

A COMPUTER BASED MAINTENANCE MANAGEMENT SYSTEM WITH DECISION PROGRAMS

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ABSTRACT

The development of a computer based maintenance management system is presented for industries using optimization models. The system which is capable of using optimization data and programs to schedule for maintenance or replacement of machines has been designed such that it enables the maintenance department control all jobs associated with plant maintenance and breakdown. It predicts the time to failure of designated plants and caters for the replacement analysis of some capital equipment. The system provides all the functions necessary for the control of maintenance spares. The system also provides complete details of the operation to be performed and parts to be used in a given maintenance job. The implementation of the system has been successfully carried out in a case study.

Keywords: Maintenance, replacement, computerization, spares, inventory.

INTRODUCTION

In most enterprises in Nigeria there is always the complain about the frequency with which installed machines and equipment breakdown (Agunmwamba, 1994). This is one of the reasons why some of our industries are producing below their installed capacity, thereby causing scarcity of goods and services. The general complaints advanced by these industries is the unavailability of spare parts. The industries generally wait until a breakdown occurs before they run about looking for spare parts. Planned maintenance is hardly practiced in most of our industries. Planned maintenance system reduces breakdowns through the application of systematic procedures to maintenance functions. Any good planned maintenance system will include routine inspection, lubrication, cleaning, adjustment, servicing and replacement program. This should be backed up by a good and comprehensive recording system to highlight the causes of breakdown and the remedial actions taken. Usually a study and analysis of these records will show the trend of the maintenance department activities (see Offiong, 1996). Studying and analyzing the accumulated maintenance information in order to establish a maintenance/replacement schedule for a manufacturing concern has been a major problem confronting maintenance engineers. A lot of work has been done in this area see Offiong (1996 – 2001), Agunmwamba (1995), Karabakal et al (1994), Federgruen and So (1990) Oguejiofor (1990), Fabrycky et al (1987), Anukam (1987), Sule and Harmon (1997), Lake and Munlemann (1979) and Mitchell (1962).

It is against this background that there is the need to develop this simplified approach to the complexity of maintenance management by making use of the micro-computer which is becoming

very popular and cheap. Generally, the aim of this paper is to reduce the complex function of maintenance management into simple computer operations.

It should be noted that unlike the manufacturing sector to which maintenance planning belongs, some sectors like banking, accounting, library and so on in Nigeria have already gone far with computerization. This is due to the fact that these sectors (banking, accounting, etc.) already had standard manual system, and hence putting them in the computer was not difficult. Computerizing the maintenance function will not, however, be easy because the existing manual maintenance management systems are not well organized in most of our industries. Thus, the work of developing a computerized maintenance plan, for most of our industries, will not be merely computerizing an existing system, but rather it will involve generating an efficient system and then computerizing it.

METHODOLOGY

A computer program capable of meeting the individual requirement of any industrial organization was first written specifically for the control and support of any maintenance scheme. After this, in order to see the application of the software, a study of the existing system in a case study was conducted.

The existing manual system of maintenance in this case study was first of all improved upon and thereafter computerized using the developed software. Doing this involved a lot of data collection, method studies and time studies. For each machine or group of machines in the case study, studies were conducted so as to determine such parameters as optimal frequency of preventive maintenance, optimal replacement period, grouping of the machine for the purpose of group maintenance, optimal group maintenance interval, optimal group replacement interval, standard procedures and time for performing certain specific jobs, etc. The studies also noted the tools and spare parts required for the specific operations. All these were then fed into the computer. Also from the stock cards, a list of all items available in the store was compiled and their maximum and minimum stock level determined and fed into the computer. The main feature of the work is the presentation of the optimization program modules which gives the sub-programs necessary for the practical execution of the optimization models in Offiong (1996 - 2001) which were employed in the studies.

As a test of the effectiveness of the system, the computer was made to print in hard copy, some of the processed optimization results, specimen of the inventory sheet, asset register, work order, work specification, plant history sheet and condition monitoring sheet.

