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A History of Maintenance: Implementing MP2

Julie Thomas

Western Kentucky University

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A History of Maintenance: Implementing MP2

Honors Thesis

Julie Thomas
Spring 2007

Approved by

Patrick Kerotiana
Byron Reardon
Raj / Alan

Abstract

This document was created to help maintenance departments in reducing downtime. The main focus of this manual is to teach maintenance personnel how to implement and use the CMMS program known as MP2. By using MP2, problem areas within a plant can be identified and tracked by electronically storing equipment information. This method will ultimately lead to less reactive maintenance and more preventive maintenance, which will therefore lessen downtime.

Acknowledgements

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History of Maintenance

Welcome to the demanding, yet often rewarding, world of industrial maintenance. While each maintenance department encounters different obstacles, they all share one common goal. That goal is simply to minimize downtime, because time equals money. Such an objective may seem easily reachable at first, but one must understand all of the different factors involved to fully comprehend the importance of maintenance. The following sections will help you see where the idea of a maintenance department first came from, why the idea of maintaining equipment is so important, and how using a program such as MP2 can aid a maintenance department in reaching its goal.

Origins

Of course maintenance departments did not always exist; there was no need for them when production of goods was done on a very small scale. Most early factories, after being mechanized, typically employed only unskilled workers. The majority of maintenance issues were therefore left up to the early engineers and owners. Not only did they work together in repairing machinery, but they also cooperated when purchasing and setting up new machinery. At this point, there were few issues regarding organization or motivation of maintenance

personnel. However, as technology advanced, more types of machinery were made available, and the need for maintenance personnel increased. Ben Niebel, author of Engineering Maintenance Management (Industrial Engineering), asserts that in 1969 maintenance departments in manufacturing organizations only comprised 1-17% of the work force and only 1-12% in 1981. However, these percentages have since risen because of the use of automated machinery; automation is taking the place of manual labor and maintenance responsibilities are increasing accordingly (B. Niebel, 1994).

Importance

Maintaining any production equipment purchased is of utmost importance, especially to highly mechanized manufacturing organizations that do not have the means to replace their equipment every decade or so. Regular maintenance greatly prolongs equipment life and keeps downtimes to a minimum, which can quickly add up to significant cost savings. Maintenance materials alone can add up to half of the total maintenance cost in U.S. industry (B. Niebel, 1994). If these expenses can be cut by substituting planned and preventive maintenance for more reactive or emergency work, more money and time can be spent on production-focused improvements. Another important point to remember is that not only are maintenance departments capable of making expense cuts, but they also have “an effect on the marketability of the product and can be a factor in the change in future product demand” (A. Wilson, 2002). While maintenance departments are not directly related to production, they can still have a profound effect on the quality and cost of the end product.

The importance of maintaining equipment may seem obvious for any company that plans on being around for a substantial length of time, but using a computerized maintenance

management system (CMMS) is not always seen as a necessary step. According to R. Jones in *Computing and Control Engineering Journal*, the analysis of 725 AMIS maintenance management audits has shown the following:

“...over 60% of companies are not satisfied with their system and cannot demonstrate clear benefits from operating these systems. In many instances, computer systems have actually created additional work and are driving the management process rather than being a tool supporting the process.” (R. Jones, 1994)

Unfortunately, the underlying cause of this disappointment is usually a lack of planning and dedication to the implementation of the system from the beginning rather than some fault of the system itself. Many companies purchase CMMS products expecting them to do all of the work, but they are just tools as Jones said, and not cure-alls that will automatically fix all of a maintenance departments’ problems. Although MP2, the CMMS discussed in this manual, is not the only type of maintenance management software that is available, it is the one that the author is most familiar with and will serve as an example to help demonstrate what CMMS as a whole have to offer industrial maintenance departments.

Introduction to MP2

Background

During June of 2005, the author was assigned to a project as an intern at an Industrial facility. Her responsibilities were to use MP2 (software that is capable of tracking, storing, and analyzing data for the maintenance and purchasing areas of a plant) to prepare the maintenance department for an upcoming International Standards Organization (ISO) audit. This task was a very large and involved one, and only became more so with time.

At first, a colleague and the author worked together on readying the program, but several months after the 2005 ISO audit the coworker was placed on a new project, so the advancement of MP2 was left entirely up to the author. One of the maintenance supervisors was able to assist some with the general direction that should be taken, but there was no guidance on specifically what to do and what not to do or on what parts of the program were critical and which ones were not.

Purpose

The purpose of this part of the manual is to aid in improving the maintenance area of a facility. Use this manual as a guide for evolving from a poorly documented system that is based

on demand maintenance to a fully functioning, traceable, predictable, and controlled department with planned and preventive maintenance. According to Asset Maintenance Management: A Guide to Developing Strategy and Improving Performance by Alan Wilson, such an approach can “give an overall reduction in maintenance effort of up to 25% by reducing the volume of inefficient, reactive work.” (A. Wilson, 2002). The excess labor hours can then be cut to lighten the maintenance personnel load or be directed towards further plant and equipment improvement.

