Microprocessor-Based Industrial Controllers

Class 1: Concepts and History

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Presented by:

CEC CONTINUING EDUCATION CENTER

Digi-Key ELECTRONICS

This Week's Agenda

Monday	Concepts and History
Tuesday	Microprocessor Architectures
Wednesday	Controller Examples - 1
Thursday	Controller Examples - 2
Friday	Connectivity and Trends

Course Description

Industrial controllers at the device level have a long history. Over time they have evolved from relay based, to discrete logic and finally to microprocessor based logic. While the functions have remained the same, the capabilities and sophistication have grown enormously. In this class we will look at the history and development of the field and then look into the modern architectures which are currently in use. We will take a deep dive into several examples of controllers, including the algorithms and implementations for several. Finally we will look at connectivity and trends in the industry.

Today's Agenda

- Course Goals
- Early Industrial Control History
- Historical Development of PLCs
- Controller Concepts
- Algorithm Types
- Conclusion/Next Class

Course Goals

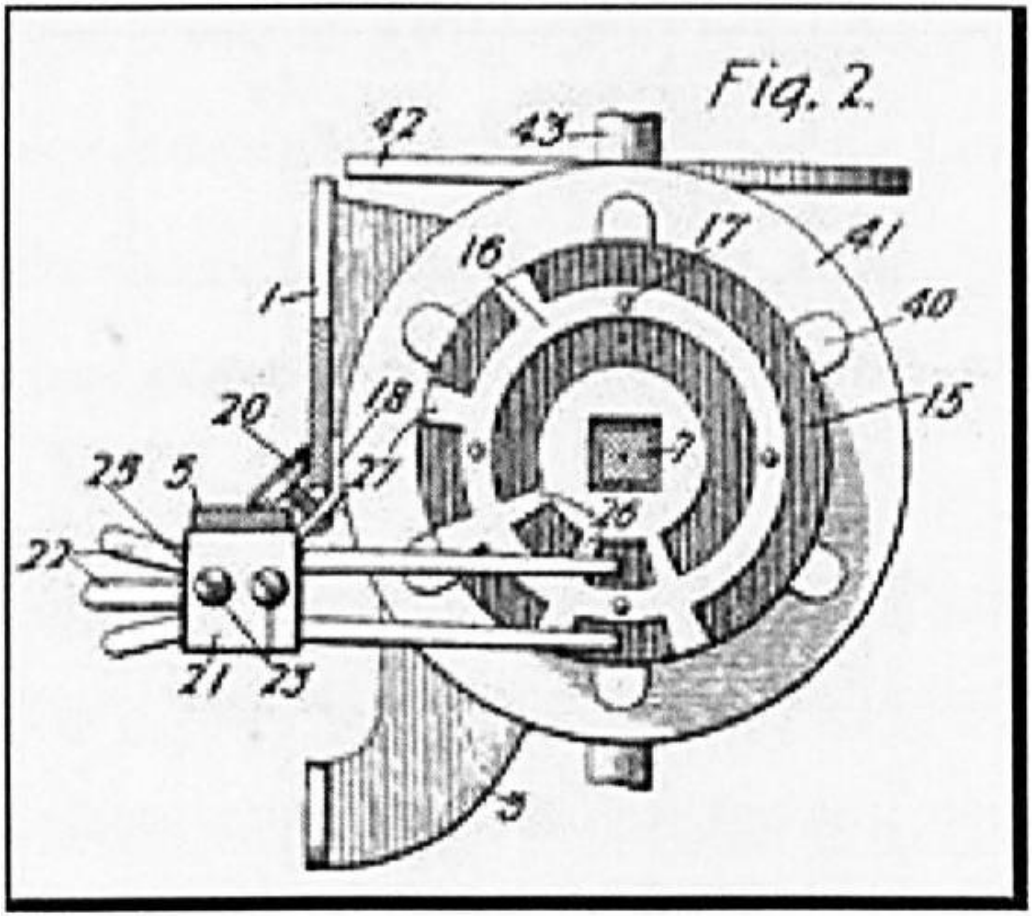
- In this course I am trying to cover three aspects of Industrial Controllers
  - History: how did we get to where we are, and the role of microcontrollers today
  - Architecture of microcontroller based Industrial controllers
  - Detailed examples of algorithms made possible by the use of microcontrollers

Early Industrial Control History

- In the beginning…
  - Automated, sequential control of industrial machinery and processes dates at least to 18th century (programmable looms in the textile industry)
  - With electrification and complexity, there was need for more complex control mechanisms

