**Chapter 1 - Questions**

1. The switch from water power to steam power caused the industrial revolution.
2. Changes in manufacturing are driven primary by a need for increased productivity.
3. At the start of the 20th century the electrification of manufacturing and the invention of the electric motor moved manufacturing to the next level.
4. The process of a machine measuring the product output and automatically correcting for improper operation is call feedback control.
5. Project : Many complex parts are used to build a one-of-a-kind product. - Job shop: - Non-complex products with few parts and small production volume. – Repetitive: 110 percent repeat business, multi-year contracts, high but variable production quantities. – Line: (1) the delivery time required by the customer is often shorter than the total time it takes to build the product, (2) the product has many options or models, and (3) an inventory of subassemblies is normally present.
6. Repetitive, Line, and Continuous.
7. Robots can be reprogrammed and retooled to a wide variety of automation tasks.
8. FMS are made up of a number of linked FMCs.
9. Fixed automation machines are designed for a small number of products and FMCs are designed to be flexible and produce a variety of products.
10. Project
11. The tree indicates the technologies that you must know and pyramid shows the sequence of to learn about the products.
12. *Troubleshooter—*A skilled person employed to locate trouble or make repairs on machinery or technical equipment.
13. Problem solving is solving a problem never seen before, but exercises are solution you know for previously solved problems.
14. When changes are made to the data used by the program and in very large programs that do not have a specific set of events occur until much after the software was installed.
15. a. List all of the system components that would be replaced in the advent of a failure. b. Arrange the list of system components with inputs at the top, outputs at the bottom, and the remaining items in the order that signal or information flows through them. c. Put all of the block diagram components into rectangles and apply signal flow techniques to link the rectangles in the diagram.
16. a. Record and study all system symptoms. b. Locate points on the system block diagram where abnormal operation is occurring. Place a right bracket ( ] ) after each abnormal block. c. Move to the left along the signal flow path from each bad bracket until normal operation is observed. Place a left bracket ( [ ) to the right of the block where a normal output was detected.
17. Power flow indicates power distribution and signal flow shows how information, signals, and data move from block to block.
18. The linear signal path is a series connection of blocks, a divergent signal path is present when a single block feeds two or more blocks, a convergent signal path is present when signals from two or more blocks feed into a single block, a feedback signal flow is created when part of the output signal is diverted back to the input of the system and added to the input signal, Switched signal flow paths include linear, divergent, or convergent paths, with switches present to change the flow of the signal.
19. Start the troubleshooting measurements half way between the input and the output on a signal path.
20. When brackets enclose system blocks with a divergent path, the stage before the divergence is fault-free if any of the divergent paths are normal. In convergence, if all convergent inputs are necessary for a good output then a good output means that all inputs are correct, but if that is not the case then each convergent input must be checked except the one producing the good output.
21. If the change of a switch position causes the output fault to disappear then the problem is in the path that the switch was in before switching. If that is not the case, then the problem is down stream of the switch.
22. The concept of using more general checks as the brackets are widely separated and letting the test become more specific as the brackets move closer together.
23. Those are the easiest test to make and cost less in time and effort.
24. If the front panel controls are not set properly then all others tests are not valid. Also those are the easiest test to make and cost less in time and effort.
25. They are an accurate record of what the problems is and what has been done to identify the cause of it.
26. If you don’t understand how the system operates in detail it is impossible to troubleshoot faults.
27. If a fault was detected then it is equally important to determine why the system failed so that type of failure could be prevented in the future.
28. If the symptoms are related then troubleshoot them as they were one type of problem. If they are unrelated, then troubleshoot each one as thought it were a single problem.
29. A failure is either a totally random event (a component failing) or a human driven event (a fork lift hitting a cable). In either case it would be statistically unusual for two of these to occur at the same time that were totally unrelated.

**Chapter 1 - Troubleshooting Problems**

1a. Left bracket on input side of power amplifier and right bracket on output side of speaker #1

1b. Left bracket on input side of microphone #1 and right bracket on output side of mixer.

1c. Left bracket on output side of power amplifier and right bracket on output side of speaker #2.

1. It is unlikely that both speakers would fail simultaneously so if a single failure is involved then the bracket could move to the output of the power amplifier.
2. We don’t know if both microphones are good since one could be bad and volume controls on the mixer could be set low for the other one. If the volume controls were set to a nominal position before the microphone test then the single failure assumption could be applied and the bracket moved.
3. The left bracket would move to the input of the power amplifier instead of the movement of the right indicated in the solution.
4. If the switch to the CD did not cause an output then the problem is in the power amplifier since both speakers cannot be bad (single failure assumption). The left bracket is placed on the input side of the power amplifier and the right is placed on the output side in Figure 1-5. The next test is made at the output of the summing amplifier. If the test indicates that the unit is good then the left bracket moves to the output of that unit. If the test is bad then the right bracket moves to output of that unit. The fault is found by continuing this process until one unit has brackets on the input and output.