A computerised maintenance management system as a teaching aid

Thabiso Mmelesi & Kevin N. Nwaigwe

University of Botswana
Gaborone, Botswana

ABSTRACT: A case study on implementing a computerised maintenance management system (CMMS) as a teaching aid was undertaken in the Department of Mechanical Engineering at the University of Botswana (ME-UB) in Gaborone, Botswana. The CWorks software was studied and a list was composed of assets in the various mechanical engineering laboratories. The assets were categorised by asset number and the data were input into CWorks. A workshop was held to train the main users (technicians) in the operation of the system for asset management and, in particular, preventive maintenance. Implementation of the system within the Department is described in this article. Results of a survey of students indicate a preference for a hybrid solution that involved a visit to industry combined with the use of CMMS, as a teaching aid, as the best approach to understanding computerised asset management. This study enhances understanding of asset management and the implementation of a CMMS.

INTRODUCTION

Maintenance can be defined as preventive, corrective and predictive actions carried out to ensure that machines and equipment are in good working condition [1]. A computerised maintenance management system (CMMS) is an operational and management tool for asset preservation, to ensure that production systems operate as required, and to minimise downtime. Computerised maintenance management systems have myriad options and many advantages over the manual maintenance of systems. The advantages of CMMS include:

- optimisation of device performance by reducing downtime;
- avoidance of breakdown maintenance by the detection of imminent problems;
- efficient use of personal resources by better planned maintenance activities;
- better inventory management;
- pre-emptive purchase of spare parts.

The introduction of computerised maintenance management system (CMMS) has played a pivotal role to maintenance. Having a maintenance system and process under control will help to achieve intelligent and informed decisions, thereby achieving optimised maintenance. Improved maintenance means less downtime, better quality at lower unit cost and higher production [1][2]. A maintenance system can be manual or computerised [3]. Regardless, it should support:

- planning - when, how much and the resources needed;
- doing - preventive and corrective maintenance, modifications;
- studying - cost for maintenance and production stops, required maintenance;
- learning - improvement by repeating the cycle the work will improve.

Preventive maintenance is time-driven and can be separated into time-directed maintenance (overhaul or item replacement at a fixed interval) and condition-based maintenance (predictive maintenance) [3][4].

Corrective maintenance is an activity for restoring equipment when an unscheduled failure occurs. The related costs for corrective maintenance are typically high, because repairs are carried out in a critical situation and there is lost production. Mobley defined corrective maintenance as the action taken after a failure has occurred [3].

Any equipment can suffer a malfunction that will affect or stop its operation and systems that depend on it. Hence, it is necessary to have maintenance plans and procedures to maximise equipment performance, ensuring their smooth and efficient operation to prevent malfunctions and the minimisation of failures and stoppages in operation [5].

Maintenance management was established to keep systems operating efficiently to achieve the maintenance objectives:

- extension of equipment life;
- ensuring safety;
- responding to emergencies;
- maintaining equipment in optimal condition.

Maintenance management has the aim of increasing the productivity of maintenance by determining the:

- amount of work required;
- number of technicians required;
- schedule;
- material, equipment to be assigned.

This is especially crucial for shutdown maintenance [4]. Computerised maintenance management systems include modules for:

- technical/historical data on equipment;
- work order planning;
- personnel management;
- inventory control;
- reporting facilities.

Computerised maintenance management systems are user-friendly, with the use of graphical user interfaces (GUIs) [6][7].

According to Wireman [8], the following stages are necessary to implement a CMMS:

- assembling a project implementation team;
- core team familiarisation;
- document workflow processes;
- document standard operating procedures; and
- implementation of the CMMS solution [8].

The key aim of this work was to implement a computerised maintenance management system for the University of Botswana mechanical engineering laboratories.

The implementation of a CMMS was necessary for the proper management of the University's mechanical engineering laboratories and, in particular, maximisation of the efficacy of the technical support. The CMMS will provide a central storage location for most of the data and information about assets. This implementation of CMMS will ensure there are properly planned maintenance schedules, with appropriate preventive maintenance.

