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Introduction to
**Maintenance Management
Systems**



Material Collected By: A.H

Introduction to Maintenance Management Systems

Contents:

- ✓ Maintenance Management Objectives.
- ✓ Maintenance Policies & Strategies.
- ✓ Maintenance Planning & Scheduling.
- ✓ Work Order System.
- ✓ Maintenance Cost Control.
- ✓ Spare Part Control.
- ✓ Reliability Centered Maintenance
- ✓ Total Productive Maintenance.
- ✓ Performance Keys Indicators.

Introduction to Maintenance Management Systems

References:

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- ✓ Computerized Maintenance Management System (2nd Edition)
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- ✓ Internet Articles & Resources

Chapter I

Maintenance Management Objectives

A decorative header image featuring a close-up of dandelion seed heads against a golden-yellow background. The seeds are delicate and wispy, with some still attached to their stems.

Introduction

Industry today is in a fight to survive. Competition is found not only on a domestic level, but also on international levels. In an effort to survive, all forms of production analysis, product reviews, and material reviews are made and periodically checked. Statistical process control is only one of the new methods used to reduce operational costs. However, one area many industries are now turning their attention toward is the maintenance function.

Introduction (Cont.)

Cost reduction in maintenance does not necessarily mean a reduction in service or in the quality of service. It means a better control of the maintenance organization and the related areas. To properly control the maintenance of any facility, information is required to analyze what is occurring. Manually, this requires a tremendous amount of effort and time. In recognition of this, many of the progressive companies are developing and using computer programs geared toward control of the maintenance organization. These systems are often referred to as computerized maintenance management systems (CMMS).

What is Maintenance?

- **Maintenance** - any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair the equipment. Note that modifications are not maintenance, even though they may be carried out by maintenance personnel.

What is Maintenance?

- Maintenance is war. Your enemies are the triumvirate of breakdown, deterioration, and all types of unplanned events. Your soldiers are the maintenance department and as many civilians as you can recruit. The civilians you protect are production workers, office workers, drivers, and all the other users of your organization's assets.

Joel Levitt

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What is Maintenance?

- Keeping equipment's available, reliable and cost optimized

Asset ?

- **Asset** - unlike in the accounting definition, in maintenance this is commonly taken to be any item of physical plant or equipment
- It is the basic unit of maintenance.

Asset Management ?

- **Asset Management** - the systematic planning and control of a physical resource throughout its life. This may include the specification, design, and construction of the asset, its operation, maintenance and modification while in use, and its disposal when no longer required.

Maintenance Function ?

- *The maintenance department has a more involved list of functions or responsibilities. These can be grouped into five main areas:-*
 1. Maintenance of existing equipment.
 2. Equipment inspection and services.
 3. Equipment installation.
 4. Maintenance storekeeping.
 5. Craft administration.

Maintenance Function ?

1. Maintenance of Existing Equipment

- ❖ Maintaining existing equipment is the basic reason for the department.
- ❖ The maintenance group will make repairs to the production equipment as quickly and economically as possible. They should be able to anticipate repairs, based on previous experience with the equipment.
- ❖ To prevent rapid wear of the equipment, the group should utilize cost-effective preventive maintenance programs.
- ❖ To perform these tasks as efficiently and cost effectively as possible requires the utilization of a trained workforce and the use of modern tools and maintenance methods that are available.
- ❖ However, performing all of the above tasks depends on one important item accurate record keeping. Without accurate records, it will not be possible to complete the assigned tasks in a timely and cost-effective manner.

Maintenance Function ?

2. Equipment Inspections and Service

- ❖ This task will require the engineer or manufacturer to determine the proper lubricant for the equipment. In addition to the type of lubricant, the proper amount and time intervals of application of the lubricant are necessary. The inspections are required to ensure that the equipment is in safe operating condition and is being serviced in a timely manner.
- ❖ Some installations will require that the operational personnel do some routine lubrication and servicing. Even where this is a common practice, the maintenance department should oversee the completion of the tasks.

Maintenance Function ?

3. Equipment Installation

- ❖ This responsibility varies from industry to industry and depends on the size of the installation and the maintenance workforce.
- ❖ Some industrial facilities that require constant equipment changeover may have an installation department.
- ❖ When large installation projects occur in some industries without the necessary workforce, outside contractors are used to supply the needed manpower.

Maintenance Function ?

4. Maintenance Storekeeping

- ❖ This responsibility of the maintenance group involves the receiving and distribution of the spares necessary for the repair and upkeep of the plant equipment.
- ❖ There are several important tasks involved in this responsibility. The first is recording the necessary spares for each piece of equipment. With all of the spares recorded, the maintenance group has the responsibility of setting the inventory level for each part. As the spares are used, the replacements will have to be ordered.
- ❖ The ordering process is important to prevent material outages in the stores. Material outages could result in production delays, if equipment breakdowns occur and no replacement parts are available. Keeping the stores inventory level as low as possible will prevent tying up capital investments in spares.

Maintenance Function ?

5. Craft Administration

- ❖ This is the responsibility of controlling the manpower used by the maintenance department.
- ❖ The most cost-effective way of determining the size of the workforce is the work in the maintenance backlog. By looking in the backlog, the number of employees for each craft area can easily be determined. As programs are changed and equipment is added or deleted from a department, the workforce can be adjusted as necessary.
- ❖ The responsibility for providing the necessary tools and supplies for the crafts is also included in this area.

Maintenance Objectives

1. To keep the maintenance cost per production item produced as low as possible.
2. To keep the quality of the product very high.
3. To keep the downtime for critical equipment as low as possible.
4. To keep maintenance cost as low as possible for non-critical equipment.
5. To provide and maintain adequate facilities.
6. To provide effective and trained supervision.

What is Management?

- Art of doing what is possible out of what is available
- Sharing in overheads that leads to unity of goal
- Coordination of different tones in a harmony
- Guaranty of never being caught in a surprise condition

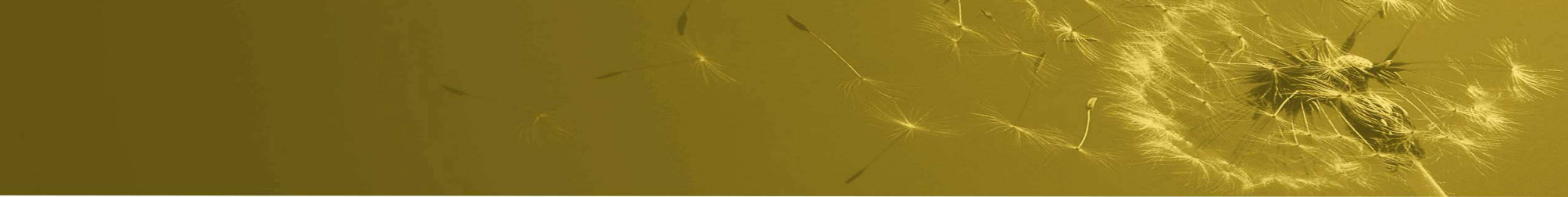
Maintenance Management

- Maintenance Management is defined as the organization of maintenance within an agreed policy.
- Maintenance Policy is a statement of principle used to achieve maintenance objectives and guide Maintenance Management decision making.

Maintenance Philosophy (Policy)

In general the following items represent the main aspects of maintenance philosophy or policy:

- Maintenance organization i.e., centralized versus decentralized maintenance.
- In-house versus outside contracting maintenance.
- Preventive versus predictive maintenance.
- Repair versus replacement.

A decorative header image showing dandelion seed heads against a golden-yellow background.

Chapter II

Maintenance Policies

Maintenance Policies

This chapter covers basic policies for the operation of a maintenance-engineering department.

While many of these policies overlap and are interdependent, they may be grouped in four general categories:

- ✓ *Policies with respect to work allocation*
- ✓ *Policies with respect to workforce*
- ✓ *Policies with respect to interplant relations*
- ✓ *Policies with respect to control*

Maintenance Policies

Policies with respect to work allocation

To Schedule or Not to Schedule?

□ It is generally accepted that, in any maintenance department where there are more than 10 men and more than two or three crafts, some planning, other than day-to-day allocation of work by foremen, can result in improved efficiency.

□ As the size of the maintenance organization increases, the extent to which work planning can be formalized and the amount of time that should be spent on this activity are increased. There should be only as much planning as necessary for maximum overall efficiency so long as the system costs less than the cost of operating without it.

Maintenance Policies

Policies with respect to work allocation

How Much Scheduling ?

□ There are practical limitations to any scheduling system. A very detailed schedule that becomes obsolete after the first hour or two of use because of emergencies is of little value.

□ If, however, actual performance indicates from 60 to 80 percent adherence during normal operation, the value of the schedule is real.

□ Justification of any scheduling system requires proof of its effectiveness in cost saved. Where some form of incentive system or work measurement exists, such proof is readily available. But in most maintenance departments no such definitive method is available and the only criteria of measurement are overall trends in maintenance costs and quality of service.

Maintenance Policies

Policies with respect to work allocation

How Much Scheduling ?

□ Some aspects to be considered in arriving at a sound work-scheduling procedure are:

➤ **Work Unit.** Most detailed schedules are laid out in terms of man-hours or, if standard times are used, fractions of hours. Other scheduling systems use a half man-day as a minimum work unit. Others may use a man-day or even a man-week as a basis.

Maintenance Policies

Policies with respect to work allocation

How Much Scheduling ?

□ Some aspects to be considered in arriving at a sound work-scheduling procedure are:

➤ **Size of Jobs Scheduled.** Some work-scheduling systems handle small jobs as well as large ones. Others schedule only major work where the number of men and the length of time involved are appreciable.

Maintenance Policies

Policies with respect to work allocation

How Much Scheduling ?

□ Some aspects to be considered in arriving at a sound work-scheduling procedure are:

➤ Percent of Total Work Load Scheduled. Although in some cases all work may be scheduled, the most effective systems recognize the inability of any maintenance-engineering department to anticipate all jobs, especially those of an emergency nature, and do not attempt scheduling for the entire work force. A portion of the available work force is left free for quick assignment to emergency jobs or other priority work not anticipated at the time of scheduling.

Maintenance Policies

Policies with respect to work allocation

How Much Scheduling ?

□ Some aspects to be considered in arriving at a sound work-scheduling procedure are:

➤ Lead Time for Scheduling. Some scheduling systems do not attempt to cover breakdown repairs and are limited to the routine preventive maintenance and to major work that can be anticipated and scheduled well in advance. In these cases a monthly or biweekly allocation of manpower suffices. In most instances, however, a weekly schedule with 2 or 3 day lead-time results in good performance, yet is sufficiently flexible to handle most unexpected work.

Maintenance Policies

Policies with respect to work allocation

Selection and Implementation of a Scheduling System

□Flow-of-Work Requests.

□Before any formalized scheduling program can be initiated, the method of requesting work from the maintenance department should be formalized.

□This request may take the form of a work description or job ticket, listing manpower or equipment requirement, or it can be in the form of a work sheet on which the same type of information is accumulated by either verbal or written communication.

□It must be routed to one central point if a scheduling system is to be used. In a small plant this can be the shop foreman, the maintenance superintendent, or the plant engineer. In a larger maintenance department it should be through a staff individual or group.

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Maintenance Policies

Policies with respect to work allocation

Selection and Implementation of a Scheduling System

□Determination of Priority

□In any maintenance organization, which is efficiently manned, the work load in terms of quantity or timing, exceeds the availability of men and/or equipment.

□For this reason the problem of defining the order in which the work is to be carried out. or establishing priority, exists and is an important factor in scheduling.

Maintenance Policies

Policies with respect to work allocation

Selection and Implementation of a Scheduling System

□Determination of Priority (Cont.)

□In a small plant with one operating department and a small maintenance organization, establishment of priorities may amount to casual discussion between maintenance and production.

□However, as the plant grows and the maintenance department is called upon to provide service to more than one production department, the problem of equitable and efficient priority assignment becomes more involved. One of the most serious problems in maintaining good relations between maintenance and production departments is in this sphere.

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Maintenance Policies

Policies with respect to work allocation

Preventive vs. Breakdown Maintenance

□ Preventive maintenance has long been recognized as extremely important in the reduction of maintenance costs and improvement of equipment reliability. In practice it takes many forms.

□ Two major factors that should control the extent of a preventive program are first, the cost of the program compared with the carefully measured reduction in total repair costs and improved equipment performance; second, the percent utilization of the equipment

Maintenance Policies

Policies with respect to work allocation

Preventive vs. Breakdown Maintenance (Cont.)

□ If the cost of preparation for a preventive-maintenance inspection is essentially the same as the cost of repair after a failure accompanied by preventive inspections, the justification is small. If, on the other hand, breakdown could result in severe damage to the equipment and a far more costly, repair, the scheduled inspection time should be considered.

Maintenance Policies

Policies with respect to work allocation

Preventive vs. Breakdown Maintenance (Cont.)

□ plant preventive maintenance should be tailored to fit the function of different items of equipment rather than applied in the same manner to all equipment.

□ Indeed, a program of unit replacements can result in considerably lower maintenance costs where complete preventive maintenance is impractical.

□ In a plant using many pumps, for instance, a program of standardization, coupled with an inventory of complete units of pumps most widely used, may provide a satisfactory program for this equipment.

Maintenance Policies

Policies with respect to work allocation

Preventive vs. Breakdown Maintenance (Cont.)

□ One of the most effective methods of tempering ideal preventive maintenance with practical considerations of a continuous operation is that of taking advantage of a breakdown in some component of the line to perform vital inspections and replacements which can be accomplished in about the same time as the primary repair.

□ Production supervision usually can be sold the need for a few more hours' time for additional work with repair of a breakdown much more easily than they can be convinced of its necessity when things are apparently running smoothly.

Maintenance Policies

Policies with respect to work allocation

Preventive Engineering

□ One of the most important tools in minimizing downtime, whether or not a conventional preventive-maintenance program is possible, is called "preventive engineering."

□ Too often maintenance engineers are so busy handling emergency repairs or in other day-to-day activities that they find no opportunity to analyze the causes for breakdowns, which keep them so fully occupied.

Maintenance Policies

Policies with respect to work allocation

Preventive Engineering

□ While most engineers keep their eyes open to details such as better packings, longer-wearing bearings, and improved lubrication systems, true preventive engineering goes further than this and consists of actually setting aside a specific amount of technical manpower to analyze incidents of breakdown and determine where the real effort is needed; then through redesign, substitution, changes, and specifications, or other similar means, reducing the frequency of failure and the cost of repair.

□ Effective preventive engineering can result only when it is recognized as an independent activity of a research nature that cannot be effectively sandwiched into the schedule of a man who is occupied with putting out fires.

Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

- The primary factor in deciding whether to use an outside contractor is cost. Is it cheaper to staff internally for the performance of
 1. The type of work involved,
 2. The amount of work involved, and
 3. The expediency with which this work must be accomplished?
- In studying these relative costs it is not sufficient to consider the maintenance cost alone. The cost to the company, including downtime and quality of performance, must also be considered.

Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

There are a number of issues facing organizations that are considering maintenance outsourcing as an improvement initiative :

- To outsource or not outsource - strategic decision making
- Does a competitive outsourcing market exist?
- How much maintenance to outsource
- Establishing an appropriate tendering process
- Establishing an appropriate specification of requirements
- Establishing an appropriate contract payment structure
- Establishing an appropriate contract administration process and structure
- Establishing an appropriate structure for the contract document
- Managing the transition to the outsourced arrangement
- Contract termination arrangements

Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

To outsource or not outsource - strategic decision making:-

- **Conventional wisdom regarding the outsourcing decision states that you should outsource your "non-core" business activities.**



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

	Strategic	Non-Strategic
Competitive	As Is	(Needs discussion)
Non-Competitive	Re-engineer	Outsource



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

- ❖ In the last diagram, we consider the outsourcing decision along two dimensions. The first, Strategic-Non Strategic, considers how important the activity proposed for outsourcing is to the organization in achieving long term strategic competitive advantage in its chosen marketplace.
- ❖ The second dimension, Competitive-Non Competitive, relates to how competitively the function being considered for outsourcing is currently being performed compared to the external competitive marketplace.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Putting the two elements together gives four possible outcomes.

1. Those functions that are of Strategic importance to the firm, and which are currently being performed competitively require no further action - the status quo should be retained.
2. Those functions that are of Strategic importance to the firm, but which are not currently being performed competitively with the external marketplace should not (in the long run) be outsourced. Instead, a better long-term option is to re-engineer them to ensure that they are performed at a competitive cost.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

3. Those functions that are not of Strategic importance to the firm, and which are not currently being performed competitively with the external marketplace should be outsourced. There is little value in investing in improving this function.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

4. The final combination, those functions that are not of Strategic importance to the firm, but which are being performed competitively with the external marketplace is more interesting. A number of options exist :

- ❖ selling the function as a going concern,
- ❖ extending the function to provide services to external customers,
- ❖ outsourcing the function, or
- ❖ raise the profile of the function to turn it into a source of strategic competitive advantage.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Does a competitive outsourcing market exist?

- ❖ A second consideration for outsourcing, is to decide whether a competitive market for the outsourced services actually exists.
- ❖ By adopting an appropriate outsourcing strategy (such as letting work to two or more contractors, rather than to one exclusively), awareness of this possible outcome prior to establishing the outsourcing strategy is vital if the outsourcing organization is not to find itself "locked in" to a sole provider.



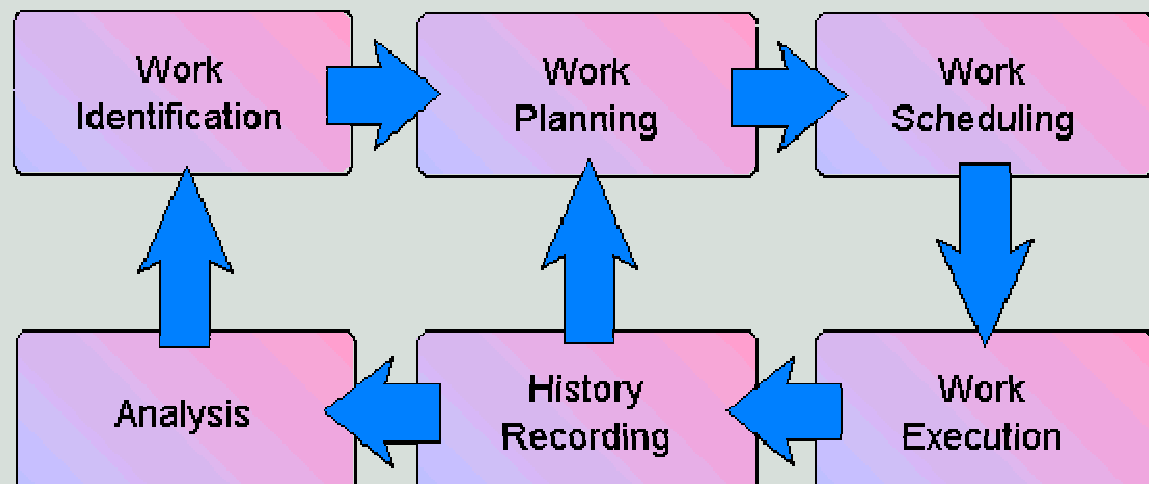
Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

An important consideration in making the maintenance outsourcing decision is what aspects of maintenance to outsource. If we consider the maintenance management process as consisting of six major steps, as shown below, then a number of options exist.



