SUCCESS THROUGH PLANNED MAINTENANCE AT MALELANE MILL

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Abstract

The success achieved at Malelane Mill over the past six years through the use of a planned maintenance system tailored to suit the mill's particular needs is described. Emphasis is given to the complementary factors which influenced the success of the maintenance system. The maintenance organization structure is explained with details of training given both inhouse and at external sources. Details of maintenance documentation and graphs showing the improvements achieved are included. A brief description of the maintenance costing system in use is given as well as a look at the future changes planned for the maintenance system.

Introduction

This is not a paper on how to install a planned maintenance system but rather an account of the success which was achieved in improving mechanical efficiency through the use of a planned maintenance system together with all the important complementary factors which were necessary to achieve success.

The objective of the plant maintenance department at Malelane is to provide a service which will ensure the optimum utilization of the processing plant at the most economical cost. The successful achievement of this objective depends on several factors such as:

- the use of a proper planned maintenance system
- reliable and well-trained maintenance staff
- adequate workshop facilities
- reasonable inventory levels
- full acceptance and backing by top management
- stability of the workforce ie low staff turnover
- the right attitude prevailing among the maintenance staff
- a highly motivated maintenance crew
- strict discipline must be exercised in applying the planned maintenance system
- use of well-trained, capable operating staff.

Planned maintenance has been practised in one form or another ever since the inception of the mill; however in this paper the success achieved during the past six years ie from the 1978/79 to the 1984/85 season, will be considered.

Maintenance system

In reviewing the planned maintenance system as it existed in 1978/79 it was decided that the plant should be maintained in two ways; the critical equipment on the extraction department should be maintained through the use of planned maintenance and other less critical equipment be maintained on a breakdown basis.

The first step was to update the weekly Engineering lost time report which is a document compiled by recording all factory stoppages and which gives reasons for all stops longer than half an hour. To be able to take corrective action to prevent or at least to reduce breakdowns which affected time efficiency, weekly meetings were held at which the breakdown report was thoroughly analysed and recommendations made to prevent a recurrence of the breakdown (Figure 1).

Transvaalse Suikerkorporasie Beperk

Planning Department

Lost Time - Report

To: _____

Date: _____

SUMMARY FOR WEEK ENDING 3/1/85	WEEK		YEAR TO DATE		MECHANICAL EFFICIENCY FOR PREVIOUS 2 WEEKS	
CRUSHING WEEK NO. 40	BUDGET	ACTUAL	BUDGET	ACTUAL	CRUSHING WEEK NO.	
CANE CRUSHED		43 563	1 639 000	1 600 514		
TOTAL TIME LOST NO CANE	23	7,216	419	934,154		
TOTAL TIME LOST PLANNED STOP		3,000	576	413,484	39	38
TOTAL MECHANICAL STOPS	6	7,383	302	286,303	92,05	97,89
MECHANICAL EFFICIENCY	95,35	95,29	94,48	94,57	94,54	94,62

DIVISION OF LOST TIME	LOST TIME PAST WEEK			LOST TIME YEAR TO DATE		
FREQUENCY/HOURS/PERCENTAGE	F	HOURS	%	F	HOURS	%
ROAD TIPPLER AND FEEDER TABLE				19	12,600	4,40
MAIN CARRIER				28	10,932	3,82
CANE KNIVES				12	10,723	3,75
SHREDDER	1	1,083	14,67	72	32,151	11,23
FRONT END CONVEYOR BELTS				51	12,147	4,24
FRONT END SLAT CONVEYORS				84	27,035	9,44
DEWATERING MILLS	3	0,417	5.65	167	51,108	17,85
DIFFUSERS	4	0,584	7,91	77	13,285	4,64
OTHER REASONS FRONT END	4	1,633	22,12	36	27,700	9,68
WORKSHOP M1, M2 & E1 TOTAL	12	3,717	50,35	546	197,938	69,14
BOILERS	1	0,033	0,45	250	48,665	16,99
CONVEYORS AND BAGASSE CRANE	2	0,967	13,09	39	16,266	5,68
POWER GENERATION	2	2,666	36,11	13	18,850	6,58
OTHER REASONS POWERSTATION				4	4,584	1,60
WORKSHOP M3 & E2 TOTAL	5	3,666	49,65	306	88,365	30,86
TOTAL HOURS LOST	17	7,383	100,00	852	286,303	100,00