The CMMS can be deployed university-wide, with the mechanical engineering laboratories as a pilot. The benefits will include reduction of equipment breakdown and, ultimately, the cost of maintenance. Another benefit is that it will become a training package, which can attract funds to the University. This can result by conducting short courses on how to implement CMMS in firms within Botswana.

CMMS FUNCTIONS

Equipment in the University laboratories was documented using CWorks CMMS software asset numbers. Equipment without an asset number was assigned dummy numbers. There were 55 assets in the Mechanical Research Laboratory, 73 assets in the Plant Laboratory, 45 assets in the Project Workshop, 66 assets in the Thermodynamics and Refrigeration Laboratory, 52 assets in the Fluids and Process Laboratory, and 71 assets in the Materials Testing Laboratory.

Information was also input on the technicians who are the main users of the system. A CMMS workshop was conducted for the technicians on appreciation of the computerised maintenance management system. The Cworks CMMS software has the following applications, as shown in Figure 1. In Figure 2 is a typical list of assets.

The list of assets in the mechanical engineering laboratories was categorised by laboratory, e.g. the Thermodynamics and Refrigeration Laboratory, Fluids and Process Laboratory, Materials Testing Laboratory, Project Workshop, Plant Laboratory, and the Mechanical Research Laboratory.

Each had the following abbreviation:

- Thermodynamics and Refrigeration Laboratory (TRL);
- Fluids and Process Laboratory (FPL);
- Materials Testing Laboratory (MTL);

- Project Workshop (PW);
- Plant Laboratory (PL);
- Mechanical Research Laboratory (MRL).

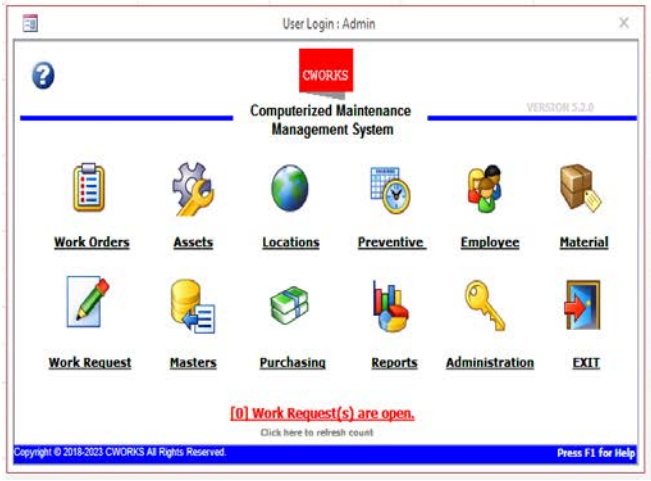

Figure 1: Main menu - CWorks.

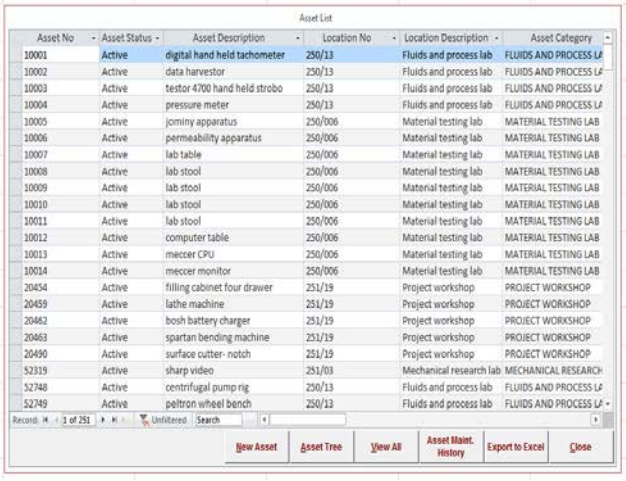

Figure 2: Asset list from the CWorks asset module.

Maintenance of assets is planned within the preventive maintenance module (PM); see Figure 3.

