

# THE USE OF A DIGITAL COMPUTER FOR ROUTINE MONTHLY CALCULATIONS

By J. R. FITZGERALD

*Sugar Milling Research Institute*

## Abstract

This paper considers the application of a digital computer in a cane sugar factory to routine calculations. As the example, it considers in detail the application of computing to the very simple yet tedious calculations involved in the preparation of the Sugar Milling Research Institute's monthly summaries of laboratory reports. The success of this application immediately opens the field to the possible use of a computer for on-line routine factory control calculations.

The paper has been presented to serve more as an introduction to computerized calculations for process personnel rather than as a detailed applicational exercise and consequently discussion has been limited to general terms.

## Introduction

An electronic digital computer is a calculating machine programmed to manipulate input data according to a prearranged routine referred to as the program. Its primary assets are speed, reliability, accuracy and memory. It can do many man-months of hand calculations in a matter of seconds and with sufficient precision and reliability to guide the flight of man to and from outer space. Commercially, its most important feature is its memory or its information storage and retrieval ability which eliminates the vast filing and accounting systems usually required in a large organization.

The application of the digital computer to any industrial process, including a cane sugar milling factory, falls broadly into four categories:

1. Simulation of the process.
2. Optimization of the process.
3. Direct digital control of the process.
4. Routine process calculations.

The simulation and optimization of a process are advanced forms of process control usually requiring sophisticated mathematical modelling to reap their full benefits. A mathematical model is a set of algebraic equations formulated to represent the relationship between the various parameters and variables in the process. Simulation is usually done to obtain information about the process under conditions not met with under normal operation — this may be done independently of the process or by making use of the inherent fluctuations present in the process when operating under normal "steady-state" conditions. Optimization is used to obtain the best results in respect of maximum profit under a specific set of conditions — the constraints usually being equipment capacity, product specifications and raw material composition.

Direct control of a process is more appropriate to analogue rather than digital computerization but the availability of suitable analogue-to-digital interfaces allow their efficient use in this field. The ability of a digital computer to store records, update averages and keep inventories allows it to be easily programmed to do the routine process control calculations.

