Logic Diagram Workshop

Presented By:
David Sellers; Senior Engineer
Facility Dynamics Engineering

Learning Objectives

Upon Completing this Class, Attendees Will:

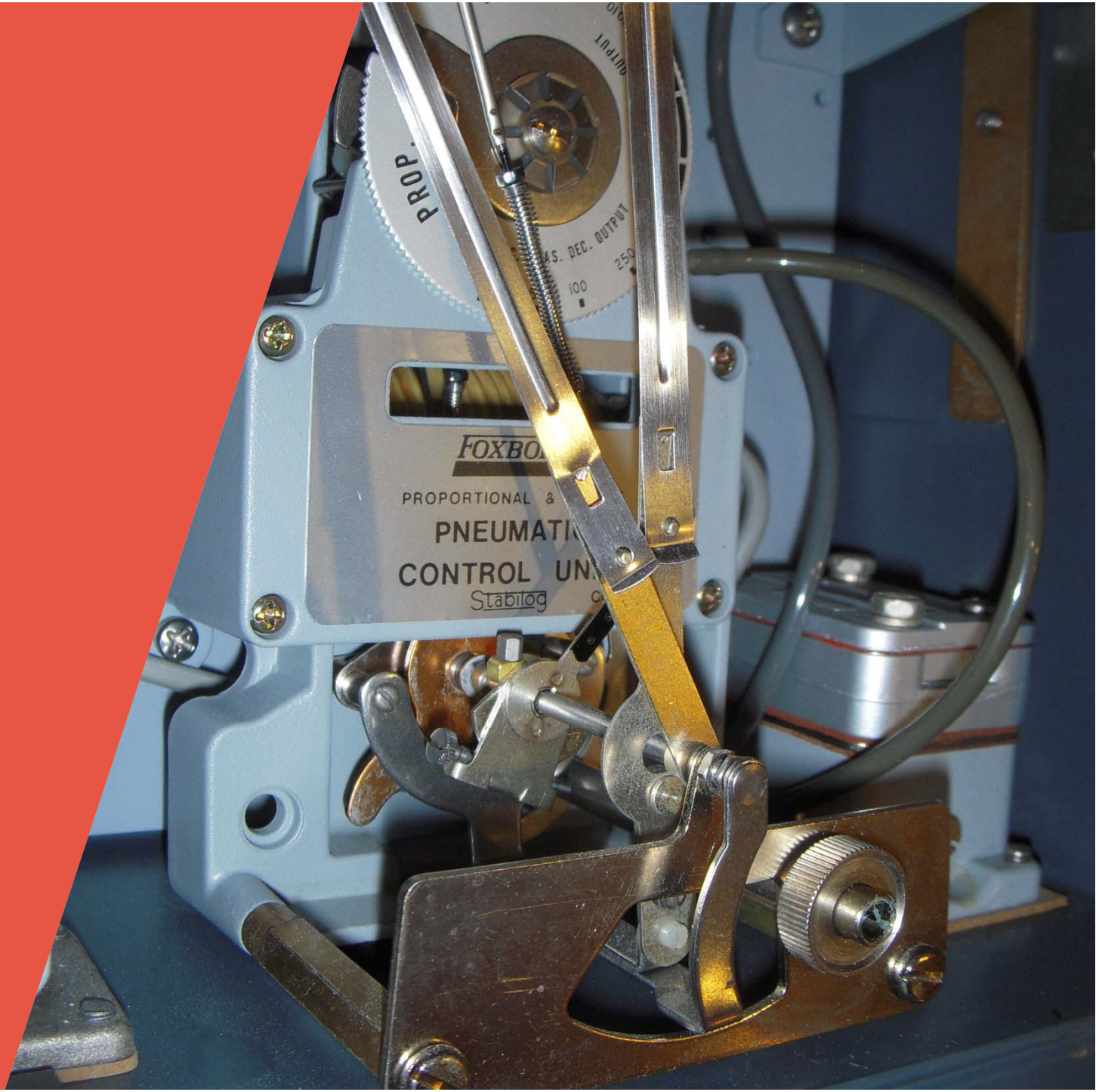
- Recognize the value of clearly communicating control logic and how logic diagrams can facilitate this understanding
- Summarize the steps associated with organizing control logic development
- Define ways to present and verify control logic
- Describe how control logic needs to address not only the requirements of the design day but also the requirements of all of the other days of the year
- Understand how control logic needs to reflect the physics of the system to which it is applied

