PRACTICAL AUTOMATION

By D. L. HUGHES

Introduction

The basic requirements of an automated operation are the elimination of the human elements of fatigue and misjudgement. The tendency to install automatic control panels simply to be in vogue, should be guarded against, as there are many instances where, for various reasons, the operator cannot be dispensed with and the application of simple control devices would suffice.

The purpose of this paper is to outline the factors governing the application and successful operation of automatic control panels with special reference to the performance of the automatic carrier control at Umfolozi.

Design Considerations

One or more of the following benefits can be gained from automation:

(1) Increased throughput,

(2) Less down time resulting from mal-operation,

(3) Reduction in labour.

Items 1 and 2 will most certainly be the results of correctly applied automation, but item 3 will only be realised if the control gear is correctly engineered.

The design of the equipment should be such that it is reliable and does not require specialised labour for maintenance. The capabilities of the maintenance staff should be borne in mind while designing the circuits. This is not difficult to do, as there are usually a number of ways of arriving at the desired result.

Careful selection of components will favourably influence the cost and reliability of the scheme. The author is of the opinion that a control scheme should not be implemented unless the capital outlay can be recovered within four years.

Specialised Personnel

The question so often raised with regard to automatic equipment is: "How many specially trained men are required for maintenance purposes". The author firmly believes that no extra personnel need be carried, provided the circuitry is designed with due regard to the capabilities of the existing maintenance staff.

There is a vast difference between a "Text Book Design" and an operationally sound design. Many engineers have, no doubt, been confronted with electronic devices which require V.I.P. treatment and object to anything but normal operating conditions.

Designers of electronic equipment have a tendency to adhere rigidly to light current principles, whereas, if the best of light and heavy current principles were combined, the result would be an operationally robust design. It would not, however, be as compact as the purely electronic construction.

It is not within the scope of this paper to discuss the pros and cons of control gear design, but in passing, it is of interest to note that the performance of the Umfolozi installation substantiates the author's views.

Automatic Carriers at Umfolozi

The automatic equipment controlling the cane carriers at Umfolozi has been in operation for two full seasons, and the performance during this past season has met expectations. The previous season of operation was regarded as a research period during which time all snags were investigated.

Before investigating the performance of the equipment it would be as well to discuss the development of the scheme.

The decision to automate the cane carriers was taken during the 1962 off-crop, and as no investigation had been carried out as to the operational requirements of such a scheme, a number of assumptions had to be made in order to establish the control parameters.

Circuit design and layout was strongly influenced by the capabilities of the mainteance staff—this led to the adoption of a relay system to perform the logic functions. This system left much to be desired and it was decided during the 1963 off-crop to adapt electronic circuits to perform the logic functions.

In order to achieve reliability and simplicity it became necessary to resort to a fair amount of unorthodox circuitry—the performance has, nevertheless, proved highly satisfactory.