FIGURE 1 Lost time report

Often these recommendations meant modifications to equipment or the changing of material specifications. It was felt that the best way to know what was happening to the plant was to place heavy emphasis on daily inspections, hence the next step was to review the daily inspection schedule. Care was taken to cover the important points that had to be inspected for early warnings of impending breakdowns to enable the foreman to plan for the work arising out of the daily inspections, most of which had to be carried out during the two-weekly factory shutdown. The daily inspection schedules were designed in such a way that the minimum amount of writing by the artisan was necessary.

The use of machinery breakdown reports was strictly enforced, and these were analysed at the daily meetings between Engineers and Process staff. Initially it was quite common for the section fitter to be called into the meeting to give his views

of the breakdown, particularly if the breakdown occurred on equipment which the artisan was supposed to have covered during his daily inspections. This action helped to discipline the artisans into carrying out a thorough daily inspection.

It is believed that a maintenance system must always be dynamic and must be adapted and changed to suit the circumstances to ensure that the system works for the maintenance team and that the reverse does not become true. Initially inspection schedules and service schedules were reviewed frequently and changes made to improve the effectiveness of the maintenance services required to be carried out. The maintenance staff and production personnel were kept constantly aware that breakdowns did not "just happen" but that every breakdown could be traced to a definite cause.

The factory is shut down for twenty hours every fourteenth day and during this period two-weekly schedules are carried out. All other stopday work is planned and discussed at the "shutdown" meeting held on the Wednesday before the specific shutdown. Job requests are made for all the work arising out of the inspection schedules and any minor modifications are planned and carried out during the stopday.

In order to prevent breakdowns, or at least reduce breakdowns, the foregoing action was a step in the right direction. The other area where time efficiency was lost was in the time taken to execute repairs, so seminars were arranged for the maintenance staff from foreman level up, on the use of P.E.R.T. and simple bar charts to enable them to raise the productivity of their staff and thereby reduce down time by using improved planning techniques.

At Malelane the front end of the mill has been expanded at a far greater rate than the back end so that there is certain equipment which has no spare capacity; the A centrifugals and particularly the refined sugar centrifugals are examples.

Any failure of the refined centrifugals for a prolonged period can cause the crushing rate to be slowed down. This situation was of course much easier when there were prolonged stops on the front end due to poor mechanical efficiency, but as efforts to improve mechanical efficiency began to show improvement it was found necessary to focus more attention on the centrifugal station. This was achieved by instituting a weekly breakdown report covering all the breakdowns that had occurred in this department, and this report was also discussed at the weekly meetings.

Service and inspection schedules pertaining to these machines were reviewed and the necessary changes brought about to make the inspections more meaningful and within six months the operational availability of these machines had improved greatly. The rest of the boiling house and refinery is maintained on a partly breakdown system and partly planned maintenance system.

Notable changes are the increase in daily inspections and offcrop preparation work and the decrease in the percentage of breakdown requests (Table 1).

TABLE 1

Classification of planned maintenance work

Crushing season		79/80	80/81	81/82	82/83	83/84	84/85
Daily inspections	%	9,0	9,0	9,5	12,5	13,0	14,0
Service schedules	%	3,0	3,0	4,0	4,5	5,0	5,5
Breakdown requests	%	4	4	1,5	1,0	1,0	1,5
Maintenance	%	76	76	75	71	69	65
Offcrop preparation	%	2,0	2,0	4,0	5,0	6,0	8,0
Modifications	%	4,0	6,0	5,0	3,5	4,0	2,8

Offcrop maintenance

The maintenance philosophy is that every endeavour is made not to over-maintain any equipment by frequent dismantling, inspection and reassembling as it has been proved that apart from the increase in costs more problems are built into the equipment this way than were there in the first place.

