sells a 6' X 10' piece from a 6' X 20' steel plate 1" thick. The 6' X 20' is the defined unit in this case. Some firms make split case shipments an entirely different type of transaction identified by its own code. Others maintain split case cards becuase their less than unit sales are somewhat regular and definable. Indeed, the problem of less than unit sales has often been referred to as the most perplexing and obstinate roadblock to true inventory control for the steel distributor. An approach for the problem of steel plate we cited earlier might be to keep special cards for material in less than stock sizes. Criteria such as average width and length, weight, or square footage could be used with A, B, and C cards reflecting the various size ranges possible. These three set-up cards would be in the item file along with the unit cards representing stock-size plates. When an A, B, or C short was used to fill an order, the balances on the set-up cards would be changed to reflect what was used up and what remained.

Unit inventory control is well designed to provide the inventory clerk with reorder point signals for every item under the plan. Three different colored cards are used to indicate minimum, danger, and out-of-stock points. They are inserted into the tub file for every item. As the clerk pulls item inventory cards to fill orders, he will eventually encounter one of these cards. He will relay it immediately to the specialist or buyer handling the particular line of products to determine what action should be taken. The same cards used for inventory control may be suitable for other applications: purchasing, accounting, billing. Closer stock control means less dollar tie-up in non-productive inventory, and a close watch can be kept over what inventory we do have so that management will be informed of any problems which might arise.

Stock Allocation: This plan has many things about it to recommend its use to the steel distributor. It combines the advantages of the balance forward and unit inventory plans but was designed specifically for use where the inventory consists of thousands of items, and shipping quantities vary greatly from one order to the next. In such a situation it becomes necessary to preview orders to insure that the maximum number of partial shipments may be made. The necessary ingredients for this plan are an inventory file similar to that used in the balance forward system, and a stock editor who could be trained from the staff of the purchasing department. When an order is received, a master invoice and separate item cards are prepared. The stock editor reviews each item and decides how to fill that part of the order: ship all from stock, make a partial shipment and back order the balance, make a complete back order pending receipt of new stock from the mill. Stock allocation localizes responsibility for inventory control directly upon one individual, the stock editor. He has sufficient flexibility to offer informed comment on which direction our stocks should be trending. Although he does not prepare the mill orders himself, nor may the final decision to buy or not-to-buy be his, the very presence of such an individual with such a broad range of experience in stock review is a distinct asset. Of course, the next step to computer control is quite obvious. Eliminate the role of the stock editor by programming the unit cards directly into the computer and have the machine perform the routine elements of the job. It could then reject the cards on which special back order questions are involved. Using the principle of exception, we could have the computer watching the routine transactions and stock handling the problem cases.

We have discussed the basic approaches to the mechanics of inventory control through punched cards and computer equipment. Often the needs of a particular firm or industry will dictate modifications. It is difficult to say which plan and what modifications would best serve the steel distributor. We shall study later a modification of the unit inventory plan which one distributor used with success. A good deal more study and research is needed before the final answers become clearer. Both the unit inventory and stock forward plans have features of control which could be quite helpful in localizing both the problems and the controls for the distributor.

There are many things computers can do beyond helping us with the mechanics of record-keeping. They can take on the burden of analytical work usually handled by clerical personnel, perform it rapidly with more flexibility in approach and accuracy in results. The many calculations fundamental to the determination of order quantity, reorder point, working and safety stock levels could not be worked efficiently by anything but a high speed computer. In taking over these special comparisons, the computer uses as reference special statistics cards which can be punched for each item in stock. These cards may be converted to tape in an intermediate process if the tape is necessary to meet an input problem. The cards or tape thus prepared serve as the foundation for computing the control factors we just mentioned.

As we noted earlier, economic ordering quantity is derived from the attempt to relate the costs of acquiring more stock to the costs of keeping that inventory. Lead time refers to the number of days from time of order till receipt of goods from the mill. Safety stocks, as we noted are designed to minimize risk of stockouts. Each may be computed from formulae similar to the one we described above. The resulting information is transferred to the balance or summary card. Having established all the check points necessary for inventory control, the computer can cycle each item card, compute days of coverage based on current sales pattern and compare coverage with reorder point. When coverage is less than the reorder spread, an order card is punched. The order card sets in motion a separate ordering cycle. If coverage is greater than the reorder point, no additional card is punched. The computer has scanned the inventory, related coverage to reorder points in a scientific manner, and told us of the items which need attention in the course of but a few hours while a clerical system might not have given us the information in days.

