Table 6.2: Example of a generic database.

Component and Failure Modes	Mean	Median	Error Factor	Component Boundary
Pumps				
Motor-driven				Pump and motor; excludes control circuits.
Failure to start	3E-3/d	1 E-3/d	10	
Failure to run, given start				
Normal Environment	3E-5/h	1 E-5/h	10	
Extreme Environment	3E-3/h	1 E-3/h	10	
Turbine-driven				Pump, turbine, steam and throttle valves, and governor.
Failure to start	3E-2/d	1 E-2/d	10	
Failure to run, given start	1 E-5/h	1 E-5/h	3	
Diesel-driven				Pump,diesel, lube-oil system, fuel oil, suction and exhaust air, and starting system.
Failure to start	1 E-3/d	1E 3/d	3	
Failure to run, given start	8E-4/h	1 E-4/h	30	

4.4.9 Lognormal Distribution

The lognormal distribution is used quite frequently in reliability and safety studies. The relationship to normal distribution is as follows: if the stochastic variable ln(x) has a normal distribution, x has a lognormal distribution. The probability density function is given by:

$$f(x) = \frac{1}{x\sigma\sqrt{2\Pi}} \exp[-\frac{\{\ln(x)-\mu\}^2}{2\sigma^2}] \tag{4.35}$$

The error factor is defined as follows:

$$EF = \sqrt{\frac{x_{0.95}}{x_{0.05}}} \tag{4.36}$$

4.7.2 Continuous distributions

The following inputs are required.

Generic failure data : Failure rate
Error factor

Plant-specific data : Number of failures
Exposure (operating time or calendar time)

The generic error factor (EF) is a measure of the uncertainty in the generic information. It is the square root of the ratio of the 95 per cent percentile and the 5 per cent percentile. The percentiles are the upper and lower value of the uncertainty interval.

$$EF = \sqrt{\frac{P_{95\%}}{P_{5\%}}} \tag{4.83}$$

Table 6.3: Example of ranges for pumps.

Component type	Failure mode	Range
Diesel-driven pump	Fail to start Fail to run	3E-4 - 3E-2 -/d 1E-3 - 3E-2 -/h
Motor-driven pump	Fail to start Fail to run	3E-4 - 3E-2 -/d 1E-4- 3E-4-/h
Turbine-driven pump	Fail to start Fail to run	3E-3 - 3E-2 -/d 1E-5 - 1E-3 -/h

Table 6.4: Components for which in general plant-specific data can be collected.		
Component	**Type**	**Failure mode**
Diesel Generator		- Fail to run - Fail to start
Pumps	- Motor-driven - Turbine-driven	- Fail to run - Fail to start
Valves	- Motor-operated - Medium-operated - Check - Relief - Manual - Safety	- Fail to open - Fail to close