Care is taken not to under-maintain the plant and run the risk of having major equipment failures during the crushing season. Over the past 6 years a reasonably accurate record of the plant wear pattern has been built up.

The work arising out of service schedules and inspections is planned by the respective workshop foremen. The process department compiles a list of essential work which they require to be carried out by the engineering department, including modifications which they are putting forward for management consideration.

An estimate of the man hours required from every engineering discipline is made under the heading of every plant cost code. This man hour loading is discussed with the Engineers and Process staff, always keeping a watchful eye on the maintenance budget.

The approved list is computed and tabulated in book form and offcrop job requests are raised by the planning office personnel.

The final maintenance crew requirements are established by subtracting the Transvaalse Suikerkorporasie Beperk's maintenance crew's man hours from the total, the balance being usually made up by employing contractors. However no contractor labour has been employed for the past three years due to:

- improving the standard of black maintenance workers' performance through inhouse and external training;
- more use made of operating staff to carry out some of the routine maintenance;
- improvement in the planning and execution of pre-shutdown maintenance repair work and making up of spares;
- improved planning of the entire shutdown to ensure maximum productivity by own maintenance crew;
- reduction of the offcrop work by carrying out maintenance during the crushing season wherever possible.

Weekly progress reports are compiled by the planning office and are discussed at the progress meetings. These reports show the expected percentage of the work to be completed by each department each week in order to avoid delaying the start-up. The list shows the weekly complement of artisan staff required to complete the work on time.

At the completion of the offcrop work the offcrop book is updated by erasing cancelled work and by adding any additional work which arose during the offcrop. The actual times taken per works order are inserted against the foreman's estimated time and the book returned to the respective foreman to serve as a guide for planning the next offcrop maintenance programme.

This organization structure was obviously not ideal and it was impossible for the Factory Engineer to give sufficient attention to each of his subordinates (Figure 2).

The organization was restructured as shown in Figure 3 by dividing the duties between a Factory Engineer and a Powerstation Engineer.

The following is the designation and complement of the respective workshops:

M1 = Mechanical workshop - front end and mill yard maintenance.
Foreman - 1 supervisory artisan - 3 section fitters.