When an order is actually entered with the mill, the computer will continue to be of service. If "days-of-stock remaining" level drops below the safety margin, the machine prepares an expediting card to start tracers on the needed material. The use of electronic data-processing equipment makes possible the fruition of the concept of management be exception. Only the out of the ordinary or exceptional cases are examined for remedial action while the routine of recording, reorder, and expediting can move along smoothly with a minimum of direct supervision. Furthermore, the continual analysis of inventory by computer means that the firm can approach efficient use of its assets through economic ordering with minimum dollar tie-up. Notice also that these advantages are available without a complete conversion to IDP. Even the partially automated office can obtain direct benefits from the computer and its accessory equipment. Initial installation and purchase costs can thus be held to a minimum for even the medium-sized distributor.

In order to place this chapter in fuller perspective, we feel it necessary to illustrate some of our points with relatively short, but current, case studies. Unfortunately, we find the selection of such studies in the steel warehousing field to be so scanty that we must draw upon the experience of firms facing a similar group of problems to further our evaluation of computer applications for data-processing and inventory control.

Esso Standard Oil Co. - Storehouse Accounting (10): Esso Standard is the largest domestic affiliate of Standard Oil Co. of New Jersey. It markets its products thru eighteen states in the East and South. It operates this country's largest oil refinery at Baton Rouge, Louisiana. The firm's experience with mechanized data-processing equipment extends as far back as 1939. However, in 1953 the firm examined the rapid growth of its mechanized accounting and non-accounting work and found that its systems had grown rather haphazardly. They were causing much duplication of effort. A good deal of simplification seemed to be in order to come up with procedures capable of crossing departmental lines with full flexibility. A decision was made to study the various internal operations that were, or possibly could be, handled on mechanized equipment. The final goal was an evaluation of the worth of a computer for the company. The study did eventually lead to the purchase of an IBM 705 computer.

Amongst others, a system utilizing data processing for materials and stores was developed to use this equipment. It provided for the mechanization of stock control cards, automatic purchase order preparation and follow up, automatic invoice verification, and the preparation of accounts payable checks. This was quite a task and required much painstaking detail work in the formative process. The Esso storehouses contain upwards of 30,000 items of supplies. All the items were given symbol numbers and put on tapes which included such pertinent information as description and size, data about the preferred supplier, quantity and dollar balances, average and unit price, terms, and such control points as ordering point, minimum safety level, and the like.

Punched cards are prepared every day with information relating to any item on the master tape. This information may consist of receipts, issues, deletions, plus such special data as a new supplier's name and address. The master tape is played into the memory section of the computer and the new tape is read into the master tape. Changes are made where necessary, and after all the transactions for a given symbol number are completed, the amended master tape is checked by the machine to see if the reorder point for the item has been reached. If this is the case, the computer can prepare a purchase order since the tape contains all the information needed for such an order. All orders for the same vendor are combined to be placed on the same purchase order. Follow up cards for the order are pre-printed at the same time for later use. In instances where human intervention is required to check specific problems such as negative balances and the like, the machine will print out all the master information permitting the specialist a well-informed investigation. Here again we see management by exception. The process is automatic up to the point that the controls defined by norms programmed within the computer are surpassed. At that point human examination is needed.

Order follow up is also programmed into the computer. In typing the original order, the computer also calculated a due date based on average lead time for that type of material. Working with this due date in mind, the machine will issue follow up requests at pre-determined intervals. Shipping promises received from vendors are keypunched into the system. The machine compares these promises with the due dates it established initially and if a significant discrepancy exists, the computer will issue a notice to the purchasing department to expedite the problem item. The Purchasing Department can concentrate on handling the exceptional problems and need not spend time or effort on the orders which will arrive on time.