DECISION MODELS

There are four main decision models involved in this work.

(a) Inventory models

This model enables the Maintenance Engineer to determine the maximum and minimum level of stock for any item in the store. The model employed here is that of Offiong (1998) which was based on Mitchell (1962) classified spares as class A, class B and class C using A, B, C analysis. Class A are either adequate warning giving slow moving spares. These spares are usually expensive. They include gear box, shafts, machine housing, etc. Class B are

inadequate warning slow moving spares are usually describe as stand-by spares. These spares are also expensive. They include crankshaft, bearing, pump etc. Class C are described as fast moving spares. They are usually not expensive. They include items like electrodes, bolts, valves, etc. The model states that for:

- i. Class A items, their maximum and minimum stock level will be stated as zero.
- ii. Class B items, their maximum stock level N_{max} is obtained by using equation 1 to obtain $C(N)$ for $N = 0, 1, 2$ and then selecting the minimum $C(N)$.

$$C(N) = hp \left(N - \frac{L}{T} \left(\sum_{n=0}^{N-1} P(n) / \sum_{n=0}^N P(n) \right) \right) + \frac{R}{T} \left(P(N) / \left(\sum_{n=0}^N P(n) \right) \right) + \frac{S}{T} \left(1 - P(N) / \sum_{n=0}^N P(n) \right) \dots 1$$

The minimum stock level N_{min} here is given as:

$$N_{min} = N_{max} - 1 \dots 2$$

Where N is the maximum stock, L is the average lead-time, S is the average ordering cost, T is the average time between demands, R is the run-out cost, h is the ratio of annual holding cost to price and $P(n) = \exp\left(\frac{-L}{T}\right) \left(\frac{L}{T}\right)^n (n!)^{-1}$.

- iii. Class C items, the model gives the maximum level of stock S_{max} as:

$$S_{max} = \sqrt{\frac{2AO}{C}} + SAL \left(\sqrt{\frac{2AO}{C}} \right) \dots 3$$

and, the minimum level of stock S_{min} as:

$$S_{min} = AL + SAL \left(\sqrt{\frac{2AO}{C}} \right) \dots 4$$

Where A is the total annual requirement, O is the ordering cost per order, C is the carrying cost per unit, S is the stock-out acceptance factor and L is the lead time.

Decision Program 1 is written to perform this function see Offiong (1996).

(b) Capital Equipment Replacement Model

This model enables the Maintenance Engineer to carry out replacement analysis for a major asset to determine its optimal replacement period. The model employed here is that of Offiong (2001a) which was a modification of Lake and Muhlemman (1979) and is given as:

$$K(T) = \frac{A - b_s T^{n_s} e^{-rT} + \int_0^T (a_m + b_m t^{n_m}) e^{-rt} dt}{i - e^{-r(T+J)}} \dots 5$$

where $K(T)$ is the average sum of capital depreciation and maintenance cost, T is the optimal replacement interval, J is the time taken to install the machine, r is the discounting rate, a is the acquisition cost, b_s is the depreciation factor, n_s accounts for the degree of non-linearity or linearity of the salvage function, t is the continuous time from purchase, a_m is the maintenance cost of the machine at $t = 0$ [i.e. when the machine is brand new], b_m is the maintenance cost increment factor and n_m accounts for the degree of non-linearity or linearity of the maintenance cost function.

Decision here will involve using equation 4 to obtain $K(T)$ for $T = 1, 2, 3, \dots$ until the first minimum is found.

Optimization program 2 is written to perform this function see Offiong (1996).