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Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

- ❖ In the first instance, organizations may choose simply to outsource the work execution step, while retaining the remaining steps in-house. This is often done on a limited basis, for example, when employing contractors to supplement an in-house work force during times of high workload, during major shutdowns, for example. This is the minimalist approach to outsourcing.
- ❖ An alternative approach is to outsource all of the above activities with the exception of the analysis and work identification steps. In this approach, the contractor is permitted to plan and schedule his own work, and decide how and when work is to be done, but the outsourcing organization retains control over what is to be done.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

- ❖ A third approach is to outsource all of the above steps, thus giving control over the development of equipment maintenance strategies (ie Preventive and Predictive Maintenance programs) to the contractor. In this instance, the contract must be structured around the achievement of desired outcomes in terms of equipment performance, with the contractor being given latitude to achieve this to the best of his ability.
- ❖ There are advantages and disadvantages to each approach, and the most appropriate approach will depend on the client's particular situation.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

- ❖ Many organizations today are adopting Total Productive Maintenance principles, which encourage Production operators to take a higher level of responsibility for equipment performance, and also encourage them to perform many minor maintenance tasks. There is also a growing realization that the manner in which equipment is operated can have a huge bearing on maintenance costs and the maintenance activities required to be performed if equipment performance targets are to be met.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

- ❖ A high level of teamwork between the Maintenance contractors and the Production operators is, therefore, vital to the successful completion of the contract. This leads to the view that an alternative, and possibly better, approach to the outsourcing of maintenance is to include plant operation in the scope of the contract.



Material Collected By: A.H



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

How much maintenance to outsource?

- ❖ Finally, taking things one step further again, there is also a growing realization that maintenance is limited in achieving higher equipment performance by the fundamental design of the equipment being maintained.
- ❖ There is, therefore, a school of thought that says that the best way to overcome this limitation, in an outsourcing environment, is to also give the contractor responsibility for the design of the equipment. This can be done either by giving him responsibility for ongoing equipment modifications, or by giving him responsibility for the initial design of the equipment, as in a BOOM (Build, Own, Operate and Maintain) contract, which is gaining favour in many infrastructure projects.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate tendering process

- ❖ The tendering process for a major outsourcing contract is likely to be different to the contracting process for major capital works in a few key aspects.
- ❖ Of particular importance will be the explicit consideration of risk at various key points in the contracting process, and the identification of appropriate strategies for managing those risks. These could take the form of either shaping or hedging actions. Shaping actions are those action undertaken to minimize the likelihood of the risk factor occurring. Hedging actions are those actions undertaken to minimize the impact of the risk factor, should it occur.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate tendering process

- ❖ In addition, the evaluation criteria for the selection of an appropriate maintenance contractor are likely to be quite different from those for a major capital project. It is likely that significant work will be required to develop appropriate criteria, and to ensure that sufficient information is obtained from tenderers to be able to make an informed decision.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate specification of requirements:

- ❖ The specification of requirement during the tendering process will need to be carefully considered.
- ❖ Ensure that the requirements specification is outcome-based, rather than input-based. In other words, the specification will need to detail **what** is to be achieved from the contract, not **how** it is to be achieved, or what inputs will be required for its achievement.
- ❖ Ensuring that **all** the required outcomes are specified is a major undertaking. Agreeing how the achievement of all of these outcomes will be measured is also, potentially, a huge undertaking. Deciding how to measure that was a difficult process.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate contract payment structure

❖ **There are a number of alternative contract payment structures. These include but not limited to:**

- ❖ Fixed or Firm price
- ❖ Variable Price
- ❖ Price ceiling incentive
- ❖ Cost plus incentive fee



❖ **Each of these price structures represents a different level of risk sharing between the contractor and the outsourcing organization.**



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate contract payment structure

- ❖ A number of considerations will need to be made in determining the most appropriate payment structure. These include:
 - ❖ The extent to which objective assessment of contract performance is possible
 - ❖ The ease with which realistic targets can be set for contractor performance
 - ❖ The administrative effort involved with each payment option
 - ❖ The degree of certainty with which the desired contract outcomes can be specified.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate contract payment structure

Transition arrangement may be put in place to gradually transfer the payment structure from one method to another over time, as a greater degree of certainty over the requirements of the contract, and more accurate knowledge of target levels of performance is established.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate contract administration process and structure

- ❖ Before the contract is let, the client will need to have decided on the appropriate contract administration process, and the roles and responsibilities of his own staff in managing the contract.
- ❖ He will also need to establish the structures, processes and equip his people with the skills to perform the required duties.
- ❖ We have seen many potentially successful outsourcing contracts fail, simply because the client did not manage those contracts effectively.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Establishing an appropriate structure for the contract document

- ❖ Most standard contracts in place at most organizations, are not appropriate for large outsourcing contracts. Many Standard Terms and Conditions are inappropriate for large, long-term service-related contracts .
- ❖ It is best to combine Special Conditions of Contract with revised Standard Conditions of Contract to develop a new contract structure that is appropriate for the particular contract being let.



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Managing the transition to the outsourced arrangement

- ❖ There are many issues to be addressed by the outsourcing organization in the transition to the new arrangements. Among these are matters such as:
 - ❖ **Staff** - which will be retained by the organization, which will be employed by the contractor, which will be let go?
 - ❖ **Drawings** - who has responsibility for ensuring that drawings are kept up to date, who will be the custodian of site drawings?
 - ❖ **Computer systems** - will the contractor have access to the client's Computerized Maintenance Management system? Will they maintain their own computerized Maintenance records? Who is responsible for ensuring that all data in the Computerized Maintenance Management systems are accurate?



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Managing the transition to the outsourced arrangement

- ❖ There are many issues to be addressed by the outsourcing organization in the transition to the new arrangements. Among these are matters such as:
 - ❖ **Materials Management** - will the contractor provide his own materials, or will the client provide these?
 - ❖ **Workshop facilities and tools** - who owns and maintains these?



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Contract termination arrangements

- ❖ Another critical issue that needs to be addressed before the contract is let, is how the situation will be managed if the decision is made to terminate the existing contract.
- ❖ In particular, agreement needs to be reached regarding the duties and obligations of the outgoing contractor in handing over to the incoming contractor (or the client organization, should they decide to bring maintenance back in-house).



Maintenance Policies

Policies with respect to workforce

Own Work Force or Outside Contractors?

Conclusion

- ❖ While these are some of the major considerations for organizations considering outsourcing maintenance, there are many others.
- ❖ Needless to say, the decision to outsource any major function, such as maintenance, is not one that should be taken lightly, and careful consideration of all major issues is vital, if the transition to contracted maintenance is to be smooth and satisfactory to both parties.



Maintenance Policies

Policies with respect to workforce

Shift Coverage

- ❖ **The two extremes in providing maintenance for continuous operation are to provide full coverage during all hours that the plant is in operation or to maintain day coverage only, letting the plant shift for itself during other periods or to accept minimum essential service on call-in, overtime basis.**
- ❖ **The optimum arrangement is something in between, depending a great deal upon circumstances in an individual plant.**



Maintenance Policies

Policies with respect to workforce

Shift Coverage

- ❖ **In considering the staffing of a maintenance department to cover more than one-shift operation, many factors are involved:**
 - ❖ **Efficiency of the Worker.**
 - ❖ **Location of the plant.**



Maintenance Policies

Policies with respect to workforce

Centralization vs. Decentralization

Advantages of a centralized maintenance shop are:

1. Easier dispatching from a more diversified craft group
2. The justification of more and higher-quality equipment
3. Better interlocking of craft effort
4. More specialized supervision
5. Improved training facilities



Maintenance Policies

Policies with respect to workforce

Centralization vs. Decentralization

The advantages of decentralized maintenance are:

1. Reduced travel time to and from job
2. More intimate equipment knowledge through repeated experience
3. Improved application to job due to closer alliance with the objectives of a smaller unit— "production-mindedness".
4. Better preventive maintenance due to greater interest
5. Improved maintenance production relationship



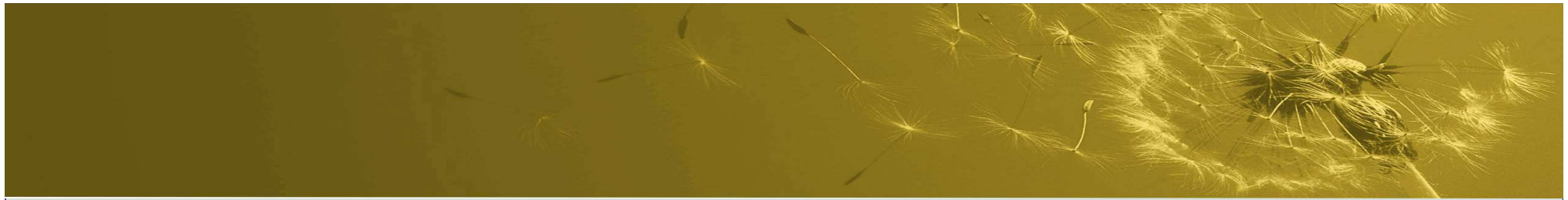
Maintenance Policies

Policies with respect to workforce

Centralization vs. Decentralization

- ❖ **In practice, however, it has been found that neither one alone is the panacea for difficulties in work distribution.**
- ❖ **Often a compromise system in which both centralized and decentralized maintenance coexist has proved most effective.**





Chapter III

Maintenance Planning & Scheduling

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Breakdown Maintenance
- Scheduled Shutdown Maintenance
- Preventive Maintenance
- Predictive Maintenance

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Breakdown Maintenance (BM)

An Equipment Maintenance Strategy, where no routine maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is Corrective Maintenance, and then only after the equipment has suffered a failure. Also described as a Run-to-Failure strategy.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Breakdown Maintenance (BM)
 - Is generally the economic approach for equipment which causes no significant safety hazards or loss of revenue and suffers little consequential damage on breakdown.
 - Ex: small pipe work leaks and non critical mechanical, electrical and instruments faults

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- **Corrective Maintenance (CM)**
 - It is the measure of Preventive Maintenance and Predictive Maintenance success and effectiveness
 - Using the established protocols, training and planning of Preventive Maintenance in conducting corrective maintenance tasks

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- **Scheduled Shutdown Maintenance (SSM)**
 - One of the oldest strategy for maintenance.
 - There will be a situation in which scheduled shutdown maintenance is required. This may be due to regulation, essential inspections, major cleaning and repair work, which for safety or technical reasons, cannot be carried on stream.
 - Scheduling of down time to be arranged with production department according to production plane.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Scheduled Shutdown Maintenance (SSM)
 - Modes:
 - Separate Mode (SSM is executed every plant, separately.
 - Plant Group Mode: All the complex is divided into a few plants groups.
 - Whole refinery mode.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Preventive Maintenance (PM)
 - an equipment maintenance strategy based on replacing, overhauling or remanufacturing an item at a fixed interval, regardless of its condition at the time.
Scheduled Restoration tasks and Scheduled Discard tasks are both examples of Preventive Maintenance tasks
 - It was introduced for the first time in 1950s from USA.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Preventive Maintenance (PM)
 - Should only be applied where the probable cost of lost revenue and/ or consequential damage resulting from failure scientifically exceeds the cost of such preventive maintenance work and associated down time.
 - Suitable application for preventive maintenance , typically would be large, high speed rotating machinery, un spared unit charge pumps, condensers and coolers prone to salt plugging, electrical switch gear, motor and critical instrumentation.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

Necessity and Benefit of Applying PM Program

- Availability of information
- Trend tracking
- Prevention of sudden failure
- Optimizing equipment performance
- Managing the manpower
- Minimizing the inventory stock

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

Major Steps of Setting up a PM Program

- Collecting the equipment's to be maintained and classifying them
- Establishing common standard procedures
- Specifying the tools
- Specifying the spare parts
- Sharing departments
- Manpower
- Time Scheduling and due dates resolution

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Predictive Maintenance (PDM)
 - An equipment maintenance strategy based on measuring the condition of equipment in order to assess whether it will fail during some future period, and then taking appropriate action to avoid the consequences of that failure. The condition of equipment could be monitored using Condition Monitoring, Statistical Process Control techniques, by monitoring equipment performance, or through the use of the Human Senses. The terms Condition Based Maintenance, On-Condition Maintenance and Predictive Maintenance can be used interchangeably.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Predictive Maintenance (PDM)
 - Was introduced around 1970 to improve the defect of over maintenance that preventive maintenance inherently held.
 - It is the application of measurement techniques, usually on-stream, designed to provide information on the current condition of a piece of equipment or system so as to allow the timing extent of preventive maintenance to be decided on rational basis.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Predictive Maintenance (PDM)
 - Includes corrosion measurement activities by using ultrasonic test, radiograph test, Corroso Meter, ...etc, that were called “On Stream Inspection” (OSI), as well as rotating machinery diagnosis activities using vibration and noise analysis, etc....
 - Predictive maintenance indicates generally only the diagnosis, and if deterioration are detected in diagnosis and consequently overhaul is requested the execution of repair will be arranged in schedule of Preventive Maintenance.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Unit Run lengths and Shutdown Duration:
 - Process unit runtime should be established, within the constraints of safety and legal requirements on the basis of maximizing the profitability of operation.
 - It is normally necessary for planning purposes to fix a schedule for the shutdown of process units .
 - Similarly shutdown durations should be set at an optimum which balance profit lost during down time against the cost of additional resources required to reduce such downtime.

Maintenance Planning & Scheduling

Maintenance Types (Strategies)

- Emergency Maintenance:
 - All works should require a formal work order.
 - Emergency maintenance and critical maintenance (work needed immediately or within 24 hours) is seldom planned.

Maintenance Planning & Scheduling

Planning:

- Management surveys show that the average productivity of maintenance employees is between 25 and 35%.
- This means that a craftsman has less than 4 hours of productive time per 8-hour day due to poor maintenance management.

Maintenance Planning & Scheduling

The following are some of the most common wastes of productive time:-

- Waiting for instructions
- Looking for supervisors
- Checking out the job
- Multiple trips to the stores
- No special tools
- Waiting for approval
- Too many craftworkers per job
- Insufficient workers scheduled for the job.
- Incomplete planning & communications
- Waiting for equipment to be shutdown
- Waiting for drawings from engineering

Maintenance Planning & Scheduling

- On the average, 2 hours are lost every time worker is pulled off a job for any reason.
- To prevent this major loss of productivity, it is necessary to implement some form of job planning function.
- The concept of job planning is to determine what is to be done and how it is to be done.
- Job planning consists of two main areas:
 - Craft skills
 - Material required for the job.
- These labor and material requirements may be converted to dollars to give an estimate of the cost of completing the work order.

Maintenance Planning & Scheduling

Planning

- Planning can be accomplished by the supervisor if there are relatively few maintenance personnel.
- If there are more than 20 craftsmen, planning is best done by separate maintenance planners, otherwise the foremen have a tendency to do paperwork when they could more profitably spend their time in supervising and directing the work of the craftsmen.

Maintenance Planning & Scheduling

Type of Work to be planned:

- Emergency maintenance and critical maintenance (work needed immediately or within 24 hours) is seldom planned.
- These request are of short duration and are performed so quickly that there is no time to plan them.
- These types of work orders should not be considered in planning functions

Maintenance Planning & Scheduling

Type of Work to be planned:

- Normal corrective or routine work orders should be the primary consideration of the planning function.
- These work orders are received and placed in work backlog.
- As the workforce and materials become available to carry out the work, it is scheduled.
- Included in this type of work are preventive and predictive maintenance work orders.

Maintenance Planning & Scheduling

Type of Work to be planned:

- The other group of work requests that can be planned are the shutdown, turnaround, or the outage work orders.
- For this type of work, it is important that the equipment be shut down and overhauled in the shortest possible time.
- Only by accurate estimating and scheduling of these work requests can the shutdown be successful.

Maintenance Planning & Scheduling

How to Plan Maintenance Work :

- Effective planning requires the planners to be skilled and knowledgeable in the craft area they are planning; therefore, supervisors or top craftsmen will make the best planners.
- If an inexperienced individual is promoted to planner, the results of the planning program will not be satisfactory. Instead of increasing productivity, you may find productivity decreasing.

Maintenance Planning & Scheduling

How to Plan Maintenance Work :

- The planning begins once the work order is approved by management.
- It is then assigned to the planner, who carefully studies the job.
- The planner must decide the following:-
 1. The crafts required,
 2. The time required,
 3. The materials required, and
 4. Whether outside help in the form specialists, contractors, or special rental equipment is required.

Maintenance Planning & Scheduling

How to Plan Maintenance Work :

- When the planner is deciding on the required crafts, he must also decide not only the number of craftsmen, but also the skill level required.
- The time estimate for work order is important. If there is no time estimate, you will never know the man-hours of work that is in the crafts backlog. Without this information, you can never accurately determine the proper staffing levels for your plant.

Maintenance Planning & Scheduling

How to Plan Maintenance Work :

- The material required for the work order will determine whether it can be scheduled.
- If the necessary materials are not available and the work order is scheduled, the craftsmen will lose productivity looking for the spare parts and waiting for supervisor to find them work that can be performed.
- It is also necessary to plan the materials so that an accurate estimate of the cost of the work order can be obtained.

Maintenance Planning & Scheduling

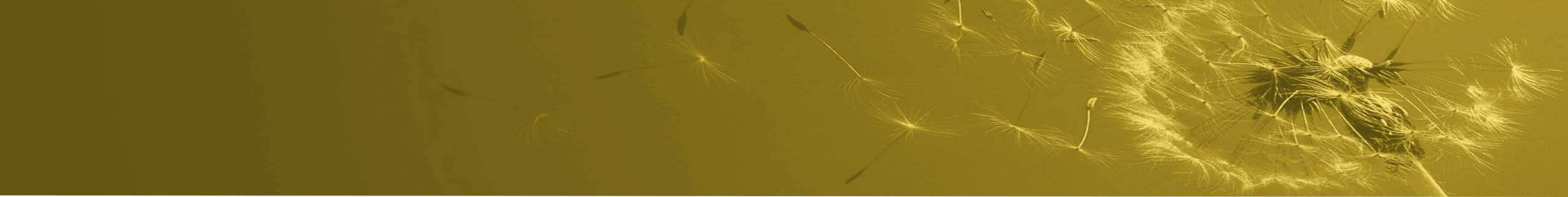
How to Plan Maintenance Work :

- The miscellaneous items to be planned are important to proper completion of the work order.
- If special skills are required from outside source, the in-house craftsmen may not be able to complete the work order quickly or with necessary quality.
- Also, if special tools or equipment are required, it would be pointless to schedule the work order without them.
- Once the work order is planned and scheduled, the planner should be available in case question arise on procedure or materials for the work order.

