

Seminar on Industrial Automation

Topic:
Introduction to Automation

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Outline

- Definition & Reasons to Automate
 - What is automation?
 - Examples of automated systems
 - Regulatory and Logic Control Systems
 - Discrete and Continuous Plant or Processes
- Automation Technologies
 - PLC & PAC
 - HMI/SCADA

What is Automation?

- *Automation is the application of mechanical, electrical and computer technology for the operation and control of processes*
- *Automation is the technology by which a process or procedure is accomplished without human assistance*

Reasons to Automate

- Increase of productivity
 - Reduction of:
 - Production times
 - Labor cost
 - Expenses in raw material and inventory
- Improvement of product quality
 - Certification (for international marketing)
- Increase Safety and Security
- Environment protection

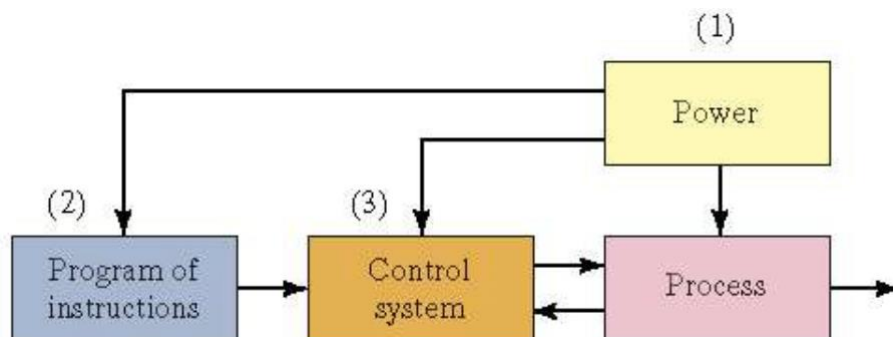
Automated System

Automation it is implemented using a Program of Instructions combined with a Control System that executes the instructions

Basic elements of an automated system:

1. Power
 - to accomplish the process and operate the system
2. Program of instructions
 - the computational intelligence to direct the process
3. Control system
 - the devices capable of actuate the instructions

Elements of an automated system



Power to accomplish the automated process

- Power for the process
 - To drive the process itself
 - To load and unload the work unit (proper position and orientation)
 - Transport between operations
- Power for automation
 - Controller unit
 - Power to actuate the control signals
 - Data acquisition and information processing

Electricity: the main power source

- Widely available at moderate cost
- Can be readily converted to alternative forms, e.g., mechanical, thermal, light, etc.
- Low level power can be used for signal transmission, data processing, and communication
- Can be stored in long-life batteries

Controller unit

- Read program of instructions
- Make the control calculations
- Execute instructions by transmitting the proper commands to the actuating devices

Actuators are electromechanical devices such as switches and motors.

Program of instructions

“Set of commands that specify the sequence of steps in the work cycle and the details of each step”

- Examples:
 - CNC part program
 - Robot program
 - PLC program
- During each step, there are one or more activities involving changes in one or more process parameters
 - Examples:
 - Temperature setting of a furnace
 - Motor on or off

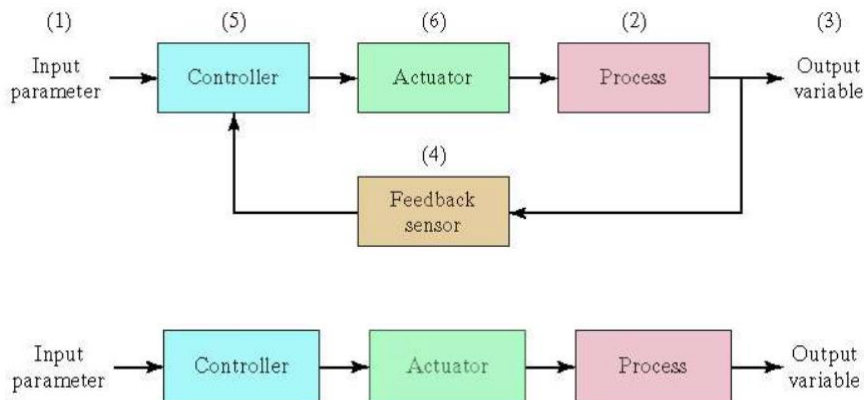
Control system

- The Control element of the automated system executes the program of instructions.
- The control system causes the process to accomplish its defined function, to carry out some manufacturing operation

Control systems: two types

1. Closed-loop (feedback) control system – a system in which the output variable is compared with an input parameter, and any difference between the two is used to drive the output into agreement with the input
2. Open-loop control system – operates without the feedback loop
 - Simpler and less expensive
 - Risk that the actuator will not have the intended effect