Even if MP2 or a similar program is already in place in the maintenance department, it would still be strongly recommended to use this manual, as it can spark new ideas for improvement. For example, some of the reports which can be created (see section on Reports) ascertain whether or not there are enough labor hours, provide evidence that some employees are better utilizing their time than others, as well as outline and analyze the most downtime on specific pieces of equipment.

The following sections are conveniently broken down into easy-to-follow steps and are presented in chronological order. To get the most out of this manual, please read the following pages with a critical eye and think of ways that you can slightly change or alter the examples offered here to best fit your facility. Remember that, as with any computer program, what is retrieved is only as good as what is.

Capabilities

If MP2 is implemented in the maintenance department of your facility in accordance with the recommendations of this manual, improvements throughout the entire plant will be seen. This is because MP2 sets up a controlled, accurate, and very elaborate database of all of the

equipment in the plant, which is very useful not only from the maintenance standpoint, but also from the accounting and purchasing sides. The accounting department can link equipment to the appropriate expenses and depreciations through many fields in MP2; however, if your accounting department does not operate under MP2, an expense sub-account number can be used to align the two systems (further explained under Gathering Data section).

Having an accurate database of equipment throughout the plant is extremely important for purchasing reasons because eventually, if the above-mentioned expense sub-account numbers are assigned, parts can be purchased ahead of time and can then be prepared on carts with the required tools for scheduled preventive maintenance. This will drastically cut down on time spent looking for correct tools and parts.

System Requirements

Computer requirements vary with the version of MP2 that is chosen. For MP2 Professional Version 6.0 SQL Server Edition, the one that this manual is based on, the following will be needed for the Network File Server: a Pentium server or higher for the processor, 32Mb of RAM, and a hard disk with 500Mb and 11ms access time or faster. The Operating System Requirements are PC or MS/DOS version 5.0 or higher and Microsoft Windows version 3.1 or higher. The Network File Server is necessary because after a few months of data entry, any computer not used solely for MP2 would quickly get bogged down. The other computers (just used for access to the MP2 file server) would ideally be anywhere from 1 to 20 in number, depending on how many seats are needed and how much capital investment is made. A seat consists of a username and password; although several people can have access to MP2 on one

seat if they all know the password, only one of them can occupy the seat at any given point in time.

People and system setup are very important because they are needed in making MP2 operational. Besides a competent maintenance manager, a plant with 750-1000 different pieces of equipment should ideally have maintenance supervisors for 1-2 main areas, approximately 40 trained maintenance technicians, two MP2 data analysts, and several MP2 data-entry clerks. If fewer people are available to work on the system, the goal is still accomplishable, but it will take a longer amount of time to see the same results. Also, as with any other project, the task will be made much easier if the full support of superiors can be gained.

As far as physical setup, the best way to ensure that Work Orders are completed and returned is to have a large wall-hanging organizer with an “IN” and “OUT” slot for each maintenance personnel. At the beginning and end of each shift, the maintenance manger should go over the main activities of the day so that any current problems can be discussed with both the incoming and outgoing sifts. Afterwards, the maintenance personnel can go to the organizer to pick up their new Work Orders and return their old ones. When initially implemented, there may be difficulty cycling Work Orders through because the amount of reactive maintenance emergencies could leave little time for preventive work. However, after a period of three or four months a substantial improvement in the ratio of preventive versus reactive Work Orders being completed should be seen. Remember to try to keep the end result in mind as much as possible. If you know what you are working towards and help others to understand it as well, you will get the cooperation needed.

Equipment

MP2 has many different screens that can be used, but the three most important for maintenance purposes are “Equipment,” “Tasks,” and “Work Orders.” The Equipment screen is what will be used almost entirely for the first phase of setting up MP2 (see Appendix A). The Equipment screen’s role is to store all kinds of information on each piece of equipment that needs to be tracked. These assets are then linked to certain Tasks to create Work Orders, which will be explained further on page 13.

Required Fields

Nearly every screen in MP2 contains cells called “Required” or “Key” fields. For example, in order to create a piece of Equipment, the Required Field of “Equipment Number” must have some value present in it. Besides the Equipment Number, there are many other types of fields that may be used to help describe the Equipment being entered. Although most of these fields are going to be very useful, some of them will not be. For example, if a plant’s accounting department uses a program different from MP2 to calculate depreciations and other cost-related percentages, the tab of Financial Data is left blank. Instead, only the following fields should be

used for basic functions: Asset Number, Equipment Number, Description, Model Number, Serial Number, Manufacturer, Expense Sub-account, Location, Sub-location 1, and Equipment Type.

