

# CHAPTER 17

## Maintenance and Reliability

### DISCUSSION QUESTIONS

1. The objective of maintenance and reliability is to maintain the capability of the system while controlling costs.
2. Candidates for preventive maintenance can be identified by looking at the distributions for MTBF (mean time between failures). If the distributions have a small standard deviation, they are usually a candidate for preventive maintenance.
3. Infant mortality refers to the high rate of failures that exists for many products when they are relatively new.
4. Simulation is an appropriate technique with which to investigate maintenance problems because failures tend to occur randomly, and the probability of occurrence is often described by a probability distribution that is difficult to employ in a closed-form mathematical solution.
5. Training of operators to perform maintenance may improve morale and commitment of the individual to the job or organization. On the other hand, all operators are not capable of performing the necessary maintenance functions or they may perform them less efficiently than a specialist. In addition, it is not always cost effective to purchase the necessary special equipment for the operator's use.
6. Some ways in which the manager can evaluate the effectiveness of the maintenance function include:
  - Maintenance productivity as measured by:
 
$$\frac{\text{Units of production}}{\text{Maintenance hours}}$$
 or
 
$$\frac{\text{Maintenance hours}}{\text{Replacement cost of investment}}$$
 or
 
$$\frac{\text{Actual maintenance hours to do job}}{\text{Standard maintenance hours to do job}}$$
  - Machine utilization as measured by:
 
$$\frac{(A - B) - (C + D)}{(A - B)}$$
 where:
    - $A$  = total available operating hours
    - $B$  = scheduled downtime
    - $C$  = scheduled mechanical downtime
    - $D$  = nonscheduled mechanical downtime

- Effectiveness of preventive maintenance as measured by:

$$1 - \frac{\text{Emergency maintenance hours}}{\text{Preventive maintenance hours}}$$

7. Machine design can ameliorate the maintenance problem by, among other actions, stressing component reliability, simplicity of design and the use of common or standard components, simplicity of operation, and provision of appropriate product explanations and user instructions.
8. Information technology can play a number of roles in the maintenance function, among them:
  - Files of parts and vendors
  - Management of data regarding failures
  - Active monitoring of system states
  - Problem diagnosis and tracking
  - Via simulation—testing and evaluation of maintenance policy
  - Enabling more precise control to reduce the likelihood of failure
  - Enabling improved system design
9. The best response would probably be to enumerate the actual costs, both tangible and intangible, for each practice. Costs of waiting until it breaks to fix it might include:
  - Unnecessary damage to the machine
  - Significant down time on the production line
  - Random interruption of the production schedule
  - Ruined raw materials
  - Poor quality of products produced in a time period prior to breakdown
  - Frustration of employees
  - Costs to repair the machine

Costs of preventive maintenance would include primarily the cost to replace the machine component. Downtime could be scheduled so as to reduce its cost; and the frustration of employees, etc., would certainly be less than incurred when the breakdown occurs.
10. Only when preventive maintenance occurs prior to *all* outliers of the failure distribution will preventive maintenance preclude *all* failures. Even though most breakdowns of a component may occur after time  $t$ , some of them may occur earlier. The earlier breakdowns may not be eliminated by the preventive maintenance policy. A distribution of natural causes exists.

# Operation Management Problem Manual Solution

**Joseph G. Monks**



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