Esso achieved full utilization of its computer's potential by preparing a number of diverse control functions to be handled by the machine. Equipment of this sort operates at such fantastic speeds that the costs of installation would be prohibitive if the computer were bought to handle only one job, inventory control for example. The machine would be loafing without a wide range of operations to perform. Esso included payroll and personnel records, sales data and shipping reports, operations analysis, fixed asset reports, financial and cost information, secondary reports, technical computing for scientific and economic studies as well as inventory control within the aegis of its computer program.

Square D Co. - Computer Control of Parts Inventory (11): Square D produces electrical control equipment for complicated machine tools or process industries such as steel mills or cement factories. The size of the items in its line range from tiny snap switches to large control centers which may be the core of an automated production line. Square D must stock some 24,000 parts to meet the demands of such a varied line of products. Inventory control becomes doubly important for a manufacturing firm such as Square D since the lack of a relatively insignificant part can often mean a snag in production cycles and many unkept delivery promises.

After some initial trial and experimentation, a decision was reached by Square D's management to use IBM's RAMAC computer to control the entire parts inventory. The equipment offered speed, storage capacity, and a mode of access which Square D's management considered essential. This special mode of access was probably the most effective selling feature IBM could offer in this case. RAMAC affords random access to the information it controls. Transactions can be entered and taken out in any order. This eliminates the need to sort all input by part number before we can use the machine. With so many items to control, Square D could not afford to be continually sorting its input and output. Inventory procedure calls for the machine to retain data for each item and post every three days: stock requirements on hand, on order, quantities available above requirements according to the schedule of order from our customers, order point including lead time, quantity available above order point. We must reorder when this figure is zero or below. Transaction cards for movement of any item in the parts inventory are punched as they occur. Every three days these accumulated cards are matched against the old balance cards, new balance cards are punched, and a new stock status report is printed at the same time. RAMAC's random access feature permits the fastest type of control since we do not have to run transaction cards for any items in which there was no movement over the past three days.

Among its additional services, RAMAC will break down a list of finished assemblies to itemize how much of each part will be required in the manufacture. It will print a detailed material list and enter orders for parts whose supply have dropped below the order point. RAMAC will control documents and insure that invalid situations are not permitted to exist within its records. Negative stock situations and the like are typed out for investigation and remedial action.

The computer replaced an old punched card system that Square D had been using for some years. So versatile is RAMAC that it can control the old punch card data for each item and have room for cost information as well. For every part, the computer carries a part number, stock status totals, stock on hand above requirements, on order, order point, stock available above order point, as well as such control data as order quantity, replacement time, vendor, average monthly usage, usage month to date, material cost, and physical location.

A primary reason for Square D's shift to computer inventory control is the pressing need of the firm for accurate and current stock status records. Its new approach permits processing transaction data immediately if necessary. Manufacturing lead time is reduced since much time-consuming paperwork has been eliminated. Over a period of time the total size and cost of parts inventory may be reduced for the same reason. As a peripheral, yet valuable, derivative, RAMAC released a number of pieces of old data processing equipment which can now be used for other types of control. The computer does the work of this old equipment in only four hours per day and still has time for other assignments.

It would be too easy to state blandly that what proved good for Esso and Square D would also be good for a form in the steel warehousing industry. There are parallels that are significant, however. Management of both firms worked on the premise that the computer could solve more than inventory control problems. Its speed could permit practically any firm to program basic accounting and payroll function along with inventory control to help justify the cost involved. On the one hand, Square D sought rapid stock status information, while Esso attempted to place its inventory control function within the context of an overall approach to computer usage. Both approaches are of interest to the steel distributor. Let us now consider two case histories drawn from experience with computer inventory control in the steel warehousing industry itself.

V. LARGE DISTRIBUTOR MOVES TOWARD INVENTORY AUTOMATION

Joseph T. Ryerson, the nation's largest steel distributor, is a wholly-owned subsidiary of the Inland Steel Corporation. Ryerson operates twenty warehouses throughout the country and is considered, as we outlined earlier, a general steel warehouse. Its product lines are many and diverse, including carbon, alloy, and stainless steels, reinforcing steel products, structural fabricating, semi-finished fabricating, industrial plastics and bearings, as well as a complete line of aluminum products. The firm lists over 60,000 different stock items, an immense but challenging target for the application of modern data-processing equipment.