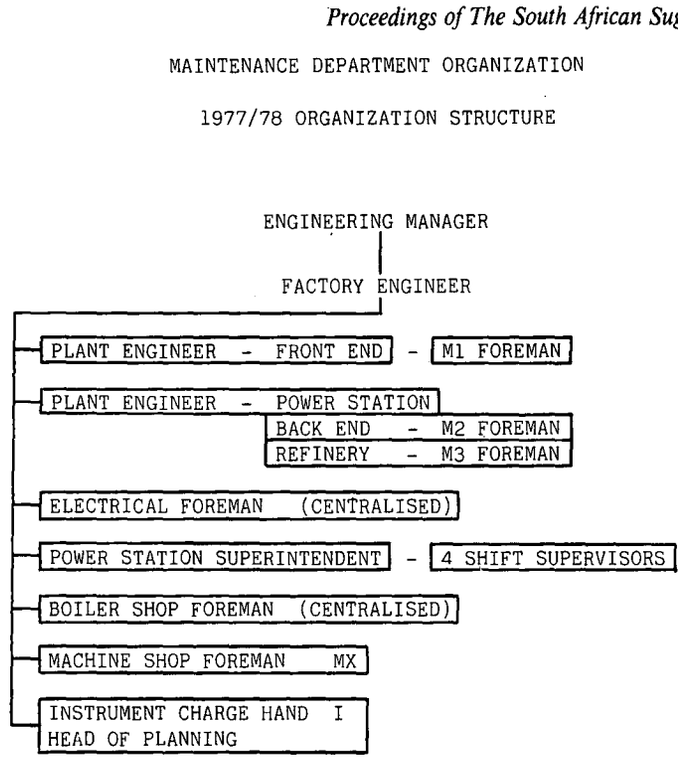

FIGURE 2 Organization structure 1977/78

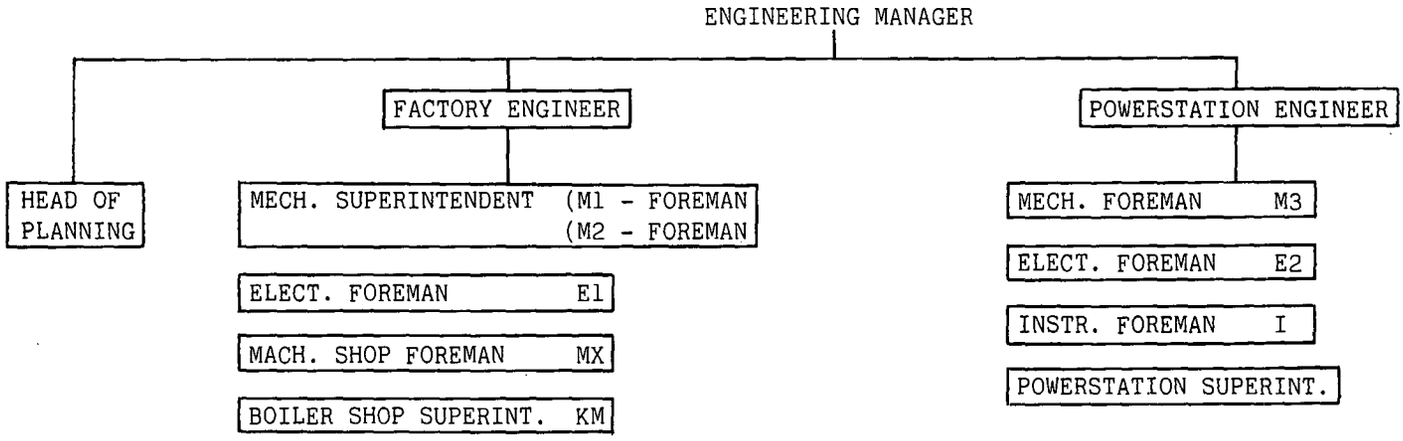

FIGURE 3 Organization structure 1978/79

M2 = Mechanical workshop - back end and refinery maintenance.
Foreman - 1 supervisory artisan - 3 section fitters.

M3 = Powerstation and auxiliary plant mechanical maintenance.
Foreman - 2 supervisory artisans - 3 section fitters.

MX = Centralised machine shop.
Foreman - 2 supervisory artisans - 3 turners - 2 fitters.

E1 = Front and back end electrical maintenance shop including mill yard.
Foreman - 1 supervisory artisan - 4 electricians.

E2 = Power generation and powerline electrical and air-conditioning maintenance shop.
Foreman - 1 supervisory artisan - 5 electricians.

I = Centralised instrument maintenance shop.
[Working] foreman - 1 technician - 1 mechanic.

The organization structure of the Planning Department is shown in Figure 4.

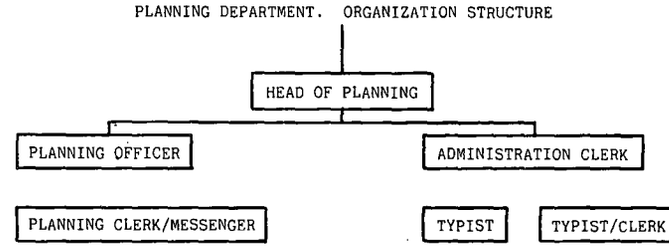

FIGURE 4 Organization structure of the Planning Department

The front end Plant Engineer resigned at the time of reorganizing the structure and has not been replaced.

