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A microcomputer based system to provide report quality borehole records

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Summary

A system has been developed to provide report quality borehole records with the aid of a microcomputer. Its aim is to provide a greater efficiency in the production of such records without jeopardizing the technical content or their reliability. The system, which consists of a suite of menu-driven programs, has been developed on a small machine which has only limited capabilities compared with many alternatives currently available. The careful development of the system has provided the facility of attaching further programs able to access the data and carry out functions which will produce further savings in the operational and business affairs of the user practice. The successful development of the system illustrates that user needs do not necessarily require equipment at the forefront of hardware development.

Introduction

Following a recent period of rapid growth, a decision was made to rationalize staff levels and administrative procedures by the installation of a microcomputer. It was considered necessary to maximize the cost benefits of the installation by ensuring constant use of the equipment. It was therefore decided that the initial applications should be those which would minimize the routine and time consuming aspects of the firm's daily workload.

It was realized that borehole records form the main source material for most aspects of geotechnical engineering, and that ultimately they form the only record of the ground conditions encountered at a site. It is not always possible to check the reliability of original records by further investigation, as development often produces ground level changes or may even alter the state and condition of the subsoil. The importance of borehole records cannot be underestimated and, as they are the keystone to most discussions, extreme care and attention should always be exercised in their compilation and checking.

It is important that the quality and production of borehole records should match their very real importance. It is a fact, however, that they can take a very long time to produce. Standard borehole records are a compilation of the information contained on drillers' field sheets and other preliminary logs, modified as necessary by the results of laboratory data or other engineering assessments. Whether they are drafted by hand or typewritten, considerable time is required to order the data and produce initial drafts. This is followed by a period of checking and making any subsequent corrections which may be needed.

The subtleties of interpretation that may be required mean that it is generally not feasible for non-technical staff to work directly from field sheets and other preliminary data without producing mistakes. Very often this means that technical staff may spend a considerable time producing the drafts for later typing for presentation. It seemed that production of borehole records was an area in which the development of a reliable and efficient computer-based system would be worthwhile.

The borehole data system

The borehole data system has been developed against an evolving 'user requirement' to provide high quality, report-ready borehole records. It was considered essential that the system should not jeopardize the technical content of the data contained in the eventual borehole record by limiting the information that could be incorporated. The system was also required to minimize the engineers' time involved without increasing the likelihood of mistakes and errors being produced.

The system has been designed to allow the input of uncontrolled raw data. This is keyed into the computer in response to simple screen prompts. No layout adjustment of the data is involved, nor are any calculations or the need to manipulate or order the data to conform to the required borehole record sheet. The computer only asks for simple listings which are taken directly from the daily drillers' sheets, preliminary engineers' logs or other field sheets. In fact, the room for error has been found to be so small that non-typists can also rapidly input the data.

Significant time savings are made by the use of the system, not only in the amount of engineers' time, but also in the total production of the records as any unnecessary input is eliminated. For example, once a

job file has been opened to which borehole data can be referred, information such as the client's name and site name is automatically inserted during printout. The efficient use of predefined rules allows automatic numbering of the boreholes, reference numbers and sheet numbers and all samples are classified, numbered and sorted regardless of the order in which they are input.

To provide the degree of usefulness required of the system, it was necessary to build in a degree of flexibility to accommodate the mistakes which can inevitably be made during input, as well as any other changes which might later be needed. It was essential that these could be carried out simply, without the need to repeat otherwise correct input information. The flexibility achieved allows additional boreholes to be added to existing datafiles so that phased investigations can be readily accommodated. The borehole information itself can be checked on the VDU screen prior to printing, and the data can be modified, corrected and printed either collectively or by individual borehole. This flexibility is extremely adaptable to individual working methods. For example, the editing capability allows the production of preliminary logs, perhaps based on field descriptions which can be later modified after the engineers have logged the samples. The records are then simply printed out in their modified form following a minimum of additional data input.

The printing controls built into the program ensure that continuous typed text, such as that forming strata descriptions, is printed within defined column widths, with automatic 'wrap-around' of the text occurring at word ends. In addition, the centring of the text block within the strata space maximizes the quality of presentation and subsequent ease of use.

The simplicity of the input method and the separation of the input and output controls means that the data can be printed to any layout of borehole record. All data is printed, scaled against depth and tabulated precisely within the chosen column widths.