Electronic systems for data-processing are not a completely unknown factor at Ryerson. As far back as twenty-five years ago, IBM Hollerith machines were used to sort and list data precoded on punched cards. This was a function which was initiated in the accounting department. As the years passed and data-processing equipment grew more technical and refined, Ryerson added equipment, shifting such operations as payroll, accounts payable, accounts receivable, and sales analysis to as mechanized a basis as possible. In 1957 the first computer was installed, an IBM 650 equipped with a magnetized drum which served as memory for the machine. The computer was able to accept instructions and data which it sorted on its drum, perform programmed instructions, and type the results out on punched cards.

The "650" is now in the process of being replaced with newer, faster equipment which will offer even more versatility to the firm. The latest step involves combining two computers in a data-processing center.

A 1401 computer will be used as a piece of accessory equipment to a 7070 computer. The 1401 will translate data from punched cards to magnetic tape for the 7070, and take the completed tapes from the 7070 and revert them to punched cards or printed documents. Here is a positive step to solve the input and output problems of such high speed equipment. An adequate level of productivity is insured with this dual computer hook-up. Of course, as we may have indicated, this equipment was installed with an eye primarily to solving Ryerson's diverse bookkeeping problems, problems which are deepened by the size (over 5,000 employees) and geographical range of the firm as well as the numerous customers and vendors whose accounts must be kept in constant order.

A potential inventory control application for this equipment has not been ignored, however. For the past four or five years, study teams have been inquiring into the ways and means of converting Ryerson's inventory control to electronic equipment. Until recently, very little of Ryerson's inventory record-keeping had been mechanized. Each plant was held responsible for maintaining the perpetual inventory records of its stock items. There is a tremendous amount of duplication of effort involved under such a program. How can this records-keeping function be transferred to data-processing equipment without sacrificing the immediate answers obtainable when each branch plant controls its own records? The nature of the distributors business requires this information to be readily at hand. Delivery promises to our customers range from a matter of a few hours to a few days for the majority of our sales. Stock records must be current if our selling position is to remain secure. Systems of data transmission have not yet reached the high stage of refinement necessary before records automation from a single point can be brought into play. The time is still far off when the inside salesman can obtain a reservation for stock and a delivery promise from a centralized control center carrying stock records for the entire chain of branch plants.

Ryerson has been laying the groundwork for inventory control in other aspects of the problem, however. As one of the first fruits of its current studies, its twenty plants have been incorporated into a periodic inventory check entitled a Normal Stock Ordering Review program, or NOSROP for short. Let us discuss this program briefly and see how it has been incorporated into the overall computer program of the firm. It works quite simply. A product analyst in the general office in Chicago sends a deck of status cards to each plant monthly. Each card represents a single item of inventory and contains a product description, commodity code number, and the plant number. The stock clerk in the branch plant fills out each card with data from his perpetual inventory cards: stock on hand, sales last month, time out of stock in the past month (a percentage figure compiled from special tables for the purpose), stock on order and the week due, as well as special information such as anticipated sales or returns. The deck of cards is returned to the product analyst who checks them and has them punched with the information from the branch plant. The resulting status card is merged with a History card for the item and both become input for the computer.

Let us discuss the History card briefly. It contains such data as the sales forecast (derived from weighting past sales history 90%, last month's sales 10%, and deriving an average figure), absolute deviation, accumulative deviation, lead time, production cycle. The computer stores the information from the History card and begins its work upon the status card. It first checks time out of stock and converts this to an estimated sales figure. The estimate is added to actual sales to arrive at an adjusted sales factor. Next, a new monthly sales forecast is arrived at by weighting the past months sales versus historic sales. The absolute, standard, and average deviations from the forecast are obtained. Economic order quantities have already been programmed into the machine for each item.

