PREVENTIVE MAINTENANCE

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- COMPUTER ASSISTANCE
- DESIGNING A PM PROGRAM
- CONDITION MONITOR
- ON-CONDITION
- ECONOMICS
- PLANNING AND ESTIMATING
- SCHEDULING
- IMPLEMENTING
- INFORMATION SYSTEMS

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Preventive Maintenance

Dedicated to my wife, Susan
and children, Jennifer and Joseph III,
for their tolerance, understanding, and support

Preface and Acknowledgments

Preventive maintenance means all actions intended to keep durable equipment in good operating condition and to avoid failures. A good preventive maintenance (PM) program is the heart of effective maintenance. Success is often a matter of degree. The proper balance that achieves minimal downtime and costs can be tenuous between preventive maintenance and corrective maintenance. Everything is going to fail at some time. PM can prevent those failures from happening at a bad time, can sense when a failure is about to occur and fix it before it causes damage, and can often preserve capital investments by keeping equipment operating as well as it did on the day it was installed.

Inept PM, however, can also cause problems. Whenever any equipment is touched, it is exposed to potential damage. It is excessively costly to replace components prematurely. Customers may perceive the PM activity as, "that machine is broken again." A PM program requires an initial investment of time, parts, people, and money. Payoff comes months later. While there is little question that a good PM program will have a high return on investment,

many people are reluctant to pay now if the return is not immediate. PM supports a commitment to long-term life-cycle cost/total cost of ownership.

Emotions play a prominent role in preventive maintenance. We all realize that perceptions often receive more attention than facts. A good data system, either manual or computerized, is necessary to provide the facts that must guide PM. PM is a dynamic process. It must support variations in equipment, wear, environment, use, personnel, schedules, and material. Changes are taking place both in technology and in management. These changes both require and support preventive maintenance. Technology provides the tools, and management provides the direction for their use. Both are necessary for success. These concepts are equally applicable to equipment and facility maintenance and field service in commerce, government, and industry.

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Contents

List of Figures

List of Tables

CHAPTER 1

Major Types of Maintenance

There are three main types of maintenance and three major divisions of preventive maintenance, as illustrated in Figure 1-1.

IMPROVEMENT MAINTENANCE

Picture these divisions as the five fingers on your hand. Improvement maintenance efforts to reduce or eliminate

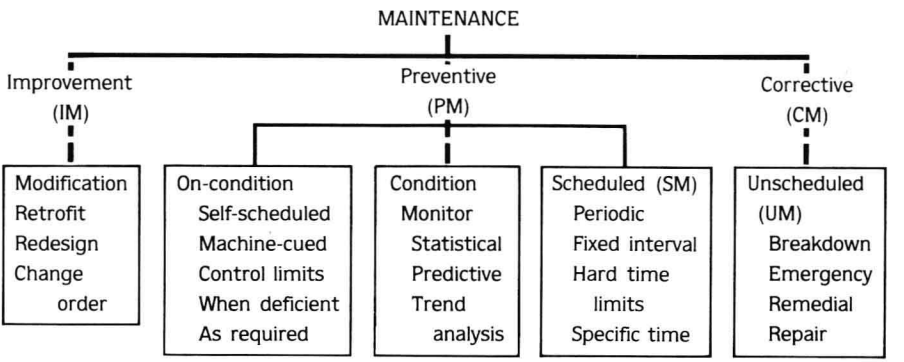

Figure 1-1
Structure of Maintenance

entirely the need for maintenance are like the thumb, the first and most valuable digit. We are often so involved in maintaining that we forget to plan ahead and eliminate the need at its source. Reliability engineering efforts should emphasize elimination of failures that require maintenance. This is an opportunity to preact instead of react.

For example, many equipment failures occur at inboard bearings that are located in dark, dirty, inaccessible locations. The oiler does not lubricate those bearings as often as he lubricates those that are easy to reach. That is a natural tendency. One can consider reducing the need for lubrication by using permanently lubricated, long-life bearings. If that is not practical, at least an automatic oiler could be installed. A major selling point of new automobiles is the elimination of ignition points that require replacement and adjustment, introduction of self-adjusting brake shoes and clutches, and extension of oil-change intervals.

CORRECTIVE MAINTENANCE

The little finger in our analogy to a human hand represents corrective (emergency, repair, remedial, unscheduled). At present, most maintenance is corrective. Repairs will always be needed. Better improvement maintenance and preventive maintenance, however, can reduce the need for emergency corrections. A shaft that is obviously broken into pieces is relatively easy to maintain because little human decision is involved. Troubleshooting and diagnostic fault detection and isolation are major time consumers in maintenance. When the problem is obvious, it can usually be corrected easily. Intermittent failures and hidden defects are more time-consuming but with diag-

nostics the causes can be isolated and then corrected. From a preventive maintenance perspective, the problems and causes that result in failures provide the targets for elimination by PM. The challenge is to detect insipient problems before they lead to total failures and to correct the defects at the lowest possible cost. That leads us to the middle three fingers—the branches of preventive maintenance.

PREVENTIVE MAINTENANCE

On-Condition

On-Condition maintenance is done when equipment needs it. Inspection through human senses or instrumentation is necessary, with thresholds established to indicate when potential problems start. Human decisions are required to establish those standards in advance so that inspection or automatic detection can determine when the threshold limit has been exceeded. Obviously, a relatively slow deterioration before failure is detectable by condition monitoring, whereas rapid, catastrophic modes of failure may not be detected. Great advances in electronics and sensor technology are being made.

Also needed is a change in human thought process. Inspection and monitoring should disassemble equipment only when a problem is detected. The following are general rules for on-condition maintenance:

—Inspect critical components.
—Regard safety as paramount.
—Repair defects.
—If it works, don't fix it.