The notable changes were:

- Each Engineer now had his own electrical workshop where artisans concentrated on a particular department so that they were able to become much more familiar with the maintenance requirements of the equipment in their section.

- The Powerstation Superintendent, by reporting to the Powerstation Engineer, was in a better position to communicate his problems and have them attended to by the powerstation maintenance crew than he was under the original organization structure.
- The planning department, now reporting to the Engineering Manager, was better able to improve its communication with and commanded more respect from the various workshop foremen who became much more co-operative in their dealings with the planning department.
- The creation of the positions of superintendents had two purposes. Firstly it gave more autonomy to the workshops for the solving of day-to-day problems and secondly the superintendents assist the Engineers by doing standby duty, otherwise each Engineer would be on standby every second week.
- Work by the centralised machine shop and boilermaking shop is requisitioned on works orders and this arrangement is functioning satisfactorily.

Definition of mechanical efficiency

At Malelane mechanical lost time has been defined as any stoppage caused by a mechanical or electrical failure which prevents the factory crushing at 100% of its rated capacity and as such all stops, even those of one minute duration are recorded.

Any slow crushing due to a mechanical problem ie changing a trashplate on one dewatering mill while continuing to crush at half throughput on the second dewatering mill is calculated and booked as mechanical lost time. Therefore the mechanical efficiency is a true reflection of the mill's performance (Figure 5).

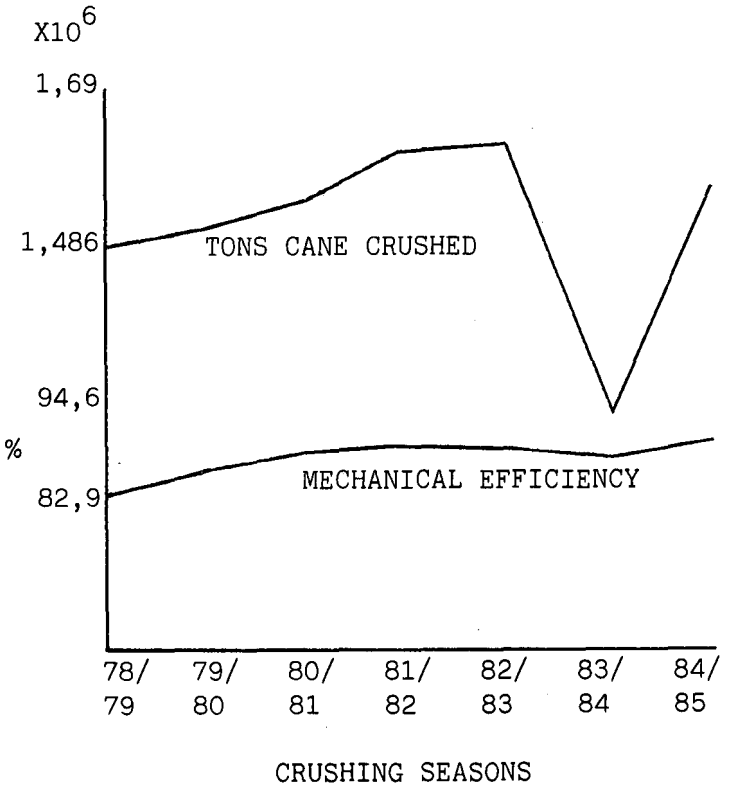

FIGURE 5 Mechanical efficiency and cane crushed 1978/79 to 1984/85

Training of maintenance staff

As previously mentioned a well-trained maintenance crew will improve the maintenance function and hence the reliability and availability of production units. Fortunately the Malelane mill is equipped with very good training facilities where a wide range of training can be given.

Artisan training needs were formulated and the necessary programme drawn up which included the following for white artisans:

Mechanical

- The correct method to fit ball and roller bearings.
- Instructions on how to dismantle and reassemble torque arm gearboxes.
- Proper fitting and care of Vee-belt drives.
- Use and maintenance of mechanical seals on centrifugal pumps.
- Belt splicing technique.
- Use and maintenance of pneumatics including fault finding.
- Servicing of hydraulic equipment.