Maintenance Planning & Scheduling

Benefits of Planning Maintenance

- Long term plans insight
- Decision making support
- Optimizing connectivity among operation and maintenance departments
- Figuring out areas of cost reduction
- Training areas and needs

A decorative header image showing dandelion seed heads against a golden-yellow background.

Chapter IV

Work Order System

Maintenance Work Order

- Before computerization of a maintenance organization can begin, there is a need to setup a method of collecting the information.
- The basic device used to enable a maintenance organization to collect and organize this information is the work order.
- The work request is a form that is used to initiate a request for maintenance work.

Maintenance Work Order

- The work order should produce information on the following:-
 - Maintenance performance
 - Maintenance cost
 - Equipment history.
- By careful utilization of this information, the maintenance organization should be able to issue maintenance budget forecasts allowing the various areas serviced to plan for necessary maintenance expenditures.

Maintenance Work Order

- In addition to the preceding objectives, work order should also be capable of providing the following:-
 - A method for requesting maintenance services
 - A method for recording maintenance tasks and their start and completion dates.
 - A method of identifying the type of work to be performed.
 - A method of providing detailed instructions for each step of the job to be performed.
 - A method of authorizing work when the costs will exceed certain level.
 - A method of planning & scheduling the work.
 - A method of assigning the work to the craftsmen
 - A method of recording the use of special tools and materials.
 - A method of recording labor and materials cost.
 - A method of generating reports that can be measure labor and supervision efficiency.
 - A method of generating reports that allow for cost analysis of all maintenance tasks

Maintenance Work Order

– Work Order Number:

- The key to the success of a work order system is the work order No.
- This number identifies the specific maintenance request.
- All maintenance charges (labor, materials, etc..) are identified by this number.
- To properly utilize the work order, a number must be assigned to each work request. This is for any work whether planned, unplanned, emergency, or preventive maintenance.

Maintenance Work Order

- Planned work is work requested that can be planned, scheduled , and completed without causing delays to the operations.
- Unplanned work is work request that is of short duration and that may be performed by craftsman while working on an another task in the same area.
- Emergency work requests (also called breakdowns orders) are requests for the work due to equipment breakdowns or pending breakdowns. There may not be time to fill out a work order before the work is started. However, to make the system work properly, the work request should be filled out at the first opportunities.
- This will still allow for all related costs to be charged to the work order number.

Maintenance Work Order

Work Order Forms

Once the numbering system is devised, the work order form must be considered. The maintenance department may choose to use forms that are supplied by certain vendors, or may choose to make up its own forms and have them printed. Whichever is chosen, the following are points to considered when selecting a work order form:

Maintenance Work Order

Work Order Forms

Work Request Definition:

- The work order form should provide for the individual work order number. The forms may be preprinted with a sequential number on each form. The form should also provide a means for entering the equipment number (identifying where the work is being performed) for tracking the maintenance costs. For accounting purposes, the report should provide a space for entering an accounting or project number.

Maintenance Work Order

Work Order Forms

Work Request Definition:

- In further specifying the work request, the work order should include:
 - priority rating
 - the type of work to be performed
 - a description of the work requested.
- In some installations, the priority and type of work are coded; that is, a list of the possible priorities and work types is made up and codes are assigned. To keep the records consistent, each work request is then assigned a priority code and a work class code, identifying the importance of the work and the type of work to be performed.

Maintenance Work Order

Work Order Forms

Work Order Scheduling

- To allow for proper scheduling of the work request, there should be some place on the work order for the supervisor (or, in some installations, a planner) to estimate the following requirements to perform the work: the man-hours, the crafts, and the materials. This will assist in proper scheduling of the work order.
- In figuring costs, there should be some method of entering planned costs by the requester. In some cases, the work order form may need a space for an individual to approve the work request if the total cost is to exceed some predetermined level.
- The work order form should also allow for detailed instructions concerning the work order to be entered. This would include the job plan (the instructions on how to carry out the work request)..

Maintenance Work Order

Work Order Forms

Report Information:

- The work order form should also allow space for the entry of the actual material and labor charges. This can be compared to the estimates, after the completion of the work order, in order to determine efficiency.
- The work order form should also allow space for the entry of the description of the actual work performed. This, when compared to the work planned, will help rate the efficiency of the planning. Also, there can be work codes specifying the work that was performed to shorten the time required in filling out the completed work order.

Maintenance Work Order

Using Work Order Forms

In practice, the following scenario is typical in processing a work order.

- **Step 1:** The work order is received by the maintenance department. The work order request is entered on a work order form with a number pre assigned to it. This number will be the key to the work order's progress through the system. Where multiple copies of the work order are used, the number should be clearly imprinted on each copy.
- **Step 2:** The individual requesting the work should be identified on the work order.
- **Step 3:** The equipment the work is being requested on, and the reason for the request, should be entered on the work order.
- **Step 4:** A detailed but brief description of the work requested should be entered on the work order. It should be noted that to save space on the form, the above information can be coded. The following are some of the fields that can be coded:
 - authorizer
 - supervisor
 - type of work
 - status
 - equipment.

Maintenance Work Order

Using Work Order Forms

- **Step 5:** The requester assigns the work order a priority, according to the standard procedures for the particular installation.
- **Step 6:** The requester enters the date of the request and the desired completion date. The requester will then keep one copy and forward the other(s) to the maintenance department.
- **Step 7:** The planner (the individual planning the work order) will review the work order request. If the planner is in agreement with the requester's input, the work order planning will begin. If the planner is not in agreement, then the requester should be contacted and the necessary changes agreed on.
- **Step 8:** Once authorization is given to perform the work, the planner begins to schedule the job. Once the planner is assured that the labor, parts, materials, and equipment are ready, the work order can be scheduled. If the work order is not to be scheduled at present, it is placed in the work backlog. The backlog is a master file of all in-completed work orders.
- **Step 9:** When the work order is scheduled, the maintenance supervisor in charge of the work will be given a copy of the work order. The supervisor will arrange the last-minute details necessary for the work to begin.

Maintenance Work Order

Using Work Order Forms

- **Step 10:** The supervisor assigns the craftsmen to the work order. Upon completion of the work order, the craftsmen report the following information:
 - materials used
 - hours worked
 - description of the actual work performed.
- **Step 11:** The supervisor verifies the information on the work order and returns it to the maintenance planner.
- **Step 12:** The maintenance planner then completes the information on the work order. After the necessary information is provided, the work order is filed in the equipment history record.

Maintenance Work Order

Work Order Forms

Usage of Completed Work Order Information

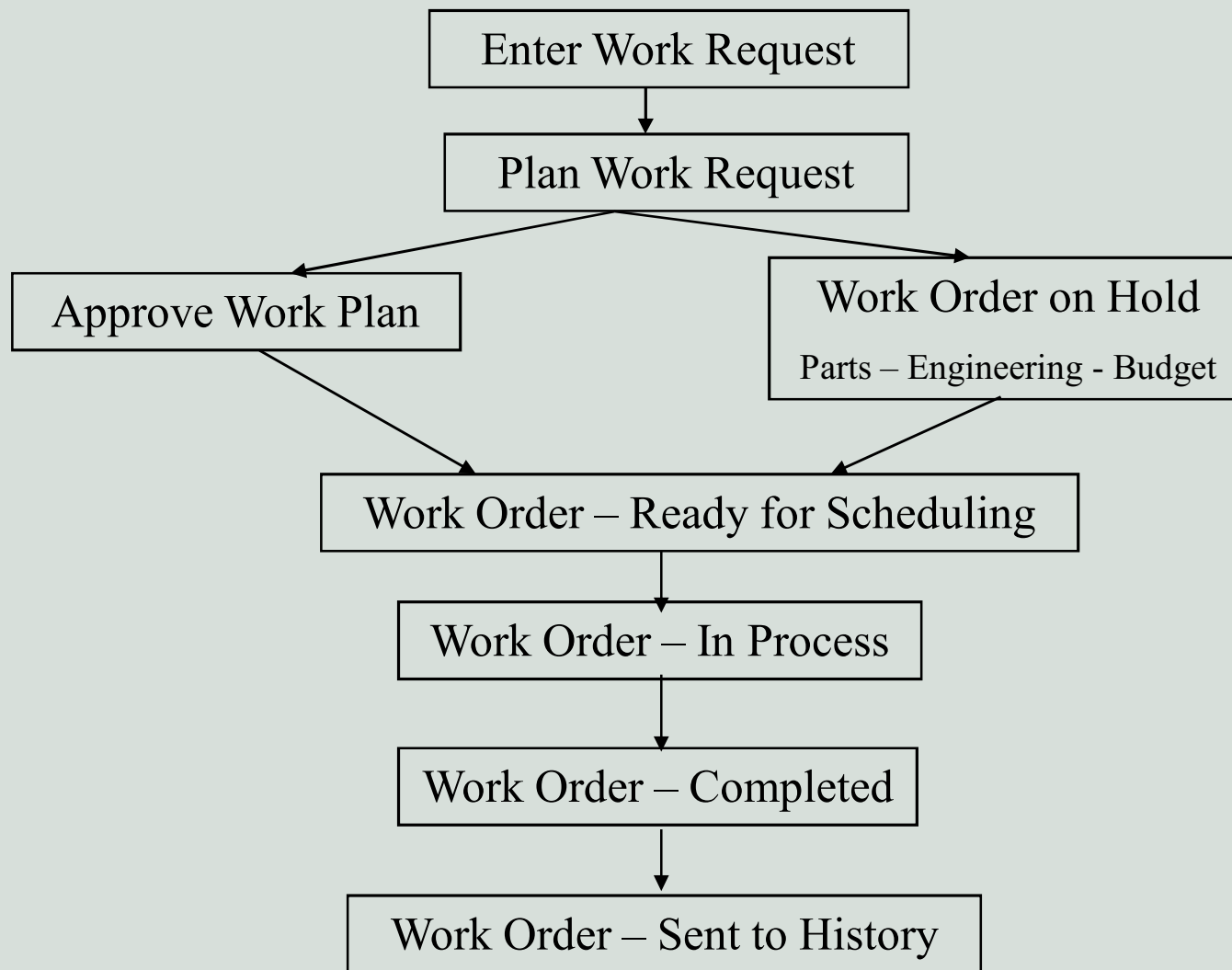
- The information on completed work orders can be used to track maintenance costs for equipment and department expenses. The two main types of expenses that can be tracked are labor and material charges.
- Labor charges are taken from the work order time charges as reported by the craftsmen and supervisors. The time charges entered are recorded as expenses against the work order. The time charges can also be used to enter the payroll information for each employee, assuring that all time is accounted for.
- Material charges are taken from the material information entered on the work order by the craftsmen or supervisor. The materials from the stores, including specific spares for the equipment, are recorded. Typical information would include the description of the material used, the part number, and the cost information (this may be filled in by the supervisor or planner). This will allow for timely reordering of critical spares. Space may be allocated for recording any special tools or equipment that the work order required.

Maintenance Work Order

Usage of Completed Work Order Information

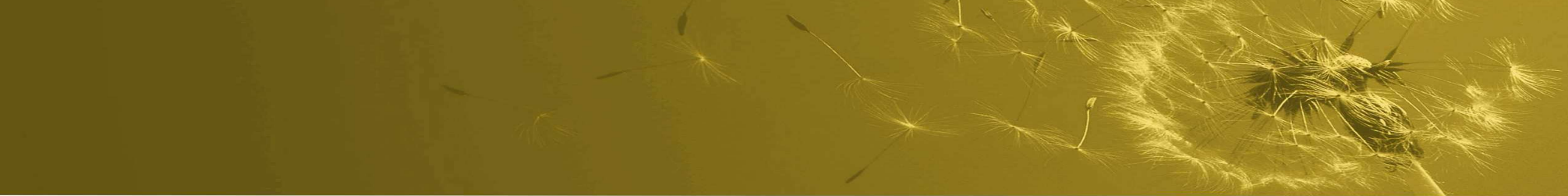
- How much information management is going to require will determine the size and detail of the work order form. A successful system will allow management to obtain the information needed to analyze costs by:
 - the job
 - equipment
 - crafts
 - priorities
 - departments.
- The backlog of work orders can also be used to determine staffing requirements and equipment shutdown periods.
- It must be kept in mind that a work order system is only as good as the personnel using it. If the personnel do not enter accurate information or are not trained in the proper use of record keeping, the system will not function properly or efficiently. By the use of skilled personnel, particularly in the planning and scheduling function, the maintenance department will operate more efficiently. Proper, realistic, and intelligent planning can result in the maintenance workforce performing 80-90% scheduled jobs and only 10-20% emergency (breakdown) or fill-in jobs. Proper use of the feedback information available by using work order system will help management upgrade and streamline the maintenance function as necessary.

Work Order Flow Diagram



Computerization of Manual Systems

- Computerization of a maintenance work order system enhance and improves maintenance efficiency if the correct computerize system for the installation is used. It must be noted that the computerized maintenance management system installation is more effective if there is a manual work order system already in effect.



Computerized Maintenance Management Systems “CMMS”

What is Computerized Maintenance Management System “CMMS”?

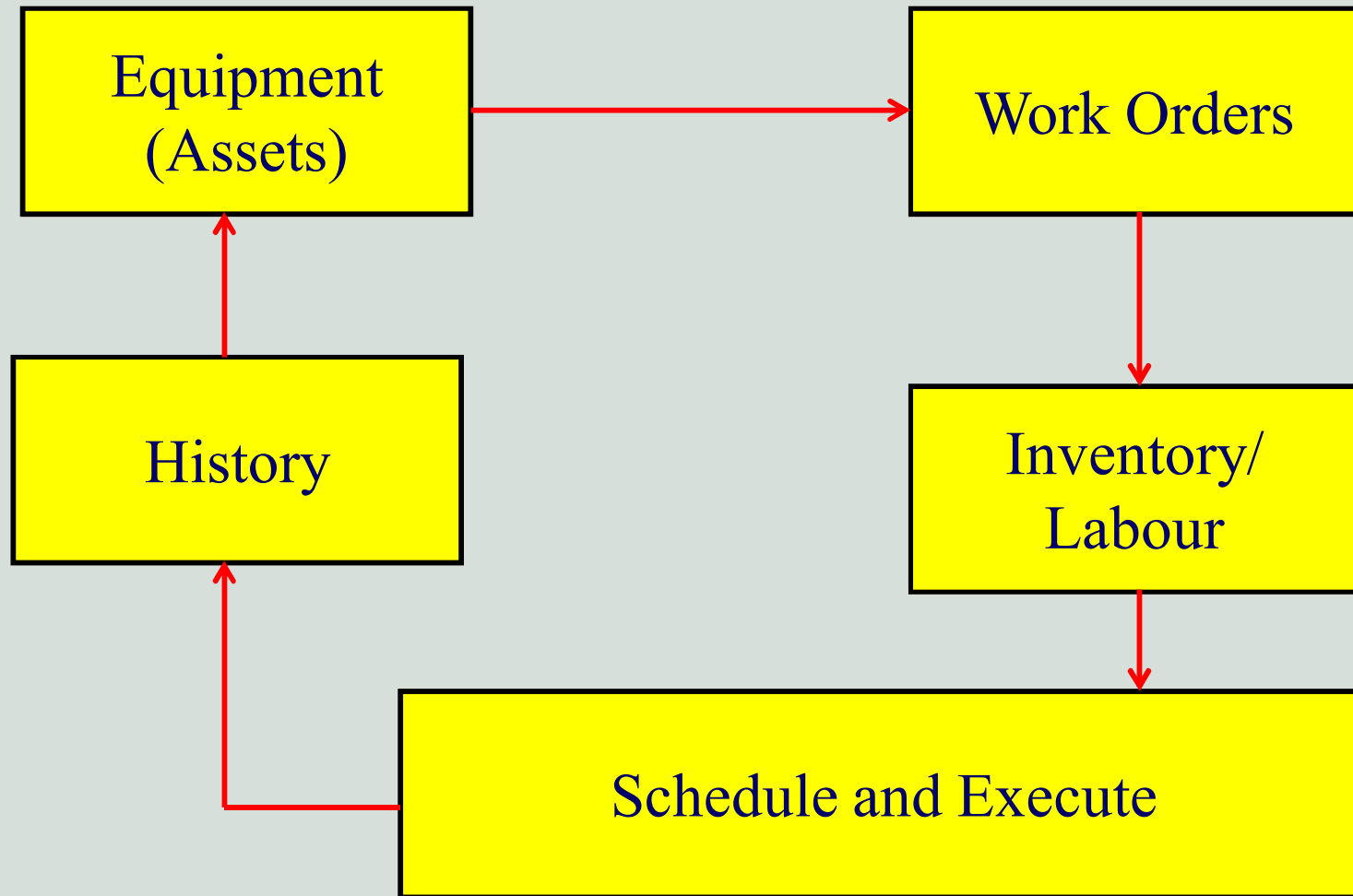
Computerized Maintenance Management System
CMMS is a computerized system to assist with the effective and efficient management of maintenance activities through the application of computer technology.