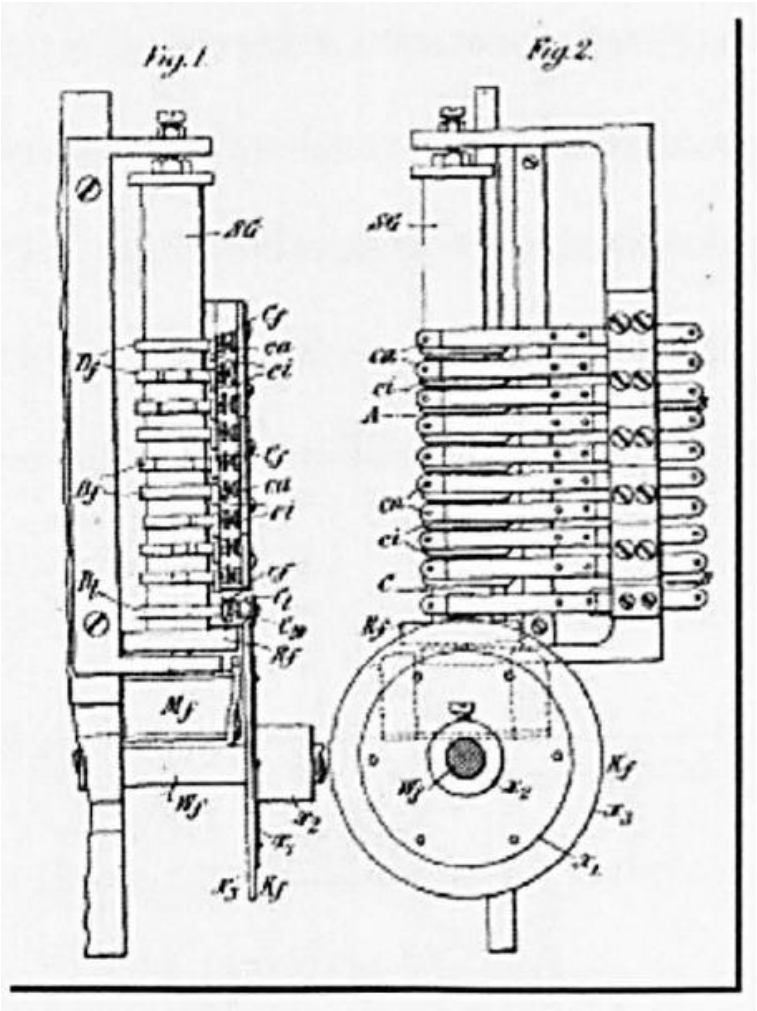
Early Industrial Control History

- Sequence switch (ca. 1915)



