Honeywell Plans for the Use of a DATAmatic 1000 In Solving Its Data Processing Problems

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In order to set the proper perspective on Honeywell's plans for the use of DATAmatic 1000 in solving its data processing problems, we should have some backgrounding in just what the DATAmatic 1000 is. Because this is one of the latest developments in electronic data processing systems, many of you perhaps know relatively little about it.

The DATAmatic 1000 concept for large volume business data processing began in the early post-war years when Raytheon computer engineers were developing the Raydac computer for Navy guided missile research. (Incidentally, the Raydac has been in successful operation for a number of years.) As early as 1949 realistic studies were being made of business operations to analyze the need for electronic processing of huge clerical workloads. These studies revealed the fact that clerical handling of data for large business is basically a repetition of sort, merge, and file updating operations, which are well adapted to the programmed logic of electronic computers. Having at hand the knowledge for building the Raydac, the design for the central processor presented no new problems. The challenge that faced the engineers was to build an integrated system, a system in which input and output was in balance with the speed of the costly central computing unit. Special attention was given to the problem of converting data from its original form to the electronic pulses of the central processor and from the central processor to printed reports. In the first part of this discussion, I will outline the principal equipment features which developed from these plans.

The DATAmatic 1000 electronic data processing system may be divided into four basic sections: the magnetic file unit, the input section, the central processor, and the output section.

In the DATAmatic 1000, three inch wide magnetic tape is the high speed intermediate storage which integrates data conversion units with the central processor to establish a balanced flexible system. Data is read from magnetic tapes at a uniform speed of 60,000 decimal digits per second. This high reading speed was accomplished by the DATAmatic engineers without materially increasing the speed of passing tape past the reading heads or in increasing the density of packing data. Data is recorded on this wide tape in 31 parallel and independent recording channels. Information is recorded along all 31 channels simultaneously in fixed and addressable blocks. Block tags are contained in a key channel and may be scanned at a high speed to select specific records. In any tape handling system, gaps must be left between information blocks to provide acceleration and deceleration — starting and stopping time. In the DATAmatic 1000, maximum utilization of magnetic tape is made possible by the following technique: from the beginning of a reel of tape to the end of the reel, information is recorded in alternate blocks —first an information block, then a record gap, then an information block, then a record gap, etc., until the end of tape has been reached. At this point the tape drive reverses itself. From this point back to the physical start of the tape, recording is made on the alternate blocks which had been used as gaps originally and the spaces which had recorded information on the first pass through the tape drive are now used as record gaps. Hence, when a full reel of tape has been traversed, it ends up at the starting point and is completely rewound. Such a reel of tape contains 37,200,000 decimal digits of information and will have taken 10.3 minutes to process.

Reliability of tape recording is, of course, critical and in the Datamatic system this is assured by an advanced technique of time modulation (detecting dots and dashes). This step forward is the result of devoting many years of research to solving the problems of electronic noise and variations in signal strength. The Datamatic magnetic file unit has incorporated many safeguards to guard against inadvertent erasures, breakage, distortion and incorrect positioning.

In the input section, masses of data are converted, off line, to the machine language on magnetic tape. Converters are now being provided for the conversion of punched cards and punched paper tape. In the near future it is anticipated that devices will be available for conversion from the written document to magnetic tape. Punched cards are read and converted into DATAmatic 1000 language at the rate of 900 cards per minute. Conversion is programmed for editing, duplicating and suppressing data punched in an 80-column card. Card data is read and checked at two reading stations. Illegal punches will be detected and cards containing illegal punching will be routed to a special pocket. The Hollerith card code is converted to four bit numeric and six bit alpha numeric codes before being written on magnetic tape. For each batch of twelve numbers or eight alphabetic characters (48 binary bits) a special proof digit is created. This batch becomes the standard DATAmatic word which is then recorded in one channel on magnetic tape. Keep this proof digit in mind because it's a very useful device throughout the DATAmatic 1000 system.

The DATAmatic central processor makes use of a large scale, general-purpose, stored-program electronic digital computer. To coordinate this system, to provide the balance of which we spoke earlier, some of the following items are of particular interest. Twin buffers provide access to and from the magnetic tape files at magnetic speeds. The duplexing, or switching, of these buffer units affords a continuous flow of data while the data processing operations take place. High speed magnetic core memory holds 24,000 digits of information, thus up to 2000 DATAmatic words and orders are held for use within 10 microseconds.