The screenshot displays a software window titled "Project Tracking Maintenance - 0000000100". The interface includes a top navigation bar with icons and a main data entry area. The data is organized into several sections:

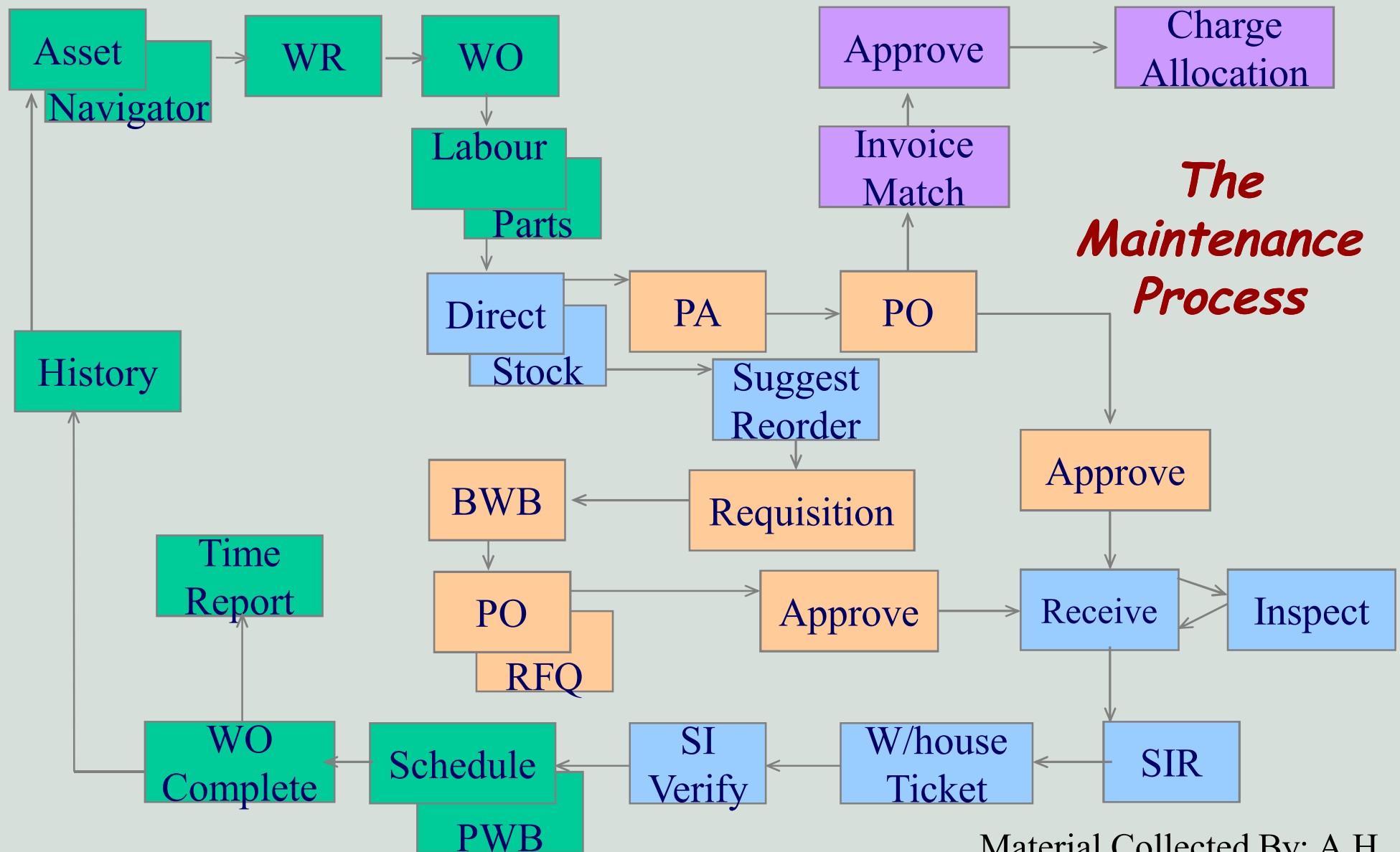
- Project Information:** Project Number (0000000100), Project Name (PROJECT 100), Parent Project, Project Manager (JAS119 SHOFF, JOE), Approval Status (APPROVED), Project Type (2), Project Status (READY), Project Priority (4), Reference Number, Department (SP1 Department), and Project Description (PROJECT 100 DESCRIPTION).
- Scheduling:** Last Modified By (JAS), Last Modified Date (2/17/98), Scheduled Start Date, Scheduled End Date, Actual Start Date, Actual End Date, and Expiration Date (3/31/98).
- General Ledger Accounts:** Labor (01.001.001.0001.001.0001), Material (01.001.001.0001.001.0001), Service Labor (01.001.001.0001.001.0001), and Service Other (01.001.001.0001.001.0001).
- User and Date:** Originator (JAS119 SHOFF, JOE) and Entry Date (2/17/98).

What is Computerized Maintenance Management System “CMMS”?

The Maintenance Process

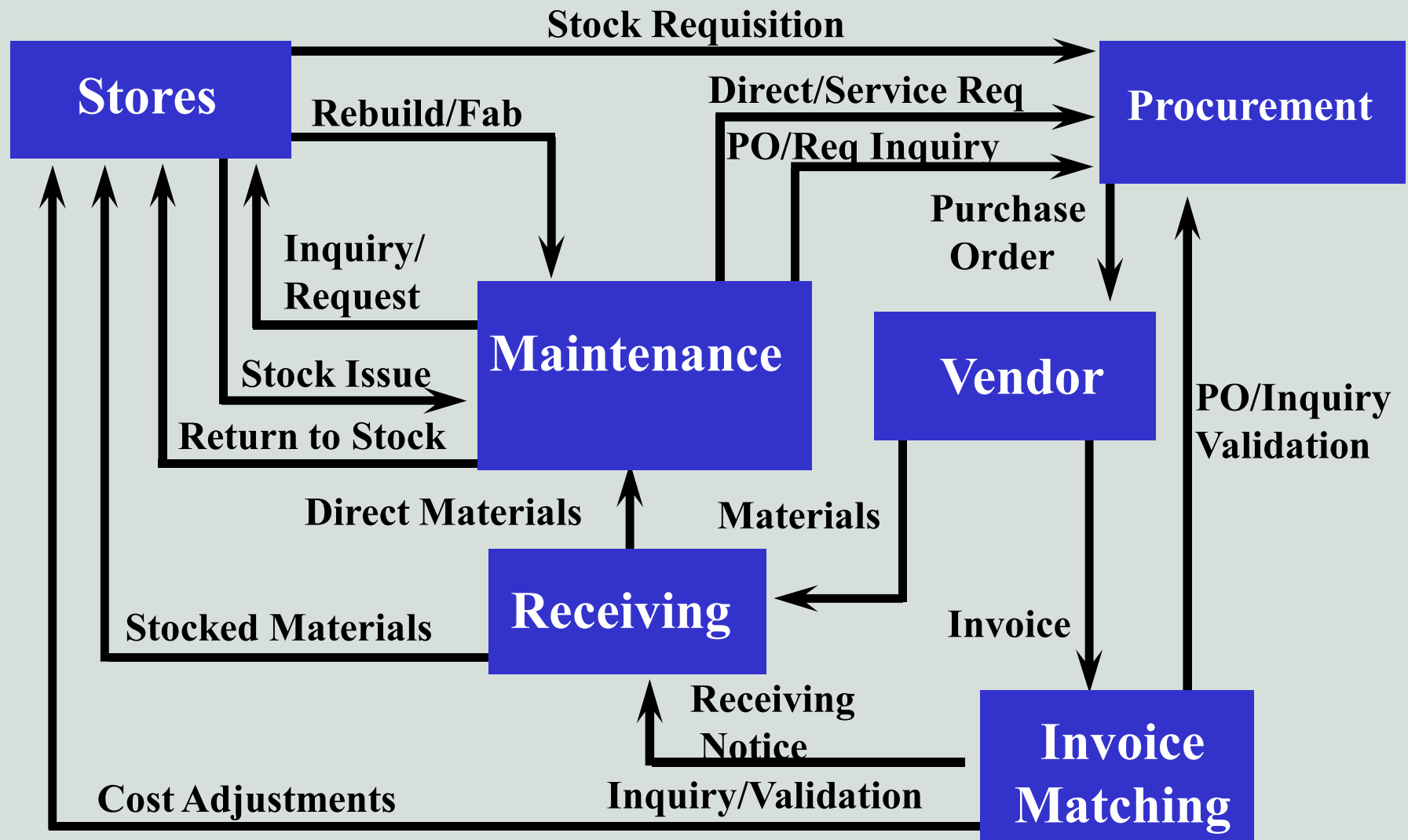


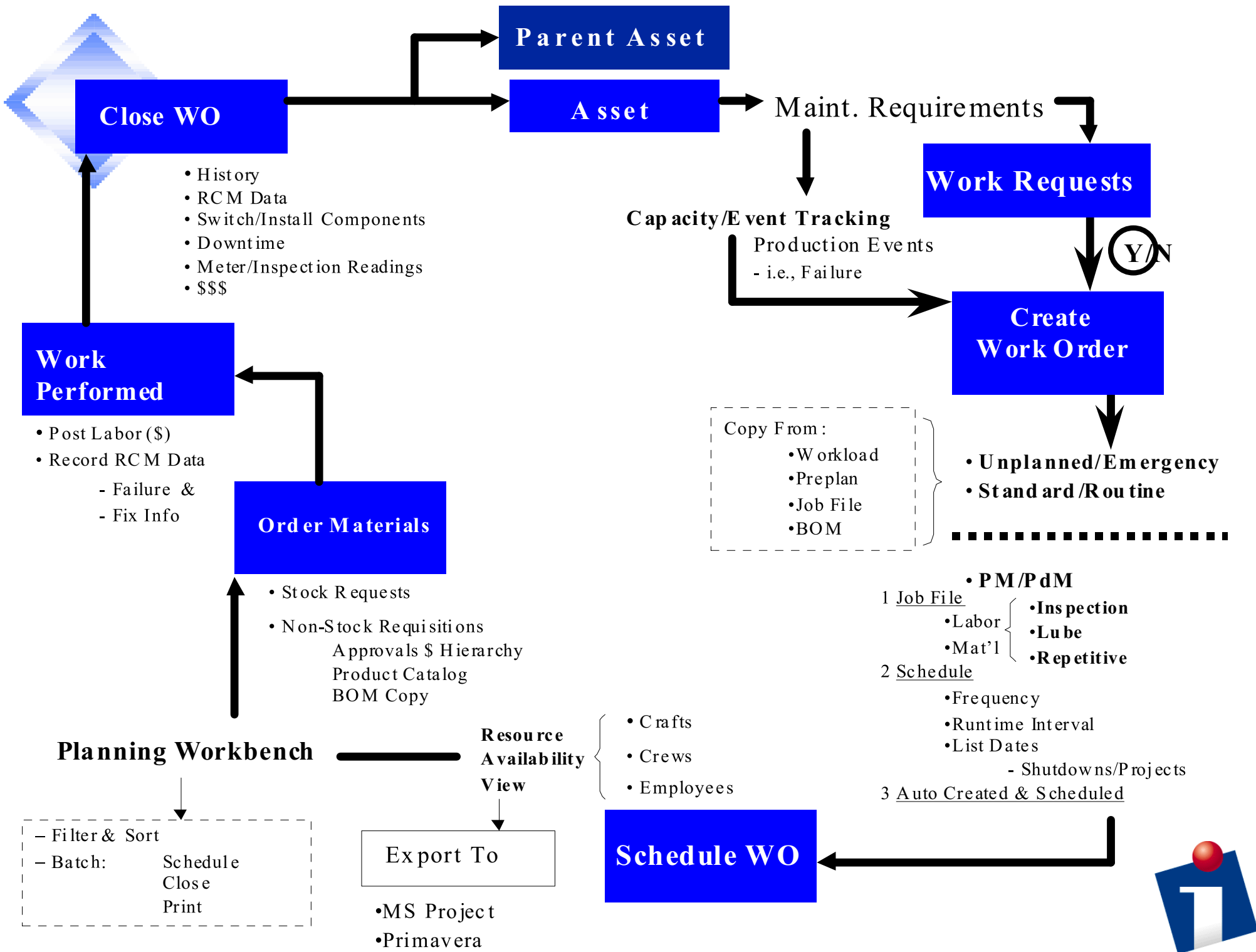
What is Computerized Maintenance Management System “CMMS”?



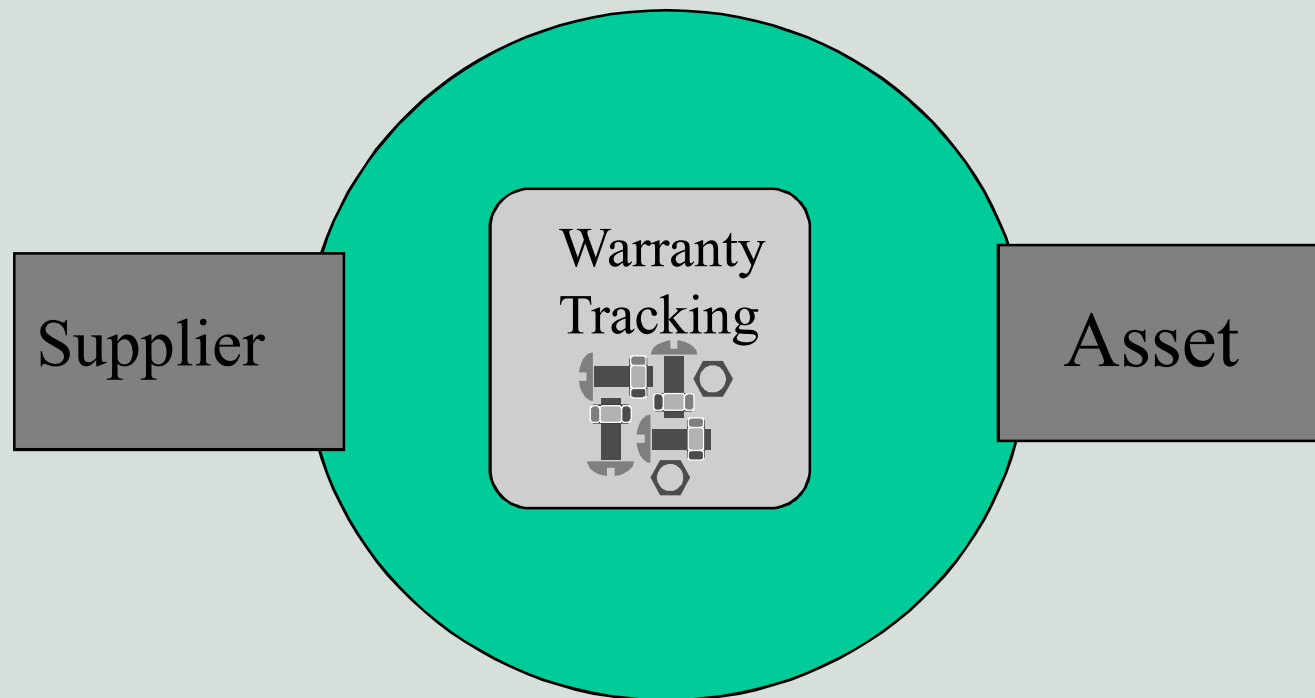
Material Collected By: A.H

Maintenance Planning and Stock Control Integration

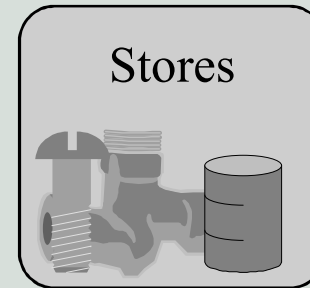




Warranty Tracking



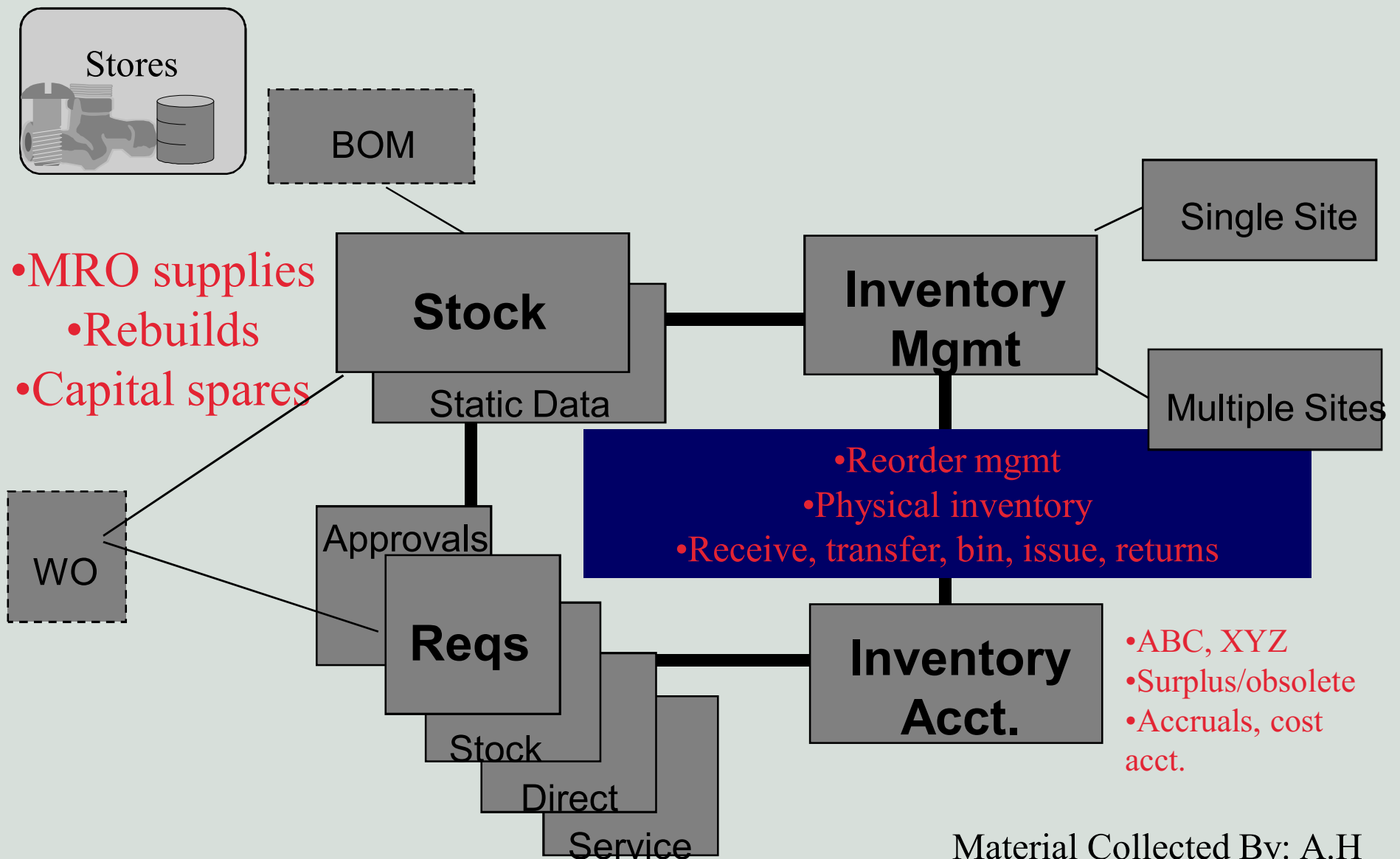
Stores



◆ Stores

- Corporate Stores
- Stock Classification
 - ▣ ABC
 - ▣ XYZ
 - ▣ Criticality
- Consignment

