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Excerpt from Joel Levitt's book, Managing Factory Maintenance, explains how to justify a preventive maintenance program and provides insight into how to set up a program.

What is preventive maintenance (PM)? It is a series of tasks that either

1. Extends the life of an asset (greasing a gearbox, for example) or
2. Detects that an asset has had critical wear and is going to fail or break down (quarterly inspection of a pump seal).

These tasks are assembled into lists. Each task is marked off when it is completed. There should always be room on the bottom or side of the task list to note comments. Actionable items should be highlighted.

These tasks should be directed at how the asset will fail. The rule is that the tasks should repair the unit's most expensive, most likely, or most dangerous failure modes. Caveat: There will still be failures and breakdown even with the best PM systems. Your goal is to reduce the breakdowns to minuscule levels and convert the breakdowns that are left into learning experiences to improve your delivery of maintenance service.

PM systems also include

1. Maintaining a record keeping system to track PM, failures, and equipment utilization. Creating baselines for other analysis activity.
2. All types of predictive activities, including inspection, taking measurements, inspecting parts for quality, and analyzing oil, temperature, and vibration. Recording all data from predictive activity for trend analysis.
3. Short or minor repairs up to 30 minutes in length. This activity is a great boost to productivity because no additional travel time is required.
4. Writing up conditions that require attention (conditions that will lead or potentially lead to a failure). Writeups of machine condition.
5. Scheduling and actually doing repairs written up by PM inspectors.
6. Using the frequency and severity of failures to refine the PM task list.
7. Continual training and upgrading of inspectors' skills, improvements to PM technology.

One point that is commonly missed is that PM is a way station to the ultimate goal of

maintainability improvement. PM can be an expensive option because it requires constant inputs of labor, materials, and downtime. The ultimate goal of maintenance is high reliability without the inputs.

Some benefits of a PM system

Your inspectors are your eyes and ears into the condition of your equipment. You can use their information on decisions to change your equipment makeup, change specifications, or increase availability.

Equipment has a breakdown curve; once over the threshold, failures increase rapidly and unpredictably. Working lower on the curve adds predictability and reliability.

Early detection prevents core damage and gives you more time to plan and secure parts and specialized tools.

Predictability shifts the maintenance workload from emergency fire fighting due to random failures to a more orderly scheduled maintenance system.

The frequency of user-detected failures will decrease as inspectors catch more and more of the problems. Decreased user problems translates to increased satisfaction.

Cost justification for PM

One way to sell PM is to discuss the effect of downtime from breakdowns. Breakdowns can be a strong selling point when we develop data on the costs.

Accumulate your average number of breakdowns per year and compare 70 percent of that cost to the cost of inspections, adjustment, cleaning, bolting, lubrication, short repairs, and corrective maintenance. We assume that 70 percent of your breakdowns will be eliminated through an average quality PM system. The following formula should be true to go ahead with a PM system:

(Number of breakdowns x average cost per breakdown x 70 percent) > cost of PM system.

Management needs to see the longer view on the nature of proper maintenance that only you can show. Sometimes, at trade conventions or meetings, managers hear that PM is hot this year and they use this enthusiasm to help get a program approved or upgraded. Be conservative in your return on investment estimate and liberal on the amount of funds it will take.

The benefits possible from a PM program are real. Getting the benefit of the installation of a PM system requires a commitment to the elements of a successful system. To maximize the return on investment in your equipment, technicians must keep equipment in peak operating condition.

The PM approach is the long-term approach. Anything less than peak operating condition results in increased operating, maintenance, ownership, or downtime costs. These costs vary slowly. Low overall costs of operation are the result of years of good maintenance policy.

Anyone can reduce maintenance costs for a few quarters by cutting back on PM inspections and associated repairs. The temptation to cut back is sometimes great because the piper gets paid 1 to 2 years down the road.

Because of the temptation and the length of time to get a return on the investment, most organizations have either no PM system or only a partial PM system. Some organizations inspect, lubricate, and adjust but don't feed back repairs to be scheduled unless there are clear and present dangers. Other organizations use fixed PM task lists with fixed frequencies without any review of failure, histories, or service.

Selling PM to management

The first step is to determine the cost of operating in your current mode. The second step is to prove through rigorous modeling that savings or significant improvement to service will result from the proposed improvement.

