

THE PROCESSING OF INFORMATION-CONTAINING DOCUMENTS

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The Problem

General Remarks

Much recent attention has been paid to the promise that digital computer techniques will simplify, speed up, and cheapen various sorts of large-scale information processing in business and industry. Only a few actual applications of this sort have so far been attempted, probably for two main reasons. First, punched-card machines are already so highly developed that, despite the potentially greater speed of the newer electronic techniques, it is difficult to introduce novel ways of accomplishing what can now be done by standard business machines. Second, and probably more important, appropriate input and output equipment to couple the world of the digital computer to the world of men often does not exist. To use a computer for scientific or engineering calculations, it is sufficient to provide it with input in the form of a device for reading punched cards or tape, and an output in the form of an electric typewriter or a card punch. Most existing computers have terminal equipment no more sophisticated than this. To use such a machine for accounting purposes, however, requires a far more imaginative solution of the input-output problem; a satisfactory solution can be achieved only on the basis of a deep understanding of the nature of the accounting activity that is being mechanized.

Thus, before the automatic processing of information can be fully successful, means must be provided for imparting the pertinent information to the machine in a form suitable for automatic handling, and for extracting the processed information in useful form. In many practical situations, the problem is made still more difficult by the fact that the original documents containing the information to be processed themselves have a significance, and must be physically handled, routed, or sorted on the basis of the information that they contain. It is an application of this sort that we wish to discuss.

While documents are often used only as vehicles for information, and can be replaced by other documents carrying the same information, there are many other instances in which the original document itself possesses a logical or legal significance, so that it must be preserved throughout an operation which may be rather complicated. In the case of a bank check, for example, the original bit of paper constitutes at all times the legal evidence of an obligation which is fully discharged only when the check is cancelled and returned to the man who drew it. Bank checks must be physically conveyed from hand to hand until they are deposited in a bank; thereafter they must be taken through a series of sortings and concurrent proof and bookkeeping operations, until the bank on which each check is drawn returns each check to its originator.



For an example of another kind, consider the postal service. The U. S. Post Office undertakes to transmit from sender to addressee each letter properly posted, without transforming or even inspecting the contents. Indeed, the inviolability of first-class mail is jealously guarded by the postal authorities, except in such special situations as that which required the censorship of overseas mail in wartime. Except in the case of V-mail, which had as its object condensation of the bulk of letters going abroad, no large-scale attempt has ever been made to impose on the letter-writing public a scheme of transforming and transmitting the information contained in a letter, in lieu of the straightforward transmission of the letter itself. Even when the art of electrical communication is more highly developed than it is today, a tear-stained note on scented paper will probably have more emotional significance to its recipient than would a transformed message transmitted with the speed of light!

Not only bank checks and letters, but also any original papers evidencing indebtedness or obligation, must be processed in a similar fashion. Thus department-store or oil-company charge slips, chits at hotels and clubs, and similar papers characteristic of the increasing public use of credit, must themselves be handled while the information they contain is concurrently being processed.

A Specific Application

Let us consider more closely a problem of the sort mentioned above: the handling of checks by a bank. We shall suppose that the bank has several or many branches, and that the volume of check clearings is sufficient to make it desirable for the bank to perform a head-office clearing-house operation within its own organization; the generalization to other situations will be easy.

At a given branch bank, checks accompanied by deposit slips are handed or mailed in by depositors. A first proof and sorting operation is performed at the branch, in which the deposit-slip total is verified against the independently run-up total of the individual checks belonging to that deposit slip. The proof-machine operator at the same time sorts the checks into a few gross categories; for each category a printed tape listing each item in the category is prepared.

Periodically, checks drawn on other banks or branches are bundled up, in the gross categories mentioned, and forwarded to the head office. With each such bundle goes a printed tape listing the items contained in it; this tape plays for the head office the role that the deposit slip played at the branch. In the head office there is performed a proof and sorting operation precisely similar to that previously done at the branch; the tape total is compared with the individually run total of the separate checks in a batch, and the batch is further sorted according to the bank of origin of each check.