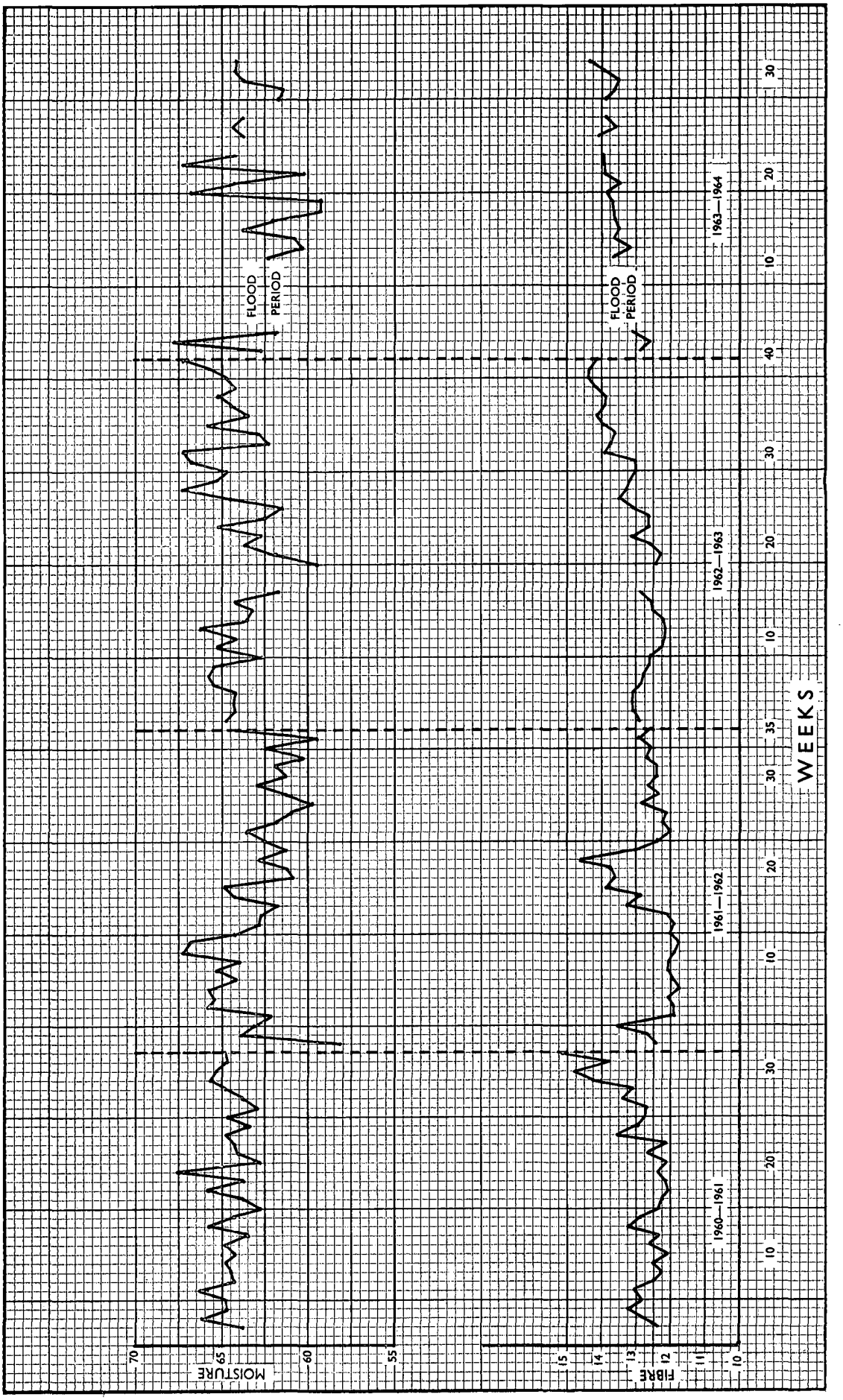
The cost of all the control gear, including the modifications has amounted to R742 plus 700 man hours of labour. The cost of the driving motors has not been taken into account as they were existing on the carrier system.

Performance

It has been alleged that the crusher performance has deteriorated since the installation of the automatics. This allegation has, apparently, been based on the fact that the Umfolozi crusher performance does not measure up to that of other mills.

A true comparison can only be made by reviewing the crusher performance over a number of seasons.

For the purpose of comparison it was intended to use the unit of residual absolute juice per cent fibre in bagasse on the crusher, but unfortunately it was found that the results obtained from the daily figures did not correspond with the Mutual Milling figures. The matter was discussed with Mr. van Hengel of the Sugar Milling Research Institute and it was established that the figure for residual absolute juice per cent fibre was not at all reliable and could not be used. This state of affairs was brought about by unsatisfactory sampling of the secondary juice due to unforeseen circumstances.


MOISTURE
70
65
60
55
FIBRE
15
14
13
12
11
10
FLOOD PERIOD
FLOOD PERIOD
1960—1961
1961—1962
1962—1963
1963—1964
WEEKS
10
20
30
35
40

It was decided, on Mr. van Hengel's recommendation, to base the comparison on the Moisture percentage Bagasse of the crusher. The graph in figure 1 gives an indication of the weekly moistures and the fibre per cent cane. The average seasonal figures are as follows:

	1960-61	1961-62	1962-63	1963-64
Moisture .	64.604	62.921	64.337	63.073
Fibre . .	12.881	12.562	13.122	13.623

In the light of these figures it can safely be claimed that the automatic controls have not adversely affected the crusher performance.

The most significant achievement has been the complete elimination of cane knife trip-outs and chokes. The following table reflects the time lost due to cane knife chokes:

Season	*Time Lost*
1959-60	24 hrs. 05 mins.
1960-61	29 hrs. 25 mins.
1961-62	49 hrs. 30 mins.
1962-63	14 hrs. 35 mins.
1963-64	Nil

The automatic controls have been in operation over the last two seasons.

Analysis of Stoppages

The stoppage time logged against the automatic controls amounted to 4 hours 15 minutes for the 1963-64 season. Of this time, 2 hours 5 minutes was due to electrical trouble.

The following is a detailed analysis of the stoppages:

10 minutes	Relay coil burnt out.
15 minutes	Loose connection on the rotor circuit of the main carrier motor.
100 minutes	Miscellaneous stops which were called for in order to adjust or repair auxilliary circuits. Most of these stops occurred early in the season.
45 minutes	The tacho-generator drive chains gave trouble until suitable jockey sprockets could be devised.
10 minutes	Jammed killer plate.
20 minutes	Organised stop in order to alter the killer plate.
55 minutes	Overloading of the auxilliary carrier motor occurred from time to time, especially after the floods, when the chain rollers had a tendency to seize up as a result of fine sand from the dirty cane entering the bearings.