When possible, include other departments such as production, accounting, or even marketing to

help prepare your arguments. Good maintenance effort affects every part of the plant, so every part of the plant has candidates to contribute in your discussions. Marketing is often a good choice because good maintenance will help them with the customers by ensuring delivery dates and maintaining quality.

The end customer is sometimes the strongest voice for PM. All new vendors to General Motors are subject to a plant audit. One of the elements of the audit is the existence of a PM system (that seems to work). They don't want to put their production in the hands of an organization that uses haphazard maintenance practices.

In some cases maintenance costs increase while overall costs decrease. The offset comes from decreased downtime, improved customer service, or other areas.

We are in an extremely competitive battle for the organization's investment dollars. Investments in maintenance can earn big returns. We must sell our strong suits, which are cost avoidance, improved customer satisfaction, and reduced downtime. Use the language (and issues) of your organization to sell a PM program. In every organization some issues are more important than any others. The benefits of PM are summarized in the section "Benefits of a PM System: The Stakeholders' Priorities."

Steps for installing a PM system

1. Set up the PM task force. The PM task force should include craftspeople (I prefer to include the shop steward in union environments or another opinion leader), one or two staff people (particularly an old timer who has seen everything), and someone from data processing (if you are computerizing at this point). In a modern production facility members of production and production control should be involved on some basis.

2. Analyze the needs and concerns of the maintenance stakeholders. Look at each group and see how they contribute to the success of the organization. Determine who is affected by changes in maintenance. The stakeholders should include at least production, production control, stores, plant manager, top management, purchasing, accounting, housekeeping, maintenance craftspeople, maintenance staff (supervisors, planners, clerks), and even outside vendors. Remember each stakeholder group must be sold individually. Each one has different needs, concerns, fears, and prejudices.

3. Provide the task force with available resources (people/skills/hours), the required demands (zero-based budget documents), and an analysis of the replacement cost of the asset being

supported. The value of the productive output and its associated factory cost also is useful.

4. Have the task force set goals from the system. Objectives are set. At this early point consider training for members of the task force in computer skills (if you plan on computerizing) like typing, Windows, word processors, and spreadsheets. Create daily situations in which the newly trained people have to interact with the computer, such as using the word processor or developing spreadsheet templates. This practice is essential at the early point because you want the task force members to have expertise with computers before computerization of maintenance. Also consider putting in a manual work order system at this point (if you don't have one).

5. After the goals are set, pick a name for the effort. I suggest you stay away from PM system as a name because it has negative connotations for nonmaintenance professionals. Some good names might include PIE (Profit Improvement Effort), DEEP (Downtime Elimination and Education Effort), or QIP (Quality Improvement Effort). The name should reflect the goals.

6. Prepare a preliminary budget for the project and divide the numbers into setup and ongoing.

Setup budget items

- Modernization of equipment to PM standard (capital costs)
- Pay for system to store information
- Labor for data collection, data entry
- Labor to train inspectors
- Labor for task force meetings, losses on shop floor
- Labor to set up task lists, frequencies, standards
- Purchase of any predictive maintenance devices
- Labor to train all mechanics in entry and use of system.

Ongoing budget items

- Labor to carry out PM task lists, short repairs
- Parts costs for task lists, planned component replacement
- Additional investments in predictive technology
- Funds to carry out writeups (corrective maintenance tasks that will maintain a higher standard of maintenance).

7. Sell the PM project to all stakeholders, focusing on their needs, concerns, and fears. When approval or sign-off is given, continue to the next steps. If approval is withheld, retrace your steps and reanalyze.

8. Inventory and tag all equipment to be considered for PM. Compile a list of all of the assets (or units) that you are responsible for. If no list exists, start the process with the accounting asset list. This list is a starting point; beware of assets too old and fully depreciated on the accounting list because these assets are the biggest maintenance consumers. The accounting list will aggregate all building systems under "building" rather than breaking them out to electrical distribution system, compressed air piping, etc.

The list should include the following:

- Asset number, brass tag number, or unit number. It should be a unique number.
- Make and model of the equipment, if relevant.
- Serial number, basic specifications, and capacities.
- Physical location.
- Financial location (where to charge)--department, area of responsibility.
- Subcomponents of the asset. Include high cost items, especially if they require special skills to support.

9. Select a system to store information about equipment and select forms for PM-generated work orders and check-off sheets. Design first draft of performance reports, to be revised later, that audit the PM system.