(c) Low Cost Item Replacement Model

This model enables the Maintenance Engineer to determine the optimal group replacement interval for low cost items, the model employed here is that of Offiong (2000) which was based on the work of Fabrycky et al (1987) and is given as:

$$K = \frac{1}{n} \left(AC_s \sum_{n=1}^{i-1} f_i + AC_a \sum_{n=1}^{i-1} f_i + B \sum_{n=1}^{i-1} C_i + C_a f_0 + C_s \right) \quad \dots 6$$

where K is the cost of replacement per interval, C_s is the setup cost for only replacement, C_a is the additional cost of replacing an individual item after setup, n is the number of items in the group, f_i is the number of replacement made at the end of i th period, c_i is the inactivity cost at the end of i th period and $f_0 = n$. Optimization here involves using equation 5 to obtain K until the first minimum value is found which is lower than C_N the average cost per interval of individual replacement only. The decision is usually to group –replace only if the minimum value of k is smaller than C_N and to replace only on failure if otherwise. Decision program 3 is written to perform this function see Offiong (2000).

(d) Group Maintenance Model

This model enables the Maintenance Engineer to determine the major and minor maintenance frequencies for any group of machines. The model employed here is that of Offiong (2001b) which was a modification of Sule and Harmon (1979). For convenience, the formulation of the model maintenance scheduling is divided into two parts, namely minor and major maintenance schedule. During a major maintenance an individual machine is checked and reset while during a minor maintenance all machines are checked and reset simultaneously. The model gives the total annual cost as:

$$TC = \frac{1}{T} \left(\sum_{j=1}^M \sum_{i=1}^N B_{ij} S_{ij} + \sum_{i=1}^N k_i C_i - \sum_{i=1}^N C_i + \sum_{i=1}^N \lambda_i P_i + C \right) + \sum_{i=1}^N a_i + \frac{T^n}{n+1} \sum_{i=1}^N \frac{b_i [1 - \lambda_i]}{k_i^n} + \sum_{i=1}^N a_i \lambda_i \quad \dots 7$$

Where T_c is total [production and repair] cost of operation per unit; T is cycle time or major maintenance interval; M is number of breakdown types in a machine; N is number of machines in the group; B_{ij} is expected number of breakdown type j in machine i per cycle; S_{ij}

is cost of breakdown type j in machine i per cycle; (K_i-1) is number of minor maintenance in machine i ; C_i is cost of minor preventive maintenance on machine; λ_i is downtime factor of machine i ; P_i is inactivity cost of machine i per cycle; C is cost of major preventive maintenance; a_i is fixed cost of production for machine i ; b_i is wear factor of machine i ; n is degree of production cost polynomial; t is production time for previous repair:

The aim here is to determine the optimal value of T , the cycle time, and the frequencies of the minor maintenance k_i [$k_1, k_2, k_3 \dots k_n$] for each machine within T to minimize the total cost of production and repairs TC . Decision program 4 is written to perform this function see Offiong (1996).

SOFTWARE DEVELOPMENT

In Nigeria, the use of computer in maintenance management is practiced by only the multi-nationals Shell, Agip, Mobil etc. A survey has revealed that even in these multi-nationals, the computers are mainly limited to a few maintenance operations like inventory control and record keeping.

The formulation of the program follows an approach similar to the one in Well (1989).

The programs are written in Basic and are arranged in modules. These modules are written and tested separately before they are put together to form a complete program. However, it is ensured that inter-relationship between modules are decided upon before the modules are created, so that final integration of the parts into a complete whole is straight forward. The program is organized such that one module or submodule contains necessary instructions jumps to call another module or submodule to perform a specific task. This technique has the advantage of accessing any module of choice any time. The software is called Kan II Maintenance Management System.

STRUCTURE OF THE SOFTWARE

The coordinated maintenance program is divided into five main modules namely- inventory control, maintenance operation, asset record, optimization record and optimization programs.

- (a) **Inventory Control modules** – These modules are put together to help the Maintenance Engineer in controlling movements of spares from the maintenance store. The objective here is to ensure that stock out (below minimum stock level) does not occur and that surplus stock (above maximum level) are not carried. The inventory module is made up of seven submodules.
- i. Initialisation which makes provision for records in the inventory file to be changed using a password known only to the Maintenance Engineer.
 - ii. Creation which makes it possible to store in the data file for each spares, the description, quantity in stock, unit price and minimum/maximum stock level.
 - iii. Status which helps the store keeper to know the stock status of any item in the store. The stock status of any spare will normally include part number, quantity at hand, minimum/maximum stock level.
 - iv. Supply which caters for the supply of spares to the maintenance department by adding the quantity supplied to the previous quantity in stock and storing this information in the data file.