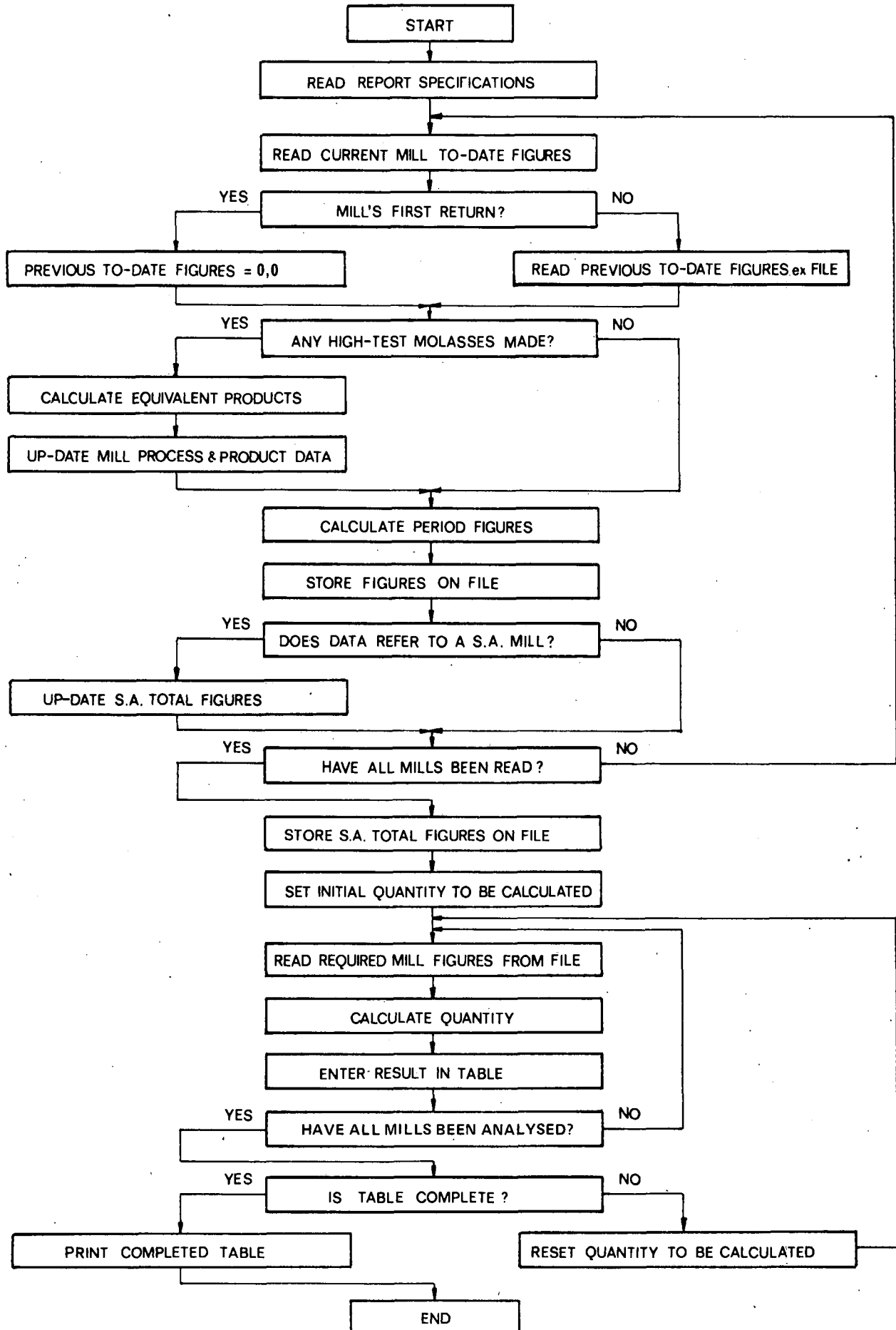
## Application to monthly figures

The primary objective, when the decision was made to use a digital computer for the calculation of the monthly figures, was to reduce the man-hours spent in checking the figures submitted by the various mills and in determining the South African average performance figures. This was later extended to include the possible use of the computer output for the reproduction and duplication of the tables on which the results are presented.

Previously all mill returns were checked manually for errors and the appropriate figures were totalled and averaged to obtain the mean South African mill performance. In most cases, errors usually arose due to incorrectly transcribed figures at the mill and as the basic data was not always readily available or involved the fault, long detailed cross-calculations were often required to confirm a doubtful figure. When it is considered that the previous monthly report forms required over 150 values, the occurrence of this type of error was relatively frequent. Once the completed table had been prepared, the figures were typed on to stencils for duplication. Errors arising at this step are obvious and in spite of careful checking, a limited number were usually present each month.

The object of writing a programme of this nature therefore was to reduce to a bare minimum the amount and preparation of the data required for the generation of the table and to allow for every possible situation which might arise with respect to the returns. Neglecting the non-mill figures of cane variety and rainfall, the complete table may be calculated from 29 current to-date figures provided the previous period's to-date figures are available.

The manipulation of the basic data within the computer programme is almost identical to the method one would adopt if presented with the figures to be analysed on a hand or desk calculator, while storage within the memory may be directly related to an entry in a ledger book. If, in fact, the calculation, no matter how long or complicated, cannot be done on a desk calculator, it cannot be done on a computer.



Consider the logic flow diagram in the accompanying figure. The first step is to read into the computer the report specifications and programme control parameters — this information will include number of mills to be considered, report number, the period under review, etc. Each set of current mill figures is now read in turn, processed as required and stored in the monthly data file.

Having read a set of mill figures, the appropriate previous to-date figures are found either on the monthly data file or are assumed to be equal to zero. A check is then made for the production of high-test molasses; if any was made, the equivalent "sugar" products are estimated and added to any actual products reported. The period quantities are now obtained by subtraction and the current to-date data written on to the monthly storage file. If the mill under consideration is a South African mill, the period and to-date values are added to the averaging totals. Once all the mills have been read, these totals are similarly read on to the monthly file and all subsequent operations with these figures are identical to that for a mill.

The second half of the diagram refers to the development of the table and the printing of this information. The logical approach is to work down the table row by row doing the same calculation for each mill in turn until the row is complete rather than to complete the table for each mill in turn. The results are immediately stored within the memory in a "dummy" table to facilitate the printing of this information once it has been completed.

The logic diagram described above is an idealized one; it does not necessarily reflect the best or only way of producing the figures but the general approach to handle the data. The actual manipulation of the data is a modification within the basic structure considered above to suit the capacity and facilities of the machine to be utilized.

The most convenient machine available to the Institute is an I.B.M. 1130, a relatively small machine by modern standards but totally adequate for the calculations envisaged. It does present certain difficulties in the preparation of a suitable output for reproduction as it is designed mainly as a scientific machine rather than a commercial model. This particular machine does, however, have the facility to transfer information from memory on to cards in binary code for use in later executions of the programme. This implies that the whole operation of the programme deck is conducted in a temporary mode requiring no permanent storage within the machine itself but rather permanent storage on a deck of cards.