Feedback control system and open loop control system

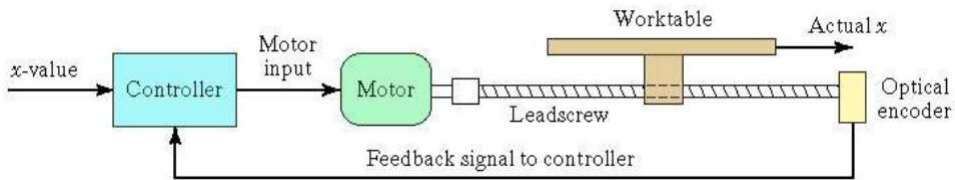


Closed loop control systems

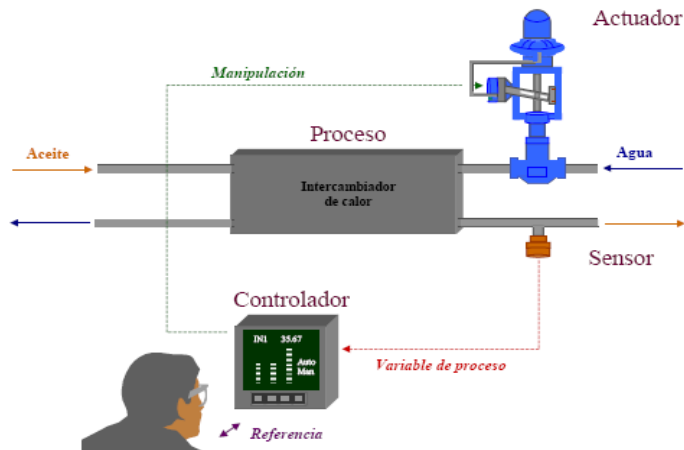
1. *Input Parameter (set point) represents the desired value of the output*
2. *The process is the operation or function being controlled (output value)*
3. *A sensor is used to measure the output variable and close the loop between input and output.*
4. *The controller compares the output with the input and makes the required adjustment in the process to reduce the difference between them.*
5. *The adjustment is accomplished using one or more actuators which are the hardware devices that physically carry out the control actions.*

Positioning system using feedback control

A one-axis position control system consisting of a leadscrew driven by a dc servomotor and using an optical encoder as the feedback sensor

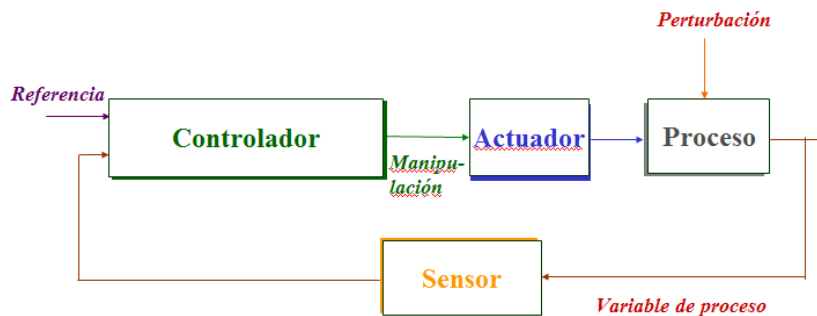


Example automated system



Closed Loop Control

Sistema de control automático
Modelo o mapa conceptual



When to use open-loop control

- Actions performed by the control system are simple
- Actuating function is very reliable
- Any reaction forces opposing the actuation are small enough as to have no effect on the actuation
- If these conditions do not apply, then a closed-loop control system should be used

Advanced automation functions

1. Safety monitoring

“Use of sensors to track the system's operation and identify conditions that are unsafe or potentially unsafe”

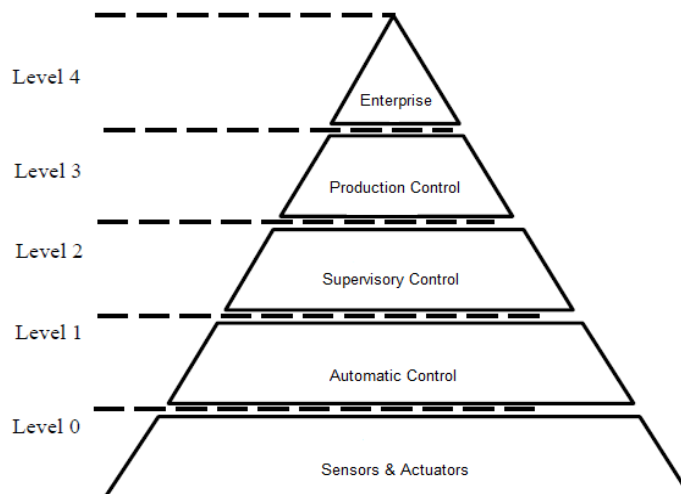
2. Maintenance and repair diagnostics

The capabilities of an automated system to assist in identifying the source of potential or actual malfunctions and failures of the system