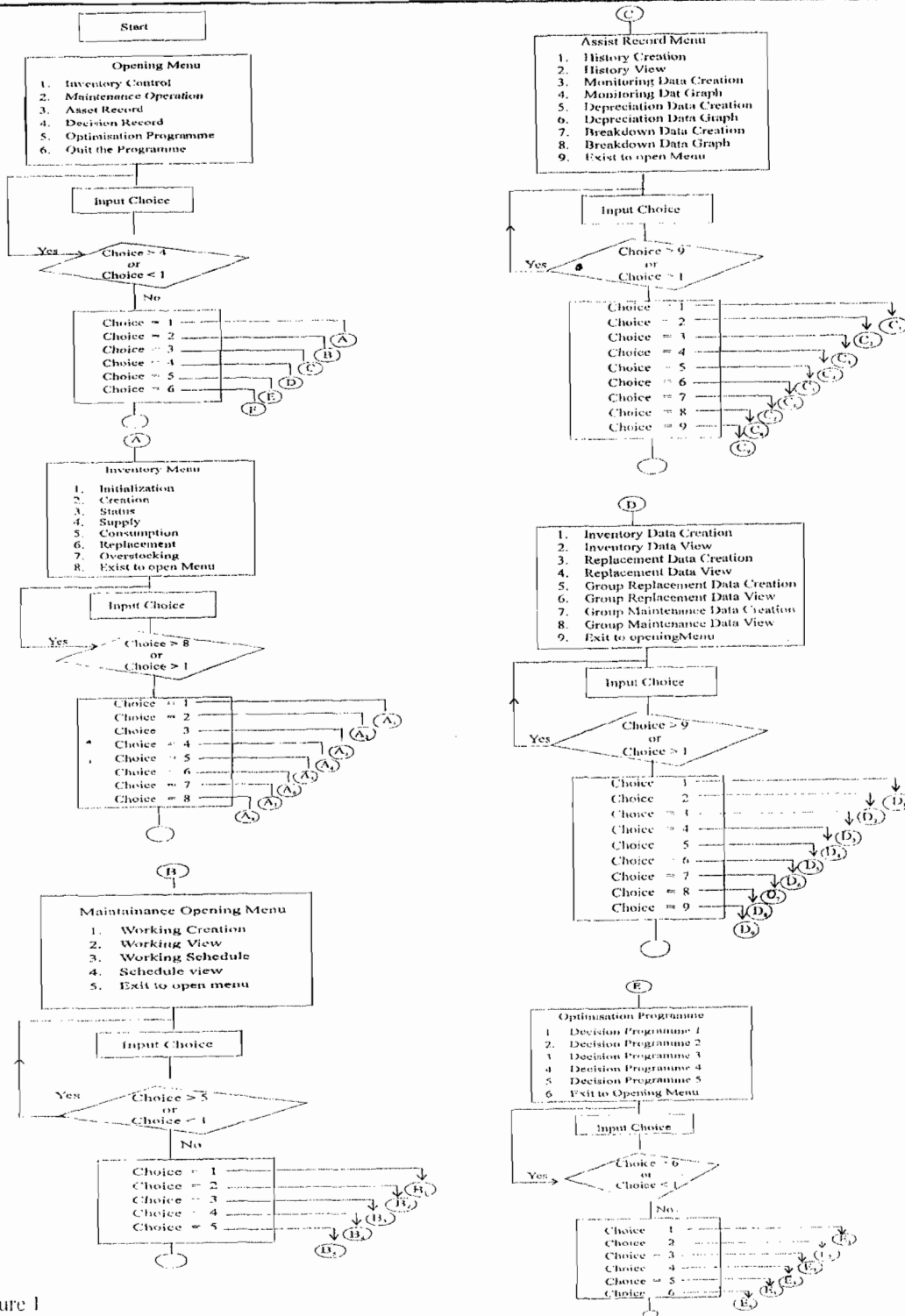


Figure 1

Note that A₁, A₂, A₃, A₄, A₅, A₆, A₇, A₈, A₉, B₁, B₂, B₃, B₄, B₅, C₁, C₂, C₃, C₄, C₅, C₆, C₇, C₈, C₉, D₁, D₂, D₃, D₄, D₅, D₆, D₇, D₈, D₉, E₁, E₂, E₃, E₄, E₅, and E₆ are subprograms which have been written and tested separated before they are incorporated into the software. See Offiong (1996) for the listing of these subprograms and the entire software.

- v. Consumption which caters for the insurance of spares for maintenance task by subtracting the quantity issued from the previous quantity in stock and storing this information in the data file.
 - vi. Replenishment which is put forward to help the Maintenance Engineer replenish his stock of spares. In this submodule the computer reads all items of the store in the file and for all items below their minimum stock level, it will print description, quantity in stock and minimum/maximum stock level.
 - vii. Overstocking which is put forward to help the Maintenance Engineer know the extent to which he has over stocked the store. In this submodule the computer reads all items of the store in the file and for all items above their maximum stock level, it will print description, quantity in stock and minimum/maximum stock level.
- i) **Maintenance Operation Module** - This module is put forward to help the Maintenance Supervisor determine:
- (i) For the various preventive maintenance tasks, the major and minor frequencies at which it should be done, the procedures, the spares, the tools and the materials required to do them.
 - (ii) For the different days (or weeks) of the year, what preventive maintenance task should be done and who should do them. The module which is basically a communication between the Maintenance Engineer and Maintenance Supervisor is divided into four submodules namely work creation, work view, schedule creation and schedule view.
- j) **Asset Record Module** - This module is put forward to enable the Maintenance Engineer analyze and determine the state of his plant assets. The module is divided into eight submodules.