The Asset Number (listed above) is different from the Equipment Number because it is used primarily for accounting and purchasing reasons. The Equipment Number can be thought of as an abbreviation of the Equipment Description and is used primarily for easier sorting and searching of Equipment. A good Equipment Number example would be in the case of a Punch Press machine. The Asset Number is hopefully already listed in accounting from when the machine was first purchased, in which case the number previously assigned by accounting should be used. For the Equipment Description use a full spelling like “Punch Press #8” and for the Equipment Number perhaps something like “PP8.” The Equipment Number field has a limited number of characters, so it is important to be as brief as possible.

Another important point about the Equipment Number is that when someone is entering a Work Order and a piece of Equipment has to be assigned, he or she can fill in the Equipment Number field first, and then all of the other fields associated with that particular equipment will automatically be filled in by MP2. Therefore, think ahead when designing the Equipment Numbers so that they will be easy to remember for faster data entry in the future. Equipment Type is a very useful field that can be used to sort equipment that is of the same type. If we go with the Punch Press example again, the Equipment Type would most likely be “PUNCH PRESS,” or maybe “PP” for a shorter version. Sorting or Filtering by Equipment Type will help to view all machines listed of the type chosen so that data can be compared or viewed to select a Work Order.

An optional field that may be useful for certain pieces of equipment is “Meter.” As discussed further under the Task and Work Order topics, the Meter field basically allows for automatic scheduling of maintenance such as filter changes or routine lubrication based on a reading. Every time the status of the filter is checked, a number such as the gallons per minute could be recorded. At a certain pre-designated number, a Preventive Maintenance (PM) request would be generated to change the filter. The Meter field is important at the Equipment level because every Meter is tied to a specific piece of Equipment. Once the most beneficial fields have been determined, information from the various pieces of equipment can be gathered.

Gathering Data

Gathering and entering equipment information, besides typing in the never-ending supply of Work Orders, is probably the most tedious part of the entire effort to implement MP2. Be prepared to spend several weeks on this stage alone.

The first step in this stage is to physically go around to every single piece of equipment in the plant and write down as much applicable information that can be found (refer back to the fields earlier decided upon to help figure out any information that may be missing). This may be a major undertaking in some older plants, especially if processes such as die casting, punch pressing, and heat-treating are involved. Any labels that are on the pieces of machinery are most likely covered in dirt and grime and might even be painted over in some cases. Also, do not be surprised if some machinery has more than one tag, each with different information. If this does become an issue, retagging all equipment is definitely a future project to consider. In the mean time, attempting to cross reference physical data found on the machines with accounting records may prove to be helpful.

Once all of the equipment data has been gathered, it is ready to be entered into MP2. Make sure that a group effort is made when deciding on the best way to describe the locations of equipment; thoroughly thinking out this step will be a great help in the long run. If proper thought is not put into this step, there will almost definitely be painstaking changes that will have to be made further down the road.

Some tips when making these decisions are to think of a way that the Sub-location 2 and 3 fields will not have to be used. This will help make it simpler to create Expense Sub-accounts and other fields later on if desired. Most of all, it rids MP2 of unnecessary divisions and makes for a less complicated Equipment Tree. The Equipment Tree is simply a view that is available if the Location field is clicked on while under the Equipment screen (see Appendix D). By breaking the equipment down in this visual format, MP2 allows locations that may need to be renamed or pieces of equipment that might need to be moved to be quickly seen.

The Expense Sub-account field, mentioned earlier as a field to help link the maintenance and accounting departments, is just that. Numbers can be entered into the Expense Sub-account field that can correspond to numbers in the accounting department to help align the two systems if MP2 is not used in both departments. Aligning the two is beneficial because if each major group of equipment has an assigned number, any time anything is purchased for a piece of equipment in that group, accounting can record that cost. Every month, reports can be produced that show which group, or Expense Sub-account, is requiring the most amount of money so that any necessary projects or investigations can be initiated. This is a very important way to help narrow down and cut the costs of any maintenance department.

Obtaining an accurate list of any problems with this method, however, depends on how well the equipment was assigned to the Expense Sub-account numbers. Generally, one can go by the Equipment Locations and Equipment Sub-locations already being used to get a good idea of which pieces of equipment should belong to one group. Another thing to think about is the importance of some types of equipment over others. For example, hoists with a lifting capacity of 15 tons are more important than a small lathe because of the safety hazard. Therefore, a separate Expense Sub-account for the hoists may be needed.

Sub-components

One of the interesting things about MP2 is that it is able to associate Sub-components with Equipment. This means that if there are Equipment listings for a motor and a controller for a main machine, the Equipment can be arranged so that the motor and controller are Sub-components of the main machine. Although this serves no functional purpose in MP2, it, like the equipment tree, helps visually demonstrate the relationship of different pieces of equipment to each other (see Appendix E).