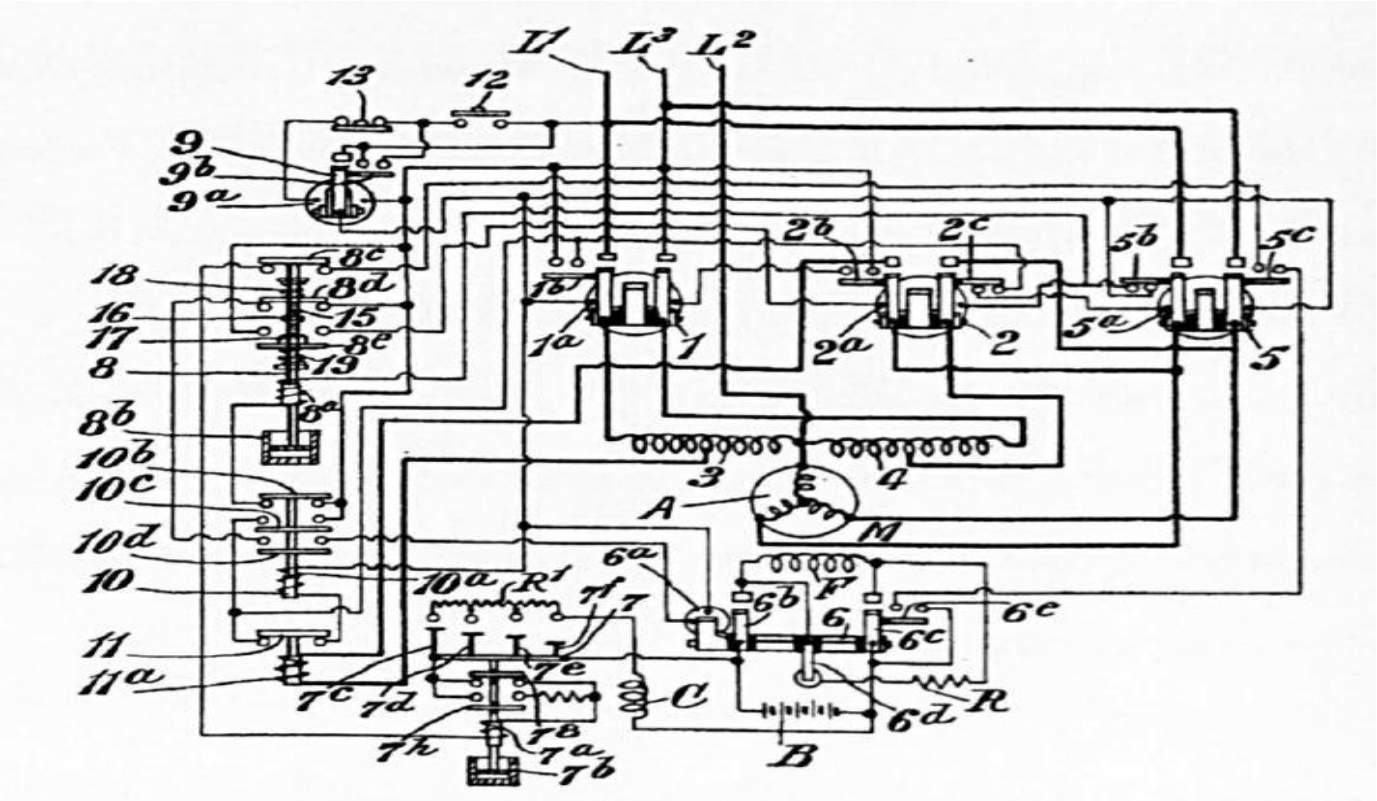
Early Industrial Control History

- Electro-mechanically operated switch (ca. 1910)