- The first two sub modules; history creation and history view makes it possible for vital information about some plant assets to be stored and printed when necessary. The print out which is usually called the asset register will state the name of equipment, item number, priority rating, replacement date, preventive maintenance, inspections, warnings, breakdown with dates, causes and duration.
- The second two sub modules; monitoring data creation and monitoring data graphic view makes it possible for condition monitoring data to be stored and employed in giving a graphic screen display, which helps the Maintenance Engineer predict the time to failure.
- The third two sub modules; depreciation data creation and depreciation data graphic view makes it possible for depreciation analysis data to be stored and employed in giving a graphic screen display, which helps the Maintenance Engineer predict the time to a major overhauling and avoid possible serious consequences of a major breakdown.
- The last two submodules; Breakdown data creation and Breakdown data, graphic view makes it possible for breakdown/preventive maintenance data to be stored and employed in giving a graphic screen display, which will help the Maintenance Engineer carry out breakdown/preventive maintenance analysis which is aimed at ensuring that preventive maintenance is carried out just before a breakdown.
- k) **Optimization Record Module** - This module is put forward to store data that will help the Maintenance Engineer in taking optimal decisions using the above mentioned optimization models. This module is divided into eight submodules. The first two submodules; Inventory data creation and Inventory data view make it possible for inventory data to be stored and employed

FERDINAND OIL MILL PLC, URUALLA	
MATERIAL REQUISITION FORM	
ITEM NO. QUANTITY REQUIRED:	DESCRIPTION DATE:
ENGINEER SIGNATURE	ISSUED BY
RECEIVED BY	
SUPPLIED BY	RECEIVED BY
STORE MANAGER'S SIGNATURE	

Figure 2. A material requisition form designed for the execution of the Kanil maintenance management system.