All the steps necessary to arrive at a decision as to what action to take on the item have been made. If there is a positive sales forecast, the computer checks to see what is on order for the item. If there is nothing on order, the machine checks to see if what we have on hand will be enough to carry us through the normal replacement cycle. If not, an emergency card will be typed out to indicate how many pieces, or feet, or pounds are needed. If there is enough stock to last through lead time and one production cycle, the computer checks working inventory to see if that will carry us through. If not, it is time to place an order. If there is enough stock, the computer checks to see if working inventory alone, without the receipt of orders already placed with the mills, will carry us through. If it will, the order or orders on with the mills can be cancelled. It becomes apparent just how much Ryerson's NOSROP control plan relies on the computer's ability to compare sets of numbers at tremendous speeds.

The results of this comparison process are threefold. First, a revised History card is prepared which contains a new monthly sales forecast. Second, an action card is printed if any action on the item is called for. We may need a transfer of emergency stock from another plant, a requisition for a new order, or the cancellation of orders already placed with the mills. Third, an exception card is printed if the activity of the item does not fall within the error limits established by the original sales forecast. Immediate use is made of these reports. An action report is compiled from the action cards and copies are sent to each of the branch plant inventory managers who review the recommended action and indicate where they differ in opinion. Once they accept the report and add their amendments, it is returned to the product analyst for further processing. Orders are prepared for the items for which requisition cards were made up by the machine. The exception cards are compiled into an Exception Report which is also sent to the branch manager concerned. Those items which are not "tracking properly" are reviewed and the sales forecast is changed where necessary.

NOSROP has eliminated a good deal of clerical time and labor in tracing and evaluating the status of each item in stock. Since the reorder phase of the program has been centralized much duplication of effort has been eliminated. A standard, consistent approach is being made toward inventory control, without varying individual interpretations of what course to pursue. For the long run, NOSROP seems to point the way to further centralization and automation for Ryerson's inventory control. Once the problems of high speed data transmission over long distances have been ironed out there will be further opportunities for cost-saving centralization with the branches left freer to devote their time to selling. A centralized approach means better inventory studies, more time to face the questions of handling and packaging, as well as more concentrated attention to the issues involved in the continual search for better processing equipment for the plant.

Flexibility will remain the keynote of Ryerson's advance into data-processing. Like Esso, our program demands the inclusion of many diverse functions within our control center. And yet, like Square D, such features as random access for stored data are at a premium. Ryerson's approach is a valid one for many a large and medium-sized distributor since virtually all of them have seen some type of data-processing developed to handle some of their accounting problems.

VI. SMALL DISTRIBUTOR SWITCHES TO UNIT INVENTORY CONTROL (13)

Before its merger with the Inland Steel Corporation and Ryerson, the Vinson Steel and Aluminum Co. of Dallas and Houston, Texas was typical of the alert and aggressive distributors in the Southwest. Vinson was founded by people whose prior experience had centered around the oil industry and who did not approach the steel business with any "tried and true" formulas for success. After an initial period in which an attempt was made to employ a perpetual inventory system through clerical help, Vinson's management decided to try the new approach in 1956. This was at a time when the few distributors who were interested in data-processing were still in the study-group stage. Remington Rand was called in, and after some preliminary study, a system of unit-inventory control managed by a small computer was installed as part of an overall program which, of course, included all the accounting work of the firm.

Unit inventory control was adopted because of the flexibility it afforded this small specialty warehouse. A tub file of punched cards was established and used to represent the equivalent inventory out in the plant itself. A close control over inventory was kept through this system and reorder points were quite easy to identify as we noted in our initial appraisal of unit inventory. The system was eventually tied in with sales forecasting, billing, and vendor invoice approval. It is interesting to note that once the system was freed of its initial "bugs", items consisting of many hundreds of thousands of pounds, coiled steel sheets for example, were controlled to extremely close levels of fractions of one per cent as revealed by periodic physical checks of the plant inventory.

A small warehouse like Vinson could adopt a unit inventory system and make it work while a large firm like Ryerson would be totally unable to make progress under straight unit plan. While Vinson controlled a thousand items Ryerson would have to maintain tub files of sixty thousand items, an impossible task.