The DATAmatic 1000 central processor makes efficient use of the powerful three-address order system. Single order words are designed to perform a whole series of processing steps for a standard sort routine, or for merging and other file maintenance tasks. The automatic business computer makes it possible for a programmer to write a brief set of orders to define and select a complete routine from the compiler's library of sub-routines.

Reliability and accuracy of the central processor operations received top consideration from the design engineers and have been safeguarded from every aspect. The special proof digit that we mentioned earlier is one of the important features. For each transfer, or any operation involving a DATAmatic word, a weight count calculation is made to check the accuracy of that word. In some instances, special duplicate circuitry checks the transmission of data as a further precaution. In connection with this discussion of the devices used to insure that no undetected inaccurate handling of data takes place, it is appropriate to discuss the modular construction of the central processor. The central processor is an assembly of package units (as are all circuitry components of the DATAmatic system). These packages are a result of current advances in printed circuitry, semi-conductors and plug-in units. Marginal checking programs are used to impose extreme operating conditions on the DATAmatic 1000 prior to production runs. A package which contains a faulty part (such as a weak tube) is quickly located by automatic marginal checking and may be quickly replaced by a spare package, thus minimizing machine down time for maintenance. The principle of modular construction applies not only to the packages but to the sections and frames in which they are installed. The result is ample, lightweight components which may be broken down and transported to usual office spaces where installation may be made without expensive modification of office structures. Each frame of the DATAmatic central processor contains its own built-in cooling unit, specially designed to maintain ideal operating temperatures.

The DATAmatic operator's control console is designed for monitoring automatic machine operations using an indicator panel and Flexowriter print-out. Special variations in the routine program may be introduced by the operator, and he controls the particular input-output set up for each operating run.

Off-line access to information stored on magnetic tapes is made possible through the use of a desk top File Reference Unit. The file reference unit searches for the desired record and when the record is located, provides for edited print-out of the desired data.

Mass print-out, that is print-out other than the occasional use of the Flexowriter on the control console, takes place off-line, while the other sections of the system are carrying on other functions. Printed data is available at 150 lines per minute or at 900 lines per minute. Output in the form of punched cards or punched paper tape is also available.

In a typical system, such as the one planned for installation at Minneapolis-Honeywell, the central processor (including high speed memory, arithmetic, control unit, buffers and console) constitute about one-half of the cost of the system. Magnetic file units, converters, etc., make up the balance. As many as 100 magnetic file units may be tied in with the central processor and, of course, an unlimited number of input and output units may be used.

The balance of this presentation is devoted to a discussion of the specific problems we have faced at Minneapolis-Honeywell—from the feasibility study to the point we have reached today, and our plans for the future. For those of you who are not familiar with Honeywell, the following information will probably be helpful in getting an understanding of the type of application we are making.

Minneapolis-Honeywell employs about 33,000 people in the United States and Canada. We have five principal divisions with factories in many cities scattered from one end of the country to the other. Corporate offices and two of the divisions are headquartered in Minneapolis.

In 1954 we established an Office Automation Department, reporting to an officer, and serving all divisions of the Company. This department was instructed to carry out a four-point program as follows:

1. Analyze the existing operations to define the record keeping problem.
2. Study all electronic data processing equipment available.
3. Determine the benefits of office automation in terms of cost savings.
4. Determine any other benefits in terms of better management data.

In order to get our feasibility study started, we concentrated our study in one division—Temperature Controls, headquartered in Minneapolis. We further confined our efforts to five departments in this division which appeared to us to be likely to possess the greatest potential in clerical savings. These departments were the Production Control Department, the Financial Accounting Department, the Cost Accounting Department, the Credit Department and the Machine Accounting Department. As a practical matter, the job of analyzing existing operations was far too great for the small staff of the newly created Office Automation Department, and also too time consuming. We, therefore, recruited help from the departments being studied and taught them first the familiar systems and procedures analysis techniques. This systematic examination of our existing data processing methods provided an immediate reward beyond our expectations. In the first year of study, while we were spending $42,000 on the survey, our analysts turned up elements of inefficiency and developed improvements which have produced annual savings in excess of $56,000 and more savings have been accruing since then. Gains over and above these measurable dollar savings were made in this area. The very close examination of data handling revealed many weaknesses that had developed over the years. Corrective action was taken as a result of this examination.