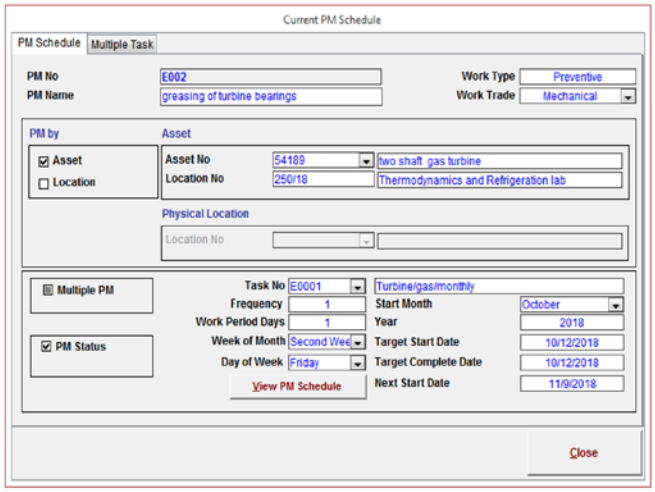

Figure 3: Example PM schedule.

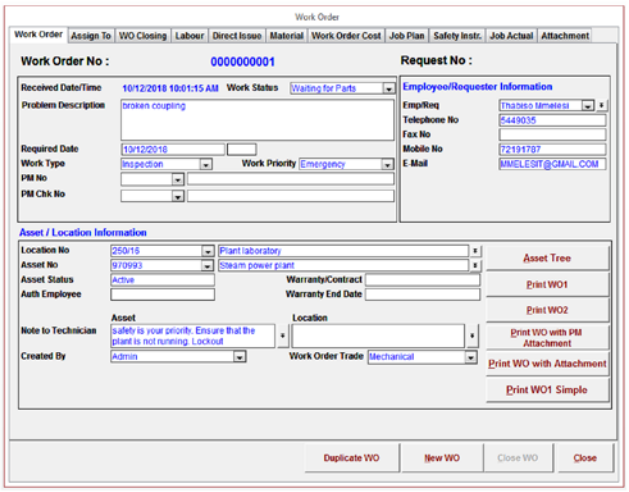

Figure 4: Typical order form.

The PM numbers differentiate the tasks and their descriptions. Time scheduling of tasks includes frequency and date of completion. The PM tasks can be assigned by worker type and kind of work. Typical tasks carried out in a mechanical engineering laboratory steam plant are:

- Boiler: inspection of the boiler is carried out every Monday of the week to check for any rusts and leaks from the drainage valves.
- Turbine and dynamometer: the turbine bearings should be greased with a lithium-based grease. The greasing interval is carried out every 3,000 hours of operation. Replacement of the flexible coupling connecting the turbine to the dynamometer is inspected periodically to ensure no damage.
- Cooling tower: inspection of the water recirculation system to check for scales and corrosion of metal parts.

The work order screen generates a new work order. A supervisor assigns tasks to staff. Tasks can be by work type; for instance, it can be used to perform day-to-day inspection of a steam plant (Figure 4).

The report module provides a wide range of reports. Reports produced by CWorks are for management information of the maintenance department. Displayed in Figure 5 is a typical report on assets and work requests generated from CWorks.

Shown in Figure 6 is a list of location by assets. Assets location within the laboratory were categorised within the location module. Figure 7 shows information on all employees working within the laboratory. Access rights are granted and limited by the level and scope of responsibility of each employee. Work requests on an asset are carried out by the work request module (Figure 8), which includes problem description, work type and work trade.

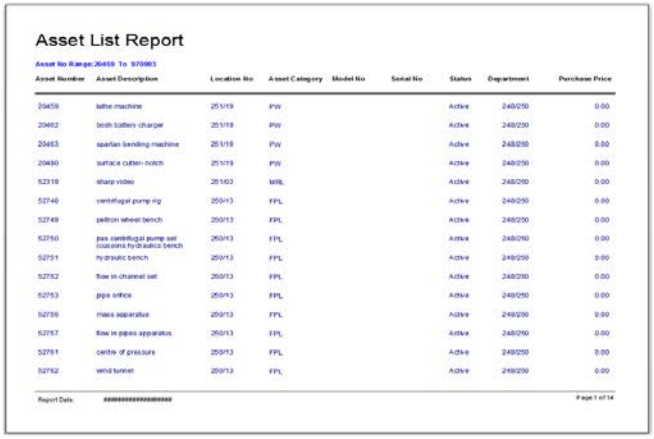

Figure 5: Asset list report.

