Computerized Maintenance Management Systems (CMMS)

An Impartial View of CMMS Functions, Selection and Implementation

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Introduction

Computerized Maintenance Management Systems are increasingly being used to manage and control plant and equipment maintenance in modern manufacturing and service industries. This view of the selection and implementation process can assist those who are considering CMMS for the first time, to decide their requirements.

A number of years ago, the principles of CMMS were applied to hospital equipment maintenance, where critical breakdowns could lead to the development of life threatening situations. In recent years, private companies have come to recognize the value of these systems as a maintenance performance and improvement tool. The advent of the PC during the last few years has further boosted their popularity. As more and more maintenance personnel become computer literate they are regarded as an increasingly attractive option. Companies are also investing in CMMS's because they are generally designed to support the document control requirements of ISO 9002 and are a key part of the TPM philosophy.

Manual Systems

Computerized systems are now being installed in preference to the manual (paper based) preventive maintenance systems that have been around for many years. Commonly, these paper systems are little more than a record of scheduled maintenance. These have had limited success because of:

- the problems associated with training people to be disciplined enough to *maintain the maintenance system,* that is, to input the data to the system
- the effort required, by supervisors and managers, in the *organization* and *documentation* of the system
- trade group's reluctance to become involved in paper work
- the effort associated with the *acquisition* and *compilation* of meaningful data and statistics from the system.

In a typical paper system, each piece of equipment or asset will have a history card or file. This file will contain the asset's detailed description, along with information on maintenance procedures to be used, periodicities, trades required, last maintenance dates, and perhaps some out of date information about a breakdown, which occurred years ago! To determine what maintenance is due requires someone to look through every card, check each of the last maintenance dates against the periodicities and select those, which are due. Next, the appropriate maintenance *procedures* must be selected

from the file before work instructions are raised and issued to the relevant trade's persons. Upon completion of the work, the relevant asset's file must be selected, details updated and the file replaced in its slot. Whether one or several persons complete these tasks, many man-hours are involved and to properly support any reasonable sized system of this type can become virtually a full time occupation.

What does a CMMS do?

Some of the standard functions available from a CMMS are discussed later in this document and those who have had no previous exposure to CMMS will find this useful. However, in essence, a CMMS may be used to:

- control the company's list of maintainable assets through an asset register
- control accounting of assets, purchase price, depreciation rates, etc.
- schedule planned preventive maintenance routines
- control preventive maintenance procedures and documentation
- control the issue and documentation of planned and unplanned maintenance work.
- organize the maintenance personnel database
- schedule calibration for gauges and instruments
- control portable appliance testing
- assist in maintenance project management
- provide maintenance budgeting and costing statistics
- control maintenance inventory (store's management, requisition and purchasing)
- process condition monitoring inputs
- Provide analysis tools for maintenance performance.

The above listing illustrates most of the functions, which may be available in a CMMS. It is extremely important however, that prospective purchasers ask themselves a few questions before making any decisions. Many companies spend thousands of pounds on complex, integrated systems for which they have little use. It is only after they are installed that it becomes apparent that perhaps only 5 to 10% of the available functions will be used. You must be clear on the following:

- Do you have the resources and the commitment to implement the system? Remember that in a small sized company a significant amount of time will be required to collect and input data. Someone will be required to create a library of maintenance procedures where this does not already exist.
- Are you willing to provide support and administer the system on an on-going basis? The extent of this support will clearly be dependent on the size of your system.
- Do you require the system to control your stores and or purchasing? Are you willing to commit the people power to input the data for this?
- Do you need it for accounting purposes or just maintenance control?
- Do you really need a multi-user system, and if so, how many people are likely to use it? Remember that this should be based on who *is* likely to use it, *not* who you would *like* to use it.
- On multi-user systems, are you willing to commit your personnel to the training, which is likely to be required?

In conclusion, much thought and discussion must take place before any decision can be made on your requirements.

What returns can be expected?

The transition to CMMS will require some investment. The return on this investment will be dependent on the suitability of the selected software package, the effectiveness of its implementation and the commitment of all personnel to the new system. Most vendors sell their packages by claiming:

- increased plant availability - by reducing down time
- lower operating costs - by reducing overtime, spares inventory and
- prolonged asset life - by more effective maintenance
- reductions in spare part inventory - by identifying parts through links to equipment
- much improved control over preventive maintenance schedule and documentation
- simplified access to maintenance data and statistics - through report generator

Whatever the claims made by the supplier, one of the main benefits to be gained from a CMMS is that it helps and encourages the user to focus on good maintenance practice. Procedures become formalized and organized through having to conform to the requirements of the new system. The table below illustrates a few of the common differences in an organized versus a disorganized maintenance department.

