26 AUTOMATED LINES, SYSTEMS, OR PROCESSES

ANSWERS—QUIZ 1

1. a
2. b
3. b
4. b
5. c
6. The just-in-time method (JIT), a manufacturing philosophy that reduces inventories and relies heavily on computerized scheduling, allegedly permits manufacturers to have more flexibility and to reduce costs.
7. The downside of automation designed, implemented, or modified around JIT principles is that machines may be interdependent, with little or no provision for inventory to back up between any two stations.
8. Safety in automated manufacturing can be greatly increased in two ways: (1) by careful identification of hazards, and (2) by the development of strategies to control the environment where the processes are taking place.
9. Design-in safety has two objectives for AGVs: to keep the AGVs from colliding with people and other vehicles, and, if an anticollision device fails to work, to prevent the AGV from operating until it can be repaired.
10. Safe operation of any chemical process requires that the persons in charge ask the three "whats":
    - What can go wrong?
    - What is the probability that something will go wrong?
    - What would be the consequences if something does go wrong?
11. *Process safety management* is a means of managing process safety by recognizing and understanding the risks of production and by operating in a safe manner so that hazards do not result in injuries and loss of life or property. Elements of process safety management include:
    - analyzing hazards and managing risks
    - managing a change in facility design or operation
    - maintaining the integrity of equipment
    - training and performance
    - investigating incidents
    - responding to and controlling emergencies
    - auditing
    - taking corrective actions

ANSWERS—QUIZ 2

1. b
2. a
3. a
4. b
5. d
6. a
7. A robot's arm, from the base of the robot through the wrist, is called the manipulator.
8. All persons involved with robots must remember the following points:
    - If the robot is motionless, do not assume it will remain so. Many programs have delays or waits, when the robot "sits" until told to do something.
    - If the robot is repeating a pattern, do not assume it will continue the repetition. Computers can automatically modify the path a robot has been programmed to follow and thereby trap personnel within the work envelope when the robot moves in an unexpected direction.
9. Up-front planning for safety represents another manufacturing philosophy with safety implications. One way of addressing safety concerns associated with automation is to categorize safety costs as part of the original installation. These costs are factored into management's buy/no-buy decision and capitalized as part of the original investment.
10. Design-in safety can contribute to safer working conditions because safety planning is targeted toward specific work procedures rather than based on a one-size-fits-all philosophy.
11. Effective safety training becomes even more important in automated production. Because automated manufacturing processes often require workers to interface with more than one system component, such as a program, terminal, machine, materials handling system, or robot, workers need to understand other parts of the systems besides their own. Programmable automation and automated manufacturing systems

require that operators, maintenance personnel, and supervisors develop many skills to work safely and productively. Yet safety and health professionals cannot assume that all workers have the necessary skills to read and understand technical manuals and specifications.

ANSWERS—CASE STUDY

1. The Robotic Industries Association defines an industrial robot as "a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices, through variable programmed motions for the performance of a variety of tasks."
2. Robots have become the automation of choice in factory environments where working conditions are potentially hazardous or overly strenuous for human workers. Processes such as spray painting on an automotive assembly line or loading molten steel in extremely hot temperatures are good candidates for robots. Robots are used for arc and resistance welding, assembly, dispensing and applying sealants and adhesives, painting, loading and unloading machines, transferring parts from one conveyor to another, packaging, and palletizing.
3. In 1982, a survey of 190 factories, conducted by the Labor Ministry of Japan, reported 11 incidents, including two deaths. In 1987, an analysis of cause and effect of 32 industrial robot incidents reported in Swedish, West German, Japanese, and American literature indicated that in 24 of the 32 cases, a definite cause associated with robot-human interaction could be reported. Of the 32 incidents, 13 were attributed to human error. Workplace design accounted for 20 incidents; 18 were related to guarding, and 2 were related to interfacing. (Many of these incidents had more than one cause.) Of the 32 incidents recorded, 72% involved the operator or a nearby worker.