Stores Module



Reporting

(v7.6) ENTERPRISE MPAC

File Edit Details Services Links Modules Window Help

Submit Report

Report Name	Report Description
Address Import Table Purge	Purges all processed or cancelled rows from the Address
Asset BOM Adjustment Report	The Asset BOM Adjustment Report lists stock items iss
Asset Cost Summary List	The Asset Cost Report shows, by asset number, cost th
Asset History	The Asset History Report shows an audit trail of change
Asset Revision Details History	The Asset Revision Details History Report shows a deta
Automatic Commitment of SIRs	Automatically sets commitment for Stock Issue Request
Automatic Work Order Processing	Automatic Work Order Processing

Ending Date

Generate Duplicate Work Orders (Y/N)

Schedule Multiple Step Repetitive Work Orders (Y/N)

Craft Code

Print Direct to Planner

Start submission at 19/05/98 09:13:39

Create repeating submission ☐ Frequency 0 Type

Ready

Reporting

 (v7.6) ENTERPRISE MPAC

File Edit Details Services Links Modules Window Help

 View Reports

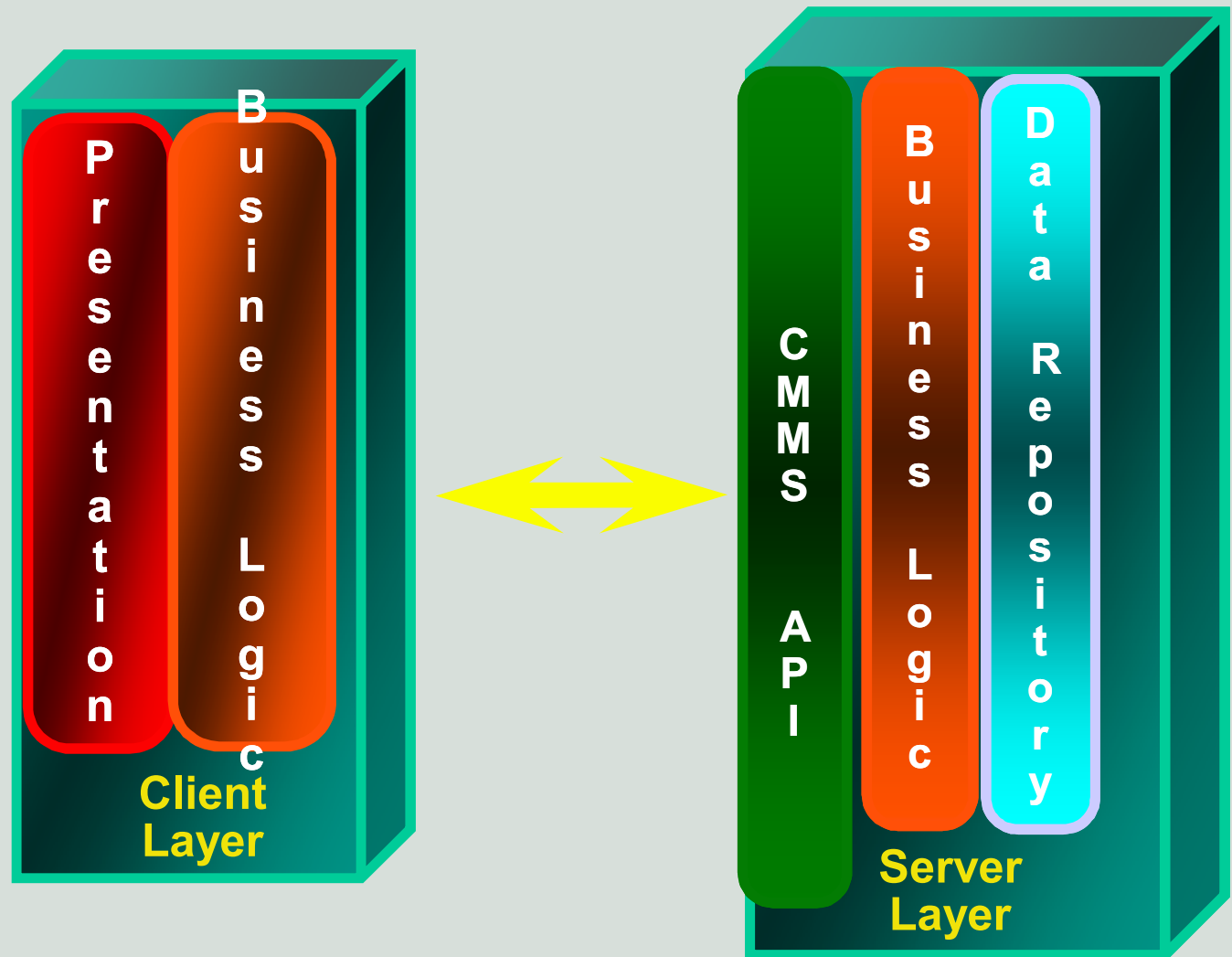
Auto-Refresh ☒

Submission ID	Report Name	Report Status	Date Submitted	Time Submitted
1061	Work Order Print	Complete	18/05/98	10:4
1060	Work Order Print	Complete	18/05/98	10:4
1059	Work Order Print	Complete	18/05/98	10:2
1058	Work Order Print	Complete	18/05/98	10:1
1057	Work Order Print	Complete	18/05/98	10:1

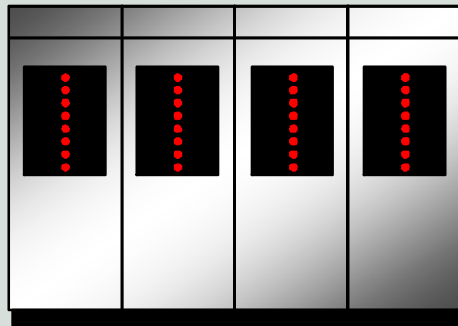
Ready

Open Application Interface

- Open API enables 3rd party or custom application integration



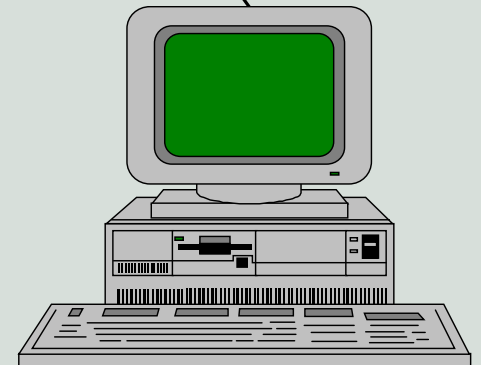
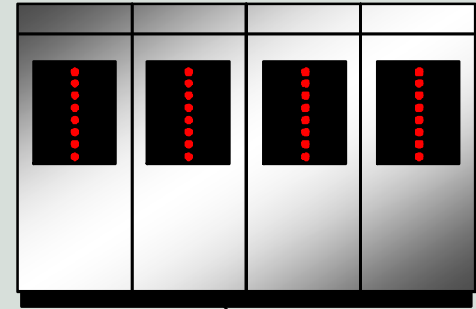
Customer Migration



Existing System



- Data Transition Software
- Migration Support Services



ENTERPRISE

Introduction To CMMS

- Computerized Maintenance Management System or CMMS has been developed to organize, expatiate and monitor all maintenance activities.
- CMMS are usually fragmented into inventory, preventive maintenance and work order tracking.
- As CMMS program have to be integrated, allowing control of all the major areas of maintenance in one system.
- The system vary in size allowing organization with 5 to 5000 craft workers to be cost effective in using them.

Introduction To CMMS

- The need for and use of a CMMS is not specific to any one industry or type of application.
- CMMS are being used by federal, state, municipal organizations, all types and sizes of manufacturing and process plants, hotels, colleges and universities and so on.
- Any facility or corporation that has a maintenance workforce is a potential user of a CMM system.
- However, each organization will have some differences in their requirements to be cost effective in using them.

Introduction To CMMS

Potential Savings

- The potential costs of doing nothing are high. Industry statistics show that billions of dollars are spent annually to maintain physical plants, commercial buildings, educational and healthcare facilities and equipment. Over one-third of all the dollars spent on maintenance are wasted due to poor or inadequate maintenance management.
- When scheduled maintenance is not followed, premature breakdown is a certain outcome. The associated costs of breakdown do not stop with equipment repair and replacement - there are also the realities of unproductive downtime, lost business, displacement of building occupants, uneven workloads, overtime, and emergency inventory purchasing.

Introduction To CMMS

Old Methods Provide Limited Benefits

- Historically, most systems for managing maintenance activities have been manual.
- Everything from index cards, to memo files, to wall-mounted log charts. These outdated methods were cumbersome, incomplete, and inefficient, and were generally used inconsistently.
- Computer-aided maintenance management is a much more reliable and better overall maintenance tracking system.

Introduction To CMMS

The Need Of a CMMS Today

- 1) **The Safety Factor** - Fire in the airport have been attributed to bad maintenance. Many facilities have to review their maintenance system if there are to bring credibility to their maintenance departments.
- 2) **The ISO Factor** - Many manufacturing companies are implementing ISO. A maintenance system is now a requirement under ISO 9002.
- 3) **The Productivity Factor** - In an effort to have an edge over their competitors, many companies are turning toward TQM (Total Quality Management) of which TPM (Total Productive Maintenance) is a major program. One of the key element in TPM is a maintenance system.
- 4) **The Cost Factor** -An effective maintenance management program results in savings in maintenance time and costs, improves productivity

What is Computerized Maintenance Management System “CMMS”?

Areas of Savings

Maintenance Efficiency

Equipment Uptime

Equipment Efficiency

What is Computerized Maintenance Management System “CMMS”?

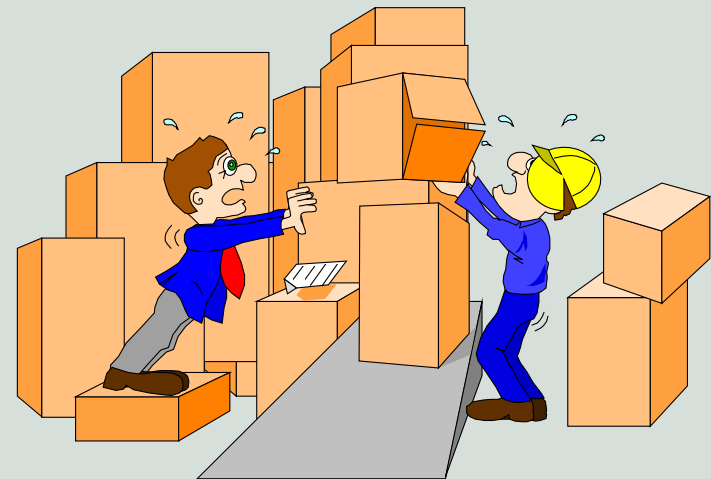
Waste in Maintenance??

- Labor Productivity
- Stores - Materials
- Safety & Environment

What is Computerized Maintenance Management System “CMMS”?

What Removes Waste??

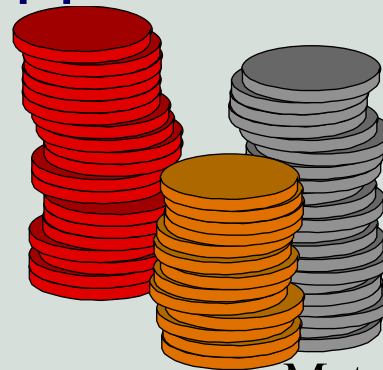
- Preventive Maintenance
- Controlled Stores
- Planning
- Scheduling
- Backlog Control



What is Computerized Maintenance Management System “CMMS”?

Typical Materials Savings

- Industry Week (Magazine):
 - 17.8% Reduction in Total Inventory Levels
 - 19.4% Lower Material Cost
- For a Company with \$10M annual inventory costs, the savings could approach \$2M.

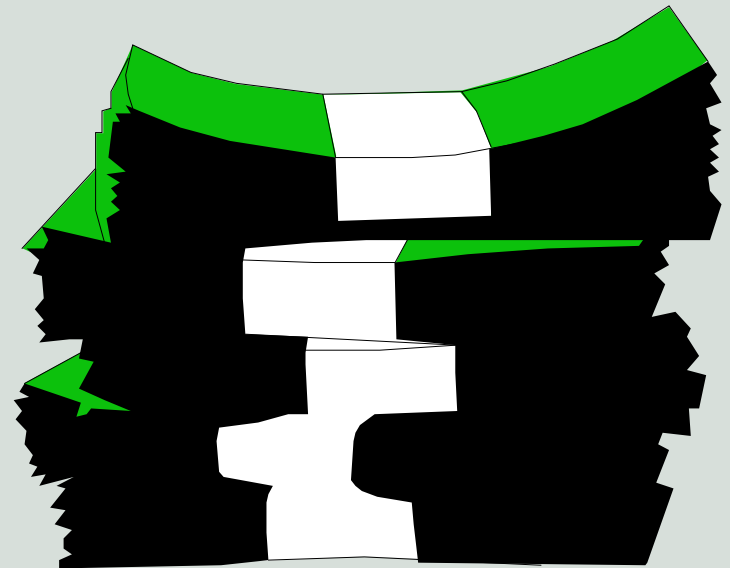


Material Collected By: A.H

What is Computerized Maintenance Management System “CMMS”?

In addition to these Savings

- Energy Cost Savings
 - Mechanical
 - Electrical
 - Steam
 - Fluid Power
- Capital Equipment Savings
- Warranty Savings
- Quality Savings



What is Computerized Maintenance Management System “CMMS”?

The Impact of CMMS

- Reduce equipment downtime through the benefits of regular scheduled preventive maintenance
- Increased equipment life
- Increased craft productivity
- Reduction in stores inventory
- Reduction in emergency and critical maintenance.
- Provide historical records to assist in maintenance planning and budgeting
- Provide maintenance reports in a format that is required by the user

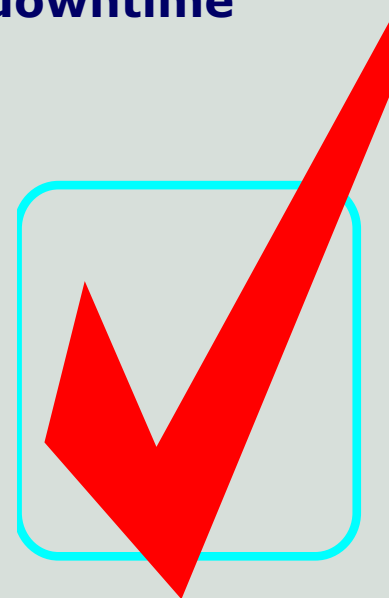
What is Computerized Maintenance Management System “CMMS”?

The Impact of CMMS

Top Ten Benefits

Average Improvement

Increased Maintenance Productivity	29%
Improved Equipment availability/reduced downtime	17%
Reduced excess inventory	21%
Less stock shortages	29%
Increased Planned Maintenance	78%
Reduced Emergency Work	31%
Less Overtime	22%
Less Waiting Time	29%
Reduced Emergency Purchasing	29%
Better Pricing from vendors	18%



Material Collected By: A.H



The Asset Optimization Pyramid

**Asset Care Continuous
Improvement**

**Financial
Optimization**

**Total Productive
Maintenance**

**Reliability
Engineering**

**Predictive
Maintenance**

**Operator
Involvement**

**Maintenance Inventory &
Purchasing**

Preventive Maintenance

Maintenance Work Flow

CMMS Usage

Material Collected By: A.H

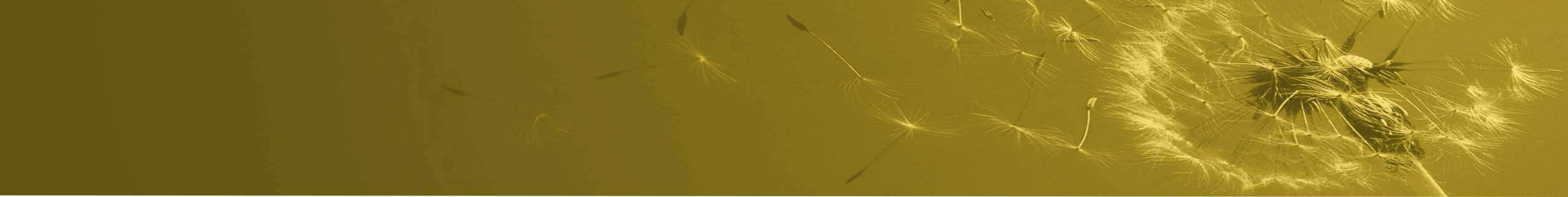
Maintenance Statistics

- 1/3 of all companies have maintenance planners.
- Less than 10% of these maintenance planners are utilized efficiently.
- Most maintenance organizations are either dissatisfied with or do not use a work order system.
- Only 10% of companies with a work order system utilize performance monitoring.
- Only 10% of companies with a work order system perform Failure Analysis.
- Only 22% of all companies are satisfied with their current *PM program*.



Computerized Maintenance Management Systems

Evaluation, Selection & Implementation



System Selection

*Author : Terry Wireman
Computerized Maintenance Management Systems
Industrial Press Inc., 1986*

System Selection

Do I need a computerized maintenance management system?

There is a three-step process that can be followed to answer that question. The steps are:

- System analysis.
- System selection.
- System implementation

System Selection

How does one decide if a computerized maintenance management system is required?

To start, one should examine the maintenance system that is currently in use. The following are some questions to ask:

1. Are the maintenance costs for your installation rising faster than the operating costs?
2. How much more are you spending on maintenance than you were 5 years ago
3. Do you know what it costs to maintain each piece of equipment?
4. Do your maintenance craftsmen spend most of their time waiting to work?
5. Do you have storage bins full of spare parts that never seem to be used?
6. Does your equipment seem to break down at the worst possible time or without any warning?
7. Do you have access to the information needed to plan properly for the future?
8. Is the information you have in a usable form?

System Selection

1. System Analysis

If these questions call attention to problem areas in your facility, it would be wise for you to investigate computerized maintenance management systems. However, if you feel that the maintenance at your facility is satisfactory, consider the fact that a computerized maintenance management system can help to speed up the present activities. This will not require additional employees; it will increase the productivity of the present workforce. It will also reduce the time required to search for filed information.

To begin, a study needs to be made of the present maintenance organization. This will help to determine how efficient the organization is and where improvements can be made. If it is found to be efficient, consider how efficient the organization will be in 5 or 10 years.

It would be beneficial at this time to take a maintenance audit to see how many problem areas are evident. (It should be noted, however, that a computerized maintenance management system will not improve a poor record keeping system; it will complicate it.)

System Selection

2. System Selection

If the decision is made to investigate acquiring a computerized maintenance management system, it is advisable to form a committee. The committee should be made up of individuals from the following areas: engineering, maintenance, stores, accounting, and data processing. This committee should accomplish the following:

1. Review present record keeping systems and paper work flow.

2. Set objectives for the system in the areas of:

- Work order processing.

- Maintenance stores.

- Preventive Maintenance.