FERDINAND OIL MILL PLC, URUALLA	
MATERIAL SUPPLY FORM	
ITEM NO. QUANTITY REQUIRED:	DESCRIPTION DATE:
ENGINEER SIGNATURE	ISSUED BY
RECEIVED BY	
SUPPLIED BY	RECEIVED BY
STORE MANAGER'S SIGNATURE	

Figure 3. A material supply form designed for the execution of the Kanil maintenance management system.

FERDINAND OIL MILL PLC, URUALLA	
BREAKDOWN HISTORY FORM	
ITEM NO. BREAKDOWN DESCRIPTION	DESCRIPTION DATE:
BREAKDOWN CAUSE	
REPAIR CARRIED OUT REPAIRSMAN	

Figure 4. A breakdown history form designed for the execution of the Kanil maintenance management system.

FERDINAND OIL MILL PLC, URUALLA						
MONITORING DATA FORM						
Item No	Description	Quantity				
		Week1	Week2	Week3	Week4	Week5
CM01	Kanil filter E0D4 - 1					
CM02	Fatty Acid Separator 814/23 - 1					
CM11	Polishing Filter 816A1 - 1					
CM15	Polishing Filter 816A2 - 1					
CM19	Oil Separator 0-6 - 1					
CM21	Condenser-Condenser 814/23					

Figure 5. A monitoring data form designed for the execution of the Kanil Maintenance Management System.

FERDINAND OIL MILL PLC, URUALLA						
MONITORING DATA FORM						
Item No	DESCRIPTION	Percentage Breakdown Time				
		Year1	Year2	Year3	Year4	Year5
DE001	Expeller 1					
DE002	Expeller 2					
DE003	Expeller 3					
DE004	Expeller 4					
DE005	Expeller 5					
DE006	Expeller 6					

Figure 6. A depreciation data form designed for the execution of the Kanil maintenance management system.

FERDINAND OIL MILL PLC, URUALLA						
BREAKDOWN DATA FORM						
Item No	DESCRIPTION	Average Breakdown Interval in months				
		Year1	Year2	Year3	Year4	Year5
DE001	Expeller 1					
DE002	Expeller 2					
DE003	Expeller 3					
DE004	Expeller 4					
DE005	Expeller 5					
DE006	Expeller 6					

Figure 7. A Breakdown data form designed for the execution of the Kanil Maintenance management system.

FERDINAND OIL MILL, PLC, URUALLA						
GROUP MAINTENANCE OPTIMIZATION RECORD FORM						
Item No	Description	Group				
		Major Maintenance Cost	Monitoring Maintenance Cost	Inactivity Cost:		
		Number of breakdown				
TYPE 1	TYPE 2	TYPE 3	TYPE 1	TYPE 2	TYPE 3	Cost of breakdown
Production Cost Data						
Time in	1	2	3	4	5	6 7 8 9 10
Cost						

Figure 8. A group maintenance optimization record form assigned for the execution of the Kanil maintenance management system.

in deterring the maximum and minimum level of stock for any item in the store. For a particular item, these data will include – name of item, classification, ordering cost, run-out cost, average time between demand, price per item, average lead time and ratio of annual holding cost to price.

The second two submodules; Replacement data creation and replacement data view make it possible for replacement data to be stored and employed in determining the optimal replacement period for capital asset. For a particular asset, these data will include; name of equipment, salvage value, invest rate, inflation rate and maintenance cost at year 0, 1, 2, 3, ..., 10 ;

The third two submodules; Group replacement data creation and group replacement data view make it possible for group replacement data to be stored and employed in determining the optimal group replacement interval for a group of low cost items. For a particular item, these data will include; name of item, set up cost, additional cost, cost per item and survivors at time 0, 1, 2, 3, ..., 10.

The last two submodules; Group maintenance data creation and Group maintenance data and print data that will be used in determining optimal major and minor maintenance frequencies for a group of machines.

For a particular machine these data will include; name of equipment name of group, major maintenance cost, minor maintenance cost, downtime factor, inactivity cost per unit time, number of breakdown types 1, 2, and 3, cost of breakdown type 1, 2, and 3 and production cost at time 1, 2, 3, ... 10.

