Introduction to Automation

ISPE Young Professionals
January 20, 2011
Timothy Alosi
New England Controls
Today’s Speaker

Timothy Alosi
New England Controls
Tim.Alosi@NewEnglandControls.com

• 20+ Years in Automation
• Local life sciences experience
  • Lab Integration
  • Large Scale Manufacturing
  • MES and Data Warehousing
Today’s Topics

- Why Automate
- Control Concepts
- Automation System Architecture
- Process Control Application
Why Automate

- Why
- Where
Control Concepts

- Terminology
- Control Loop Basics
Terminology: Control Loop

- **Controller**
- **Input**
- **Output**
- **Transmitter**
- **Final Control Element**
Terminology: Process Defined

- **Process** – The process refers only to the quantity or condition of a fluid within a vessel or piping system.
- **Control Equipment** – All the other elements in the loop – the transmitter, controller, and final control element. These are not part of the process.
Terminology: Variables

- **Controlled Variables** – These are the quantities, qualities, or conditions that are to be held at some specific value.
  - Temperature
  - pH

- **Disturbances** – These are variables that can impact the quality, quantity or condition or the controlled variables.
  - WFI drop valve opening
  - Filter blockage or damage

- **Manipulated Variables** – A variable that can be manipulated to ensure that the controlled variables remain at the desired level despite disturbances to the process.
  - Control Valve position
  - Pump Speed
Three tasks must be performed in order to implement process control:

- Measure the process variable
- Compare the PV to the SP to determine if an error exists.
- Adjust the manipulated variable to minimize the error.
Process Control Example: Level Control
Process Control Example: Level Control
Automation Architecture

- Inputs and Outputs
- Process Controllers
- Scalability
- Communication Networks
- Application Software
NEED: connect to the devices that measure and manipulate the Process
Automation System Architecture

Process Controller with Input /Output (I/O) Cards

Point-to-Point Wiring
• Analog Inputs
• Analog Outputs
• Discrete Inputs
• Discrete Outputs

NEED: connect to the devices that measure and manipulate the Process
Automation System Architecture

Process Controller with Input /Output (I/O) Cards

Digital Busses
• Foundation Fieldbus
• DeviceNet
• Profibus
• AS-I
• Modbus

NEED: connect to the devices that measure and manipulate the Process
Automation System Architecture

Process Controller with Input /Output (I/O) Cards

Wireless
• Industrial 802.15

NEED: connect to the devices that measure and manipulate the Process
Types of Process Controllers

- Single Loop Controllers
- Modular “Mix and Match” Add different functionality based on needs / size
- PC with Specialty IO/Software
- Compact “All in One”
Automation in All Sizes

Single Loop Controllers
1 – 5 I/O

Small, Modular Systems
10’s – 100’s of I/O

Full Size Industrial Systems
1000’s – 10,000’s of I/O
Redundancy

- Network Connections
- Digital Busses Cards
- Power Supplies
- Controllers
- Classic I/O Cards
Automation System Networking

- Engineering
- Historian
- Operator Station

- Dual Path Communications for high Availability
- Firewalls for Security

- Primary Network
- Secondary Network

- Process Controller 1
- Process Controller 2
Application Software

- Engineering and Diagnostics
- Batch and Recipe Execution
- Plant Operations and Alarms
- Integration, History Collection and Analysis
Operations

PC Based Operator Station

Mobile Worker HMI

Panel Mounted HMI
Engineering Environment

Ladder Logic

Function Blocks

Sequential Function Chart
Process Historians
Process Control Application

- Discrete Control
- Regulatory / Continuous Control
- Process and Safety Interlocking
- Batch and Sequential Logic
Discrete Control

- Only two states are recognized.
- Difficult to maintain a precise set point
  - On / Off
  - Up / Down
  - Hotter / Colder

- Examples
  - Home Thermostat
  - Switches
  - Motors
  - On-Off valves

- Application Example: Machine Control (filling/capping)
Continuous/Analog Control

- Monitoring and Controlling variable measurements and control elements (flow, pressure, temperature)
- Application Example: Bioreactor Temperature, pH and Dissolved Oxygen
Process and Safety Interlocking

- Monitoring and reacting to conditions that could cause process excursions, equipment damage or unsafe conditions
Batch / Sequencing Control

- Coordinates both discrete and analog control to ensure that an automated sequence is completed and abnormal conditions addressed.
Implementation of Physical Model

S88 Physical Model

- Area
- Process Cell
- Unit
- Equipment Module
- Control Module
Automation Life Cycle

Manage → Plan → Implement → Design → Plan → Manage
GAMP “V” Validation Model – Drives Project Activities
Thank You