Electrical

- Fundamentals of DC drives.
- Elementary and advanced electronics.

Artisan Supervisory training

- Supervisory management training for selected artisans, both elementary and advance courses.

Training for black maintenance workers

Similar training was given, but was initially concentrated on basic training in fitting, welding and electrical wiring.

The next step was to concentrate on specific task training in which the individual was taught to do repetitive jobs.

The training of black workers has progressed considerably over the years and several maintenance workers hold an NTC1 certificate and have successfully completed the modular courses 1 and 2 in fitting, turning and boilermaking offered at the Malelane mill.

In the past three years all white and black workers have taken the so-called 6M course developed by the National Productivity Institute. This course gives the worker a better appreciation of how a public company functions and the part their contribution plays in the company and for themselves.

The workshop organization has been further restructured by including the position of supervisory artisans. These positions are filled by artisans who have at least three years' practical experience at Malelane mill and who have successfully completed both the elementary and advanced courses in supervisory management.

Each of these persons is in charge of two to three maintenance or assistant maintenance workers and is held responsible for their on-the-job training as well as for ensuring that the highest possible productivity be achieved by his crew in performing their maintenance tasks.

The creation of these supervisory artisan positions was introduced to increase the productivity of, in the first instance, the qualified artisans by ensuring that they concentrate on the more sophisticated work while the routine work is carried out by the supervisory artisan and his crew of black maintenance workers. This approach has also been instrumental in improving plant maintenance.

Training of maintenance foremen, superintendents and engineers

All foremen, superintendents and engineers have received management training by outside organizations. Training included subjects such as time management, maintenance management and inventory management. Industrial relation seminars have been held inhouse. Safety courses by NOSA have been attended by all foremen and superintendents.

Motivation:

To motivate the maintenance crew two large notice boards were erected, one near the entrance to the mill and one at the stairs leading to the boiler operating floor. The weekly budgeted mechanical efficiency and the actual mechanical efficiency achieved with a short explanation of and reasons for the lost time are shown on the boards. The boards serve to inform the artisans of the standard of their maintenance and act as a motivator for all factory personnel.

Initially regular monthly meetings were held to which all artisans were invited. No agenda was used at these meetings but a short information session was held covering crushing progress, mechanical efficiency and information of a general nature which affected the company and its employees. The information sessions lasted about fifteen minutes after which the artisans were encouraged to ask questions or put their points of view on any matter concerning their work.

Often useful suggestions were made at these meetings and any grievances raised were attended to. All foremen, superintendents and process personnel attended these meetings.

The meetings have since been scheduled for every three months, but they remain strictly informal.

Maintenance costing system

The entire factory is divided up into clearly defined process sections with cost codes being allocated to each of the sections and sub codes defining specific items of equipment. For example:

- the cane intake and preparation section is costed under the code 21/000 while a specific item such as the shredder is given a cost reference number of 21/308;
- the extraction and clarification section is given the reference code 22/000 while the diffuser for instance is identified by the cost reference number 22/106. This number refers to the diffuser with its drive and lifting screws.

A maintenance budget is prepared by the responsible engineer of each section and submitted to management for approval. The budget consists of the routine maintenance costs plus any abnormal expenditure which is any expenditure that does not occur annually such as the cost of replacing diffuser chains which are replaced approximately every five years. The costing system is structured in such a way that the cost of maintaining an equipment unit can be fairly accurately defined.

Labour hours are budgeted for each engineering discipline for each cost code. Labour rate is arrived at by dividing the total workshop cost including depreciation by the actual man hours worked. The actual hours worked is reflected on job requests, breakdown reports, inspection and service schedules.

Cost reports

Cost reports are sent to every foreman and engineer every two weeks and a full report every month, showing the actual expenditure against the budget for the period and for the year to date. Regular monthly cost meetings are held with engineers and foremen at which the variances between budget and actual costs for both material and labour are discussed.