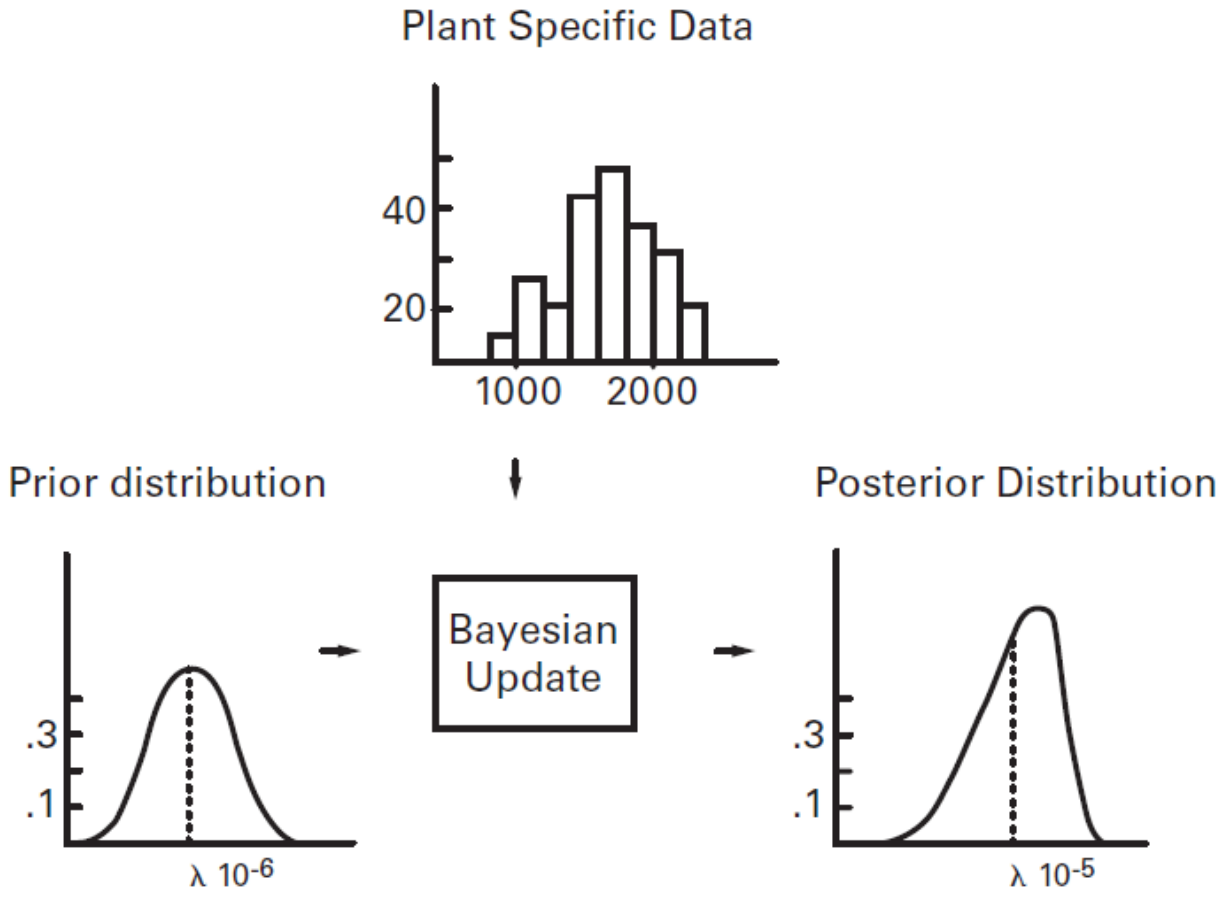
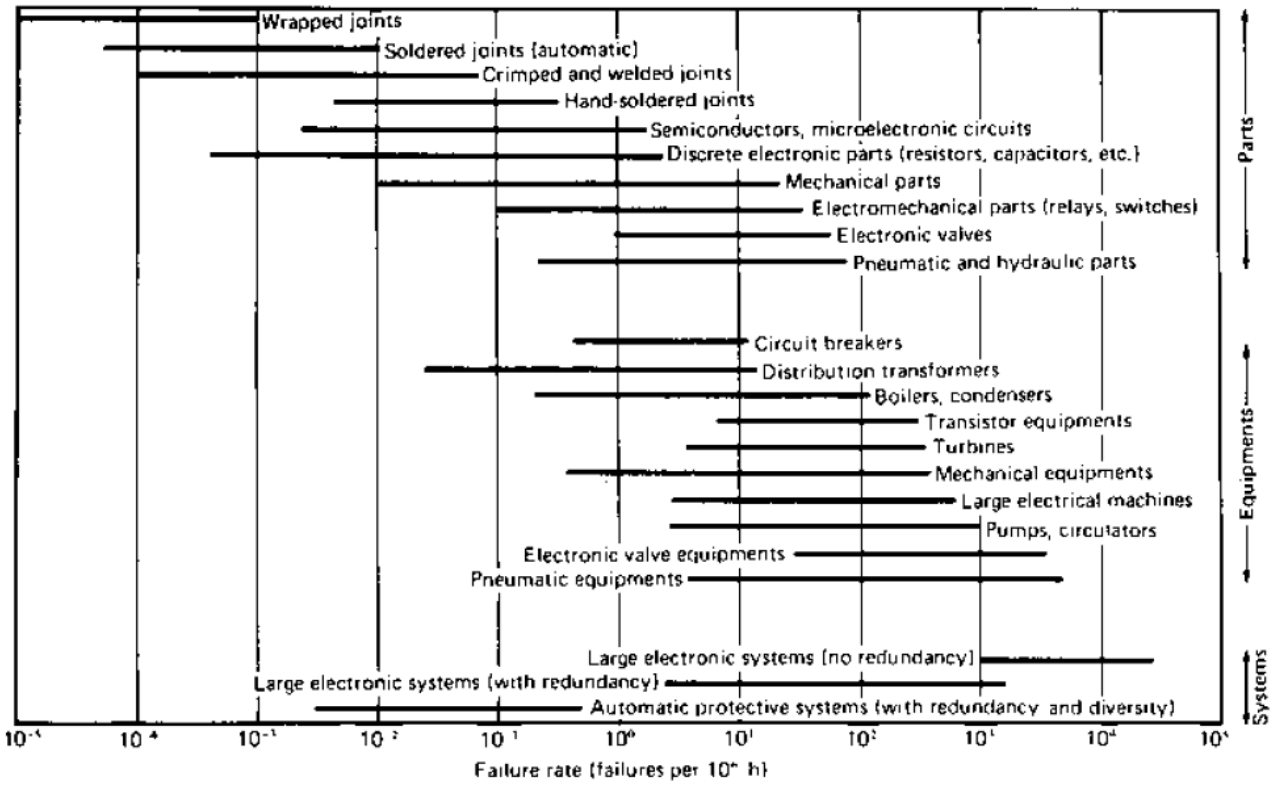


Figure 6.6: Example of Bayesian update technique.



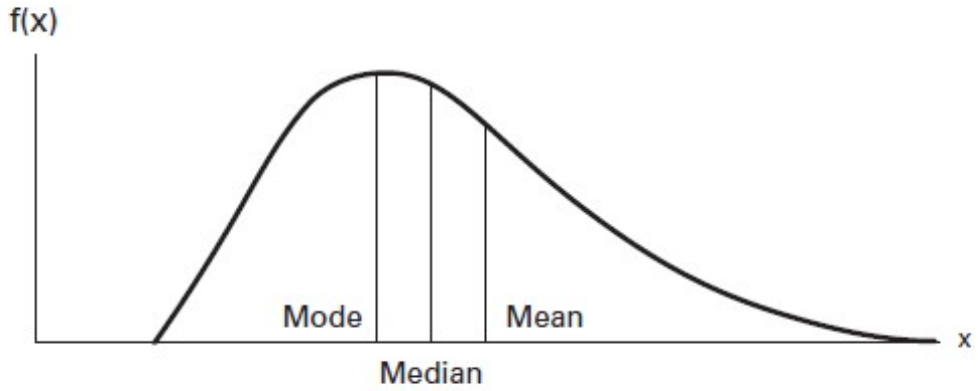


Figure 4.2: Mean, median and mode of a distribution.