Factors in good and bad maintenance

Badly Managed Maintenance	Well Managed Maintenance
• Maintenance is heavily dependent on skilled and specialized trades persons • No records are kept and much of the equipment history is inside people's heads • It is impossible to estimate maintenance costs • High levels of maintenance related overtime are being worked • Maintenance is a perceived by management as a necessary evil • The greater amount of maintenance man hours is spent on unplanned work	• Maintenance is recognized by management as an integrated, essential part of production • The Maintenance section focus is upon making equipment available through increased reliability • There is an emphasis on analysis of the reasons for down time • There is a commitment to planned work • There is an emphasis on training • Continuous improvement programs are in place • Operators are involved in the maintenance of their equipment

Functions of a CMMS

CMMS's are often perceived to be no more than a means of scheduling maintenance work. This is because most people's experiences of maintenance management will have been on one of the manual systems previously discussed. While preventive maintenance scheduling is normally part of a computerized system, most of them are capable of much more than this. Virtually all aspects of a maintenance department's work can be managed by the modern, integrated software packages. These can have many options, which may be chosen according to the user's requirements. Many vendors supply their

software in a modular fashion. Purchasers can then select those modules, which are suitable for their application.

Wide ranging statistical data and reports should be readily available from any CMMS system, for example it should be capable of providing information such as the number of times a machine has broken down for a specific fault in a given period, etc. Details of the options, which are generally available, are outlined below. Key functions of each of these, which must be considered when selecting a package, are also shown.

Asset Management and Asset Register

This is the option, which will facilitate the creation of an asset register. The asset register will hold comprehensive details of each asset. Typical data to be stored would include Asset Number, Department, Asset Name, Model, Serial Number, Drawing Numbers, Purchase price, Location, Supplier, planned and unplanned maintenance history, etc.

Field descriptors should be user configurable so that, at the time of input, users are prompted for data using terminology, which is familiar to them. For example, when entering details of a particular piece of equipment, default input may be 'Asset Location'. Users may prefer this to be changed to 'A11 Pump Assembly Line Number'. When details of a specific asset require to be viewed or printed, a search capability should be available on any of the defined fields.

Preventive Maintenance Scheduling

The maintenance schedule should have a flexible set up, allowing each asset to have a defined maintenance profile which may include details of various periods, trades required, procedures required, estimated job times and when the equipment is available, etc. It should also be possible to link assets to the *preventive maintenance procedure library* discussed below.

Preventive Maintenance Procedure Library Control

The preventive maintenance procedure library is generally a database of all the preventive maintenance procedures required for the maintainable assets in the system. In a paper system, records will be held which contain details of preventive maintenance to be carried out on all equipment. Each time a maintenance is scheduled the technician will require to refer to the procedure on file. With statutory or mandatory procedures this leads to document control problems, since inevitably, technicians will retain personal, and perhaps out of date, copies of these procedures.

With a computerized system, up to date procedures can be printed (or for the environmentally conscious - viewed) each time the maintenance is due. Once technicians have been trained in the system they have access to the library at all times and there is no need or inclination for them to keep personal copies. When a change is required to be made to a procedure it is carried out on the library document, ensuring that all people who subsequently refer to it will see the amended version.

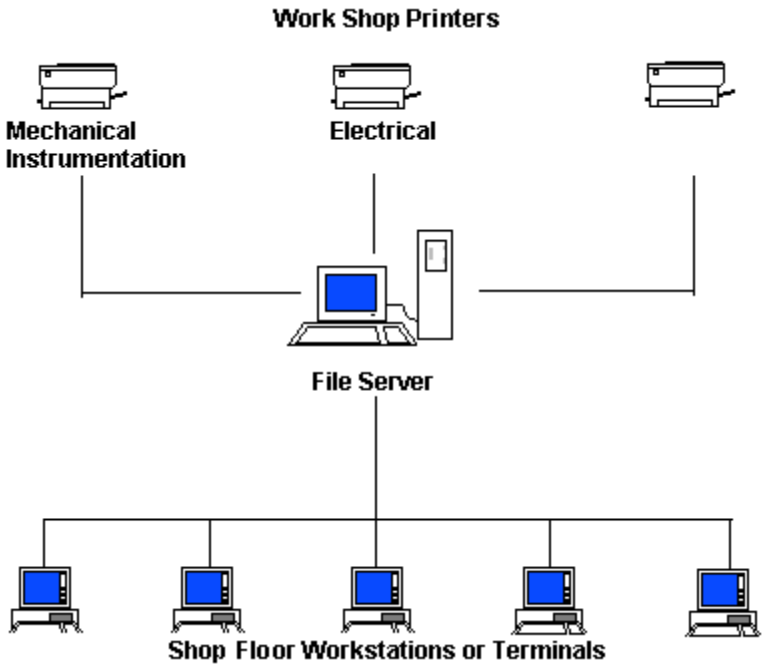
As discussed previously, it is generally desirable to have a system that allows many assets to be linked to a single procedure. If the procedure requires to be modified then this needs to be done once only, all linked assets will continue to use the modified version in the library. For example, all the pump motors in a plant may be maintained using a common pump motor maintenance procedure. If an amendment to the procedure is necessary, this is done on the master procedure in the library. All assets linked to that procedure would be automatically updated.

