## 11.8 SUMMARY

We have described some of the problems of designing and producing reliable software and how these problems are different from those associated with hardware reliability. The importance of being able to produce reliable and fault-tolerant software will continue to increase as the use of devices incorporating computers grows. Improved production methods will increase software reliability; however, it will remain difficult to make software-based systems tolerant of unanticipated errors. Safe failure of systems incorporating software will continue to depend in the last resort on hardware safety provisions.

For many real-time engineering applications loosely coupled distributed computer systems can be used. The advantage of such systems is that they can be made robust through the use of redundant processors and communication systems. The loose coupling permits the containment of faults to specific parts of the system thus reducing the extent of the performance failure and easing the problem of reinstatement. Most applications of this type are well defined and hence it is possible to specify closely actions to be taken in the event of expected failure modes and most systems can continue to operate in a degraded mode. For example, it is normal for tasks to be allocated at construction time to a specific node (processor) in the system and the action to be taken in the event of failure of that node is normally predetermined.

As with any distributed system there is the problem of system consistency and steps must be taken to ensure that at the end of the recovery procedure the system is returned to a consistent state. For many real-time engineering applications much of the data decreases in value as it ages and hence much of the system will automatically return to a consistent state as new plant data is obtained. The problem areas concern environmental data that is input in incremental rather than absolute form; in such cases consistency can only be regained by restarting the device or system from some known absolute datum.

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