Software description

The software has been developed for a Triumph Adler Alphatronic P2 microcomputer which runs on an Intel 8080A microprocessor. The operating system is a microcomputer operating system (MOS), but CP/M can be optionally loaded. The unit has a free user memory of 48 K dynamic RAM. Storage is from twin disk drives taking 5.25 inch floppy disks, each with 160 kByte capacity. This drives a Triumph Adler TRD 170S bi-directional high quality daisy-wheel printer.

The software has been developed in TA-BASIC and consists of a suite of menu-driven programs, enabling the storage, maintenance and retrieval of the borehole data. Initial development has a suite of the following four main programs.

1. *A menu program*, to enable all applications to be loaded and run in a consistent and user-friendly manner. The use of menu options to provide access to a suite of programs is a convenient and familiar method which requires no understanding of or familiarization with the computer system and the operating language, over and above the ability to switch the machine on and off. In this way the desired aim that the system can be used by all levels of staff is readily achieved.

2. *A data entry program*, to enable fast and efficient entry of the raw data which is stored for future processing. A sequential file system was chosen as the storage vehicle, to minimize the space requirement for the data files. A particular feature of the program is its self-validation of the data as it is input. By checking the information against a comprehensive suite of predefined rules, it draws to the attention of the user any invalid input statements, allowing for their immediate correction. The program also allows the addition of further boreholes to an existing data file.

3. *A data file amendment program*, to enable the recall and amendment of stored data. The information can be recalled from a datafile *in toto* or by specific boreholes. It is displayed on the screen of the VDU where it can be checked and, if necessary, amended.

4. *A data file print program*, to extract, manipulate and format data for printing on to preprinted borehole record sheets in a consistently high quality format. The program contains subroutines to enable complex text manipulation and formatting for output.

In addition to the major programs described, a number of utility programs have been developed to give greater power to the data manipulation than that available in the software language. These include a general purpose sort program which will sort uncontrolled data against any given alphanumeric criteria and an unformatted datafile dump program, which will dump the contents of a data file to either the VDU screen or the printer as requested, and thereby facilitate data checking. In addition, an individual file copying program has been developed which will copy either data files or program files within or between the disk drives of the machine.

Figure 1 shows a flowchart of the system to illustrate the method it uses to produce the final borehole record from the various drillers', laboratory and engineers' sheets, collectively called the input documents. Figure 2 shows the program flowchart for the data entry program. The program is loaded from the main menu which is initially displayed automatically following start-up of the system. Upon selection of the data entry program the user is asked whether a new file is to be created or whether additions are required to an existing one. The program continues to prompt for data entry. If a new file is opened it will initially ask for the job header information. This is the