Unplanned Work Reporting

All systems should support unplanned work (breakdown) reporting. The exact format of this will be dependent on local requirements but may allow production personnel access to an input screen, through which they can report defects or breakdowns. The required input will be clearly defined, so that the reporter is prompted for each piece of information required. Typically, this will include the asset number of the equipment, the reporter's name and brief details of the fault.

Other organizations may prefer that a maintenance controller raises the defect report after having been notified by production personnel. In either case the system will facilitate the listing of all outstanding breakdown work, allowing this to be allocated and actioned. This may require no more than a single user software package, installed on a PC. All incoming and outgoing work would require to be handled by a maintenance controller who would be responsible for all data input to and output from the system.

The above scenario is only practical in a small organization with low work order traffic. In any medium to large company it is more likely that a networked multi-user CMMS would be selected. This may perhaps be configured like that shown in the sketch below.



In this installation, the production operation requires support from three separate service groups, each of which operates from a dedicated workshop. There are a number of shop floor terminals located strategically, around the production area. A networked printer is installed in each workshop. The main software package is installed on the file server.

When a defect or breakdown occurs, someone from production must notify the required trade group. This is done through the nearest terminal, by inputting brief details of the fault, the asset number or description and the reporter's name. When this is done the software offers the reporter a choice of the three printers. After one has been selected the work order is printed in the relevant workshop. The work order will then, automatically, be added to the list of *outstanding* work.

The trades person then actions the work, and when complete, inputs the details of the action taken. The defect status will then change from *outstanding* to *complete*. All details, which have been input, will become part of the asset history.

In determining how unplanned work reporting should be dealt with by the system it may be worthwhile creating a definition of any manual system, which is already in place. This may also be found to be a convenient method of determining your requirements in situations where no formal reporting procedure is used. A typical example of this is shown below.

Breakdown Occurs

Operator contacts maintenance supervisor with fault details

Supervisor creates work order

Supervisor issues work order to relevant trade

Mechanical or Electrical or Instrumentation

Trades person completes job

Trades person completes work order

Trades person returns completed work order to supervisor for filing

Supervisor files completed work order

From the above a definition of how you would require the software to deal with job requests may be developed.

Scheduling of Planned Maintenance

Most systems include a maintenance scheduler. When the scheduler runs, it scans each asset in turn and checks the periods when maintenance is required. It then looks at the last maintenance date for each period and if due, creates a planned maintenance work instruction for the asset. Typically, the planned maintenance scheduler will be 'rolled forward' each week, producing work instructions and adding them to the list of outstanding work. Users may be required to decide whether they would prefer the scheduler to run automatically, in real time, or by intervention at a particular time each day or each week.

Initially, it would appear that the automatic option is best, but this has its problems in that it requires regular monitoring of the outstanding work to check if any scheduled maintenance has been added to the list. A weekly scheduler run will produce a week's work in advance, allowing it to be programmed into the production schedule accordingly. Some systems allow maintenance to be scheduled according to both plant and personnel availability. This is difficult to support since the system requires constant updating of absence figures, shift changes and production volumes.

Planned Work Order Generation and Issue

In addition to the generation of unplanned work orders previously discussed, a means of outputting, that is producing hard copy of planned work orders, will be necessary. The system should allow the planned work orders to be separated into various trades, asset groups and locations, before they are printed. Other points to be considered are whether or not the user requires work order formats to be reconfigurable. Most companies prefer to be able to design their own work order forms.

Viewing Outstanding Work

Maintenance managers and supervisors will require to be able to quickly check work orders, which are outstanding. The system should support a quick and easy method of selectively displaying lists of these work orders by trade, work type, department, etc.