Tasks

The Task screen is very instrumental in improving Planned Maintenance. The main purpose of Tasks is to outline exactly which steps need to be followed during routine maintenance. Developing Tasks can be challenging because it involves much more critical thinking, but it is also one of the most important steps because it is the foundation of a good maintenance system.

Earlier, it was mentioned that Equipment can be tied to Tasks to create Work Orders. In other words, almost every machine will have certain maintenance procedures that should be performed on a regular basis (Tasks), and when those procedures are performed, detailed documentation of that particular instance will be recorded in MP2 (as a Work Order). You will notice that Tasks are only needed for preventive maintenance. In the case of reactive maintenance, only a piece of equipment and not a Task is needed to create a Work Order. See the section on Work Orders for more details on this subject.

Required Fields

The only Required Field for Tasks is “Task Number.” The Task Numbers will be similar to the Equipment Numbers in that they will be logical abbreviations of the Descriptions. For

Example, a Task Description of “WEEKLY LUBRICATION ROUTE” would have a Task Number of something similar to “LUBE-WEEK.” The sole purpose of this field is to help identify the Task in as few characters as possible. Other fields recommended for use though not required by MP2 are Scheduling by Date, Release as Separate Work Orders or Release as a Single Work Order, person Responsible, Equipment, and the Details section.

There are two ways to schedule a Task in MP2, either by date or by meter. For most cases, only Scheduling by Date will be needed. When scheduling by date, the fields of Perform Every, Date Last Performed, Next Due Date, Must be Down, and Number of Times Completed may be filled. When first entering a Task, the Date Last Performed and Number of Times Completed fields should not have a value. As Work Orders are completed on the Task, MP2 will automatically update them accordingly. The Must be Down field simply signals whether or not the Equipment has to be turned off in order to complete the Task. Any Tasks that have this field checked should be scheduled when it is known that the Equipment can be shut down for repairs, for example, on a weekend or during a full plant shutdown.

If it is best not to schedule some Tasks by date, they can always be scheduled by Meter. This process was touched on earlier but deserves further explanation. As mentioned, meters can be tied to certain pieces of Equipment to measure any value that may need to be recorded. A common Meter may indicate the amount of lubrication used weekly for different pieces of Equipment. Recording these variables in MP2 is very beneficial to both the maintenance department and the purchasing department because doing so will make tracking lubricant use and predicting when and how much more lube to buy much easier. After about a month, this information can be placed in graph form and it will become obvious which equipment is

requiring the most lubricant. The graphs are good indicators of problem machinery and can show where some serious leaks might be hiding.

If scheduling Tasks by Meter, all that has to be done is to select the Meter for the Equipment of choice that has already been entered in during the Equipment data-entry stage (see Appendix C). Variables will not actually be able to be recorded for a particular meter though until a Work Order has been created or until the Quick Meter Entry screen has been opened. The Quick Meter Entry screen can be used to record Meter readings without being required to attach them to a Work order. This is useful in a situation in which perhaps a daily Task is needed, but for the sake of minimizing paperwork a weekly Task to include all of the daily activities can be set up. Because each Meter can be associated just once with any given Work order or Task, only the Meter variables for one day of the entire week that the Work Order covered can be entered. This may be only a small percentage of the information that is needed, so it is recommended that the daily data be entered in the Quick Meter Entry screen instead, where as many readings for a meter as desired can be given.

The field of Releasing as a Single Work Order or Releasing as Separate Work Orders is a check box and only requires a relatively simple decision. Some Tasks with multiple Equipments will need to be released all at the same time, especially if they are to be performed by an outside contractor who will only be available for a couple of days. Others, however, should be released as separate Work Orders so that the work load on the maintenance personnel is not too overwhelming. If Work Orders are released at a more constant trickle, they are easier to address than if they are released in larger quantities at more random intervals. Overall, the decision of

whether or not to release the Task as separate Work Orders depends on the schedule that has been set for the Task.

The Person Responsible field is not always necessary for entering a Task, but it can be instrumental if the maintenance department is divided into two or more sections. Since there is normally one supervisor for each section with different types of Tasks specific to each area, it may be helpful to assign numbers to all of the areas. For example, one area might have “00” entered in the Person Responsible field and another “01.” These numbers can provide a way to filter the Tasks so that each side will be able to be seen as separated from the other side.

The Equipment field is obviously very important when creating a Task because every Task is specific to certain pieces of Equipment. Although a finished Task does not have to have Equipment assigned to it, it will be less time consuming to attach the Equipment once in the beginning than it will be to attach it to every single Work Order generated from the Task in the future. When picking an Equipment to add to a Task, simply type in the Equipment Number that was assigned to it earlier. This is where the benefit of creating short, self-explanatory Equipment Numbers comes into play. As soon as the Equipment Number is typed in and *enter* is pressed, all of the rest of the Equipment information is automatically filled in by MP2. If the Equipment Number is difficult to remember, the square inside the field can always be clicked to enable a search of the entire Equipment list.