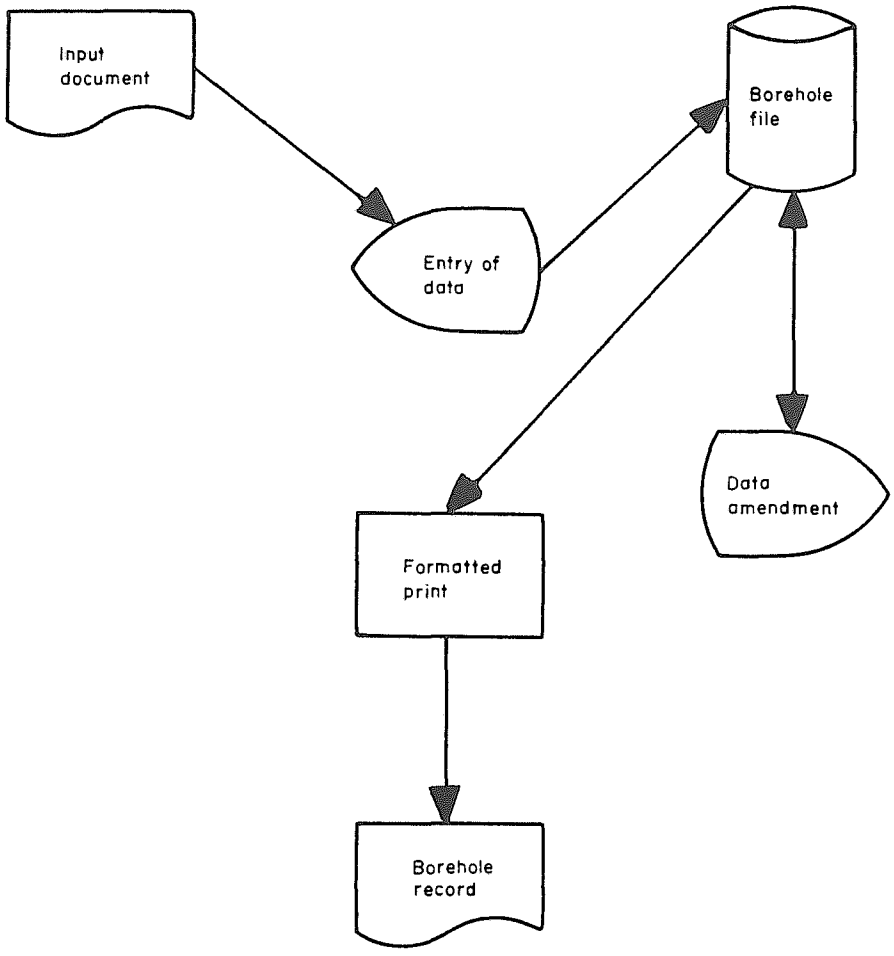

FIG. 1. Flowchart illustrating the principle of the borehole data system.

job number, client's name and site name. It will then ask for the number of boreholes to be entered. Then, for each borehole, which will be automatically numbered sequentially unless overriden by the user, it will prompt for the listings of the samples and *in situ* tests carried out. The minimum of input is required; for example, only depths are required to be given, as the sample type and reference number can be determined by the program. Variants of the data entry program have been developed to accommodate varying styles of the input documents, so the user does not need to enter the data in a particular order.

The entered data are redisplayed at logical stages during the entry period to allow for amendment prior to storage. Data are entered for each borehole and then posted to the job file. After all the nominated boreholes have been entered, the program will return the user to the main menu.

Figure 3 similarly shows the program flow chart for the data file output program, where again it can be seen that the efficient use of subroutines within the program maximize the internal control of the system under a range of conditions.

Further developments

The system has been produced with additional developments in mind. Its potential power can be fully realized by considering the extension packages to the basic system. Without altering the form of the input files or needing to re-enter the data, it is possible for quantities to be abstracted directly from the data file. These can, for instance, be merged directly with an invoice format. This is equally suited to large or small jobs; since the data are dated, it is an easy matter to produce interim invoices while automatically opening a series of balance files to allow summary sheets to be produced to any period. By producing invoices in this manner, the information can be stored to a ledger system. From this routine administrative functions may be controlled. For example, it would be possible automatically to produce and send statements on outstanding balances, while more detailed analysis may be obtained to provide cash flow forecasts or other cost analyses. Because of the manner in which the original data is stored in the system, that is to say by date, by client, by area, etc., the immediate