Unfortunately, Vinson's results were obtained over but a brief time span. The system had barely been broken in before the firm had merged with Ryerson. It has been noted that the system as developed by Vinson was doing an effective job of inventory control and the firm was considering applying more of its paperwork to data-processing equipment. The role of such an approach to inventory control for aiding the management of a small distributor cannot be discounted.

VII. CONCLUSION

Electronic control of inventory seems to be an ever-growing factor in the management of many of our economy's business concerns. The speed and efficiency offered by computers in handling the paperwork of accounting and inventory make it quite likely that this trend will continue for many years. We have studied some of the facets of electronic data-processing, taken a quick review of inventory control techniques, and seen how the two may be united into an effective working team through our general discussion and four case histories. Our analysis of the steel distributor leaves us with the strong conviction that here is a firm which must move ahead to computer controls or else become strangled in an ever-growing snarl of paperwork.

How can we relate our conclusions to the threads of data we have woven and spun through the past sixty-odd pages? Perhaps we can best accomplish this by listing the three specific points we have drawn from our work and discussing the rationale of their formulation.

First of all, we find that our study proves data-processing a valid technique for inventory control. We have seen in our analysis of "scientific inventory control" the many detailed calculations which are prerequisites to arrive at such crucial control factors as lead time and optimum ordering quantities. It is simply beyond the capacity of any clerical system to begin solving all the mathematical equations essential for control. Again these calculations are needed for a multiplicity of items, not a single size or shape. Changing demand or market conditions might dictate recalculation of an entire set of control factors. Only computer equipment offers the speed and flexibility to meet such a challenge.

Our cases have been selected to show four firms who have experimented with data-processing and inventory control. In the sum total, their experience again bears out our contentions. Neither the size of the inventory, nor the nature of the computer equipment to be employed can preclude an effective solution to inventory control. Each firm, however, must decide what particular role its equipment will play in the control of inventory. Esso merged its inventory control with an overall approach to its accounting function. Square D, on the other hand, felt the most important end its control could achieve was a continuous up-to-date review of its inventory position to insure against costly shutdowns of its manufacturing facilities. Even within as narrowly defined a field as inventory control and data-processing we find alternate choices of approach and methodology. Hence as a corallary to our initial point we must accept the need for painstaking study and research as a condition to the establishment of any effective system of inventory control.

Only a handful of small firms, and even fewer larger concerns could afford the charming but expensive "Texas" approach adopted by Vinson Steel, the subject of our fourth case study. Scarcely settled in the steel warehousing industry, Vinson raced on to data processing at a breakneck speed. The firms only salvation lay in the caliber of its management who finally became adept at the programming, circuitry, and repair of their Remington Rand computer themselves. They had to iron out innumerable bugs and devise many shortcuts before their equipment could begin to reach true effectiveness. Picture a multi-million dollar firm selling in many markets deciding one afternoon to switch their controls from clerical to machine bookkeeping. Havoc and confusion could be the only results. The analytical and frankly cautious approaches of Esso, Square D, and Ryerson are much to be preferred if computer equipment is to be used to achieve its true effectiveness and the trend to computers is not to be stunted in its infancy.

The second point raised by our study is that the steel distributor is a natural subject for the application of data-processing systems. We have spent some time in earlier chapters outlining some of the internal problems faced by the typical distributor; the lack of a specific "control" function, the need for accurate and up-to-date records, forecasting for sales and ordering programs, personnel utilization. It would be too easy to say that these problems would cease to exist the day our computer was plugged in and began to hum. However data-processing will ease some of the burdens of steel warehouse management as the more routine functions begin to be routinized within the context of punched cards or magnetic tape and a computer. We have much belabored the concept of "management by exception". The principle is a valid one however, and one that can mean lower operating and overhead costs for the firm which grows to use it.

The many thousands of items the average distributor carries in stock will lend themselves to translation to punched card or tape. Our records can be kept current and accurate since the computer can scan specific transaction cards and post new balances for any item which has experienced activity within a stated time period. Forecasts are easier to prepare since an entire sales history for an item, or group of items, is readily available simply by programming the computer to develop historical sales data and feeding the punched cards or tape to the machine.