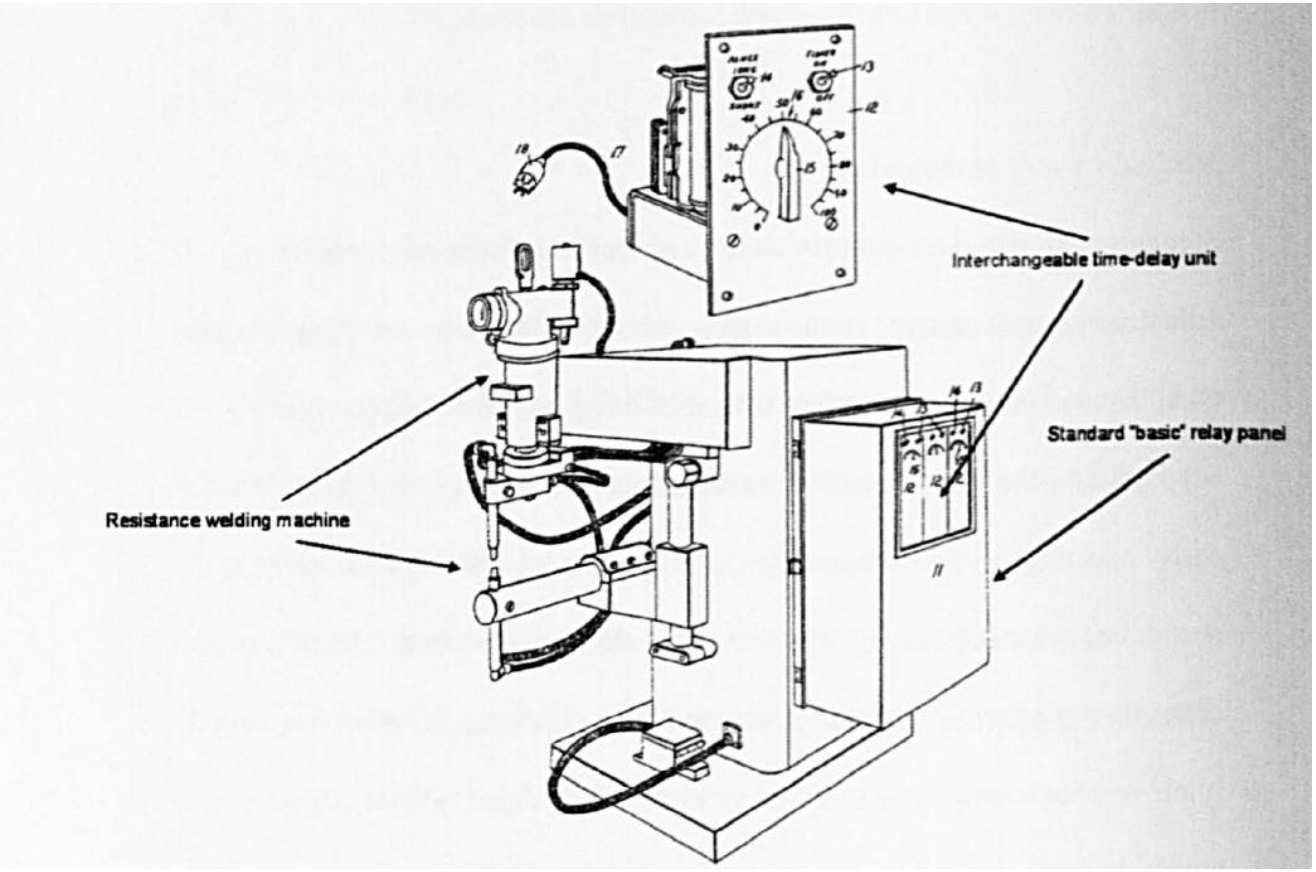
Early Industrial Control History

- Starting controller for synchronous motors (ca. 1926)



Early Industrial Control History

- Multiple sequence electric control for resistance welding (ca. 1952)



Early Industrial Control History

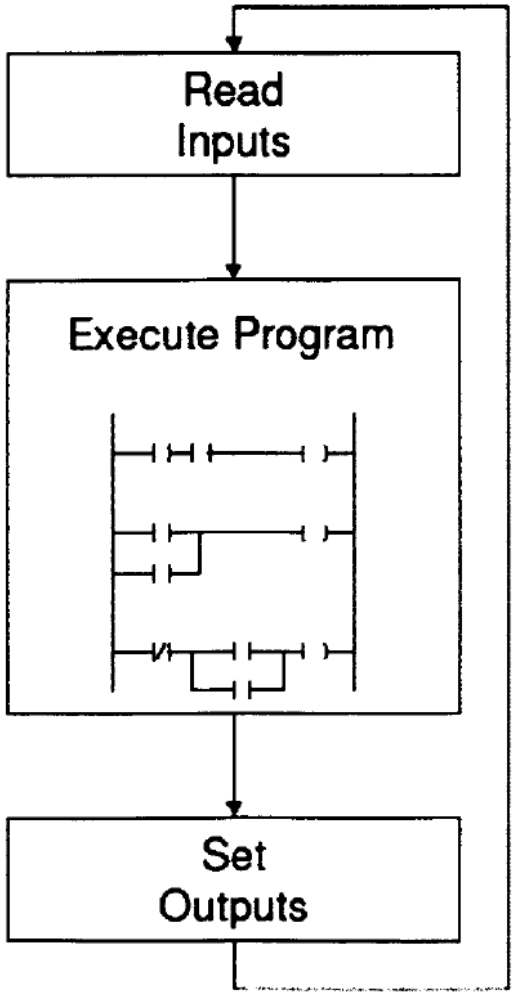
- Through the 1950s, computers were generally not used in industrial control because of the fragility of the devices
  - The one exception was large continuous flow processes, such as oil refining
- In the 1960s the application of computers for sequence control started to appear in the patent literature
  - A key feature was the cyclic program

Historical Development of PLCs

- The concept of the PLC came about in the 1960s with a set of specific requirements
  - Robustness
  - Compactness
  - Simple for engineers and plant personnel to program and change
  - Sequential operation
  - Based on patents by Edward Yetter in the mid 1960s

Historical Development of PLCs

- Inputs are read and stored in memory (in a synchronous manner)
- The program is executed on these inputs
- Outputs are stored in memory, then the results are set to effect the action