A total break down time of 41 hours 30 minutes was logged against the main and auxilliary carriers, of which only 4 hours 15 minutes was due to automation.

Conclusion

It is of interest to note that although a fair percentage of the electronic circuitry was of unorthodox design and did not undergo an extensive development programme, it performed extremely reliably and the clearing of the faults that did occur was well within the capabilities of the existing maintenance staff.

One can safely conclude that as long as automation is engineered along the lines discussed it can prove to be highly successful.

Mr. Gunn (in the chair): How can the electricians maintain this circuitry if it is unorthodox and cannot be found in text books?

Mr. Hughes: Unorthodox circuitry provokes a lot of interest. The men building this equipment have spent a lot of time checking the drawings and asking questions, and it was then that I went out of my way to explain the operation of the circuitry and in this way put it over to them in a more effective way than they could pick it up out of a text book.

Mr. Rishworth: I suggest that two of the items in the "detailed analysis of stoppages" should not have been debited against the automatic equipment, namely, (*a*) 15 minutes loose connection on the rotor circuit of the main carrier motor and (*b*) overloading of the auxiliary carrier motor, making a total credit of 70 minutes.

Mr. Hughes: At Umfolozi we have a system of recording stoppage times and the automatics, as we call them, fall into a category of their own. Any stoppages recorded against what would normally be termed automatics I have to accept as being stoppages against automation. I agree that these two items are not really due to automation.

Mr. Ash: The moistures shown in the graph for the 1963/64 season would have been even better had it not been for the flood experienced early in the season. The result of the flood was that planters were unable to load the trucks to capacity, and for very long periods the light loads were not able to keep the mill fed with cane and this caused the crusher to run empty, or light, and poor milling resulted.

Mr. Cargill: Does the automatic control keep a constant blanket level on the main cane carrier, or does it control the feed of cane to the crusher — keeping the crusher full?

Mr. Hughes: Carrier control is governed by the crusher needs. At all times the crusher is the governing device. The carrier control attempts to keep the crusher full. The main carrier is fed by the auxiliary carrier. This carrier is in turn fed by the trucks which are tipped by the tipper gang, this being a manual operation. Should the tipper gang not be able to keep up with the demand the auxiliary carrier will run empty, and the result will be the main carrier running empty, hence the crusher will run empty. The automatics attempt to keep the crusher full, the auxiliary carrier attempts to keep the main carrier full, which in turn keeps the crusher full.

Mr. Taljaard: First of all — what is meant by unorthodox circuits and secondly what precautions are used to prevent the first cane knife motor from tripping out when a heavy bundle is suddenly dropped into the carrier and to the knives? At Tongaat it was found that the time delay was not sufficient to prevent cane knife overload.

Mr. Hughes: In answer to your first question. Unorthodox circuitry I will define in this way. Normally electronic engineers go to the ultimate in electronic circuits. Let us mention switching circuits. Today the

ultimate in switching circuits are multivibrator circuits, more commonly known as flip-flop circuits. These flip-flop circuits are the ideal electronic switching devices. They have their problems, because they are not as robust as they should be. The type of circuits that I adopt are thyratron switching circuits. I am prepared to tolerate the delay in switching, this being approximately half a cycle. Half a cycle in 50 cycles per second is nothing to be concerned about when considering heavy equipment such as milling equipment. Before I answer your second question, I can remember elaborating on this first question. Mr. Tallaard asked "what are the unorthodox circuits, could I illustrate one"? Most of my unorthodox circuits consist of applying heavy current principles in place of the more complicated light current principles. They become rather bulky circuits, using bulky equipment, but it is very robust equipment, especially where heavy outputs are required from electronic circuits. One can very often tolerate slight decreases in efficiency of outputs from the electronic circuits and resort to heavy current principles, resulting in reliable circuitry.

Now, to answer your second question. We have two sections in the current sensing, one senses the current at a predetermined value well below a tripping current. Once we have reached this particular current value, the carrier slows down. Should the current rise appreciably above this, the carrier will then stop. These settings are determined practically on site and are normally set well below tripping currents, to allow the inertia of the carrier to carry the cane into the cane knives and so ride the peak that is going to occur.

Mr. Pole: Although approaches towards automation should be adopted generally, care must be exercised when automating mills, and in particular older mills that are driven in tandem, because a very small decrease in extraction due to automation could very easily offset any possible savings in labour.

Mr. Hughes: I agree with Mr. Pole. I have found it extremely difficult to devise and adapt control systems to older milling units in that the governors of the older engines are not suitable for electronic devices. One has to be careful and a lot of thought has to be put into the designing of control units for older mills. I am at present working on a scheme which I hope will be successful within a very short period.