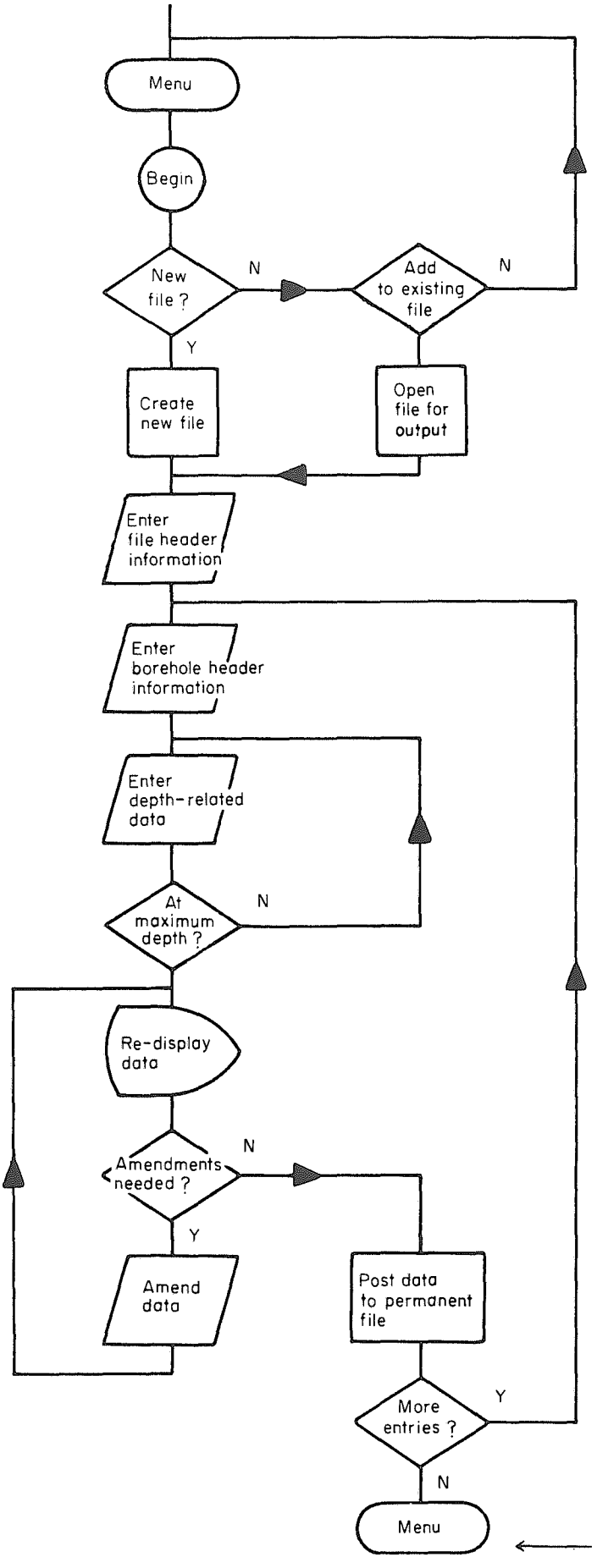

FIG. 2. Program flowchart for the data entry program.

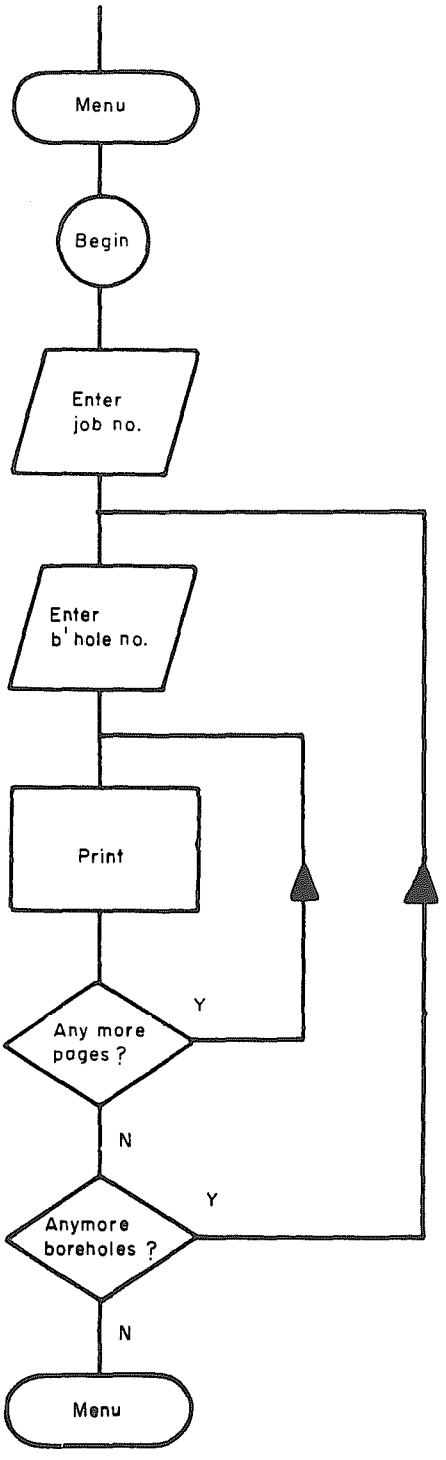

FIG. 3. Program flowchart for the data file output program.

manipulative potential is very powerful and capable of producing direct and indirect savings in areas of office and administrative functions that were not initially conceived at its inception.

Conclusion

The borehole data system has been developed on a relatively low cost microcomputer that has limited power compared with alternative readily available equipment. Its successful development illustrates the commonly misguided conception that it is necessary to install and run the equipment at the frontiers of machine capability and availability. The purpose of the system was to produce borehole records, a regular routine requirement of a geotechnical practice. Its regularity of use has enabled the development time and costs to be more easily justified, from a business point of view, than for a less frequently used but perhaps more technically interesting application. Careful design of the system has enabled extreme ease of use and has provided a form which will allow the development of additional computer-run facilities extending directly from it, which will produce their own savings in time and money to be compounded to those already obtained.