In order to fit this machine the programme written according to the logic diagram considered above had to be modified by splitting the operations into various sub-routines and utilising the over-writing ability of the compiler. In basic terms this means that the relevant data to be processed is stored in a reserved area while the programming instructions are over-written as completed by a new set. To reduce the amount of storage required, the mills are processed in batches and the table printed out as it is generated.

As the number of mills usually covered by the monthly report is of the order of 25, output on a single sheet of continuous stationery is rather impractical and in an attempt to reduce to a more convenient and standard size, the number of mills per page was limited to seven. Although this is not the maximum number that could be placed on a single page of computer output, it allowed the South African mills to be covered in three pages and the affiliated mills to be covered independently on a separate fourth sheet. The length of the table is such that it can only be printed on two sheets.

Contrary to the popular trend of producing reams of paper, it was decided to further reduce these eight sheets to four. This was done by reducing each sheet to approximately standard A4 format, joining the appropriate sheets together and, using a mask to superimpose lines to improve legibility, re-reducing to A4. These final sheets are then duplicated to produce the report currently circulated. In an attempt to detract from the rather impersonal appearance of the report (an inescapable feature of all computer outputs), it has been given a front cover.

The following brief time analysis will indicate the advantages gained by use of computerized facilities:

Previous method:	<i>Hours</i>
Checking and calculation of averages . . . . .	24,00
Typing and duplication . . . . .	8,00
	<hr/>
Total	32,00
Current method:	<i>Hours</i>
Data card punching and checking . . . . .	8,00
Computing . . . . .	0,25
Checking results . . . . .	2,00
Duplication . . . . .	2,00
	<hr/>
Total	12,25

*Note:* Computing and duplication in the current scheme involve outside agencies.

Apart from the complete removal of errors arising from transcription at the typing step, an interesting point to note is that the time spent checking actual figures has been reduced by approximately 85%. Further, any errors which may arise may be immediately traced by cross reference to other ratios involving the same figures, to a punching error or to a value submitted by the mill.

**Possible applications in the mill**

The success of this application of computerization to routine monthly calculations must immediately indicate the advantage of such facilities at all mills. It could be used for weekly or daily balances by a method similar to that described above and with further development programmed to accept analyses directly, to correct for standard conditions, up-date the necessary records and only print results when required.

In spite of extensive off-line general purpose use such as accounting, optimization, etc., the economic use of these facilities by the majority of mills is improbable and the future must rather lie in group

participation and a teleprocessing system. This type of system requires a single central computer with time-sharing terminal points at each participating mill in the group, the line between the mill and computing centre usually being telegraphic.

While the completely computerized control of the process is highly unlikely in existing mills due to the high cost of converting or adapting present equipment, with time-sharing facilities the introduction of some form of optimized off-line set-point control is possible. Substantial advances in the field of automation have been made in the sugar-beet industry but it must be accepted that sugar-beet is a less variable raw material than cane and therefore more conducive to modelling and control. However, it is hoped that future equipment and plant installations will be designed to accept automation albeit on a limited scale.

#### Discussion

**Mr. Alexander** (in the chair): I think the use of a computer for monthly calculations is an innovation that will be the start of other uses that the computer will be put to in the near future.

**Mr. Young:** In a sophisticated scheme where information is gathered cards cannot be used for backing up.

Information collected by Mr. Fitzgerald should be made available to others, e.g. Huletts Operation's

Research. The information cannot be passed across on paper as the cost would be prohibitive. The binary representation of the information must be passed across with its full integrity. If done on an I.B.M. disc file there will be immediate problems if someone else is using a different system. A paper tape system would be feasible as the sequence would not be broken.

I suggest strongly that the method of passing the information to others be investigated.

**Mr. Fitzgerald:** Until there is some improvement in the figures submitted monthly my truncated figures are no better than the monthly reports that are sent in. Although I agree with Mr. Young I think he visualises an ideal set up.

**Mr. Young:** The system I suggested is already in use in the Hulett group. We are even able to pick up information from another computer centre and bring it onto our own. I do suggest that the S.M.R.I. standardise on a method similar to ours and I suggest a committee be formed for this purpose.

**Mr. Perk:** The delay in getting out the monthly figures is due entirely to late submission of data by factories—some South African factories being later with their figures than Swaziland and Mocambique factories.

**Mr. FitzGerald:** The position has now improved enormously and all data is received by the second of the month.