10. Draft a standard operating procedure (SOP) for the PM system. This document will be revised many times before the first year is up. Begin training in the SOPs with the rest of the crew.

11. Task force members or other people from the shop and staff complete data entry or preparation of equipment record cards. Rotate this job so many people have experience. Make sure the SOP truly reflects how to enter new assets (modify as required).

12. Consider temporary workers to replace the task force's hours on the shop floor (and to replace anyone who is rotated through the data entry position). Take this opportunity to build critical mass in knowledge of your system by having your people do the data entry.

13. Conduct daily audits of data typed into the system. Verify the previous day's entries against the source document or (even better) against the nameplate information on the machine. Rotate the audit job with the data entry job.

14. Select and train people to be inspectors. Allow their input into the next steps. Consider using inspectors to help set up the specifics of the system. Include training in root cause analysis.

15. Determine which units will be under PM and which units will be B'n'F (Bust'n'fix). Remember that there is a real cost associated with including any item in the PM program. If, for example, you spend time on PM tasks for inappropriate equipment, you will not have time for the essential equipment. Costs to include in a PM program:

Cost of inclusion = cost per PM x number of PM tasks per year.

To decide which units to include in the PM system, apply the principles outlined in the section "Rules for Inclusion of Equipment in a PM System."

16. Schedule modernization on units requiring it. Plan to retire bad units if possible. Bad units that are not fixed present big problems for PM systems. It may be better to leave bad units off the system. A bad unit on the system will numb and demoralize the inspectors because they are asked to not see the problems when it comes up for PM because nothing is done between inspections.

17. Select which PM clocks you will use (days, utilization, energy, add-oil). A clock is designed to indicate wear on a system or asset. Using the number of days elapsed (every 30 days, 90 days, 1 year) is good for assets in regular use. A compressor used irregularly might respond better to run-time hours (PM every 500 hours). A concrete plant might use yards of product (PM every 10,000 yards); a steel mill might use tons of steel.

18. Decide what predictive maintenance technologies you will use. Train inspectors in techniques. Even better, provide the information to the inspectors or to the task force and let them pick the modalities.

19. Set up task lists for different levels of PM and different classes. Factor in your specific operating conditions, skill levels, operator experience, etc. Consider unit based, string based, future benefit based, and both interruptive and noninterruptive techniques. Consider a pilot program on a piece of critical equipment. Build your support through publicizing your successes.

20. Be sure inspectors are well equipped for their jobs. They need the following:

- Actual task list with space for readings, reports, observations. Task list should include specifications for the completion of the tasks and individualized drawings if indicated.
- Equipment manual, access to unit history files. Inspectors or operators should be encouraged to look through and familiarize themselves with the manuals.
- Standard tools and materials for short repairs. Operators should be given the exact tools needed for the PM or cleaning (10 mm wrench, 4 mm allen wrench, etc.). A cart designed for most short repairs (with tools and commonly needed materials) can significantly improve productivity of the mechanics.
- Any specialized tools or gauges to perform inspection.
- Standardized PM parts kits, lubricants, cleaning supplies.
- Log sheets to write up short repairs.
- Forms to write up longer jobs.

21. Assign work standards to the task lists for scheduling purposes. Observe some jobs to get an idea of the time.

22. Engineer the PM tasks. Look at the tasks through the eyes of an industrial engineer. Try to simplify, eliminate, speed up each task. Improve the tooling and ergonomics of each task.

23. Determine frequencies for the task lists (based on the clocks chosen earlier). Select parameters for the different task lists.

24. Implement system, load schedule, and balance hours. Be sure you predict when the PM hours are going to be needed and balance these needs to the crew availability. Schedule December and August very lightly. Allow catchup times.

Managing Factory Maintenance (ISBN 0-8311-3063-6), published by Industrial Press Inc., New York, provides considerably more information on preventive maintenance than is contained in this brief excerpt. The book also covers most every aspect of maintenance management, including maintenance department evaluation, communication and delegation, zero-base budgeting, predictive maintenance, total productive maintenance, managing maintenance with a computerized maintenance management system, planning and scheduling techniques, time management, and supervisor evaluation. To purchase a copy of the book, contact Industrial Press by telephone, (212) 889-6330, or on the Internet, www.industrialpress.com , or your book seller. **MT**

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