- Cost Controls.

- Required Reports.

System Selection

2. System Selection

3. identify the type of computer system that the software is to operate on. (If the hardware is to be purchased as well as the software, the decision may be postponed, pending the selection of the software package.)
4. Identify the vendor packages that meet the objectives. Some companies with adequate personnel may investigate the possibility of developing their own software. This decision should be made cautiously, since software development can be a very time consuming and costly project.
5. Evaluate the system and the vendor. This will necessitate contacting the vendor for a meeting and a demonstration. Evaluation of the vendor includes the profile of the vendor, the clients presently using the system, and the vendor's support capabilities.
6. Obtain specific price quotes from each vendor.

This information should then be compiled into a report to management. This report should provide all the necessary information for the selection of the appropriate system. The committee can include a recommendation if there is one system that is better for the intended application than any other system. However, all the evaluated systems should be included in the report



How to Choose an Appropriate EAM/CMMS

● AR	Asset Register	● P	Purchasing
● JS	Job Scheduling	● B	Budgeting
● SDP	S/D Planning	● C	Costing
● PH	Plant History	● S	Stores
● CBM	Condition Maint.	● FA	Fault Analysis
● PP	Plant Performance	● G	Graphics
● DBM	Database Manag.	● CT	Communication

How to Choose an Appropriate EAM/CMMS

- **Functionality**
- **User Friendly**
- **Technology**
- **Market Strength**

How to Choose an Appropriate EAM/CMMS

- **Functionality:**

**Overall functional coverage
(preventive maintenance , spare parts,
inventory management , order
management, diagnostics, cost analysis,
indicators , monitoring)**



How to Choose an Appropriate EAM/CMMS

- **User Friendly**

- **Look & feel Graphical User Interface (GUI)**
- **Configurable process-driven menus**
- **Configurable Online Help**
- **Search capabilities (e.g. browser)**
- **Integrated reporting tool**
- **Workflow**
- **Web enabled**



How to Choose an Appropriate EAM/CMMS

● **Technology**

- **Support multi operating platform (Windows NT, Unix , Netware, ..)**
- **Range of RDBMSs (Oracle / MS-SQL/...)**
- **Object Oriented Technology**
- **E-commerce**
- **Integration with third party solution**



How to Choose an Appropriate EAM/CMMS

- **Market Strength**
 - **Distribution Geographically Coverage
(including international presence)**
 - **Consulting staff and partnerships with
consulting firms**
 - **Mind share**
 - **Vendor viability**

System Selection

3. System Evaluation

The following checklist, although the rankings are subjective, may be used as a guide to help in the evaluation of a computerized maintenance management system. Rate each system against the competitors on each item listed and total the points. The system with the lowest number of points should be your primary candidate.

In this evaluation, rate systems A, B, and C on each of the items listed. Use a "1" for the system that would be your first choice if you were considering only that feature. Use a "2" for your second choice and a "3" for your third choice. If a system does not offer a feature, rate it a "4." In Part 7 you will total all the scores in the preceding six parts, and the system with the lowest total would be your prime candidate for a computerized maintenance management system.

System Selection

WORK ORDER MANAGEMENT

1. *The system produces corrective work orders*
2. *The system produces preventive maintenance work orders*
3. *The system tracks labor costs automatically*
4. *The system tracks material costs automatically*
5. *The work order uses priority codes*
6. *The work order uses status codes*
7. *The system sorts backlog by craft and priority.*
8. *The system can produce a list of active work orders*
9. *The system maintains an active equipment history*
10. *The system allows for manual entry of work order cost estimates*
11. *The system produces a list of work orders ready for scheduling*
12. *The system provides net capacity calculations to compensate for work interruptions*
13. *The system allows for complex planning such as crafts, materials, tools, etc.*

System Selection

PREVENTIVE MAINTENANCE (PM)

- 1. The system will schedule PM by calendar date*
- 2. The system will schedule PM by meter readings*
- 3. The system allows for more than one PM order per piece of equipment*
- 4. The system prints individual PM work orders*
- 5. The system provides a detailed description of the PM tasks to be performed*
- 6. The system prints a PM workload forecast for any given week or weeks*
- 7. The system allows for lead or lag time for scheduling the PM work order*
- 8. The system allows for a detailed listing of the PM tasks to be performed*
- 9. The system produces a report of overdue PM work orders*
- 10. The system projects the impact of the PM work load on the weekly schedule*
- ii. The system produces a report of the PM inspection results*

System Selection

STORES INVENTORY

1. *The system produces an inventory reorder report*
2. *The system maintains unit price information for all spares*
3. *The system identifies bin location of all spares*
4. *The system produces a report of all work orders waiting on material*
5. *The system attaches all material costs to the work order*
6. *The system keeps a history record on all stores items use*
7. *The system keeps the economic order quantity for stock reorder*
8. *The system keeps the max-mm stock quantities on record*
9. *The system produces a cost-of-inventory- on-hand report*
10. *The system produces a complete store stock catalog*
11. *The system provides on-line parts inventory information*
12. *The system allows for entering unused materials back into the stores inventory*

System Selection

SYSTEM REPORTS

- 1 The system produces daily control reports*
- 2. The system produces equipment history reports*
- 3 The system produces management reports on a weekly basis*
- 4. The system produces management reports on a monthly basis*
- 5. The system can produce management reports on demand*
- 6. The system produces reports tracking the system's backlog by craft*
- 7. The system produces failure analysis reports*
- 8. The system produces craft usage reports*
- 9. The system produces budget overrun reports*
- 10. The system reports on all uncompleted work orders by priority*

System Selection

GENERAL SYSTEM CONSIDERATIONS

1. *The system is user friendly*
2. *The system is menu-driven*
3. *The system is on-line and integrated*
4. *The system has an ongoing support program*
5. *The system keeps historical records until they are deleted from the system*
6. *The system has security password or code protection*
7. *The system runs on hardware already on-site*
8. *The system requires the purchase of special hardware*

System Selection

VENDOR AND SERVICE EVALUATION

1. *The vendor can supply installation support*
2. *The vendor has a documented installation*
 - *The vendor will provide a list of installation references*
 - *The vendor will provide guidance during the data input*
5. *The vendor has a maintenance consultant on staff to provide assistance in formatting data for entry into the system*
6. *The vendor provides documentation for installation, user manuals, and training manuals*
7. *The software can be self-installed*
8. *The vendor can provide training on-site or at their facilities*
9. *The vendor offers a planned enhancement and support program for existing and future software*

System Selection

FINAL ANALYSIS

<i>Enter the total points for each section</i>	<i>A</i>	<i>B</i>	<i>C</i>
--	-----------------	-----------------	-----------------

- | | | | |
|----|--------------------------------|--|--|
| 1. | Work Order Management | | |
| 2. | Preventive Maintenance | | |
| 3 | Stores Inventory | | |
| 4. | System Reports | | |
| 5. | General Considerations | | |
| 6. | Vendor and Service Evaluations | | |

Total Point Per System

System Selection

Selection Tips

While all packages have their place in the marketplace, there are some points that need to be discussed.

Point 1. Be cautious when dealing with consulting firms selling "their" software.

This is an important point because many firms sell the software, as a way of getting their consulting services into a facility. Be sure you are aware of what you are buying and the length a. cost of any support service. Some firms will sell the software and charge for a support service that may run for many months. When they charge between \$500 and \$1000 per day for this service, the bills can mount up rapidly.

Point 2. Be cautious when dealing with firms that have developed their software for in-house use.

Generally, these firms will try to conform your organization to their software rather than the other way around. They are generally higher priced, since the companies are trying to recover their development costs. The support may be minimal, and they may lack sufficient personnel to properly oversee and consult during the installation. Also, once a company has recouped its development costs for the system, it may not market the system any longer. Be sure the company plans on staying in the computerized maintenance management system area before purchasing the system.

System Selection

Selection Tips

Point 3. Do not hire someone just to computerize your present manual system.

Prepare the necessary paperwork so they understand when you are doing and what your maintenance philosophy is. If the try to computerize what you have presently, it will not increase your efficiency much.

Point 4. Do not develop your system in-house unless you do not need it for a long time.

Most in-house systems will take countless meetings and changes before they become a reality. It is cheaper to select an off-the-shelf program that closely meets our needs. The only time in-house development should be considered is when no program suits your needs, and this is highly unlikely given the present number of vendors.

Point 5 Do not select the hardware and then shop for your software.

This may restrict your choice of programs. It is best to select the software first, then buy the matching hardware.

System Selection

Selection Tips

Point 7. Price the entire package not just the software.

Many companies add extra costs that do not show up until they are asked for. Be sure you understand what you are buying and how much service is included.

Point 8. Thoroughly check the reputation of the vendor you are dealing with.

There is no better method to do this than to call sites where the system is presently in operation. This will help you understand the level of customer satisfaction. To be fair to yourself and to the vendor, try to check at least three different sites

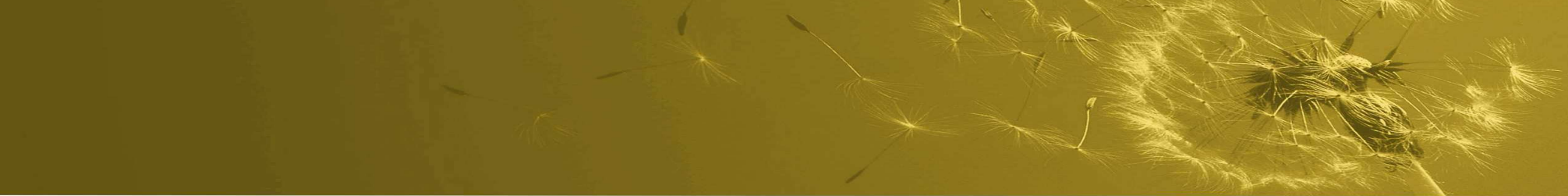
Point 9. Understand the difference between the vendor's maintenance agreement and licensing agreement.

Some vendors will sell you the package as is, with the option of subscribing to a maintenance fee that provides you with updates and software service support for the year. This is not a required feature. They will sell you the software and you do not have to have the ongoing support. However, there are firms that use a licensing agreement and require that you pay a yearly fee. There is no option. Be sure you understand the package you are buying. If you do not, you can be liable for unanticipated costs.

Material Collected By: A.H

Some CMMS Typical Cost Saving Percentage

Better scheduling of work, including increased productivity of work force	5-15%
Increased craft productivity due to parts and equipment availability	1-3%
Increased equipment uptime due to better preventive maintenance and repair scheduling	1-3%
Reduced stores inventory due to maintaining proper level of spares	10-20%

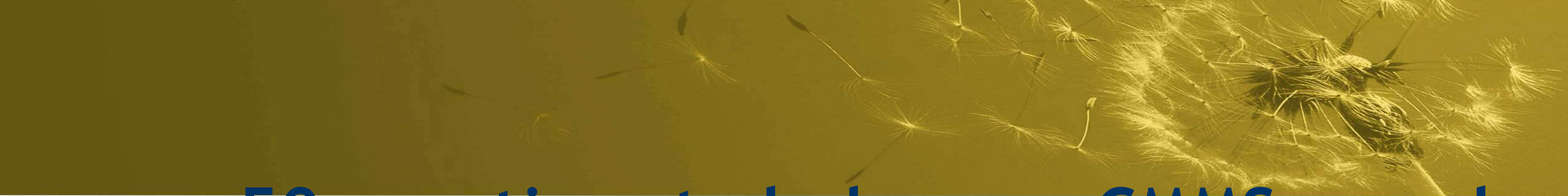


50 questions to help your CMMS search

Author : Joel Levitt

This article is an extract from Joel Levitt's book, The Handbook of Maintenance Management, and is kindly reprinted with his permission, and with the permission of his publishers, Industrial Press, Inc..

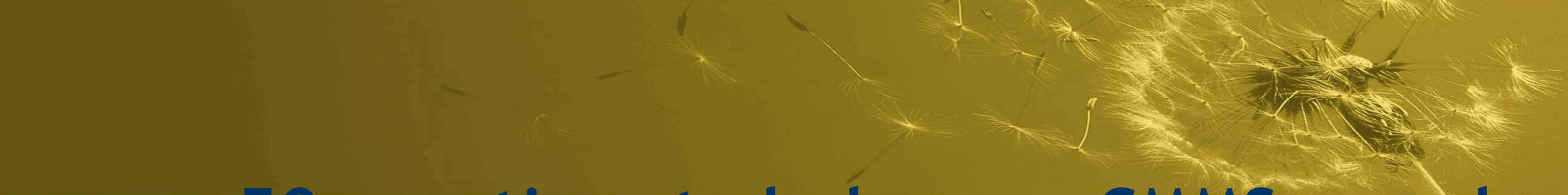
The book may be purchased through the Plant Maintenance Resource Center web site, in association with amazon.com.



50 questions to help your CMMS search

Work Order

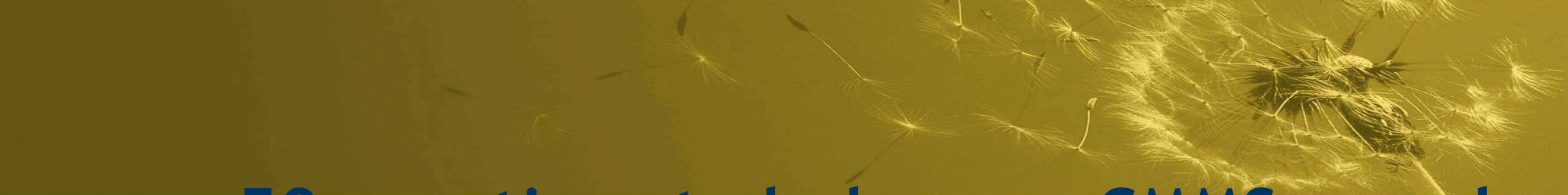
1. Produces an easy-to-use work order that allows future conversion to bar codes and other improvements to technology.
2. Work order classifies all work by some kind of repair reason code: PM, corrective, breakdown, management decision, etc.
3. Provides an easy way for a single person or designated group in maintenance to screen work orders entered by customers before authorization that work can begin.
4. Prints up-to-date lockout procedure on all work orders automatically.
5. Automatically costs work orders.
6. Provides status of all outstanding work orders.
7. Records service calls (who, what, when, where, how) which can be printed in a log format with automated time/date stamping.



50 questions to help your CMMS search

Work Order

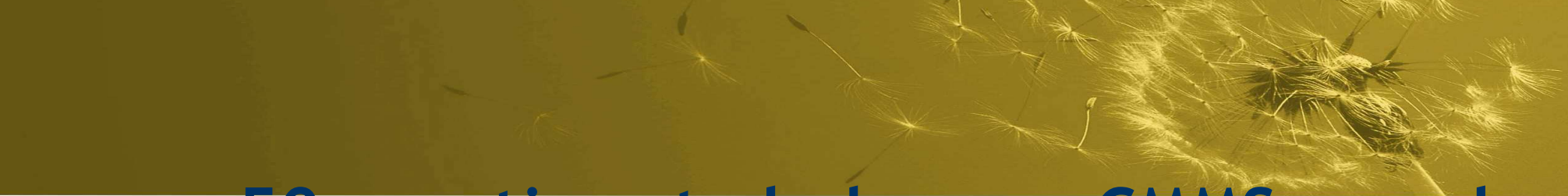
8. Allows operations people, tenants or facility users to have access to the system to find out what happened to their work request.
9. Records backlog of work and displays it by craft.
10. Work orders can be displayed or printed very easily.
11. The system facilitates labor scheduling with labor standards by task, ability to sort, and re-sort the open work orders by location of work, craft and other ways.
12. Records changes to inventory (receipts, chargeouts, physical inventories).
13. Does the storeroom part of the system have part location to help the mechanic or store keeper find infrequently used parts?
14. Can the system generate a parts catalog by type of part, vendor with yearly usage to facilitate blanket contract negotiation?
15. Does the system recommend stock levels, order points, order quantities?



50 questions to help your CMMS search

Maintenance History and Reporting

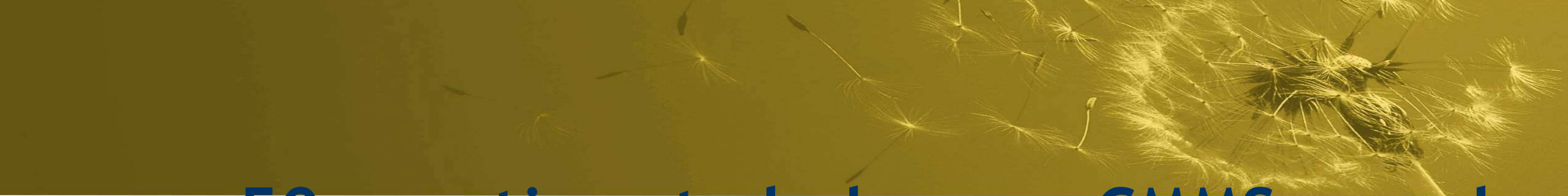
16. Maintains maintenance history that is detailed enough to tell what happened.
17. Provides information to track the service request-maintenance work order issue-work complete-customer satisfied cycle.
18. Provides reports for budgets, staffing analysis, program evaluation, performance.
19. Is able to isolate all work done (sort, arrange, analyze, select, or list) by work order, mechanic, asset, building, floor, room, type of equipment or asset.
20. Provides the ability to easily structure ad hoc (on the spur of the moment) reports to answer questions that come up. This is sometimes called a report writer.
21. Has the ability to generate equipment/asset history from birth (installation, construction, or connection) with all major repairs and summaries of smaller repairs.



50 questions to help your CMMS search

Maintenance History and Reporting

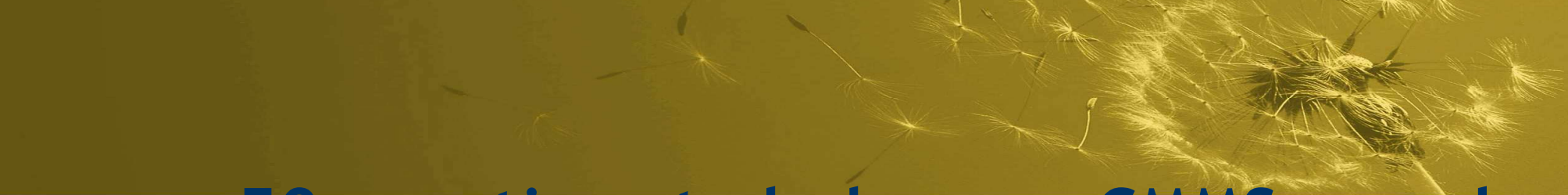
- 22. System reports are designed around Pareto principles where the system helps to identify the few important factors and helps you to manage the important few versus the trivial many.
- 23. Allows operations people, tenants or facility users to have access to the system to find out what happened to their work request.
- 24. System reports on contractor versus in-house work.
- 25. Provides reports charging back maintenance cost to department or cost center.
- 26. Has reports with mean time between failures that show how often the unit has been worked on, how many days (or machine hours) lapsed between failures, and the duration of each repair.
- 27. Will the system highlight repeat repairs when a technician needs some help?