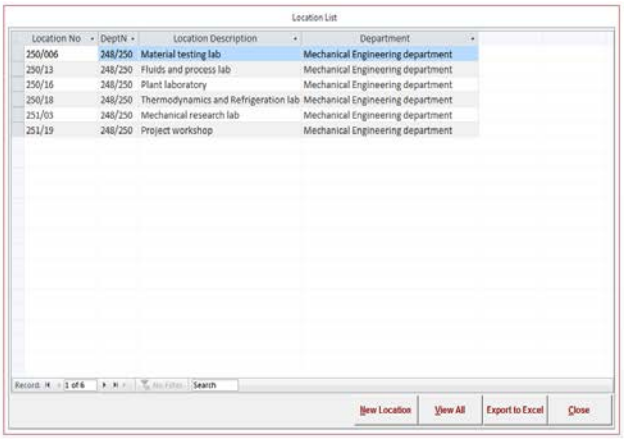

Figure 6: Location list.

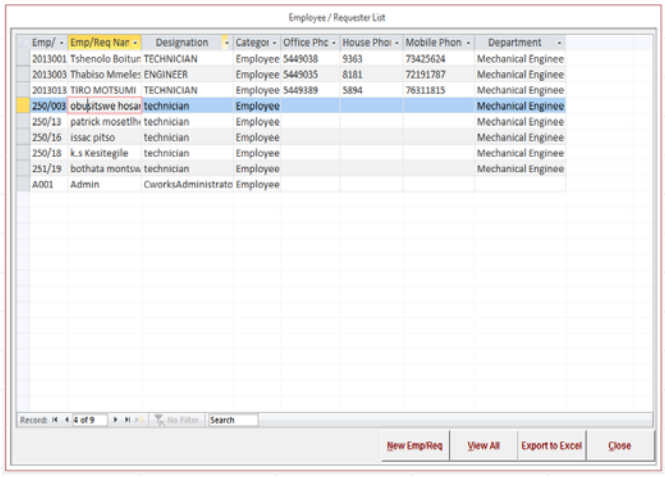

Figure 7: Typical employee list.

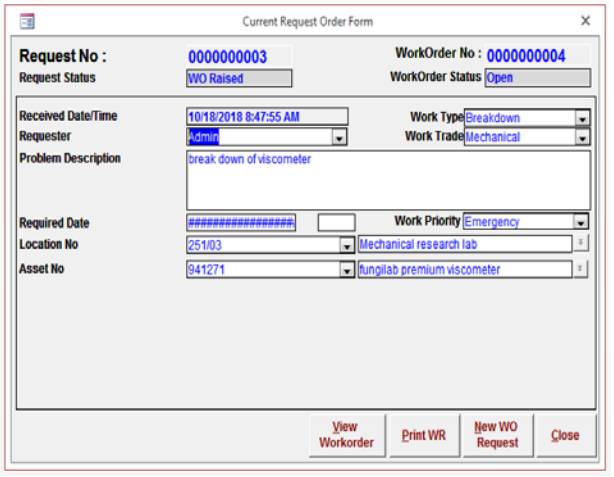

Figure 8: Typical request order form.

Asset Management Training

Technicians working in the mechanical engineering laboratories were trained on asset management with CWorks and encouraged to continue to use the system for asset management. A number of volunteer students undertaking Plant Engineering, a course that includes industrial visits to study asset management through a computerised maintenance management system, were also trained in CWorks for asset management.

IMPROVEMENT OF TEACHING THROUGH CMMS

A questionnaire was administered to volunteer students, who had previously studied the Plant Engineering course. A total of 20 students took part in the survey.

All 20 respondents agreed that CMMS was most important to their better understanding of asset management (Figure 9). This reflected the effect of just embarking on a day trip to industry to be introduced to computerised asset management. In response to their preference to industrial visits using CMMS for the appreciation of computerised asset management, 35% of the respondents preferred industrial visits (Figure 10).