The indictment had often been levelled against the entire steel industry, and often with more than a little justification, that it has been insensitive to the need for technological change. And certainly the heavy capital investments typical of the industry can engender some resistance to changes which might impair the full value of such investment. The industry as a whole, and the steel distributors along with it, are coming to take a new look at technological improvements. The pressures of competition from foreigh markets and competing products make this almost inevitable. The few warehouses who have approached data-processing have been impressed with the efficiency and cost-savings it meant for them. We saw in one of our case studies, for example, how Ryerson has been slowly but inevitably adding bookkeeping and accounting tasks to the burden of its computers. With the development of the NOSROP program which we outlined in some detail Ryerson has taken its initial step at automating much of its inventory control and placing its reorder program on an automatic basis with clerical review needed for only those items whose sales pattern swings consistently outside certain predetermined norms.

The third concluding point we wish to discuss is one that neither ourself as a research entity nor the warehousing industry as whole is yet prepared to answer. Is any one system of inventory control through data-processing the final answer, any more than another method? We have discussed Balance Forward, Unit Inventory, and Stock Allocation as potential methods of establishing inventory control for the steel warehouse. None were initially developed for the industry and yet the latter two systems, with some modifications have been employed in working day-to-day applications by specific distributors. Vinson was small enough to employ a unit inventory plan with a minimum of discomfort. Ryerson as we have already outlined, carries far too many items in its stocks to even attempt the unit approach.

NOSROP for Ryerson is a derivation of the stock allocation plan. It differs in two ways. First the stock analyst is not concerning himself with specific daily transactions but rather the flow of material over a period of time. Second, a good deal of study has been consumed to set up Ryerson's computer programming to perform a variety of calculations upon the item cards used in NOSROP. These calculations keep our sales forecast figures up to date and enable the stock analyst to note the items which are not performing as expected, either positively or negatively. Of course Ryerson is at a crossroads. Its current program is a centralized equipment. If the pressures for decentralization and fragmentation of accounting functions grow, there may appear small computer units at the local level to handle all the book-keeping and inventory control for a specific plant or cluster of plants.

There simply has not been enough working experience with these types of inventory control within the industry to come up with any definitive conclusions. As more effort and dollars are spent in this direction we are certain that techniques with a universal application within the industry will spring up and be accepted.

Problems remain, there is a severe need for information and actual working experience for distributors to draw upon. Apart from the two distributors we just discussed, only Crucible Steel and United States Steel Supply have made any significant steps in this direction. Ducommon, a major West coast distributor seems on the verge of adopting computer controls as well. All these firms have had to rely on their own research as well as the assistance of outside salesmen and consultants in finding what approach would best suit their needs.

Unfortunately, the smaller firms who could benefit form data-processing as well do not have the capital available to invest in costly and time-consuming groundwork so essential before tangible steps can be taken. Data-processing must remain for them a no-man's land until this situation is remedied or more information becomes readily available. There is a possibility that some industry-wide representative could be set up as a clearing-house for this data. The Steel Service Center Institute would make a logical candidate save for the fact that it tends to define its role as one of public relations rather than industry service.

One of our goals when we started this report many months ago was that of developing specific information on the trend to electronic controls within the industry. We had hoped the Steel Service Center Institute would be able to help us. Their data pertained to industry sales figures however. They have not attempted any recondite studies at this and probably never will since they do not consider this type of inquiry to lie within their scope of activity.

It may well be that we, ourselves, are somewhat ahead of the trend in seeking this information. Within the next two to five years we are certain that such a trend will develop and become quite discernable. The competitive pressures from firms that have made the transition and profited from the results will make it essential in this all too competitive industry with marginal profits for every one else to stay in pace or be left far behind.

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We have discussed a good many concepts in this text which were certainly far beyond the level of basics. Much of the background material we used was assimilated from many texts from which we did not quote directly. We would like to list them at this point.

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Miscellaneous Material

We have employed a number of internal reports from Joseph T. Ryerson & Son in gathering background for our discussion of their steps toward automated inventory control. Especially helpful was the booklet outlining the application of the NOSROP program.