

3. What are the quantitative measures of reliability (discuss measures for hardware, software, personnel, facilities, and data)?
4. How would you define the overall *failure rate* for a system? What should be included (or excluded)? Why?
5. Refer to Figure 12.4. Reliability predictions/estimations are usually based on what portion of the “bathtub” curve? What is likely to happen if the system is delivered to the customer during the early “infant mortality” portion of the curve? What would you do to extend the flat portion of the curve?
6. Refer to Figure 12.5. Identify some of the possible “causes” for the jagged portion of the curve.
7. A system consists of four subassemblies connected in series. The individual subassembly reliabilities are as follows:

$$\text{Subassembly } A = 0.98$$

$$\text{Subassembly } B = 0.85$$

$$\text{Subassembly } C = 0.90$$

$$\text{Subassembly } D = 0.88$$

Determine the overall system reliability.

8. A system consists of three subsystems in parallel (assume operating redundancy). The individual subsystem reliabilities are as follows:

$$\text{Subsystem } A = 0.98$$

$$\text{Subsystem } B = 0.85$$

$$\text{Subsystem } C = 0.88$$

Determine the overall system reliability.

9. Refer to Figure 12.14. Determine the overall network reliability if the individual reliabilities of the subsystems are as follows:

$$\text{Subsystem } A = 0.95$$

$$\text{Subsystem } B = 0.97$$

$$\text{Subsystem } C = 0.92$$

$$\text{Subsystem } D = 0.94$$

$$\text{Subsystem } E = 0.90$$

$$\text{Subsystem } F = 0.88$$

$$\text{Subsystem } G = 0.98$$

10. The failure rate ( $\lambda$ ) of a device is 22 failures per million hours. Two standby units are added to the system. Determine the MTBF of the system.
11. Calculate the reliability of a system consisting of one operating unit and one identical standby unit operating for a period of 200 hours. The failure rate ( $\lambda$ ) of each unit is 0.003 failure per hour and the failure sensing switch reliability is 1.0.

12. A system consists of five subsystems with the following MTBFs:

- Subsystem A: MTBF = 10,540 hours
- Subsystem B: MTBF = 16,220 hours
- Subsystem C: MTBF = 9,500 hours
- Subsystem D: MTBF = 12,100 hours
- Subsystem E: MTBF = 3,600 hours

The five subsystems are connected in series. Determine the probability of survival for an operating period of 1,000 hours.

13. Ten components were tested for 500 hours, each within prescribed operating conditions. Component 1 failed after 30 hours; component 2 failed after 85 hours; component 3 failed after 220 hours; and component 4 failed after 435 hours. Determine the overall composite failure rate ( $\lambda$ ) for the system.
14. Suppose that you have the following design data on an equipment item and that, based on these data, you may wish to accomplish a reliability prediction. What is the predicted MTBF?

Component	Quantity of Parts Used	Failure Rate (% 1,000 hours)
A	16	0.135
B	75	0.121
C	32	0.225
D	44	0.323
E	60	0.120
F	15	0.118
G	28	0.092

15. Assume that there is a requirement for a new system with a specified performance capability and a reliability of 70%. In response to an "invitation to bid," three supplier configurations have been proposed and are reflected in Figure 12.28. The component reliability factors are noted in the following table:

Component	Reliability	Component	Reliability	Component	Reliability
A	0.84	G	0.87	M	0.83
B	0.86	H	0.88	N	0.85
C	0.89	I	0.89	O	0.84
D	0.86	J	0.86	P	0.89
E	0.87	K	0.85	Q	0.89
F	0.82	L	0.86		

The overall cost associated with each of the supplier proposals is \$57,000 for Configuration A, \$39,000 for Configuration B, and \$42,000 for Configuration C.

- (a) Determine the system reliability for each of the three configurations.
- (b) In evaluating the three alternatives, employing cost-effectiveness (CE) criteria, which configuration would you select as being preferred?

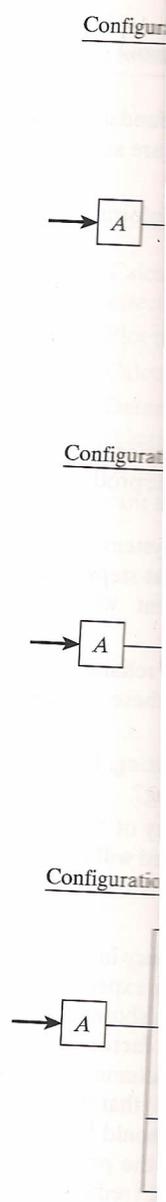


Figure 12.28

- 16. When designing a system, what steps are considered for incorporation of reliability?
- 17. What is a reliability prediction, and what are the steps that you would follow in its application?