Step Two of our program was a study of all existing electronic data processing equipment. In view of our long range plan to study and effect the centralization of data processing for all of our divisions, as well as to satisfy our ambitions of operations research, we determined that we would need a large scale data processing system. It was at this point that the DATAmatic entered the picture. I am certain that our enthusiasm for this new system influenced Management's decision to invest in the DATAmatic Corporation. At this point it should be made clear that while Minneapolis-Honeywell owns the DATAmatic Corporation, the Office Automation Department functions as a customer of the DATAmatic Corporation.

The personnel involved in the first step of the study, having been exposed to the intimate detail of present operations, was next exposed to sufficient education in logic, programming, coding and operation of the DATAmatic 1000 to permit an evaluation of its use. We were assisted by two systems men from the DATAmatic Corporation in this study.

The feasibility study gave evidence of sufficient clerical savings in one division to offset the operating cost of the DATAmatic 1000. By projecting these savings to the other divisions, we realized that we were safe in recommending to Management that we should place an order for the system. Actually, of course, we expect our greatest gains to come from improved reporting to Management. Management accepted our recommendation and we were then ready to begin to prepare in earnest for our installation.

The individuals who were educated in general terms in the use of the DATAmatic 1000 now formed the nucleus for our programming teams. Additional personnel was selected to make a total of 18 men who were given a full four-week programming training course.

In selecting the additional personnel to be added to the program, we recruited about half of them from within the operating departments that will make use of the electronic data processing equipment. The balance of the personnel was hired from outside the Company. None of the new hires had had any previous training on electronic computers. Our criteria for the new hires was good general ability and a strong interest in mathematics. Those who met these two qualifications and in addition had some experience in punched card methods have developed into outstanding programmers. In general, we set up teams of two men to handle specific, well defined problems. We have taken one man with previous experience with the Company, and with specific knowledge of the problem to be programmed, and have teamed him up with one of the new hires. This has worked out very well for us.

Before we get into the specific areas now being programmed, one more point is worth covering. While the ultimate objective may be complete integration of all data processing on the DATAmatic 1000, the approach we are taking is to attack each area separately. While each team of programmers is aware of what the others are doing and in some cases is depending on others to furnish information to him in the form of records on a magnetic tape, basically he is operating independently on a separate problem. In other words, we are not trying to change our whole system overnight. We are attempting to work in the areas which will produce the most advantages to us immediately, and are going to work toward complete integration gradually. It is our plan to first convert to electronic data processing those areas which lend themselves to parallel operations. Having mastered these areas and developed the "know-how" in these areas and having developed confidence in ourselves, we'll move in the direction of those programs which do not lend themselves to completely parallel operations.

In line with this philosophy, the first data processing functions which we will convert to the DATAmatic 1000 are those large volume jobs presently being performed on our punched card machines. I suspect that in the minds of some of you, this is a mistake since there seems to be little opportunity for savings in this area. This would be a mistake if the capacity of the DATAmatic 1000 were to be taxed by this changeover. Actually, the jobs that now take all week on some of our punched card equipment will take only a few hours on the electronic gear. We therefore feel that there are at least three sound reasons for working in this area first.

1. Programming will be relatively fast (and therefore inexpensive) because the work is already well routinized, good master files are already in existence, etc.
2. It will be possible to operate parallel systems in this area.
3. We will have a very quick offset to some of the costs of the DATAmatic 1000 system in the form of reduced punched card rentals.

It is our intention to convert payroll check preparation and all of the related reports, first. This meets all of the above stated requirements. It is a function presently handled on punched cards, it is well routinized and it is relatively free of entanglements with other office procedures.

Our 14,000-man payroll in Minneapolis (weekly and semi-monthly) will take only about an hour a week on the central processor. This time includes all necessary sorting, matching and computation time for payroll check preparation plus all of the common related functions such as tax computation and tax accumulation, social security computation, bond accounting, etc.

Another function that meets our qualification for early conversion to the computer is dividend check writing. As with payroll check writing, this is a well routinized function that is isolated from other procedures and lends itself to parallel operation.

