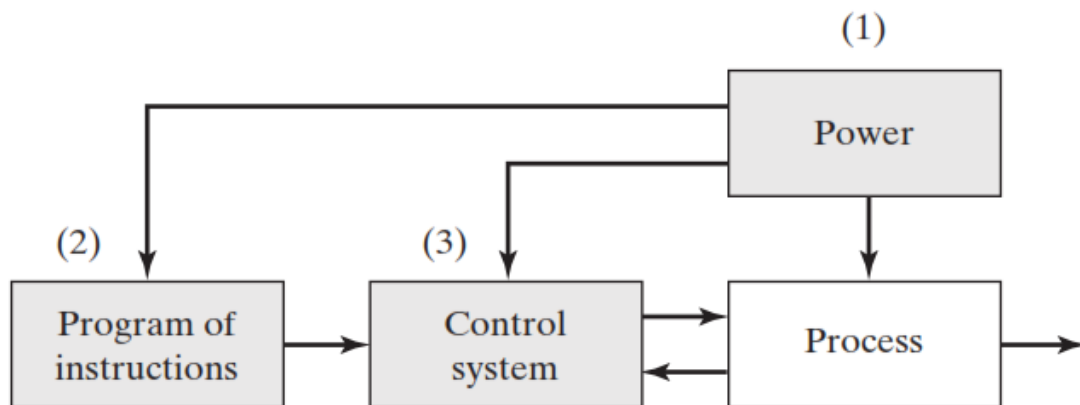




## BASIC ELEMENTS OF AUTOMATED SYSTEM

An automated system consists of three basic elements:

- (1) power to accomplish the process and operate the system,
- (2) a program of instructions to direct the process, and
- (3) a control system to actuate the instructions.



## POWER TO ACCOMPLISH THE AUTOMATED PROCESS

An automated system is used to operate some process, and power is required to drive the process as well as the controls.

The principal source of power in automated systems is electricity.

Electric power has many advantages in automated as well as nonautomated processes:

- Electric power is widely available at moderate cost. It is an important part of the industrial infrastructure.
- Electric power can be readily converted to alternative energy forms: mechanical, thermal, light, acoustic, hydraulic, and pneumatic.
- Electric power at low levels can be used to accomplish functions such as signal transmission, information processing, and data storage and communication.
- Electric energy can be stored in long-life batteries for use in locations where an external source of electrical power is not conveniently available

**TABLE 4.1** Common Manufacturing Processes and Their Power Requirements

Process	Power Form	Action Accomplished
Casting	Thermal	Melting the metal before pouring into a mold cavity where solidification occurs.
Electric discharge machining	Electrical	Metal removal is accomplished by a series of discrete electrical discharges between electrode (tool) and workpiece. The electric discharges cause very high localized temperatures that melt the metal.
Forging	Mechanical	Metal work part is deformed by opposing dies. Work parts are often heated in advance of deformation, thus thermal power is also required.
Heat-treating	Thermal	Metallic work unit is heated to temperature below melting point to effect microstructural changes.

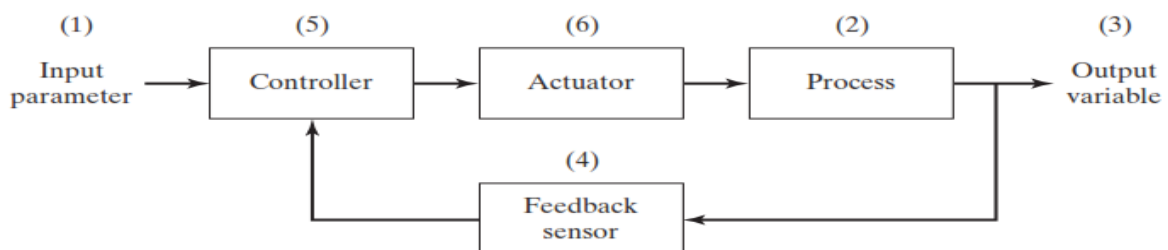
power is also required for the following material handling functions:

- Loading and unloading the work unit
- Material transport between operations
- Controller unit
- Power to actuate the control signals
- *Process parameters.* How many process parameters must be controlled during each step? Are the process parameters continuous or discrete? Do they change during the step, for example, a positioning system whose axis values change during the processing step?
- *Number of steps in work cycle.* How many distinct steps or work elements are included in the work cycle? A general sequence in discrete production operations is (1) load, (2), process, (3) unload, but the process may include multiple steps.
- *Manual participation in the work cycle.* Is a human worker required to perform certain steps in the work cycle, such as loading and unloading a production machine, or is the work cycle fully automated?
- *Operator interaction.* For example, is the operator required to enter processing data for each work cycle?
- *Variations in part or product styles.* Are the work units identical each cycle, as in mass production (fixed automation) or batch production (programmable automation), or are different part or product styles processed each cycle (flexible automation)?
- *Variations in starting work units.* Variations can occur in starting dimensions or materials. If the variations are significant, some adjustments may be required during the work cycle.

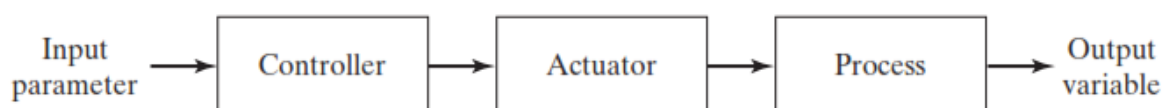
### Control system

The control element of the automated system executes the program of instructions. The control system causes the process to accomplish its defined function, which is to perform some manufacturing operation.

The controls in an automated system can be either closed loop or open loop. A closed loop control system, also known as a feedback control system,



A feedback control system.



An open-loop control system.