The proof machines which are sometimes used for this head-office operation may have either 24 or 32 compartments, depending upon which of two models is used; for each compartment a tape is printed listing the items it contains. Since checks may require sorting to many more than 32 destinations, it is clear that the average check must be run through the head-office proof-machine operation more than once.

Every step in the clearing process is dependent on the information contained in the check. This information is of two principal sorts: the amount entered on the face of the check controls the proof calculation, while the sorting process is governed by the information regarding bank of destination, which is conventionally printed at the top of the check and is also presented as a bank number assigned to the bank under a nation-wide standard scheme. The operators who run the proof machines perform a function which is logically indistinguishable from translation; they read the entries on the face of the check and inform the machine (by punching its keys) as to what those entries say. That is, they are performing a translation from the printed and written language used by human beings to the language understood by the proof machine.

In default of a machine for reading print and handwriting, which we do not yet have, one such act of translation must be performed by a human being. Once the translation has been done, however, the preservation of its results in a form that a machine can read will eliminate the need for further human agency in the later stages of the proof and sorting operation. There are several ways in which this preservation can be attempted; let us examine them.

Proposed Solutions

Punched-Card Checks

The most obvious suggestion is that the information-bearing document be itself a standard punched card, so that conventional business machines can perform the processing of the document and of the information it contains. Bank checks of this sort are indeed available, and are in fairly wide use. The fact that the punched-card check is not universal suggests that it may not be an ideal solution to the problem; if this conclusion is correct there are at least two principal shortcomings of the system which suggest themselves as reasons for it.

First is the rigidity of the system with respect to the physical form of checks. Present custom permits the depositor of a bank to choose his own style of check, within fairly wide limits of size, shape, and paper stock. Further, it permits him, when no blank check form is available to him, to write a counter check, to alter a check printed as belonging to a bank other than his own, or even to write a check on any piece of blank paper that may come to his hand. While it might be possible to re-educate the public not to expect this latitude of service from the banks, it appears that few banks are willing to take steps which limit the service they give the customer, so long as other banks are putting heavy emphasis on greater customer service.

A second and more fundamental difficulty with the punched-card check system stems from the fact that the checks spend a substantial time in passing from hand to hand, out of control of the bank, before they are finally deposited and must be cleared. Maltreatment or accidental damage occurring prior to deposit cannot be controlled by the bank, and, if it is serious enough to prevent even a small percentage of punched-card checks from feeding properly through the machines, such damage can very quickly eliminate the savings realized by installing a punched-card check system. The damaged punched-card check cannot be replaced by a good card carrying the same information (as a damaged card used in an accounting system would be), because it is a check -- unique evidence of a legal obligation. Instead, the damaged card must be carried by hand through all the operations

necessary to clear it; this is sufficiently troublesome so that even a tiny fraction of damaged cards will make a card-check system impractical for general use.

Parallel Control by Punched Cards

It has been suggested that a punched card might be prepared to accompany a check through the clearing operation. This card, into which would be punched all the pertinent information contained on the check, could be prepared at the time of the first proof operation. Corresponding stacks of these cards and of the documents that they represent would then be handled individually and simultaneously, through common control by card readers. Thus two sorters would operate side by side, the one sorting cards and the other, controlled by the first, sorting checks.

So far as the authors are aware, this scheme has never been used, which may indicate that its manifest drawbacks are so serious that it is not practical. Among these drawbacks are the following:

1. Automatic feeding and sorting equipment capable of handling documents of a wide range of size, shape, stiffness, and degree of preservation is assumed by the scheme. The required equipment poses a variety of difficult mechanical problems.

2. Two corresponding processes must be kept in synchronism, without any check on proper operation or control over the individual identities of the documents being sorted.

3. Any accidental disordering of either stack -- documents or cards -- can be repaired only by an item-by-item inspection of the disordered stack, a costly and time-consuming process.

4. The cost of the punched cards required by this scheme -- between one and two mills per card -- may be a non-trivial part of the total cost of the system. An efficient internal clearing operation can be run manually for less than five mills per item handled.