Historical Development of PLCs

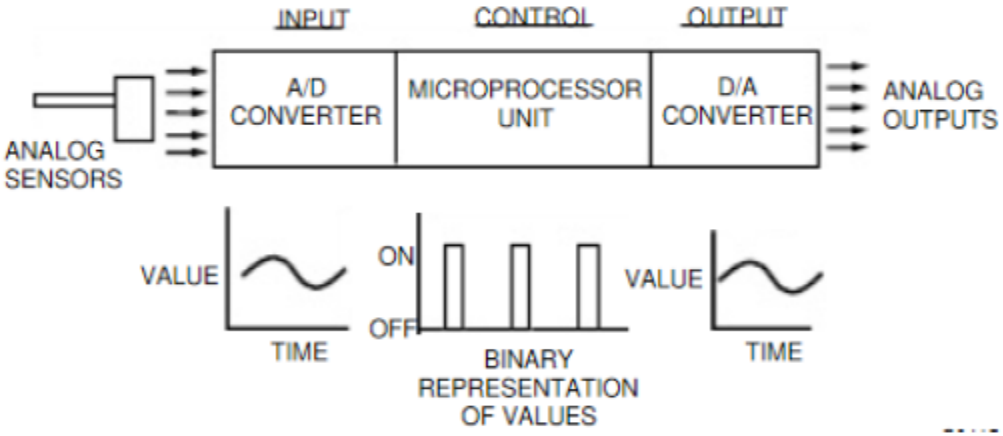
- Early PLC concepts used a separate programming device, which would be taken to each controller
  - Provides cost savings (only one was needed for many devices)
  - Security: the PLC could not be changed, except by authorized users with the device
  - Modern systems are generally networked, so this issue no longer applies

Controller Concepts

- Microprocessor Based Industrial Controllers are most useful in situations requiring continuous modulation
- The use of microprocessors allows for the implementation of more complex algorithms and a higher rate of operation
- PLCs still have their place in the environment

Controller Concepts

- Inputs and outputs can be more flexible and higher bandwidth
- The microprocessor types vary from 8-bit to 32-bit devices, with a wide range of speed, memory and peripherals



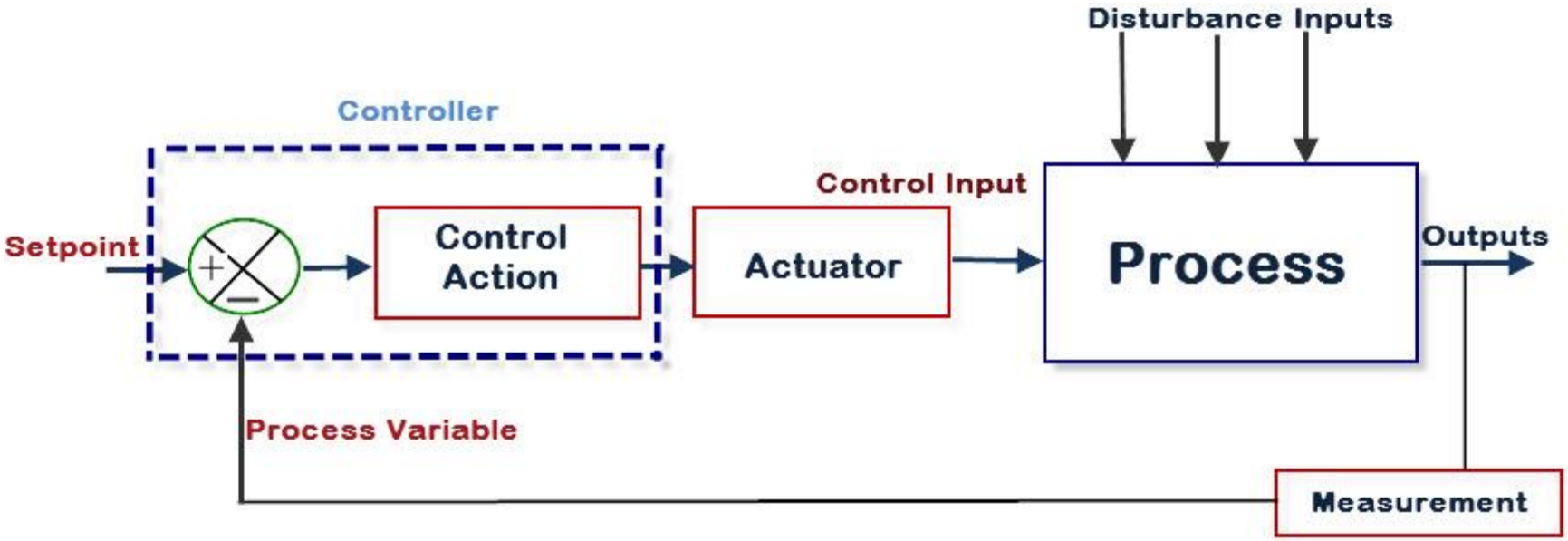
Controller Concepts

- Communication types available allow for integration of a number of controllers and processes into more complex systems
- Microprocessor based controllers can also be programmed to perform self test and diagnostics
- Development of systems can be done quickly and updated easily
- HMI design is typically more complex and flexible

