Optimal Preventative Replacement Age of an item subject to breakdown, taking account of the time required to carry out failure and preventive replacements.

So far, we assumed zero time for performing replacements.

Actually, there is time required to perform replacements.

The optimal preventive replacement age of the item is again taken as that age which minimizes the total expected cost of replacement per unit time.

Construction of the model:

C_p is the total cost of a preventive replacement

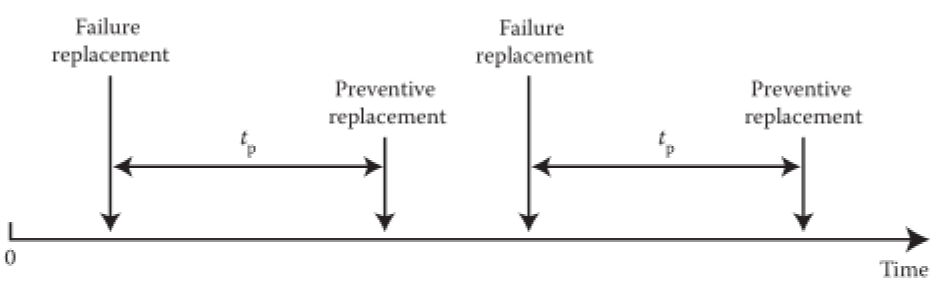
C_f is the total cost of a failure replacement

T_p is the mean time required to make a preventative replacement

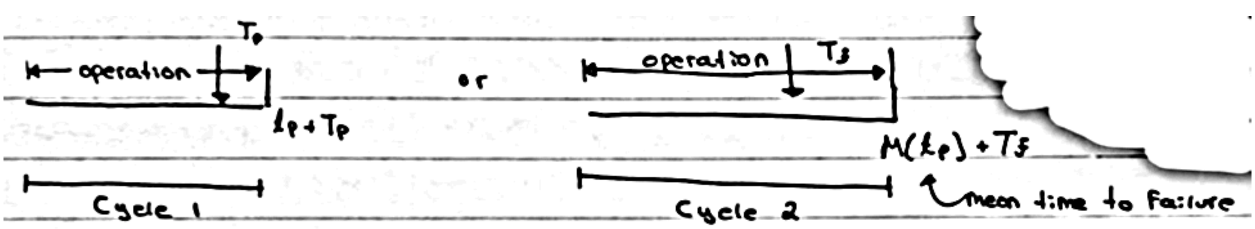
T_f is the mean time required to make a failure replacement

$f(t)$ is the probability density function of the failure times of the item

The replacement policy is to perform a preventative replacement once the item has reached a certain age, t_p, plus failure replacements as needed.



The possible cycles of operation:



The total expected replacement cost per unit time denoted $C(t_p)$, is:

$$C(t_p) = \frac{total\ expected\ replacement\ cost\ per\ cycle}{expected\ cycle\ length}$$

Total expected replacement cost per cycle

$$= C_p \cdot R(t_p) + C_f[1 - R(t_p)]$$

Expected cycle length
$=$ length of a preventive cycle · probability of a preventive cycle
$+$ expected length of a failure cycle · probability of a failure cycle.
$= (t_p + T_p)R(t_p) + [M(t_p) + T_f][1 - R(t_p)]$

$$C(t_p) = \frac{C_p \cdot R(t_p) + C_f\,[1 - R(t_p)]}{(t_p + T_p)R(t_p) + [M(t_p) + T_f][1 - R(t_p)]}$$

This is a model of the problem relating preventive replacement age, t_p, to the total expected replacement cost per unit time.

Sometimes downtime is more important, so, the objective becomes minimizing the downtime.

Optimal Preventive Replacement Interval or Age of an item subject to breakdown: Minimization of downtime.

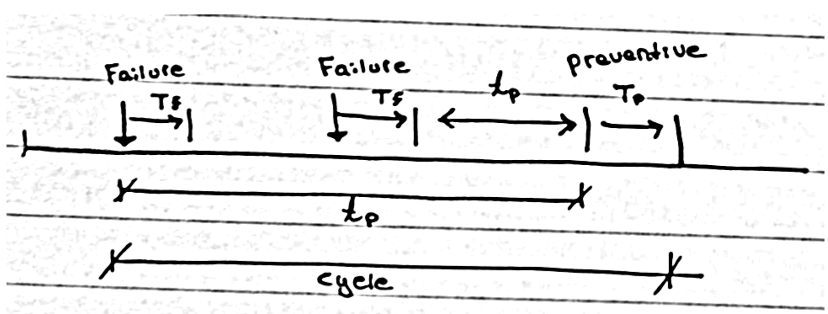
So far – minimized total cot per unit time.

In some cases, the replacement policy required may be one that minimizes total downtime per unit time or, equivalently, maximizes availability.

As the preventive replacement frequency increased, there is an increase in downtime due to these replacements, but a consequence of this is a reduction of downtime due to failure replacements, and we wish to get the best balance between them.

Construction of the model:
T_f is the mean downtime to make a failure replacement.
T_p is the time required to make a preventive replacement.
$f(t)$ is the probability density function of the failure time of the item.

Model 1: Determination of Optimal Preventive Replacement Interval



The total downtime per unit time, for preventive replacement at time t_p, denoted as $D(t_p)$

$$D(t_p) = \frac{Expected\ downtime\ due\ to\ failure + downtime\ due\ to\ preventive\ replacment}{Cycle\ length}$$

Downtime due to failures $=$ Number of failures in interval $(0, t_p)$ x time required to make a failure replacement.

$$= H(t_p) \cdot T_f$$

Downtime due to preventive replacement $= T_p$

So,

$$D(t_p) = \frac{H(t_p)T_f + T_p}{t_p + T_p}$$

Is the model of the problem relating replacement interval t_p to total downtime $D(t_p)$