The material cost trend line as seen in Figure 6 shows that the maintenance material costs have been held below a straight 12% per annum escalation on the base year 1978. On the other hand the labour costs have risen sharply mainly due to the large increase in wages over the years.

Future changes

To date the planning department has had to keep all its records manually with the result that the plant history cards do not contain full details of spares, commodity code numbers etc.

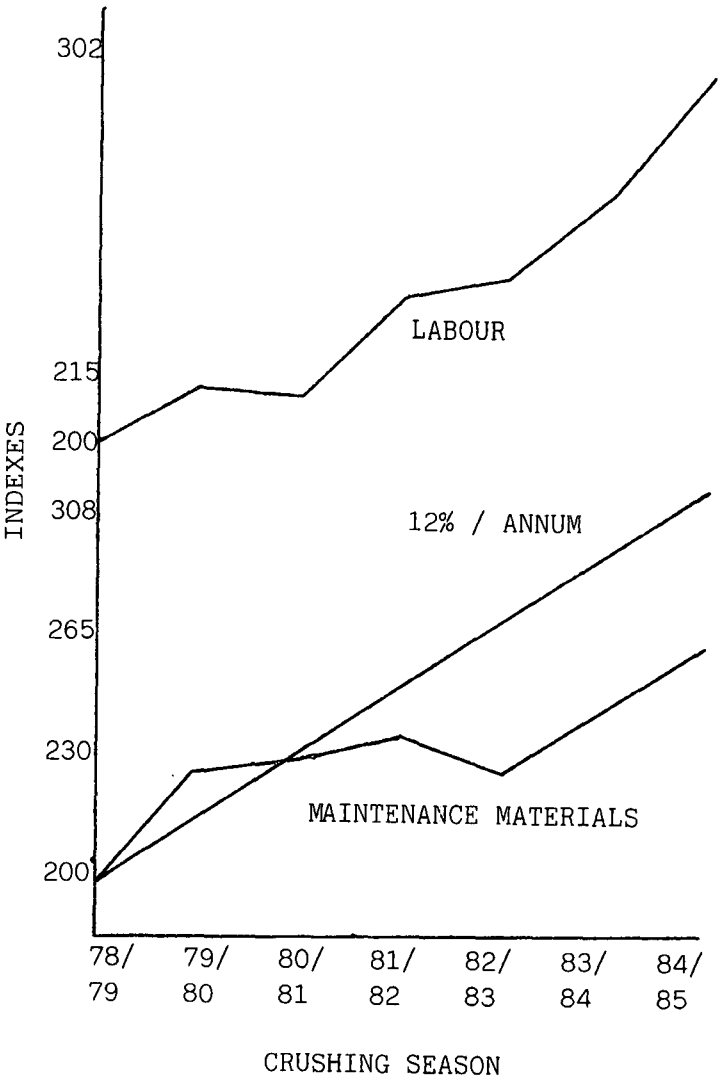

FIGURE 6 Maintenance material and labour costs 1978/79 to 1984/85

It has thus become laborious to extract information on the life of certain spares used in a particular machine.

This will change shortly when computer facilities will be installed, and it will be possible to trace any work done on a piece of equipment and to forecast more accurately the service frequencies required for maintaining the equipment. Together with this historical data the foreman will also be supplied with a VDU on which he will be able to call up and check the availability of spares to enable him to preplan his maintenance programme.

Conclusion

It is firmly believed that no matter how good a planned maintenance system may be, it will not succeed if the fact is ignored that on its own it is merely a document describing a plan of action which will remain dormant unless there is the co-operation and participation of a well motivated maintenance crew.

The mill at Malelane has achieved a great deal of success over the past six years but further improvement can still be achieved. Hopefully the improved method of gaining information on plant history faster through the use of the computer will provide the opportunity to achieve even better mechanical efficiency in the future.

Thanks are due to the management of Transvaalse Suikerkorporasie Beperk for permission to publish this information.