The Details Tab actually has a required field within it called Instruction Code that must be filled in and selected before you can begin typing the steps of the Task. The next section focuses more in depth on the subject of entering steps into the Details field.

Outlining Steps

Before recording the steps to be taken during a Task, make sure that the following three things are clear. First, it is extremely important to collaborate with others when taking notes on what steps should be entered. For any given Task, there are almost always employees already partially trained to complete a similar set of instructions, and they will be able to help write down what to look for and check. Also, some Tasks come about because of insurance reasons or to comply with ISO or OSHA standards. Any of these Tasks will already have written requirements that must be incorporated into the MP2 Task. Secondly, never enter a Task into MP2 without the approval of the Maintenance Manager. Other employees may request that certain Tasks be recorded by MP2 that do not fit the job description of the maintenance personnel or that have a high schedule frequency which may overburden the maintenance department. Finally, try to develop a set format for Tasks that will continue to be used for all future Tasks.

Having the same format for all Work Orders will help those that perform the work become familiar with the layout. After filling out a few of them, they will know exactly what information to list and where to put it. The only part that might need to be entered into the Details section other than the actual steps is an area for comments. The rest of the information, such as name, date, etc., can be listed in the spaces provided by MP2 on the Work Order.

Job Shadowing

Another capability of MP2 is that it can automatically replace some Tasks with other Tasks if the two are similar and due at the same time. This replacement is called Job Shadowing. A good example of an advantageous time to implement this feature is if one PM, say for hoists, is to be completed every month but a different PM for the same hoists is more detailed and is to

be completed only every six months. If the biannual PM includes all of the steps that the monthly one does and more, then it should replace (shadow) the monthly PM in January and July. In order to do this, go to the Task screen for the more detailed PM, and under the Job Shadowing sub-tab, select the less detailed PM.

Attachments

Attachments are very important visual aids that often go hand in hand with Meters. The term “attachment” in MP2 is any file (.doc, .txt, .pdf, etc.) outside of MP2 that can be connected with a certain Equipment, Task, or Work Order. Likely attachments for Equipment may include a map showing the location, a chart for recording temperatures, or perhaps a special document regarding any hazardous properties. Although attachments might not be commonly used under the Equipment tab, they will most likely be used for both Tasks and Work Orders. Attachments for Tasks and Work Orders are made to supplement the existing set of instructions in some way. For example, some Tasks may have been in place before the implementation of MP2, as mentioned earlier. In such a case, there is usually already some type of form on which values are measured and recorded, which is why attachments often go hand in hand with meters. Instead of getting rid of all the pre-made forms, update them where necessary and attach them to the appropriate Tasks.

Make sure to refer to the attachment in the Details section and on the Task Description field so that the person completing the Task will know that there is an additional document and so that the person printing the Work Order does not forget to print the attachment. There is a box in MP2 that can theoretically be checked for the attachments to print automatically with their respective Work Orders, but it may not always work properly. Using attachments in these cases

is very beneficial because it prevents form-change confusion among maintenance personnel and gets rid of the need to retype all of the already existing information into MP2.

The only major obstacle that may be encountered when first beginning to use attachments is how to get files on non-Network File Server computers copied in folders on the MP2 server. Because the enterer's hard drive is most likely a different one from the server, MP2 will not see any files that the enterer's personal computer has. Basically, all that needs to be done to solve this problem is to use the network to create a shortcut on the enterer's desktop to a new folder on the Network File Server. This folder, this link to MP2, is where all attachments should be placed and where all of the files used for creating reports should be exported to (for more information on creating reports, see section on Reports).

Work Orders

Work Orders is one of the final stages of data storage and analysis that MP2 is capable of. When creating Work Orders, remember that there are two different types of maintenance just as there are (in general) two different types of Work Orders. These two types are reactive and preventive. *Reactive* refers to all Work Orders that are not performed on a regular basis to prevent a piece of equipment from breaking down. *Preventive*, in this case, is defined as any Work Order that includes a set of instructions that will be reused at certain intervals. The MP2 data entry clerks will see Preventive Work Orders both when they are requested and again when they are completed. Reactive Work Orders will only be seen by the data entry clerks when they are completed. The reason that Reactive Work Orders are only seen once by the enterers is that the requestor of the Work Order is also the generator and gives it directly to the maintenance personnel without having to go through an MP2 data-entry clerk at all. However, because Preventive Work Orders have a pre-designated set of instructions to follow, they must be generated from MP2 and therefore cannot be requested by an individual. The MP2 Data Entry Clerk must assign *and* collect any preventive Work Orders.

Required Fields

The only required field for inputting a Work Order is the Work Order number, which will be automatically assigned by MP2. Some fields, such as the person responsible for making the request and the time of the request, will be filled in automatically by MP2 for tracking purposes. Other fields available for input are the Task, Employee Code, Equipment Number, Meters, Regular Hours, Scheduled Start Date, Scheduled Finish Date, Work Order Type, and Status.