- (e) **Decision program module.** This module is put forward to enable the maintenance Engineer take optimal decisions using the models given by equations 1 – 7. The module is divided into four submodules.
- (i) Decision program 1 which makes it possible to calculate the maximum and minimum level of stock for any item of the store using equations 1 – 4
 - (ii) Decision program 2 which makes it possible to determine the optimal replacement period for a capital equipment using equations 5.
 - (iii) Decision program 3 which makes it possible to determine the optimal group replacement interval for low cost items using equation 6
 - (iv) Decision program 4 which makes it possible to determine the major and minor maintenance frequencies for any group of machines using equations 7.

The computer flow chart for the program developed for the coordinated maintenance program is shown in figure 1.

THE CASE STUDY

The case study here is an Oil Mill located in Nigeria. The company is a well-known producer of vegetable oil. It has two main sections – the crushing section and the refinery section. The company employs about 100 persons out of which about 20 are maintenance staff, and has a store which contains a stock of well over 10 million Naira any time. Some of the machines that require maintenance in the company include – diesel engines, expellers, lathes, electric motors, kernel fitters, deodorizers and other vessels.

FERDINAND OIL MILL PLC. URUALLA INVENTORY SHEET FOR ITEMS BELOW MINIMUM LEVEL	
Gear Oil	Quantity in Stock: 2 Minimum stock level: 3
Meter bearing	Quantity in Stock: 2 Minimum stock level: 4
Bear 214	Quantity in Stock: 0 Minimum stock level: 1
Metal case	Quantity in Stock: 2 Minimum stock level: 4
Bearing 42315	Quantity in Stock: 1 Minimum stock level: 2
Clutch gasket	Quantity in Stock: 3 Minimum stock level: 5
Main bearing 6312	Quantity in Stock: 0 Minimum stock level: 1
Gear bearing 2220	Quantity in Stock: 0 Minimum stock level: 1
Pillow bearing 213	Quantity in Stock: 0 Minimum stock level: 1
Bearing 6218 1218	Quantity in Stock: 0 Minimum stock level: 1

Figure 9: An inventory sheet produced by the Kanif maintenance management system.

FERDINAND OIL MILL PLC. URUALLA WORK ORDER FOR 20 NOVEMBER 1995	
(1) Item No.: DE001 - 6 Personnel: E - group	Description: Expeller Location: Crushing Section 0 - 1
(2) Item No.: DE037 - 40 Personnel: A Washers	Description: Kernel Filter Location: Crushing Section 1 - 1
(3) Item No.: DE037 - 40 personnel: D - group	Description: Expeller Diesel Engine Location: Crushing Section 0 - 1

Figure 10: A work order produced by the Kanif maintenance management system

FERDINAND OIL MILL PLC. URUALLA WORK SPECIFICATION	
Item No.: DE822	Description: Dendronizer \$2
Major maintenance frequency: 0	Minor maintenance frequency: 4 months
Time required: 8 hours	spares Cost: 20.00
Labour required: 1 instrument: technical, 1 electrical technician and 1 labours	Labour cost: 180.00
Spares required: valves, cap screw, washer and spring.	
Tools required: Instrument box and hot caustic soda solution	
Safety Measures: Wear protective clothing, keep the whole area out of bounds	
Procedures: Service the agitator and clean using hot caustic soda solution. Before the caustic soda cleaning wash the vessel thoroughly with hot water to remove as much as possible any oil left in the vessel. Drain the fatty acid stream.	