50 questions to help your CMMS search

PM System

- 28. Allows mechanics to easily write up deficiencies found on PM inspection tours as planned work to be done. System then automatically generates a planned maintenance work order.
- 29. Automatically produces PM work orders on the right day, right meter reading etc..
- 30. Is able to display work load for PM for a future period such as a year by week or month by trade.
- 31. Is able to record short repairs done by PM mechanic and actual time spent.
- 32. Does the system support multiple levels of PM on the same asset, does it reset the clock if the high level is done (if you do a yearly rebuild, does the monthly PM clock get reset?)?
- 33. PM's are generated by location by trade to facilitate efficient use of people and minimize travel.



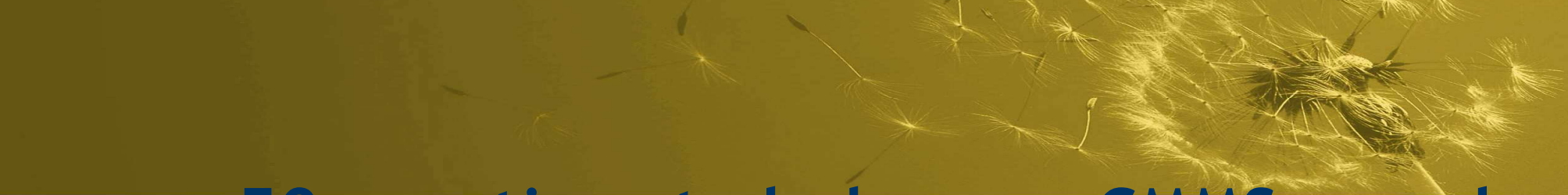
50 questions to help your CMMS search

PM System

- 34. Allow the input of data from Predictive Maintenance subsystems.
- 35. Highlights situations where the PM activity is more expensive than the breakdown.
- 36. Are there simple reports that relate the PM hours/materials to the corrective hours/materials to the emergency hours/materials? This will show the effectiveness of the PM program.

General

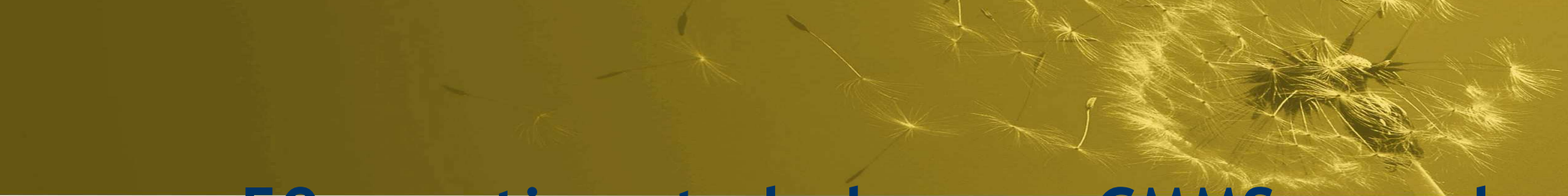
- 37. Can the system handle 3-4 times more assets that you imagine having?
- 38. System has a logical location system to locate assets and where work is done.
- 39. System tracks the warranty for components and flags warranty work.
- 40. Is easy to use for novices and quick to use for power users.



50 questions to help your CMMS search

General

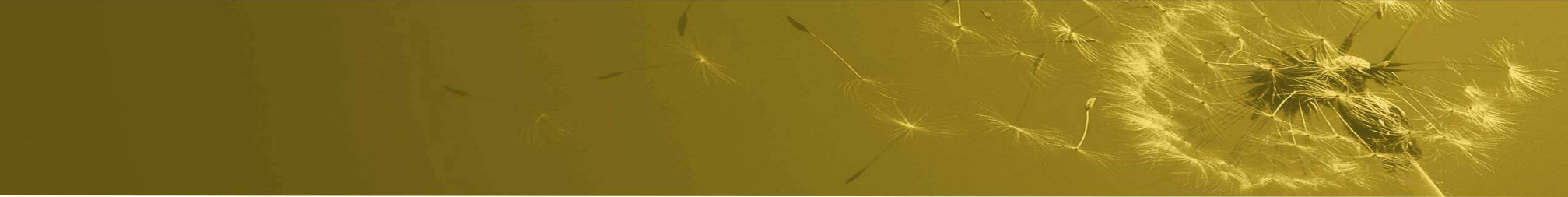
41. System integrates or can be integrated to purchasing, engineering, payroll/accounting.
42. Can the system easily handle a string PM such as a lube route, filter change route?
43. System runs on standard computer hardware, not some special hardware incompatible with everything else. Is the system compatible with Local Area Networks if it is a PC product?
44. System vendor has filled out vendor information sheet and has the financial strength to complete the contract (and stay in business for several years)..
45. Does the vendor have software support people, can you easily get through to a person? Is there an 800 number? Once you get through do the people know the product and something about maintenance? Is there an Internet site with technical support, user discussion groups, updates available for downloading, and other useful information?



50 questions to help your CMMS search

General

46. Can the vendor provide economical, necessary customization? Is this capability in-house?
47. Does the vendor have a local installation organization?
48. Are they experienced in the management of installation projects of the size of your facility? Do they have start up experience with projects this size?
49. Are the vendor's technical people well cross-trained (Software, hardware and reality ware, like how a real building works)? It is important that the computer people have experience with building/facility maintenance.
50. Has the vendor been in business 5 years or more?



Computerized Maintenance Management System

List of Common International Packages

Computerized Maintenance Management Systems (CMMS) Software Packages

- 4Site sales@flemingsystems.com
- ACAM - Australian Computerised Asset Management info@acam.com.au
- Acumen Maintrak keith@geetc.com.au
- Advanced MPC sales@megamationsystems.com
- AIMS for Windows (*)
- AMMS - Advanced Maintenance Management System amms@microwst.com
- AMOS for Windows tech@spectec.it
- AMPS Computerised Maintenance Management Software proberts@eden.com.au
- Angus Maintenance Management System sales@angus-group.com
- API-Pro teopsis@teopsis.com
- ARCHIBUS/FM
- Asset Handler!©
- Asset Integrity Management a.i.m.s@usa.net
- AssetTracker sales@equipsoft.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- Atlas (*)
- Atlas 2000 atlas@data-trak.com
- Atlas Professional atlas@data-trak.com
- Avantis.AM
- Avantis.pro
- Avantis.xa
- Aware.MNT+ CMMS Software info@pninc.com
- Baan
- BarControl Enterprise Manager (BEM) - Maintenance Module info@BarControl.com
- Basic Five ggramins@phoenixhcp.com
- BEIMS (*)

Computerized Maintenance Management Systems (CMMS) Software Packages

- Benchmark bobn [@benchmark.com](mailto:info@benchmark.com)
- BPCS Maintenance Management info@ssax.com
- BRASS info@indexcs.com.au
- Ceecom Plantware System info@ceecom.com
- CENDEC Maintenance & Materials Management info@cendec.com
- CHAMPS CMMS/EAM cskinner@champsinc.com
- Chase Professional chase@Chasesystems.net
- Chase Small Business Edition chase@Chasesystems.net
- Classic Mainpac info@geac.com.au
- CMMS Maintenance software 3.14 info@attf.com
- CMMS Solution dhlee@9.co.kr
- CMMS+ sales@tabware.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- | | |
|--|--|
| • COGZ (*) | sales@cogz.com |
| • COGZ EZ for Windows (*) | sales@cogz.com |
| • Compass 6.0 | lpe@adbsys.com |
| • CompuMaint | mdburns@compassnet.com |
| • COSWIN | web02@siveco.com |
| • CPM - Customised Plant Maintenance | gregsier@gregsier.com.au |
| • Data Engineer | info@ssg-incorp.com |
| • Data Splice Enterprise Integration Suite | info@optimiz.com |
| • DynaStar 2000 (*) | info@ddynamics.com |
| • Ekanos Asset Management | ekanos@cgocable.net |
| • EM/dBS (*) | info@emdb.com |
| • eMAINT LAN (*) | |
| • eMAINT Online (*) | |
| • eMAINT Online Plus (*) | |
| • eMAINT SQL (*) | |
| • eMAINT Web (*) | |

Computerized Maintenance Management Systems (CMMS) Software Packages

- Empire (*)
- EMPRV info@eds.com
- Enterprise MPAC (*) sales@iint.com
- EPICS
- eProTeus (*) sales@eaglecmms.com
- EQUIPAC and EQUILINK bshea@epacst.com
- Equipment PM [www@rimrocktech.com](http://www.rimrocktech.com)
- Etysys CMMS inquiries@etysys.com
- eXegetic Asset Management info@exegesys.com
- F.T.M. (Fault Tree Maintenance) werhardt@vsnl.com
- FacilityCenter
- FaciliWorks Maintenance Manager (*) sales@faciliworks.com
- FAMIS Maintenance Management
- Faraz_Net Iranmaintenance@hotmail.com
- FM Enterprise info@assetworks.com
- FM1

Computerized Maintenance Management Systems (CMMS) Software Packages

- Forstaff Maintenance Manager sales@creativesoftware.com.au
- Frontline (*) sales@shiresystems.co.nz
- GBA Master Series info@gbamasterseries.com
- Global Tracker cantors@optimalprocess.com
- G-Mant mraineri@adinet.com.uy
- Good-To-Go
- GP MATE sales@gpsonline.com
- Guardian westsoft@westernsoftware.com
- GUIDE cogep@cogep.com
- Hansen - Infrastructure Management System gstoneha@mits.com.au
- Hansen's Version 7 (*) stefanie.marquez@hansen.com
- Hardcat hardcat@hardcat.com.au
- HEMS2000 sales@EQ2.com
- Idhammar 2000
- IFS Applications
- IFS Maintenance
- IGOR sales@kakari.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- iMaint EAM sales@dpsi-cmms.com
- **Immpower**
- IMMS for Windows melmail@ghd.com.au
- Impact sales@hofincons.com
- IMPACTxp info@impactxp.com
- Impresa for MRO impresa.info@epicor.com
- Imprimis sales@tangiblevision.com
- **Indus Solution Series (*)** sales@iint.com
- InfoPMSql info@ib-informatica.com
- INSTAND M sys crearsoft@crearsoft.com
- **iProcure** info@dstm.com
- isMimics salesinfo@ismimics.com
- Ivara Enterprise Asset Management (*) inquiries@ivara.com
- **J. D. Edwards Plant & Equipment Maintenance Management**
- JBA System 21 mark_forrester@campbell-lee.co.uk

Computerized Maintenance Management Systems (CMMS) Software Packages

- KeepItUp! - Maintenance Tracking System
- KTLite
- KTRepair
- Logihold lmc@logimatic.dk
- MAC ACTIVE - Computerized Maintenance vendas@samservicos.com.br
- Machinery Manager info@fmsharvest.com
- MachineTrak microtex@usit.net
- MainBoss (*) dti@mainboss.com
- Maincam info@camtechnologies.com
- Mainpac 2100 info@geac.com.au
- Mainpac for AS/400 info@geac.com.au
- Mainpac for Windows info@geac.com.au

Computerized Maintenance Management Systems (CMMS) Software Packages

- MainPlan sales@mainplan.com
- Mainsaver eam@cayenta.com
- MAINSTAY sales@gastops.com
- Maint A-MES info@adasoftgroup.com
- MaintainIt info@dstm.com
- MaintainIt Pro info@dstm.com
- MAINTelligence sales@desmaint.com
- Maintenance and Inspection System
- Maintenance Four geoff@main4.net
- Maintenance Management-7 sjenter@aol.com
- Maintenance Manager (Symbiotic Systems) mail@symbioticsys.com
- Maintenance Manager Software info@attf.com
- Maintenance Manager Software Program
accreditationservices@accreditationservices.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- Maintenance Master (Bartley Services) bjgarner@bartleyservices.com
- Maintenance Master (Norwich Technologies) ntsales@norwichtech.com
- Maintenance Mate 1 info@BarControl.com
- Maintenance Mate 2 info@BarControl.com
- Maintenance of Critical Assets (MoCA) rdmi@rdmi.com
- Maintenance One zane@paysolutions.com.au
- Maintenance Parts Bin 4.20 nathanht@netzero.net
- Maintenance Productivity Enhancement Tool (M-PET)
marketing@summware.com
- Maintenance Scheduling System mail@sdcssoftware.com
- Maintenance Tracker triska@compuserve.com
- MaintenanceMan pla@leederassociates.com.au
- MaintiMizer (*) sales@cksystems.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- MaintScape info@asd-info.com
- MaintSmart sales@maintsmart.com
- Maintstar info@maintstar.com
- Maint-Trak maintrak@custom-biz.com
- MAPCON 2000 mapcon@mapcon.com
- Marine Planned Maintenance dej@marinesoftware.co.uk
- Master Maintenance Management sales@amerisoftwest.com
- Mat-Man matman@mat-man.com.au
- Maveric - Enterprise sales@hofincons.com
- Maveric - Lite sales@hofincons.com
- **Maximo (*)**
- Mechanic's Mate info@compliancetechnologies.com
- Megamation Directline sales@megamationsystems.com

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- Mex steve@mex.com.au
- MIMIC2001 wm@wmeng.co.uk
- MIMS Open Enterprise info@mincom.com
- Miquest miquest@miquest.co.uk
- MITS Database customdataware@mei.net
- MLS (*)
- MMT - Maintenance Management Tool iacomino.giovanni@ansaldobreda.it
- Movex Maintenance info@intentia.se
- MP2 Professional info@dstm.com
- MP5 info@dstm.com
- MPAC-SQL (*) sales@iint.com
- MPAC-UX (*) sales@iint.com
- MPRO 2000 plant@bdrsystems.com
- mPRo3 - Medical & Maintenance Manager support@mayercs.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- MPS mpsales@ozemail.com.au
- Mpulse Gold (*) sbrous@mpulsecmms.com
- Mpulse LTD (*) sbrous@mpulsecmms.com
- Mpulse Pro (*) sbrous@mpulsecmms.com
- MS2000 (*) info@micromain.com
- MS2000 Enterprise (*) info@micromain.com
- msEZ (*) info@micromain.com
- Mtsys2K umbani@mweb.co.za
- OCS Maisy firmapost@onsoft.no
- ON KEY Maintainer (*) pragma@iafrica.com
- OOPS! (Oz. of Prevention System) - Voice Activated
- Operating Control System (*) miked@cpsg.com.au
- OPMIST
- Opms enquiries@opms.net

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- P.C.S. seanjoe@usa.net
- **PassPort (*)** sales@iint.com
- PBS4 - Paradigm Business System Version 4 (*) paradigm@parasoft.com.au
- PCMaint sales@pcmstore.com
- Peaceware adccsoft@nagpur.dot.net.in
- Pemac info@pmi.pmg.ie
- PEMEX sales@gpsonline.com
- Pinnacle Asset Management Software sales@aisoftware.com.au
- PlannExpert® (*) info@plann.com
- PlanPro sales@interalsoftware.com
- PLANT qaxl@bit.net.au
- Plant Maintenance for Windows sales@stewarttech.com
- PlantWare info@fleetwareinc.com
- PMC2000 sales@dpsi-cmms.com
- PMIS sales@flemingsystems.com

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- PMXpert Sales@PMXpert.com
- PowerNet Iranmaintenance@hotmail.com
- Preventive Maintenance & Equipment Locator (PME) kwn@cool-ware.com
- ProDocTivity Real Preventive Maintenance sales@realvision.cc
- Profit Oriented Maintenance Manager (PROMM) admin@gbspromm.com
- Promaint
- Pronto greg@pronto.com.au
- Protean
- ProTek Plus support@npma.com
- ProTeus Enterprise (*) sales@eaglecmms.com
- ProTeus Expert (*) sales@eaglecmms.com
- ProVIEW aqs@ismi.net
- Pulse mschroder@pulsemining.com.au

Computerized Maintenance Management Systems (CMMS) Software Packages

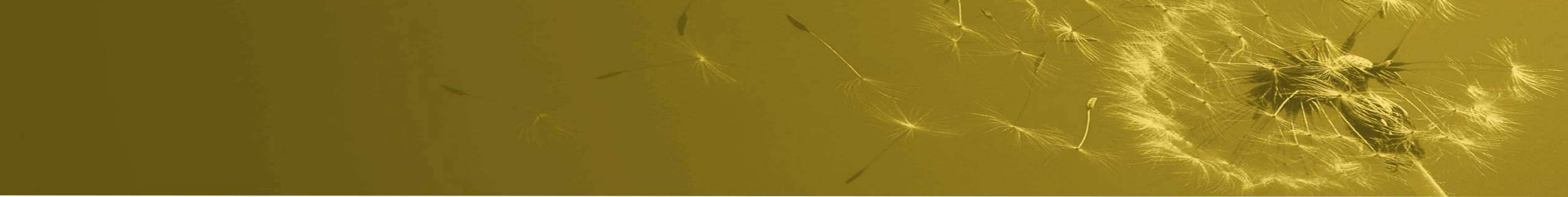
- Q4W CAMM info@engica.com
- QBIC III Computerized Facility Management System supportline@qbiciii.com
- Qquest Maintenance Management Software wessex2@mcmail.com
- Rambow
- Ramco Plant Maintenance (*) info@rsc.ramco.com
- Rapid Response Manufacturing marketing@profitkey.com
- Renaissance CS Maintenance
- Rimses
- SAGEM tracysca@cantv.net
- **SAP R/3**
- SEI sales@interal.qc.ca
- Simain MMS
- Smart/MMS info@pmsmart.com
- SMS/400 Service Management System for the AS/400

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- SOMAX Professional somax@somax.com
- Synergen Series (*) pete_kaminski@synergen.com
- TabWare sales@tabware.com
- TabWare OnLine sales@tabware.com
- TeroTech enquiries@pm-software.co.uk
- The Davison Maintenance System support@davisonsoftware.com
- TIMM - Totally Integrated Maintenance Management for Windows
psintl@ps-intl.com
- TMA Computerized Maintenance Management Software
sales@tmasys.com
- Tooltime fms@dixoncreek.com
- Total Maintenance Management (TM2) bwentland@worldnet.att.net
- Total Maintenance System® info@frsoft.com
- Total Maintenance System® for Healthcare info@frsoft.com

Computerized Maintenance Management Systems (CMMS) Software Packages

- | | |
|---|--------------------------|
| • Trident Maintenance Management System (*) | fielden@fielden.com.au |
| • Tunnel Asset Management System - TAMS | info@rcm2.co.uk |
| • Ultimo | Info@ishbv.com |
| • Ultramain | info@ultramain.com |
| • Umbrella | info@umbrellamp.com |
| • Web Work (*) | sales@teroconsulting.com |
| • WorkEpic | cygman@mscomm.com |
| • WorkMate (*) | sales@adbsys.no |
| • WorkMate | info@absoft.co.uk |
| • World Desk Pro | support@worlddeskpro.com |
| • WOT (Work Order Tracking) (*) | yossi@shoham.com |
| • Xpond's Equipment Maintenance Software | xpond@msn.com |
| • Xsite FMMS - Facilities Maintenance Management System | kramsey@kdrinc.com |
| • Yorvik (*) | sales@yorvik.com |

A decorative header image showing dandelion seed heads against a golden-yellow background.