The Task field would be only for Preventive Work Orders and is a drop-down list of all Tasks that have already been entered into the system. The Employee Code field is the area where the employee ID of the person that completed the Work Order is entered. Under the Equipment Number field, select the Equipment that the work needs to be or already has been performed on. If there are any Meters that need to be entered when closing out the Work Order, type them into the Meter field. Regular Hours is the number of hours that the laborer took to complete the Work Order during their scheduled work time. The Scheduled Start Date and Scheduled Finish Date fields are self explanatory but are used only for Preventive Work Orders since Reactive Maintenance is never scheduled.

Having different types of Work Orders is a good idea mainly because it allows Work Orders to be sorted according to whether or not they are Reactive or Preventive. With this information, reports can be created showing the ratios of planned versus non-planned Work Orders which can be tracked to show improvement as the maintenance department progresses. Some examples of main types of Work Orders that can be used are Preventive Maintenance (PM), Total Preventive Maintenance (TPM), Work Order (WO), and PM Generated Work Order

(PMWO). PMs are basically any Work Orders that have a Task associated with them. TPMs are the same as PMs, but are significantly more involved and should cover in detail each of the seven steps of autonomous maintenance. These seven steps are initial cleaning, countermeasures to sources of contamination, cleaning and lubricating standards, overall inspection, autonomous maintenance standards, process quality assurance, and autonomous supervision. Usually TPMs have a lower frequency than PMs because their steps are much more in depth.

A Work Order with a type of WO will only be a one-time job and will not need to be done on a set schedule. For clarification, all Work Orders will be represented with the phrase “Work Order” and those with a type of WO will be referred to as “WO.” Sometimes a Work Order, whether it be a PM or a WO, will return with items that need follow-up action. In such an instance, go ahead and close the original Work Order and then create a new one with the Work Order Type either as WO or as PMWO. Choose the type to be WO if the original Work Order was a WO and PMWO if the original Work Order was a PM. Because of this, the type of WO can mean several things. It could belong to a Work Order that is reactive, planned but not to be repeated, or a follow-up of a different Work Order with a type of WO. To eliminate confusion, it is strongly suggested to develop sub-groups of each of these main categories of Work Order Types. For example, some sub-categories of the type WO could be planned Work Order (PWO) or Follow-up Work Order (FUWO), depending on the needs of the facility.

The Status of the Work Order is very important and is the distinguishing factor between a Work Order that is not yet finished and a Work Order that has been appropriately addressed. There are only four choices to pick from when choosing the Status in MP2, and those four are Ready, Open, Hold, and Completed. When entering Reactive Work Orders in MP2, the status

will always be Completed, but Preventive Work orders can have any of the four types of Status, which will be explained in the next section. Basically, the Status of Ready means that the Work Order has been generated in MP2 but has not yet been handed out to the person responsible for completing the work. Open Work Orders are those that are in the process of being addressed and are in the hands of the person completing the work. Any Work Orders that have a Status of Hold are those in which the maintenance personnel encountered a problem and needed to delay the completion of the Work Order. For example, perhaps a new part needed to be ordered to complete the job and it will take several days to arrive. The Work Order should not be Open during this time, but should instead have a Status of Hold. A Completed Work Order is one that has been addressed and is ready to be closed out. After being Closed, the Work Order will appear as part of a record both in the Work Order History screen and under the History tab for that particular Equipment (see Appendix B). Each of these categories of Status are important because they affect the total time that the Work Order took to complete as calculated in MP2. The only times that count toward this total time are the periods when the Work Order is Open. If the Work Order has a Status of Ready, Hold or Completed, the timer is not activated and those lengths of time will not be added to the total.

Other parts of the Work Order process are Closing a Work Order and Work Order History. Closing a Work order can only be done after the Status of the Work Order has been changed to Complete. By Closing a Work Order, its records are moved from the Work Order screen to the Work Order History screen. At this point, a decision needs to be made. If there are multiple Work Orders that are ready to be closed at once, go to the Activities label on the toolbar, select *Work Orders*, and then *Close Work Orders*. Select the date that is to be the cutoff

for Closing Work Orders, and any Work Orders that were completed before this date will be Closed while any that fall after the date will not be Closed. If however only one Work Order needs to be closed, simply select that Work Order and then right-click in the area next to the filter and sort buttons and select *Close Current Work Order*.