Figure 11: A work specification produced by the Kanif maintenance management system

FERDINAND OIL MILL PLC. URUALLA ASSET REGISTER	
ITEM NO. DE001	DESCRIPTION: EXPPELLER 1
REPLACEMENT DATE: JUNE 1998	PRIORITY RATING: PREVENTIVE
MAINTENANCE PLAN (M)	
INSPECTIONS: LUBRICATE THE GEARS EVERY OTHER DAY. CHECK IF KERNEL IS BURNING EVERY ONE HOUR AND LOOSEN THE KNOB IF SO. GREASE THE BEARING EVERY TWO WEEKS	
WARNING: THE MACHINE SHOULD BE STOPPED FOR 12 HOURS AFTER EVERY WEEK.	
BREAKDOWN INFORMATION	
Date	Duration (hours)
11/00/95	Main bearing on the right damaged 2.5
20/7/95	Rolling 214 damaged 3.5
14/2/93	Metal Bearing damaged 12
10/5/95	Main bearing on the left damaged 2.5

Figure 11: An Asset register produced by the Kanif maintenance management system

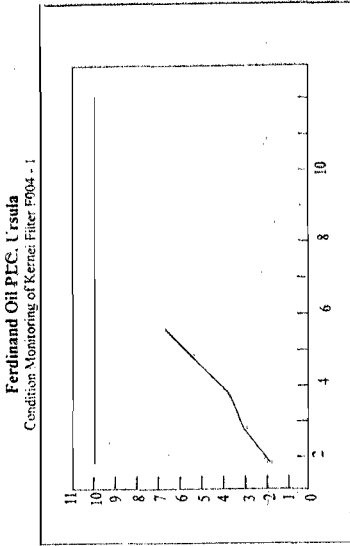


Figure 12: A monitoring sheet produced by the Kanif maintenance management system

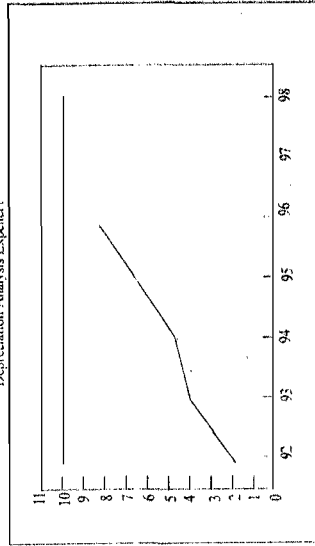


Figure 13: A depreciation sheet produced by the Kanif maintenance management system

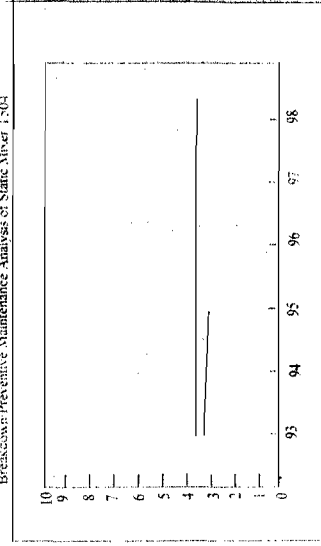


Figure 14: A breakdown sheet produced by the Kanif maintenance management system

OPERATIONAL DOCUMENTS

Some documents are essential if control is to be exercised over maintenance using the system. These documents are of two types-inputs documents and output documents. Input documents are documents which supply information that are being fed into the computer for the purpose of updating the records of the system. They include material requisition form, material supply form, breakdown history form, Monitoring Data form, Depreciation Data form, Breakdown/Data form and Group Maintenance Optimization Record form.

Examples of these documents designed for the execution of the computerized system of maintenance in the case study is shown in figures 2 – 8.

Output documents are documents given out by the computer for the purpose of executing a job, condition monitoring, asset analysis or inventory evaluation. These documents include – inventory sheet, work order sheet, work specification sheet, asset register sheet, condition monitoring analysis sheet, depreciation analysis sheet and breakdown (preventive maintenance) analysis sheet. Examples of these documents designed for execution of the computerized system of maintenance in the case study are shown in figures 9 – 15.

CONCLUSION

This work has shown how the micro-computer can be used with decision models to transform the effectiveness of a maintenance program. A computer software with decision programs which is capable of being tailored to suit the individual requirement of any industrial organization has been written specifically for the control and support of maintenance schemes. The application of this software to the maintenance control of a case study was successfully carried out. Hence, a complete package for any Maintenance Engineering seeking to computerized and optimized his maintenance program of his organization has been established.

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