3. Error detection and recovery

Use the system's available sensors to determine when a deviation or malfunction has occurred

Automation Pyramid

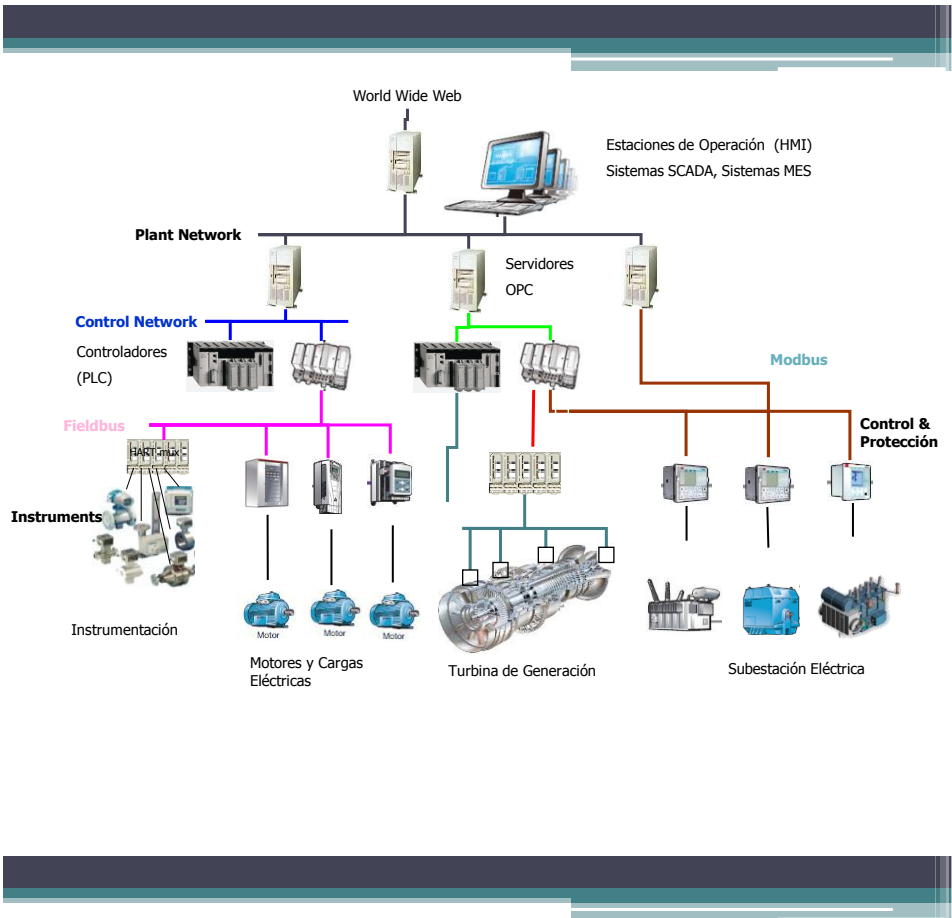


Automation Pyramid

- The automation pyramid represents various levels of automation
 - Levels 0 and 1 are focused on hardware, sensors actuators and their controllers. These are the fundamentals of automation, required but not sufficient to constitute a modern automation system.
 - Levels 2 and 3 of the pyramid represent the SCADA and MES systems that are critical to maximizing the efficiency and resources of a modern highly automated facility.
 - The top level of the pyramid, Enterprise Resource Planning, is governed by business decisions.

Automation Layers

- **Sensors and Actuators Layer:** This layer is closest to the processes and machines, used to translate signals so that signals can be derived from processes for analysis and decisions and hence control signals can be applied to the processes. This forms the base layer of the pyramid also called 'level 0' layer.
- **Automatic Control Layer:** This layer consists of automatic control and monitoring systems, which drive the actuators using the process information given by sensors. This is called as 'level 1' layer.
- **Supervisory Control Layer:** This layer drives the automatic control system by setting target/goal to the controller. Supervisory Control looks after the equipment, which may consist of several control loops. This is called as 'level 2' layer.
- **Production Control Layer:** This solves the decision problems like production targets, resource allocation, task allocation to machines, maintenance management etc. This is called 'level 3' layer.
- **Enterprise control layer:** This deals less technical and more commercial activities like supply, demand, cash flow, product marketing etc. This is called as the 'level 4' layer.



Bibliography

- *Automation, Production Systems, and Computer-Integrated Manufacturing, Third Edition, by Mikell P. Groover, Third Edition, Prentice Hall, 2008*