Entering Work Orders

Because Work Orders can be either Reactive or Preventive, there are two main methods that can be used to enter them. The first is to create and close the Work Order all at once, and the second is to create the Work Order, assign it, collect it, and then close it out. The first method is, as previously explained, associated with Reactive Work Orders, while the second is associated with Preventive Work Orders. Depending on whether the Work Order is Preventive or Reactive, some of the fields will need to be filled in up front and others will not have to be done until the Work Order is ready to be Closed. The following paragraphs will give some basic guidelines to follow when entering Reactive and Preventive Work Orders:

Reactive Work Orders are generally easier to enter than Preventive ones, but only because they just have to be entered once. For your convenience, a step-by-step guide to entering these Work Orders into MP2 has been included in Figure 1. For Preventive Work Orders, go to Activities, Work Orders, Generate Work Orders, and then select the appropriate options for the desired Work Orders to show up rather than manually adding the Work Order. This is because all of the basic information for the Work Order such as Task, Frequency, and Assigned To has already been stored in the database under the Task tab. The majority of the remaining information, such as Date, Work Order Number, and MP2 Data Entry Clerk, is automatically assigned by MP2. At this point, just make sure that the Status is Open, print the

Work Order, and assign it to an individual in maintenance. The next time the Work Order will be seen is after it has been carried out and is ready to be Closed in MP2. To close the WO, it first must be found again in MP2 (this can be done by searching for the Work Order Number). After the desired WO has been located, simply enter in all remaining and relevant information. This information should at least include the Laborer, Regular Hours, Comments, and Finish Date. After inputting this data, change the Status of the Work Order to Completed and close the Work Order as discussed previously.

Figure 1: Entering Emergency Work Orders into MP2

On MP2:	Notes:
1. Under "Work Orders," click "+" button	
2. Go to "Record View" tab	
a. Under "Description," enter:	(problem description)
b. Under "Status," enter:	(always "Completed")
c. Under "Priority," enter:	(choose from 1, 2, or 3)
d. Under "Request Date," enter:	(date job assigned)
e. Under "WO Type," enter:	(choose)
f. Under "Expense Class," enter:	(choose)
3. Go to "Equipment and Details" tab	
a. Under "RFF Code," enter:	(underlying cause)
b. Under "Down Time," enter:	(time equipment not running)
c. Under "Equipment Number," enter:	(choose)
d. If more than one equipment, click "+" button and repeat steps a. thru c.	
e. Go to "Labor" sub-tab	
1) Under "Employee Code," enter:	(choose)
2) Under "Work Date," enter:	(choose)
3) Under "Regular Hours," enter:	(choose)
4) Under "Overtime Hours," enter:	(choose)
5) If more than one worker, click "+" button and repeat steps 1) thru 4)	
6) If more than one equipment, click "Divide" button	
f. Go to "Comments" sub-tab	
1) Under "Comments," enter:	(any additional information)
2) If more than one equipment, click "Copy" button	
4. Go to "Schedule" tab	
a. Under "Assigned To," enter:	(choose)
b. Under "Assigned By," enter:	(requestor of the Work Order)

c. Under "Completion Date," enter:	(choose)
d. Under "Completion Time," enter:	(choose)
5. Repeat steps 1. thru 4. until all records for the day have been entered	
6. Ensure that all completed Work Orders are closed at least once a day	

Electronic Entry

One of the biggest steps a plant can take after the MP2 program is up and running is to convert all reactive Work Orders from paper records to electronic files. This will ease the load on the Data Entry Clerks in the long run and will also help maintenance personnel feel more involved in the MP2 program. Ideally, any supervisors, engineers, or cell technicians would request WOs from computer locations out on the plant floor which would be automatically linked to MP2. The actual setup would have to include a way for the computer to know the following: who is requesting the work (a badge swipe or manual key entry for example); which equipment needs the work (a dropdown box, equipment tree, or plant map could be used); what work needs to be done; and what is the priority of the WO.

Maintenance personnel, when ready for a new job, would go to the nearest plant-floor computer and look at the list of all WOs with a status of Ready. If the individual worker is able to complete any of the WOs, he or she would signal to the computer via the swipe of a badge or keyboard entry that the job is being taken care of. This would assign that person's name to the Laborer field in MP2, record the time and date, and change the Status to Open. When the job is done, the person would then return to a plant-floor computer, locate the WO that he or she was working on, enter any comments, and change the status of the WO to Complete.

This process, once set up, can be extremely useful and time saving because the MP2 Data Entry Clerk will have fewer data to input and the company will no longer have to worry about having enough space for Work Order hardcopy storage. Converting a maintenance department

from hardcopy records to a completely electronic MP2 system may sound rather intimidating at first, but as long as plenty of thought and planning are put in before actually launching the program, there should not be any overwhelming difficulties.

Although there is software available solely for this purpose and sold by companies such as CMMS Data Group, it is possible to create your own web page which the tables in MP2 can be linked to through a live network connection. This method of electronically entering data into MP2 is only recommended if the company has a resident communications technician with the knowledge and time to allow him or her to set up all of the links and if complete customization is valued more highly than the time and effort that will have to be devoted to setting it up. If this resource is available, make sure to communicate with others while setting up the framework and to outline the basic fields and screens that are desired well beforehand.