Maintenance Personnel Database

It may be that a maintenance personnel database is required. This is not to be confused with the company personnel database since it would generally only contain details of maintenance personnel. Once again requirements here will differ but typically details will contain name, trade, department, shifts worked, qualifications, special training received,

authorizations, etc. This may also be used for time keeping and attendance recording but some users prefer to keep this apart from maintenance records.

Stores Requisitioning, Stock Control and Purchasing

Most fully integrated packages support some kind of store's management option. If you elect to take this option it should be carefully specified to ensure that it would meet your local requirements. One benefit of opting for stock control is that trade groups can be provided with access to the store's database allowing them to find spare part numbers and check stock levels of maintenance spares. Some systems allow spares to be linked to assets thus simplifying the search for these and also ensuring that no obsolete spares are held in inventory. Some users consider that the greatest financial returns from a CMMS are to be achieved through improved stock control procedures.

Requisition and purchasing options are also generally offered in maintenance management packages. These are similar to any other computer controlled purchasing packages but once again, being part of an integrated package, they can be used to record and control maintenance spare parts usage. This allows the possibility of automatic reordering to minimum stock levels. These options are not always popular because most companies already have some kind of computerized stock control system in place. The prospect of changing to a new system is often daunting.

Gauge and Calibration Management

Several packages either offer gauge and calibration management as a separate option or, at least, allow this to be configured through the normal maintenance scheduling system. This can generally be configured in a manner that satisfies the requirements of ISO9002.

Condition Monitoring

Condition monitoring is a form of predictive maintenance where continuous monitoring of the condition of specific areas of plant and equipment takes place. When any pre-defined limit is exceeded, an alarm output is turned on. This alarm output can be input to a CMMS so that a work order will be generated immediately. This is particularly suited to continuous process plant, say paper mills, where plant failure could be extremely costly.

Typical conditions, which can be monitored, are temperature, vibration, over voltage or current and liquid level; in fact, any condition that can be detected by a sensor.

As an example, a diesel generator in a power station may have bearings on the main drive shaft which, when failing, cause a critical shut down of the equipment. Maintenance history has shown that the failure can be predicted by monitoring the temperature and vibration patter from the bearings. Sensors are set such that they will switch when either of the two parameters being monitored reaches a level, which indicates that the bearing has approximately two month's life. When this occurs, the engineer in charge can program a shutdown to allow the necessary maintenance to take place at a suitable time.

Statistical Data and Reports

It is a fact that in any system, whether it be manual or computer based, the information, which can be output from the system, is only as good as that which has been input. That is GIGO, otherwise known as garbage in = garbage out! In a good system there will be extensive information readily available for fault analysis, costing and work statistics. *This is one of the most important functions of a CMMS system*.

Once a system is up and running and users begin to realize what it can do, the administrator can be deluged by requests for complex reports. For example, 'Can I have a report which will highlight the number of times that calibration of the power supply on the Widget Tester was required on Tuesday afternoons during the middle two weeks in September last year?' This may seem like an extreme example. It is not. You can be sure that demands like this will be made. The report generator must be capable of handling these because each failure to produce some required data is looked on as a failure of the CMMS by the requestor.

All packages use a report generator of some sort to produce the reports. The package will come supplied with some standard reports. Invariably, the specialized requirements of each customer will ensure that these are of limited value. *One of the most important factors in choosing any package should be its ability to be tailored to produce the exact reports, which you require*. Ideally, the package should allow you to write or create your own reports in-house. Some companies will provide you with reasons why this cannot be done. It is in their interests to increase your dependency on their software support, ensuring that they can impose costly, software modification charges on a regular basis.

At best, the information available through proper use of statistical data and reports can be used to realise the savings promised by CMMS system vendors. At worst, the system will fail through its inability to provide the data required.

Menu Construction and Customization

Users will normally interface with the system through a series of menus. It is the manner in which these menus are designed that will determine whether or not the users like the system. To coin a now well-worn phrase, is it user friendly? Most systems allow some degree of menu customization but it is for purchasers to ensure that this is sufficient to meet their needs.

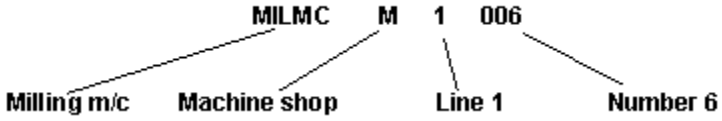
Data Layering and Access Levels

An important consideration in the implementation of a system will be who should have access to specific data. Any multi-user system should permit users to be set up such that they only have access to the data, which they require. In the networked example discussed previously the production operator could report unplanned or breakdown jobs to the system. Normally this would be the only function, which they would be required to use. There would be no need to allow them access to statistics or planned work libraries for example, since there would be no need for them to have access to the information found there. Likewise, trades groups may only require access to work order processing and procedure libraries.

