1.2 Failure patterns and failure analysis

Repetitive failures

Two statistics are commonly used:-

1. MTBF (mean time between failures)

$$= \frac{L_1 + L_2 \ldots + L_n}{n}$$

where L_1, L_2, etc., are the time to failure and *n* the number of failures

MTBF is of value in quantifying failure rates, particularly of machines involving more than one failing component. It is of most use in maintenance planning, costing and in assessing the effect of remedial measures.

2. L_{10} Life, is the running time at which the number of failures from a sample population of components reaches 10%. (Other values can also be used, e.g. L_1 Life, viz the time to 1% failures, where extreme reliability is required).

L_{10} Life is a more rigorous statistic that can only be applied to a statistically homogeneous population, i.e. nominally identical items subject to nominally identical operating conditions.

Failure patterns

Repetitive failures can be divided by time to failure according to the familiar 'bath-tub' curve, comprising the three regions: early-life failures (infantile mortality), 'mid-life' (random) failures and 'wear-out'.

Early-life failures are normally caused by built-in defects, installation errors, incorrect materials, etc.

Mid-life failures are caused by random effects external to the component, e.g. operating changes, (overload) lighting strikes, etc.

Wear-out can be the result of mechanical wear, fatigue, corrosion, etc.

The ability to identify which of these effects is dominant in the failure pattern can provide an insight into the mechanism of failure.

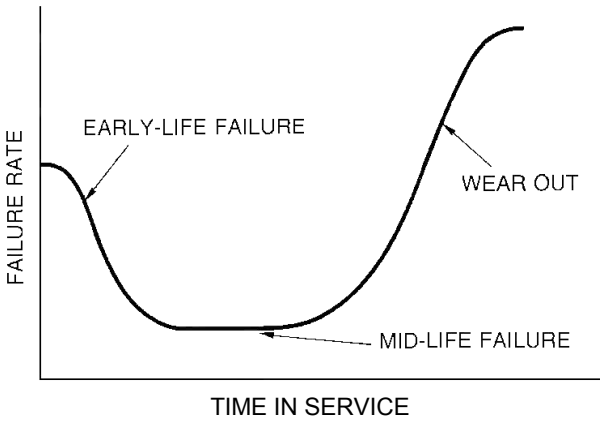

Figure 1.2 The failure rate with time of a group of similar components.

As a guide to the general cause of failure it can be useful to plot failure rate against life to see whether the relationship is falling or rising.

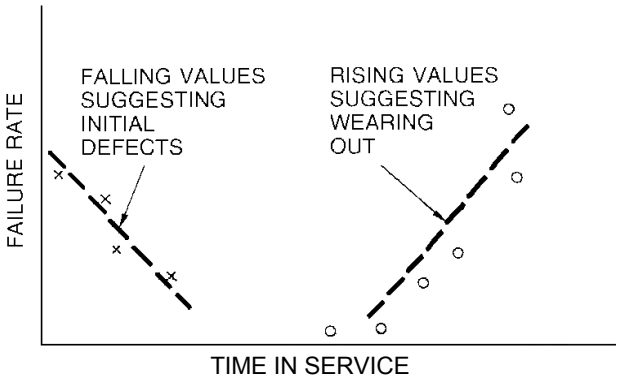

Figure 1.3 The failure rate with time used as an investigative method