Reports

Now that the MP2 system is starting to collect and store information, it is time to create some graphs and charts. Doing so can help show where all of the labor hours are going, which equipment has the most downtime, and what the ratio is between Preventive and Reactive Work Orders. Creating reports is one of the most enjoyable parts of the process because it involves finally being able to see the results of all the hard work that have been put forth thus far.

Exporting Tables

Perhaps one of the most technically difficult steps outlined in this entire manual is to export data from MP2 to an Excel or similar spreadsheet. Although there are some automatic reports already set up in MP2, they have a very low level of customization and may not contain all of the information that is needed. If an MP2 report is exported to Microsoft Excel, it can be rearranged to create graphs and problem-solving fishbone diagrams by breaking down information. However, the file types that MP2 uses to export will most likely either not export useable information at all or not display the information in a user-friendly format. Fortunately, there is a better and faster way to achieve the desired results. This process involves using Microsoft Query to get information straight from the base tables in MP2 and exporting it to

Microsoft Excel. Once the data has been exported, it will be very beneficial to create several macros with the information so that creating the same report at a future date will be neither difficult nor time consuming.

Examples

Some of the reports that may be created are a monthly Equipment Downtime Report, a Manpower Usage Report, and a Work Order Type Distribution Report. Each of these reports will help demonstrate the growth and improvement that a maintenance department may be encountering over time. An Equipment Downtime Report should contain information from the Equipment No., Equipment Type, Downtime, Description, RFF Code, Comments, and Work Date fields in MP2. If a graph is made from this data, the Equipments with the most Downtime versus their Downtimes can be shown and reasons for their large Downtimes can also be listed for future analysis.

The Manpower Usage Report is useful in showing which maintenance personnel are making the most of their time. If evidence can be provided that some are working more than others, a strong motivation will exist for the others to put forth more effort on the job. This will lead to more efficient resolutions of equipment maintenance issues. The fields from MP2 that should be used in this report are Employee Code, Work Date, Regular Hours, Overtime Hours, and Equipment No. Be aware, however, that this type of report may not be very accurate if created during the beginning stages of MP2. It could take some time for maintenance personnel to become accustomed to and support the new process; thus, they may not be recording all of their hours. Also, some may be altering their times, so be sure to ask if some jobs seem to have taken longer than expected.

Creating a Work Order Type Distribution Report may not seem necessary at first, but it is a great way to show a move away from Reactive Maintenance and towards Preventive Maintenance. This type of report can be presented to upper management to confirm that the MP2 system (or other CMMS of choice) is working as planned, which can in turn help gain more support for the maintenance improvement effort. The only fields that are needed from MP2 for this report are Work Order No., Work Order Type, and Completion Date, although others may be added for more details if desired.

Work Instructions and Training

Even after the system designing stage has been completed and MP2 is functional, there are still many ways to continue improvements. Maintenance, and even industry as a whole, is not just about maintaining the same quality of the products and processes currently available, it is about constantly finding ways to make it better, faster, and more efficient.

Developing Detailed Job Instructions

Some jobs, such as leadership and decision-making positions, would be nearly impossible to write instructions for because the tasks vary so much from day to day. However, other types of employment benefit greatly from having a clear written set of instructions because they ensure uniformity and guard against mistakes. Creating Work Instructions is a good idea, especially for MP2 Data entry-clerks and for those that will be involved in the Work Order flow process (requestors, maintenance personnel, upper management). After getting any Work Instructions approved, make sure to instruct others on their contents and to annually review them for any changes that may need to be made.

Continuous Improvement

To have a department that is focused on continuously improving, the importance of professional training must be emphasized. Encourage maintenance personnel to participate in any and all classes offered that will review old information or teach an entirely new and relevant topic. This not only increases the knowledge of the worker which is beneficial to the plant, but also increases that worker's sense of pride and self-worth. Sending several employees to classes once a year will pay for itself after two to three years as the new knowledge will be able to help properly address and solve problems in the future.

Conclusion

The importance of implementing a CMMS cannot be stressed enough. If the benefits of using such a system are truly realized, there are no limits to what can be done to better a facility. In conclusion, this manual has hopefully been both helpful and informative in preparing you for your own experiences with Computerized Maintenance Management Systems. With hard work and a willing attitude, improvements will soon be seen that will start with your department, and only end where chosen.

Bibliography

Jones, R. (1994). Computer-aided maintenance management systems. *Computing and Control Engineering Journal*, 5 (4), 189-192.

Niebel, B. (1994). *Engineering maintenance management (industrial engineering)* (2nd ed.). CRC Press.

Wilson, A. (2002). *Asset maintenance management: A guide to developing strategy and improving performance*. Industrial Press, Inc.

Appendices Removed for Confidentiality