Group Replacement:

The lamp replacement problem: The cost of transporting a lighting department's maintenance staff to a single streetlight failure and discounts associated with bulk purchase of lamps, it may be economically justifiable to replace all the lamps on a street rather than only the failed ones.

Statement of the problem:

A large number of similar items are subject to failure.

Whenever an item fails, it is replaced by a new item.

We do not assume group replacement in such conditions.

There is also possibility that group replacements can be performed at fixed intervals of time.

The cost of replacing an item under group replacement conditions is assumed to be less than that for failure replacement.

A balance is needed.

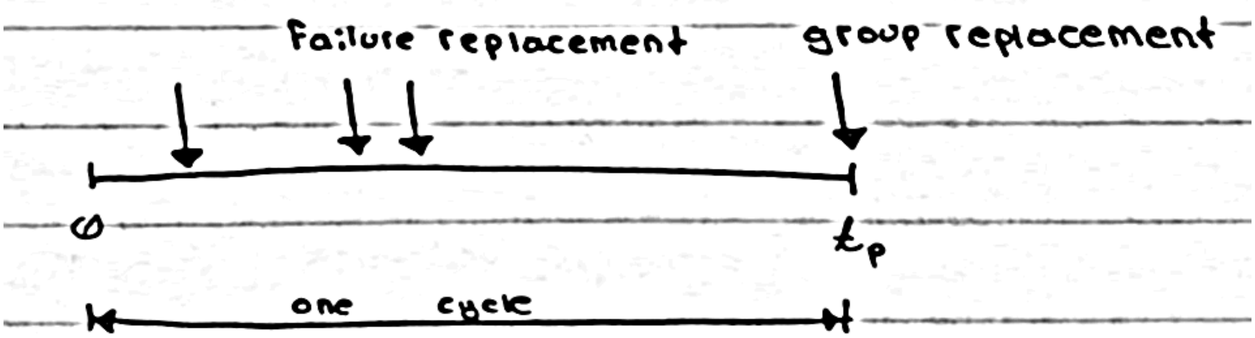
Model:

$C_g$ − cost of replacing one item under conditions of group replacement

$C_f$ − cost of replacing one item under failure replacement

$f(t)$ − the probability density function of the failure of the items

$N$ − total number of items in the group




The total expected replacement cost per unit time for group replacement at time $t_p$,

$$C(t_p) = \frac{Total\ expected\ costin\ interval\ (0, t_p)}{Interval\ Length}$$

Total expected cost in interval $(0, t_p) =$

Cost of group replacement at time $t_p$ + expected cost of failure replacements in interval $(0, t_p)$

So,

Total expected cost in interval $(0, t_p) = NC_g + NH(t_p)C_f$

$H(t_p)$ is the expected number of times the item fails in interval $(0, t_p)$

So the model is,

$$C(t_p) = \frac{NC_g + NH(t_p)C_f}{t_p}$$

To find the optimal time $t_p$, we need trial and error.

Multistage replacement:
A multistage replacement strategy may be relevant in the situation in which there is a group of similar items that can be divided into subgroups dependent on the cost of replacing an item upon its failure.

One such strategy: Assume cost of replacement in stage 1 is greater than stage 2.

In this case, the failures that occur in stage 2 are replaced by operating items in stage 1. Vacancies that occur in Stage 1, whether caused by failure or transfer of operating items in Stage 2, are replaced by new items.

(example, if a failure occurs in a rear tire in a trailer, it is replaced by a tire in the front wheel and a new tire put in the front wheel)

<u>Optimal Policies:</u>
Frequently, an item ceases to operate not because of its own failure but because there is a production stoppage for some reason.

When this happens, the maintenance specialists may have to device whether to take advantage of the downtime opportunity to perform a preventative replacement.

<u>Reparable Systems:</u>
So far, we only discussed replacement of items.

Many items are replaceable.

How best to handle the optimization of maintenance decisions associated with repairable items?

The terms minimal and general repair are frequently used.

A minimal repair can be through of as a very minor maintenance action (such as replacing a snapped fan belt on an automobile), that retains the equipment to the same state of health it was just before the minor maintenance action.

A general repair improves the system state.

Spare parts provisioning: Spare parts are required for each preventive and failure replacements.

Need models that can be useful in forecasting the inventory needed.

Construction of the model:
$t_p$ – preventive replacement time (either interval or age)
$f(t)$ –probability density function of the item's failure times
$T$ – planning horizon, typically 1 year

$EN(T, t_p)$ is the expected number of spare parts required over the planning horizon, $T$, when preventive replacement occurs in time $t_p$

$EN\left(T, t_p\right) =$ number of preventive replacement in interval $\left(0, t_p\right) +$ Expected number of failure replacement in interval $(0, T)$

$$= \frac{T}{t_p} + M\left(t_p\right)\left(\frac{T}{t_p}\right)$$