Computerized Maintenance Management System

Implementation

CMMS Implementation

The implementation phase of purchasing a computerized maintenance management system can make or break the installation. If the implementation process is rushed or left incomplete, the system will not perform satisfactory. The complete implementation can be divided into the following steps:

- Updating current records.
- System installation.
- Data entry.
- Introduction to the system.
- Training the appropriate personnel.

CMMS Implementation

□ Updating current records..

- Can be performed before the system arrives.
- While it may seem to be a waste of time and resources, it is imperative for the information to be as factual and up-to-date as possible.
- Inputting old, inaccurate information will cause all information produced by the system to be inaccurate. This type of problems would cast doubt on the reliability of the system.
- It is suggested that one receive from the selected vendor the format required for the information to be input into the system. This will ensure that the information is compiled correctly.
- Generally, if you are buying a software package, some adjustment will be required.

CMMS Implementation

□ System Installation

- If the system to be installed is just software, it will be a matter of loading the programs into the system and making sure that the programs work properly.
- If the entire system, hardware and software, is purchased, the installation becomes a little more complicated.
- Vendors shall provide the necessary support to install the system.
- It would be advisable to have some in-house personnel working with the vendor, so that the in-house staff has a better understanding of the system operation.

CMMS Implementation

□ Data Entry

- The data entry step takes all of the information in the current record keeping system and enters it into the computer data base.
- This information will provide the basis for all decision making and reporting functions.
- If the present system is not up-to-date, the computerized system won't be either.
- The more uniform the information , the easier the system will be to use.
- Do not underestimate the time it will take to enter all of these files. Large organization will accumulate a tremendous amount of information over several years. This information cannot be entered into the system in one day by one employee!
- For sites with limited resources, it has found that hiring temporary help is the most economical method for inputting the data.

CMMS Implementation

□ Introduction to the System

- This step is important to the system's success.
- If the system is not presented to the users in a positive manner, its effectiveness can be reduced.
- It is important for the group to accept the computerized maintenance management system as a tool for them to use.
- If it is introduced as “big brother,” to watch and see that they do their jobs better, the employees and supervisors may be reluctant to use the system.
- If employees and frontline supervisors do not cooperate with the system, they can negate any positive effects the system would have. However, if they are convinced that the system will help them do their jobs more efficiently, they can be great contributors to the success of the system.
- Its more effective if the users are familiarized with the system in small groups. If they can, as individuals, see the action of the system, they will gain confidence in the system and its purposes.

CMMS Implementation

□ Personnel Training

- Training will ensure that the various groups will use the system.
- The vendor should offer good training program . Use training time build into system price (or even if an additional cost) to train several key individuals in the operation of the system. Then use these individuals to help train the other users in the plant.
- If the vendor offers user & training manual, be sure to obtain a sufficient supply of both.
- It is not recommended that one buy a software package and attempt to get by without training.
- If the training is not taken, you probably will never achieve the maximum benefit from the system.

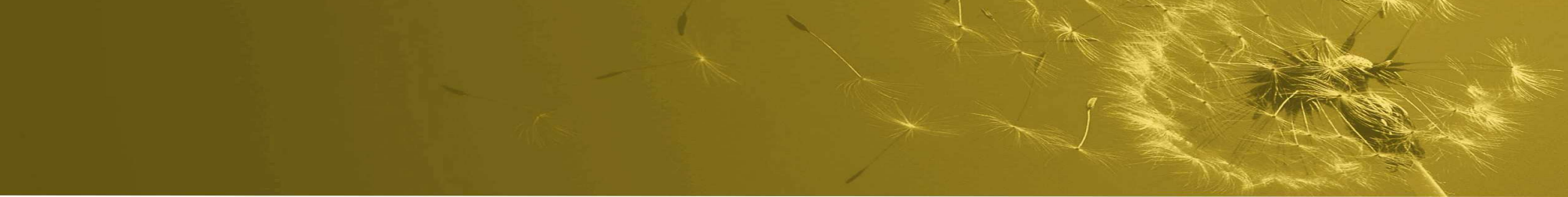
CMMS Implementation

□ Problems

- Do not try to accomplish unrealistic goals and installation times. Set reasonable goals for the manpower and time available.
- Provide appropriate personnel during data entry into the system. This will prevent personnel from taking short cuts while entering information, trying to meet deadlines.
- Provide personnel to work with vendor during installation of the system (both hardware & software). The knowledge gained may help prevent system problems in the future.
- Provide adequate training for all personnel using the system. Untrained personnel will not use the system effectively, contributing to less than optimal performance of the system.
- Provide all computer workstations with a copy of the user manual and training material. No employee has a perfect memory. These material will be a reference source when problems develop.

Conclusion

- *Following the guidelines provided in this course will assist management in justifying, selecting and implementing a computerized maintenance management system.*
- *Selection of the system should be a researched and logical decision. Purchasing a system that provides the needs and not the wants of an organization will assist in making the selection cost effective. By not purchasing an expensive system that is beyond the requirements of the installation, the computerized management system costs can be easier to justify.*
- *Implementation should be smooth and logical procedure. Proper preparation and training will contribute to an effective installation.*
- *The computerized maintenance management system become a standard at all progressive installations. Management will have to decide if it is a time for their facility to invest in this useful tool.*

A decorative header image showing dandelion seed heads against a golden-yellow background.

Chapter VI

Predictive Maintenance

Material Collected By: A.H

Predictive Maintenance

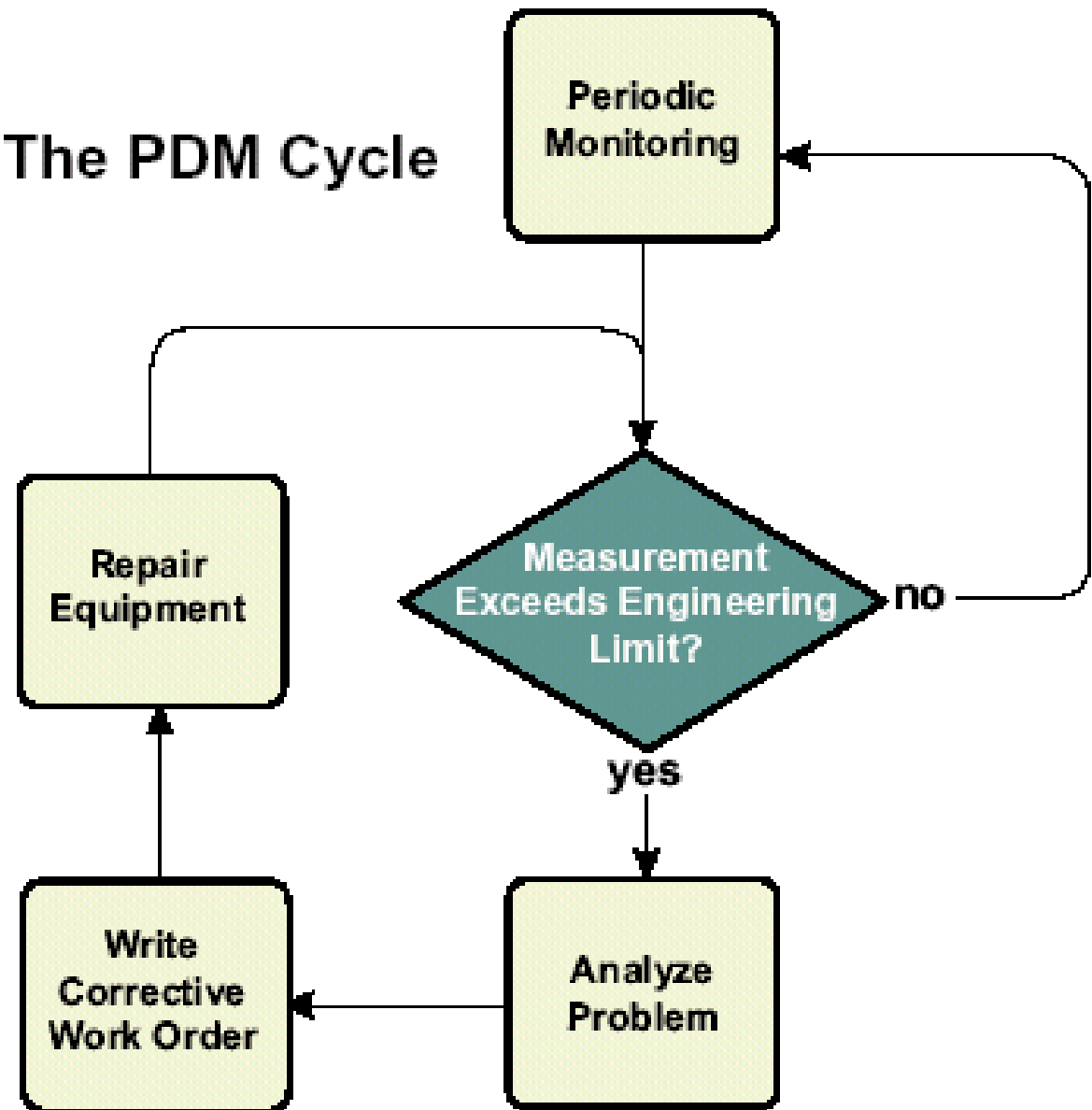
- **Predictive maintenance (PDM)** compares the trend of measured physical parameters against known engineering limits for the purpose of detecting, analyzing, and correcting problems before failure occurs.
- A predictive approach can be applied to any equipment problem if, first, a physical parameter like vibration, temperature, pressure, voltage, current, or resistance can be measured.
- An engineering limit for the measured physical parameter must be established so a problem can be detected during routine monitoring. Also, the limit should be low enough to detect the problem before excessive damage occurs.
- Correcting of the root problem is the key to most predictive efforts.

Predictive Maintenance

The PDM cycle

Once a new piece of critical equipment has been added to the program and baselined, it enters the PDM cycle.

The PDM Cycle



Predictive Maintenance

The PDM cycle

- The established parameters are measured periodically (weekly, biweekly, monthly, etc.). If the measurement exceeds the established engineering limit, it must be analyzed further.
- Analysis can take many forms. For example, a vibration signature can be taken on rotating equipment. A trained analyst may review the signature for common problems, such as misalignment and imbalance, as well as for not-so-common problems, like resonance.
- Once the source of the problem is determined, the best repair activity can be chosen. If the engineering limit is set low enough, there will still be plenty of time to correct the problem before further damage occurs.
- A work request is usually written to start the repair process. Correction of the root problem allows the equipment to reenter the periodic monitoring program.

Predictive Maintenance

The spectrum of PDM

There has been a historical misconception that equipment failures cannot be predicted. However, with predictive technology, a vast number of equipment failures can be predicted.

Vibration measurement on rotating equipment is probably the best known of current predictive applications, but other categories of industrial equipment also benefit from a predictive approach.

Predictive Maintenance

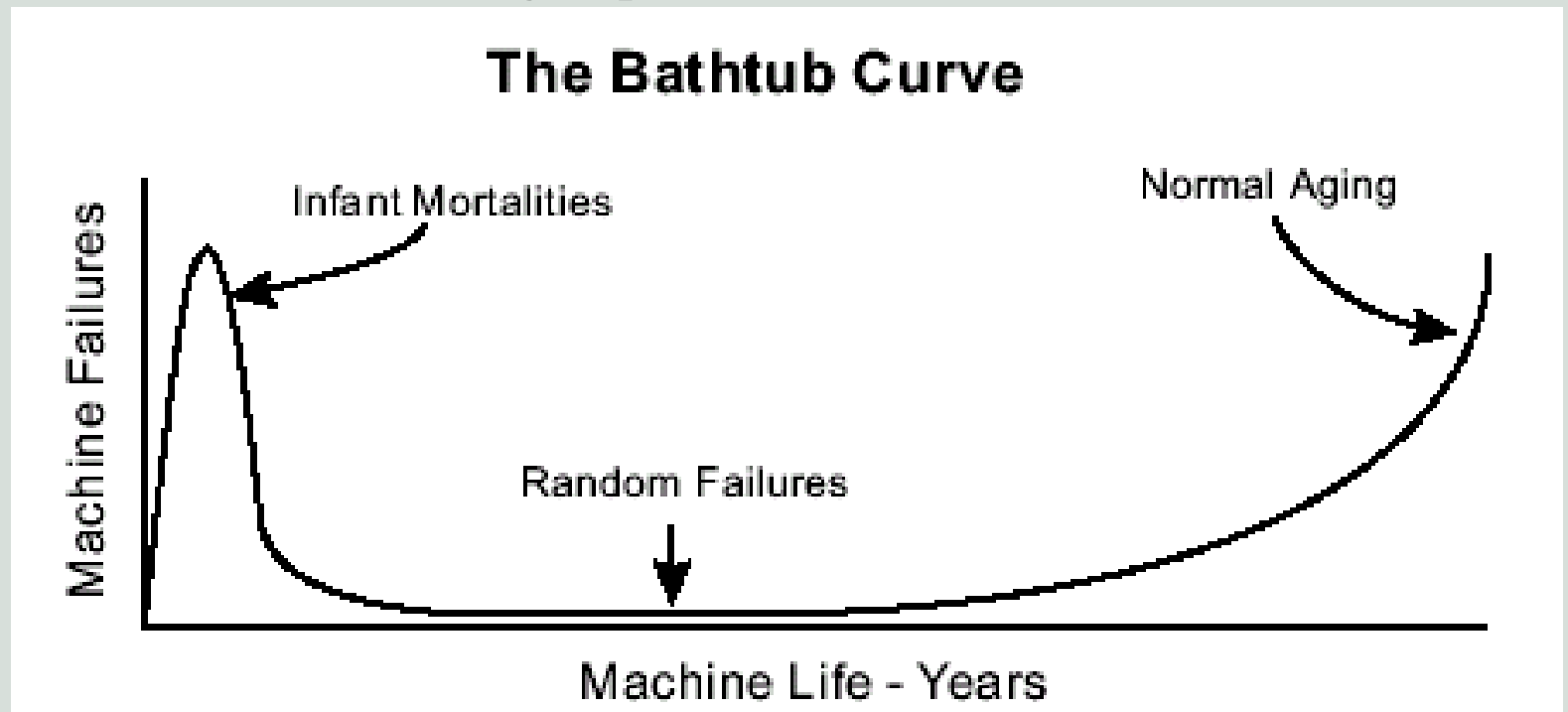
Spectrum of Predictive Maintenance

Equipment Category	Equipment Types	Failure Mode	Failure Cause	Detection Method
Rotating Machinery	Pumps, Motors, Compressors, Blowers	Premature Bearing Loss	Excessive Force	Vibration and Lube Analysis
		Lubrication Failure	Over, Under, or Improper Lube; Heat and Moisture	Spectrographic & Ferrographic Analysis
Electrical Equipment	Motors, Cable, Starters, Transformers	Insulation Failure	Heat, Moisture	Time / Resistance Tests, I/R Scans Oil Analysis
		Corona Discharge	Moisture Splice Methods	Ultrasound
Heat Transfer Equipment	Exchangers, Condensers	Fouling	Sediment / Material Buildup	Heat Transfer Calculations
Containment and Transfer Equipment	Tanks, Piping, Reactors	Corrosion	Chemical Attack	Corrosion Meters, Thickness Checks
		Stress cracks	Metal Fatigue	Acoustic Emission

Predictive Maintenance

The mortality of machinery

The plot of typical machinery life spans is shown in the so-called bathtub curve. Among collections of equipment, there is a rather high incidence of early failures, called infant mortalities. Most equipment that survives infancy will continue to perform with few failures occurring. In time, however, the failures begin to increase until the last of the group succumbs.



Predictive Maintenance

Finding the parameters

- The failures that form the latter part of the curve are caused by identifiable physical phenomena. Depending upon the complexity of the machine, there may be several aging processes at work in a single piece of equipment, any of which may cause the ultimate failure. These processes are usually related to the basic physics of the materials and how the machine is used.
- Knowledge of the physical properties of materials comes from either theoretically or empirically derived conclusions. To understand how failures can be predicted, the mortality of machinery and the finding of parameters need to be understood.

Predictive Maintenance

Finding the parameters (Cont.)

- Many parameters used to predict failures follow from empirical studies and the application of statistical analysis to actual failures.
- For example, experiments in the 1930s showed that measurement of forces on bearings can be accomplished by measuring the total movement of the machine during operation along with the speed of this movement.
- Of course, this movement is vibration. Thus, forces on bearings can be determined by measuring vibration at or near the bearings.

Predictive Maintenance

Defining limits

- Ideally the limit will be set at a measurement value just below the point corresponding to the first discovery of irreparable or costly defects.
- Many engineered limits have already been established for equipment by manufacturers, professional societies and industrial groups. For example, the Vibration Institute, a not-for-profit professional organization, and other organizations have established levels of equipment health as a function of vibration velocity based on experiments.

Predictive Maintenance

Defining limits (Cont.)

- A simplification of this equipment health data is shown in Table , "Rotating machinery ratings".
- This table is useful for categorizing vibration levels on most industrial equipment operating between 600 rpm and 3600 rpm.

Rotating Machinery Ratings		
Rating	Vibration Level	Necessary Action
Good	Less than .15 ips	Continue to Trend
Fair	.15 ips to .30 ips	Continue to Trend
Poor	.30 ips & above	Analyze & Correct

Predictive Maintenance

Limits Based on Product Quality

- A vibration level below 0.3 ips may be acceptable for most rotating equipment, but it may not be sufficient for some processes or operations.
- A new area of predictive maintenance focuses not only on the *reliability* of the *device* being monitored but also on the *quality* of the *product* being manufactured.
- For example, observation of many plastic injection molding operations reveals that vibration levels above 0.2 ips on hydraulic pumps may not result in pump failure but often result in lower product quality.
- Another example, spindle machinery used in the manufacture of precision aircraft and automotive parts often operates at speeds in excess of 10,000 rpm. Normal vibration velocity limits do not apply to this equipment.