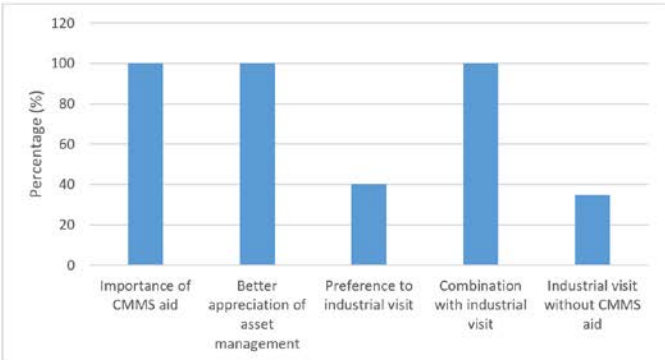

Figure 9: Students' response - effectiveness.

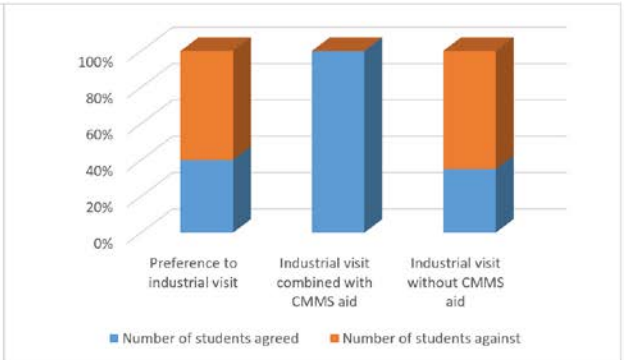

Figure 10: Comparative responses to selected attributes.

There was a feeling that the tool in industry represented an actual scenario the students will encounter upon graduation. However, 65% expressed the opinion that a day visit and a seminar was not enough to understand the concept and a day trip overwhelms the students, but only 40% preferred studying the concept using the tool without visiting the industry. This group believed that more time and attention should be devoted to the concept compared to just an industrial visit. This is 5% more than those who wanted just an industrial visit. All the respondents agreed that a combination of CMMS with an industrial visit is the best scenario. Using this hybrid, enough time is given to understanding the concept and to appreciating the industrial application.

CONCLUSIONS

The computerised maintenance management system CWorks has been implemented as a teaching aid in the mechanical engineering laboratories at the University of Botswana. Assets were identified, grouped and assigned asset numbers in CWorks. Assets included were in six mechanical engineering laboratories.

Using dummy information, the system was tested by producing maintenance schedules for equipment. The results were positive. Staff in the laboratory were trained on the use of the software for asset management and the responses of surveyed students showed the tool as an effective approach towards improving the teaching of computerised asset management.

REFERENCES

1. Alsyouf, I., The role of maintenance in improving companies' productivity and profitability. *Inter. J. of Produc. Economics*, 105, **1**, 70-79 (2007).
2. Campbell, J., *Maintenance Excellence, Optimizing Equipment Life-Cycle Decisions.* New York: Dekker, Cop., (2001).
3. Mobley, K.R., *An Introduction to Predictive Maintenance*. (2nd Edn), Amsterdam: Butterworth Heinemann (2002).
4. Gento, A.M., Decision rules for a maintenance database. *J. of Quality in Mainten. Engng.*, 10, **3**, 210-220 (2004).
5. O'Donoghue, C.D. and Prendergast, J.G., Implementation and benefits of introducing a computerized maintenance management system into a textile manufacturing company. *J. of Materials Processing Technol.*, 153, 226-232 (2004).
6. Pintelon, L., Preez, N. and Puyvelde, F., Information technology: opportunities for maintenance management. *J. of Quality in Mainten. Engng.*, 5, **1**, 9-24 (1999).
7. Artiba, A., Maintenance strategies and reliability optimization. *J. of Quality in Mainten. Engng.*, 11, **2**, 105-106 (2005).
8. Wireman, T., *Computerized Maintenance Management Systems.* (2nd Edn), New York: Industrial Press Inc. (1994).