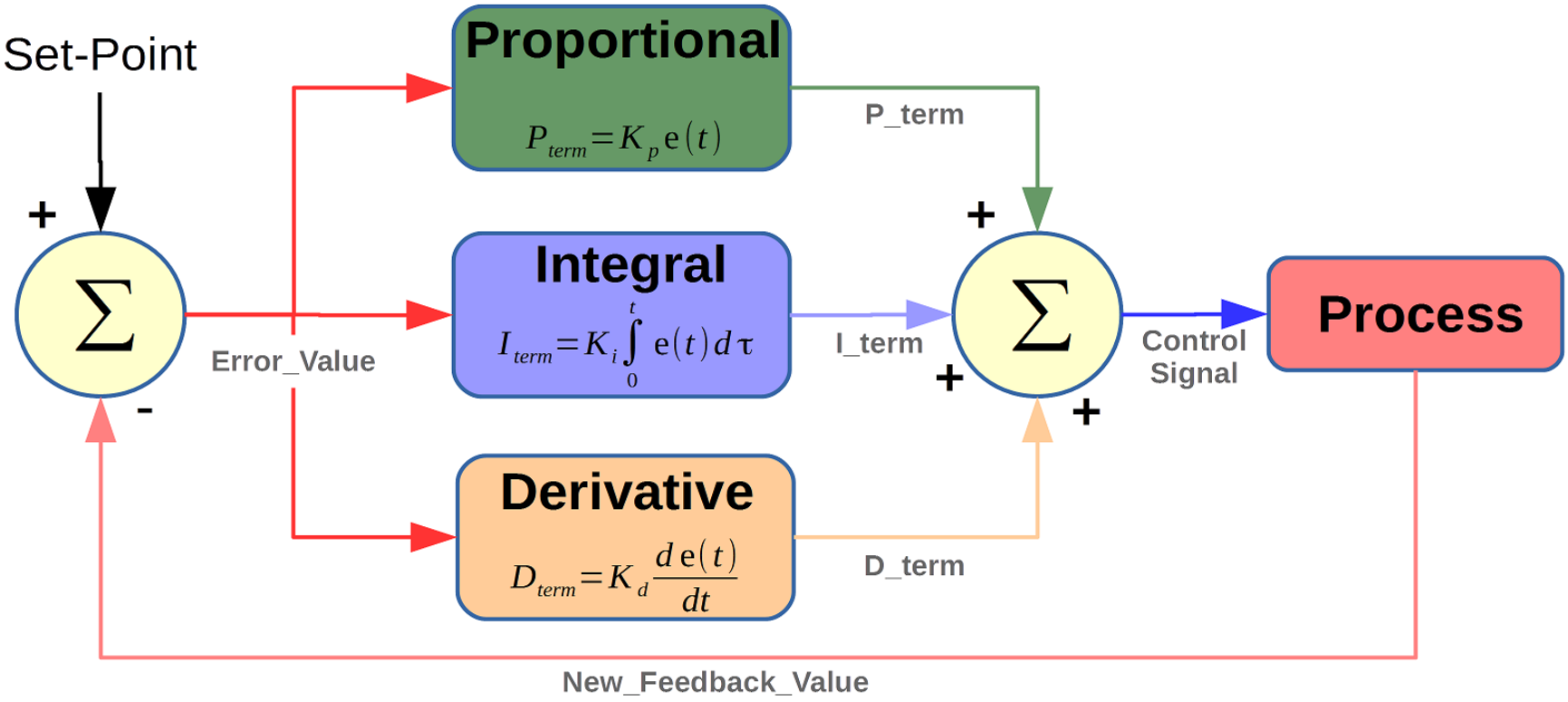
Algorithm Types

- Control system algorithms come in various types
- Some are:
  - Process Variable
  - On-Off Control
  - Open-Loop Control
  - Feed-Forward Control
  - Closed-Loop Control
  - PID (Proportional-Integral-Derivative)

Algorithm Types



Algorithm Types



Conclusion/Next Class

- In today's lecture we set the stage for the week
- We looked at history of Industrial Controllers from the early types through PLCs
  - This is to set the context
- We reviewed concepts and algorithm types
- Tomorrow we will look that the architectures used, including hardware and software