CHAPTER 8

Conclusions

We began this book by describing the place of modelling and evaluation in the total setting of system reliability planning. This is an important phase of a reliability program as the reliability model integrates the information available on the various components to provide overall system indices. Several reliability measures have been defined and techniques described for their calculation. The choice of a particular index depends on the penalty factors associated with system failures. If the penalty depends on the total duration of failure, availability is a relevant measure. If, however, the number of failures is more important, frequency is a more appropriate index. Ideally a reliability measure should be sensitive to all the factors which affect reliability. In practice, however, some measures are more sensitive to a certain parameter than the others. A single measure is, therefore, not likely to give a complete picture of system reliability and the use of more than one reliability index is preferable.

The central concept running throughout the book is the *frequency balancing approach*. This method gives the same linear, differential or integro–differential equations as would be obtained by conventional means. The chief advantage of this approach is the simplicity with which frequency, cycle time and mean duration indices can be calculated. Another important feature of this technique is the equivalent transition rate. This concept has been used to derive conditions of mergeability which set the mathematical limits for model reduction. Correct appreciation of the conditions of mergeability is important for model reduction. Many gross mistakes have been committed in the literature because of a lack of such an understanding.

Reliability evaluation of large and complex systems can sometimes be quite difficult. The difficulties are more computational than conceptual. When the system is composed of independent elements, model reduction using the concept of equivalent transfer rates proves quite useful. When dependent failures are encountered, model reduction becomes limited. Two useful techniques under these circumstances are truncation and sequential truncation.

In reliability models, assumptions are made about the probability distributions of times to failure and times to restore. It goes without saying that model formulation approaches reality only to the extent that the assumed distributions approach the actual ones. The bulk of this book is devoted to Markovian models. These models assume exponential distributions for the mean up and down times. The techniques of dealing with non-Markovian models have also been described

in detail. Analytical methods involving integro–differential equations are useful but the solution can be quite intractable for fairly complex systems. The device of stages transforms a non-Markovian model into a Markovian model and a solution is therefore possible. The only disadvantage of this method is the multiplication of the number of states.

Mathematical modelling provides a compact and efficient means of obtaining system reliability measures. The mathematical model abstracts the essence of the physical system and provides a deeper insight into the cause and effect relationships within the system. All reliability problems, however, cannot be solved analytically. Simulation is a more flexible approach and can take into account many factors which cannot be handled by mathematical models. The approach, however, is time-consuming and does not provide the same insight into the system. Wherever possible, an analytical approach is definitely superior to using a simulation technique.

The emphasis throughout the book is not on the development of particular reliability models but on deepening the insight into the theory, philosophy and the techniques of system reliability modelling. The purpose is to enhance the reader's capability for reliability modelling and evaluation.

We conclude this book by repeating the warning given in the introduction. After making a number of experiments with the reliability model, it is possible to develop a confidence in the results which may not prove justified by a closer examination of the data. The reliability model transforms data into reliability measures and, given a correct model, the validity of these measures depends on the validity of the data used.