Coding Information into an Ordinary Check

It has occasionally been suggested that the necessary information carried by a check be coded directly into the check itself, in a form suitable for machine reading. While this idea does not have the rigidity of the punched-card check scheme, it has the damaged-item difficulty in an exaggerated form. Punched cards are standardized and carefully controlled precisely because their uniformity makes the design of reliable handling equipment less difficult than it would otherwise be. Machinery to handle automatically a heterogeneous mixture of documents of various shapes, sizes, and degree of preservation would be very difficult to make; and the usual check form, being of flimsier stock than that used for punched cards, would be far more susceptible to damage which would prevent it going through the machines at all.

The Information-Bearing Attachment

The foregoing discussion makes it almost self-evident that the problem can be solved by preparing and affixing to the check, at the time of the first proof operation, an information-bearing attachment which contains in machine language the pertinent information written and printed on the face of the check. This has the advantages of the punched-card check system -- standardization of the size, form, and style of the thing to be fed and read by the machine, in this case, the attachment -- without the disadvantages. For the attachment, being prepared after the check is deposited, remains under the control of the bank throughout the clearing operation, and it can be preserved from damage if the bank simply takes adequate pains to protect it. Further, no restriction is put on the customer's preparation of checks; the attachment can be affixed to any sort of paper whatever.

Once the attachment is prepared and affixed to the check or other document, all further human reading or handling is unnecessary. Since the attachment is prepared at the time the document enters the mechanized system, a fresh and reliable medium is available for carrying the information in machine language, which can take the form of perforations, marks, signals in magnetic recording media, etc. The size, weight, and information code of the attachment are standard, so that positioning, feeding, and handling operations can all be performed on the attachment, without reference to the size, shape, degree of preservation, or nature of the original document which is carried along when the attachment is handled. To simplify the problems of mechanical design, the attachment can be provided with special marks, slots, or holes to assist in indexing it as it is handled.

It is also of importance to observe that the information-bearing attachment is not the important document. It contains information, and that is all. If that information is incorrectly entered on the attachment, or if the attachment becomes damaged so that it will not feed properly through the machines, the old attachment can be replaced by a fresh new one, simply at the cost of the effort required to make a new attachment. There is no necessity to carry checks by hand through the clearing operation, as is required in the case of damaged punched-card checks.

The International Telemeter Corporation is currently developing equipment for mechanizing the clearance of checks on the basis of the attachment concept. The attachment is prepared in the bank or branch of deposit, at the time the deposit items and deposit slips undergo the first proof operation. According to present practice, the amount of each check is entered on a keyboard, and the bank of origin is noted, though not necessarily entered. At the expense of entering the bank identification number from the face of the check during the first proof operation, all further human handling can be eliminated from the check-clearing process.

According to our preliminary designs for the actual machines which prepare and affix the attachments, and do the later sorting and proof operations automatically, the attachment will be a short length of seven-hole punched tape, affixed to the check by a heat-sensitive adhesive. The reading of the attachment

will be done by a photoelectric reader, in the automatic stages of the clearing operation which follow the step of preparing the attachment.

The upper limit on the operating speed of the automatic proof and sorting machines is set by the necessity for physical transport of the checks. It is a design objective to handle them at ten items per second. This speed is so low that the concurrent logical processing of information, required by the proof operations which must accompany sorting, can go much faster. It is accordingly our intention to let one magnetic drum and its associated logical circuits serve a number of sorting stations, perhaps four or five.

The machines now being designed and constructed are primarily intended for use in the automatic clearance of bank checks, but it is our aim to keep the mechanical design sufficiently general so that the same machines will handle other types of documents. Only the logic will need to be altered to use these machines in another application.

The attachment concept clearly lends itself not only to the proof and sorting of checks for their clearance to the bank of destination, but also to the bookkeeping, posting, and sorting operation that the bank of destination must perform before returning cancelled checks to the depositors who have drawn them. At present, we are not including this operation in our considerations and designs, though it seems that this would be a straightforward extension of the technique.