Implementation Strategy and Beyond

With the impact any CMMS will have on a service department it is important that a proper implementation strategy is developed. Apart from decisions on the functions required from a system it will be necessary to properly manage its installation. Production and service group training requirements will have to be considered. The initial data input, which in itself, can be a huge task will have to be planned. If a good company asset register is available this will help, but drawing from experience, it is unlikely that even if it does exist, this will have been properly maintained.

Even apparently simple decisions, such as the way assets are numbered can have future implications. A numbering system should have a formal structure where possible. To illustrate this, a system may be developed where a 10-character asset number is used. This may be formatted so that the first five characters are used to describe the equipment, the next two the department and area code and the last three the equipment number. Let's take the example of milling machine number 6, on line 1 in the machine shop. This may be allocated the asset number: MILMCM1006.



When personnel become familiar with this system they will be able to correctly identify equipment, department and location from just the asset number. Likewise the database can easily be queried for all equipment in the machine shop by listing all equipment which has the letter 'M' as the sixth character of its asset number.

During the creation of the asset register it is possible that some assets will be omitted. This need not be a concern if strictly all work is logged through the system. The omission of any asset will be obvious when a reportable problem occurs.

The commitment of all involved should be assured before proceeding with the project since lack of commitment from any one group could cause it to fail. The commitment of trades groups should be sought at an early stage since it is likely that, at least initially, they will view any changes with suspicion. Many people see the introduction of the CMMS as a means of closely monitoring the amount of work, which they are doing. While it is likely that there will be an element of this, the positive aspects should be selected and used to 'sell' the system. For example, stress the ease with which users will be able to get information and the access they will have to formal work procedures. If stock control is being introduced stress the advantages of this. When the system has been implemented and accepted it is likely that it will improve accountability due to jobs being linked to personnel. Also, if trade groups are to be involved in the input of data to the system (by closing off their own work orders) it is crucial that they are fully trained and aware of the importance of accurate input.

System administration and maintenance will require to be considered. Who will be responsible? As your organization becomes more dependent on the new system the impact of a system failure must be minimized through the use of a good data backup system.

Maintenance Metrics and Performance Indices

The effectiveness of any system can only be assessed by measuring the effect it has on your maintenance performance. A *before and after* assessment is generally impossible since there will probably be no mechanism in place to measure maintenance performance before the system is installed. This makes it important to give some thought to the *maintenance metrics*, which you will be using in advance of the implementation. Immediately the system is installed these metrics can be used to track

on-going progress. It must be emphasized that any metric should have a trigger level set at which point corrective action *must* take place. *There is no point in producing a graph, which does not indicate what is acceptable performance*.

Planned versus Unplanned Work

What exactly should be measured is for the user to decide, and will be the source of much discussion. Requirements will also depend on whether the situation is viewed from an engineering or an accounting perspective. What is important on one site may be of no consequence on another. However, one of the universal objectives of any maintenance improvement plan must be *to improve the ratio of planned versus unplanned work*. Clearly, the ultimate aim must be to move the unplanned maintenance level as far as possible toward zero. In practice many unorganized maintenance departments will have a ratio of 90% unplanned to 10% planned work; much of their work will be reactive. A CMMS will make this easy to monitor and produce a suitable metric. Over a period, it can be used, along with the other statistics which will be available, to reverse the trend.

Just a few of the many other maintenance metrics, which may be relevant, are listed below:

- Man hours unallocated (unproductive hours)
- % Overtime hours
- Cost of maintenance overtime
- Backlog of work
- Average time per breakdown job
- Cost of spares
- Cost of labor
- Equipment effectiveness
- Total maintenance cost per unit of output
- Cost of lost output due to unplanned downtime
- Cost of lost output due to planned downtime
- Downtime percentages, by area and by asset
- Mean Time Between Stops or Mean Time Between Failures

Any investment in CMMS will be dependent on the size of the system required. In a small company a single user system on a stand-alone PC may suffice. The hardware and software cost for this could be less than £2K. In a large company where all available options are required on a 40-user system the costs could be £200K. The amount of personnel required to implement the system will again be dependent on the size of the system but on a large multi-user system one to two man-years would not be unusual. On-going costs of system administration and support must be considered along with any software support contracts, which are involved. There is no magic wand, which can be used to implement CMMS. No matter what your approach it is likely to require considerable investment, in terms of finance and manpower.

Reference

http://www.plant-maintenance.com/articles/CMMS_systems.shtml