Having acquired "know-how" on the DATAmatic 1000 and more confidence in ourselves, we feel that at this point we will be prepared to move into areas that are less adaptable to parallel operations. Closely related to payroll check writing is the cost accounting function of labor distribution. I don't propose to go into all of the details of this, but I would like to pursue it far enough to make one point. At Minneapolis-Honeywell we operate on a standard cost system and we also use a work measurement plan to evaluate the efficiency of employees engaged in direct labor. This makes our labor distribution a double-barrelled proposition since we are concerned with both dollar standards and time standards. The master tape which contains this detail must then be broken down to contain detail on every operation on every part and every operation going into a complete device. This same sort of detail is required by our Methods Department, our Production Control Department and in some aspects by the Sales Analysis Section of the Financial Accounting Department. The point I have attempted to make is that in spite of our desire to consider various functions separately in our early programming efforts, coordination of all phases is vitally necessary from the start.

In the Financial Accounting area our prime target is the general ledger. This illustrates another interesting point. The task of programming the general ledger itself does not appear to be a very fruitful function. Actually, when we approach this function, we are doing it with the idea of producing speedier reporting and quick analysis of exceptions to the normal. In order to effect speedier reporting, it is necessary to pursue each of the inputs to the general ledger which cause delays. Labor distribution, which we have already discussed, is one of these. Our closing entry for sales is another. Payroll distribution of our field organization is another and there are more. Thus it is that the general ledger, which at first glance appears to be a relatively simple function, grows into a monster.

One more comment on the general ledger. Present practices on general ledger work require posting to detail ledgers, etc., before a trial balance can be prepared. At Minneapolis-Honeywell we currently produce our ledger on punched card equipment but the same general principle applies. We must first run lengthy detail ledgers before we can prepare our trial balance. With the DATAmatic 1000, we will produce a trial balance first, then we will prepare the detail ledgers.

In one area we are programming a customer invoicing operation. This is a contract billing function where billings are issued on the basis of the degree of completion of contract jobs. This is a good sized programming job but is so specialized that I won't bother you with details of it here.

The final area now being programmed for the DATAmatic 1000 is that of Production Control. In this area it is planned to start with the scheduling function, record keeping and control of component and raw material inventories. Since Production Control is a field for specialists and each company must build a system around its own peculiar requirements, we will not attempt to go into any details of the operation here except to describe some of the gains we expect to achieve.

First of all, the complete accuracy of machine processing is particularly important in this field. In accounting areas, it is possible to establish control figures and check points to verify your work. This is generally not true in Production Control. The elimination of the human element will lead to more accurate reporting.

Secondly, the high speeds of the DATAmatic 1000 are very beneficial in this area. Changes in the pattern of customers' demands will be immediately reflected in our planning. Quicker handling will permit shorter lead times, smaller inventories of components and raw material and smaller inventories of completed devices on our shelves.

Looking to the future, we have some rather firm plans and we are doing some "blue sky thinking."

In the realm of firm plans we have one very obvious one—that is in our Engineering Department. At the present time Honeywell is leasing, in Minneapolis, a medium size digital computer and has a considerable investment in analogue computers. First of all, the type of work being done on the digital computer will be switched at once to the DATAmatic 1000, again resulting in an offset to the cost of the new equipment. We also expect that a considerable portion of the work now being done on analogue computers will gradually shift to the digital equipment.

Another step that will be taken shortly after installation of the DATAmatic 1000 is to establish a committee of programmers to begin the work of overall integration. You will recall that I have mentioned earlier that we are attacking isolated problems at the present time. While doing this we are not completely ignoring the ultimate goal of integration. The team which will be set up after installation will work directly toward this goal.

Thus far in this discussion, I have confined myself to our plans for data processing in one division in Minneapolis. We are taking this approach because we have a large volume of work in this area and we feel that we will be better prepared to handle the more difficult problems of processing data for other divisions. Even though delivery of this equipment to Minneapolis-Honeywell is more than a year away, we have already begun to lay the ground work for handling the data of the second division of the company. Our Aero Division is also headquartered in Minneapolis, though on the opposite side of town. The nucleus of our programming team has already been formed by the selection of a small group of men who are now doing a systems job. In another six months, these men will be trained as programmers and they will then start the actual job of programming for the DATAmatic 1000. By steps, each of the other more remote divisions will get into the act.

One more word about our company-wide operation for central data processing. The DATAmatic 1000 will be installed in Minneapolis and will serve other divisions strictly as a service bureau. Minneapolis will not dictate to anyone how the problems are to be solved and will not do the programming for the other divisions. They are autonomous now and will remain so.

In conclusion, we have an awareness of what operation research might provide for us at some future time and we do not think that it is unimportant, but right now we do not have anyone working on that phase of the problem. It is our feeling that before any progress can be made in that area, we must first successfully solve the data processing problems.

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