Learning Objectives

Agenda

- Control System Building Blocks
- Basic Logic Concepts
- Introduction to a Logic Diagram Tool
- Light Switch Logic Interactive Exercise
- PID Basics
- SketchUp Introduction
- Level Control Interactive Exercise
- Heat Exchanger Logic Interactive Exercise

Control System Building Blocks



The Fundamental Goal of the Control System

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control


07/01/97

The Fundamental Goal of the Control System

You can get what you want in a very inefficient manner

See *Commissioning to Meet Space Qualification Criteria vs. Energy Consumption Optimization Focused Commissioning* for details

The Holistic (Green) Goal of the Control System

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control as efficiently and sustainably as possible

The “Three R’s”

- Repeatable
  - To make, do, or perform (an action) again (and again, and again, and again ….)
- Reliable
  - Giving the same result on successive trials
- Robust
  - Sturdy; capable of performing without failure under a wide range of conditions

Control System Building Blocks

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

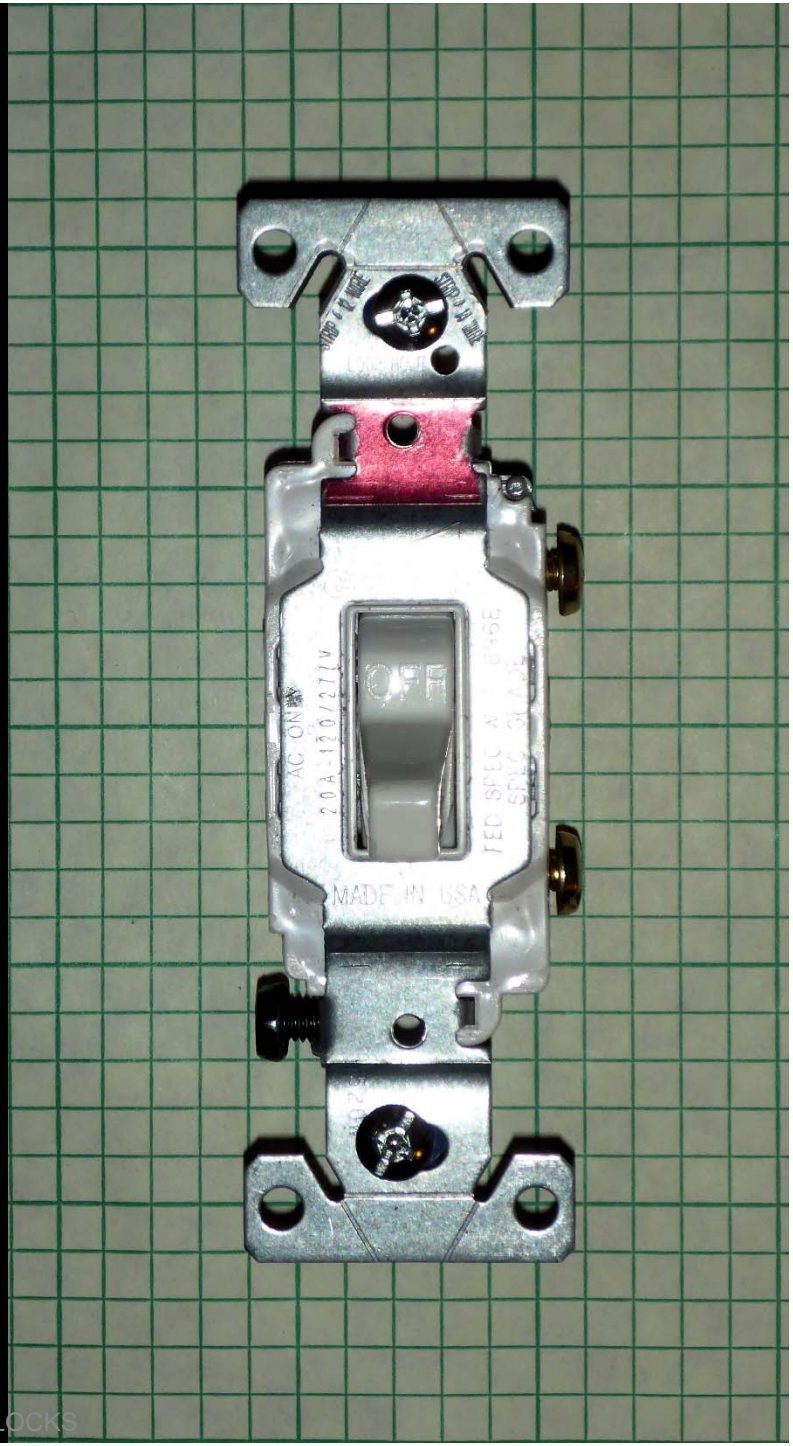
Control System Building Blocks

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

Inputs

Measure the process variable

A Digital Input



A Digital Input

With automatic operating state indication …

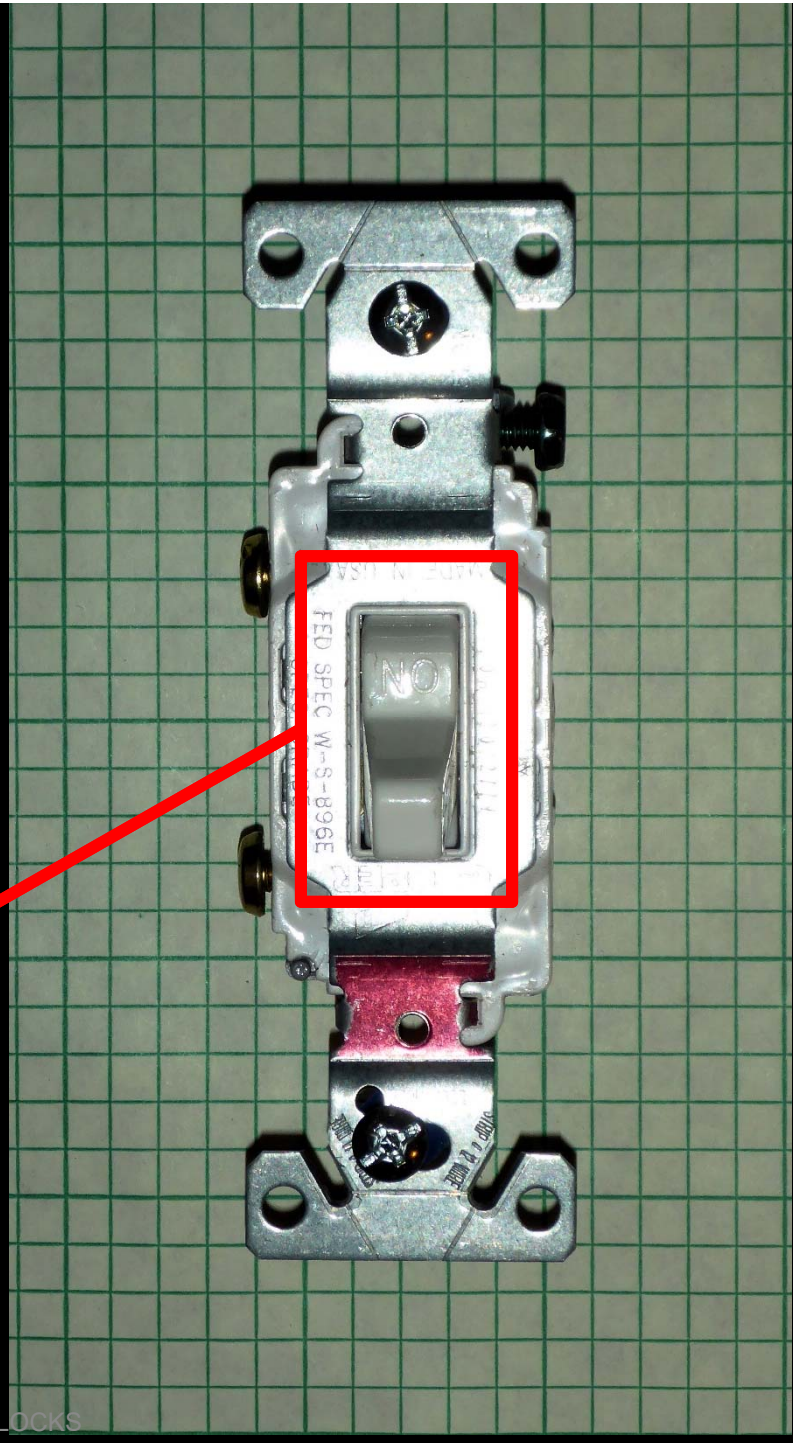
A Digital Input

With automatic operating state indication …

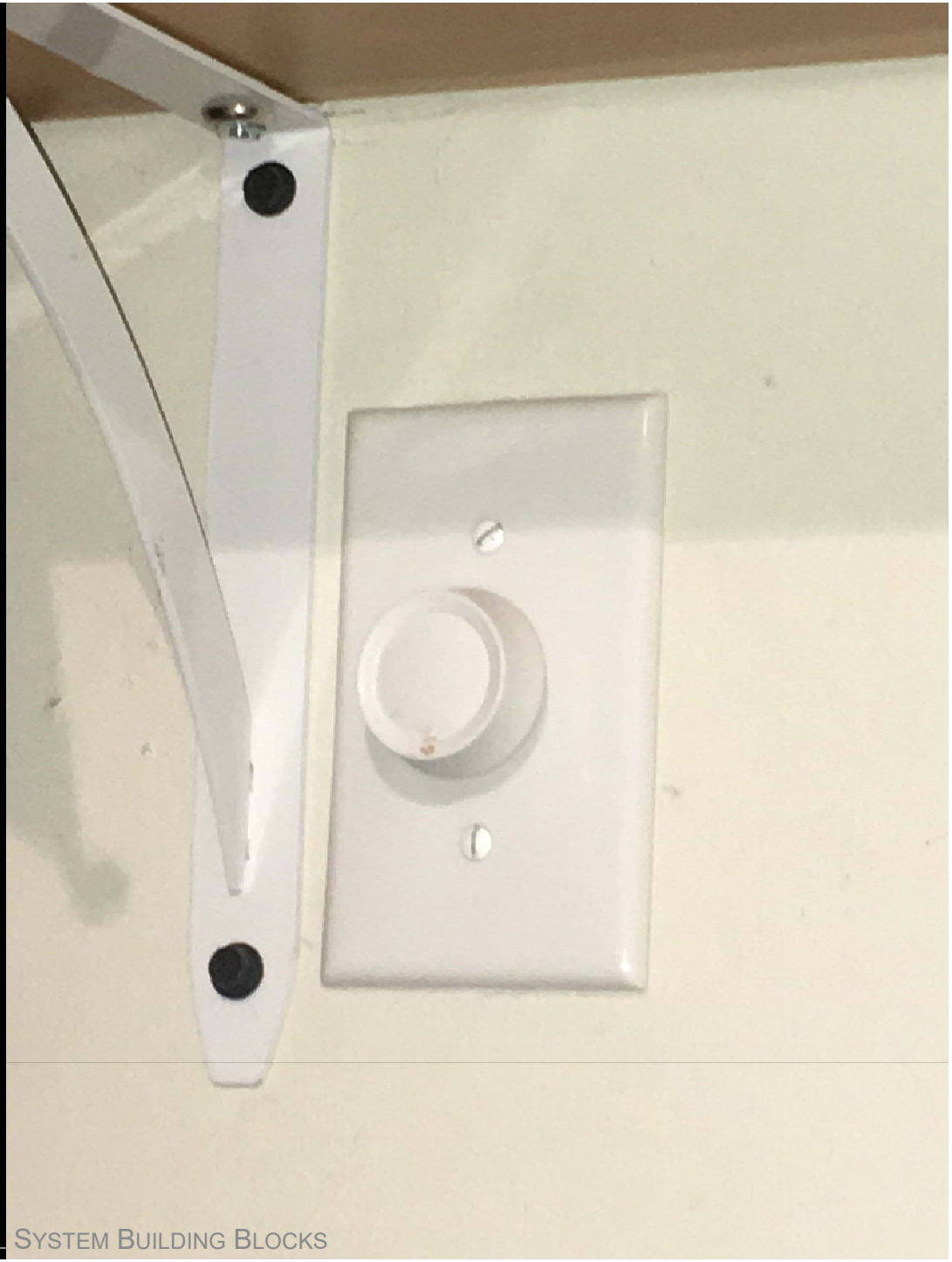
A Digital Input

… and automated fault detection

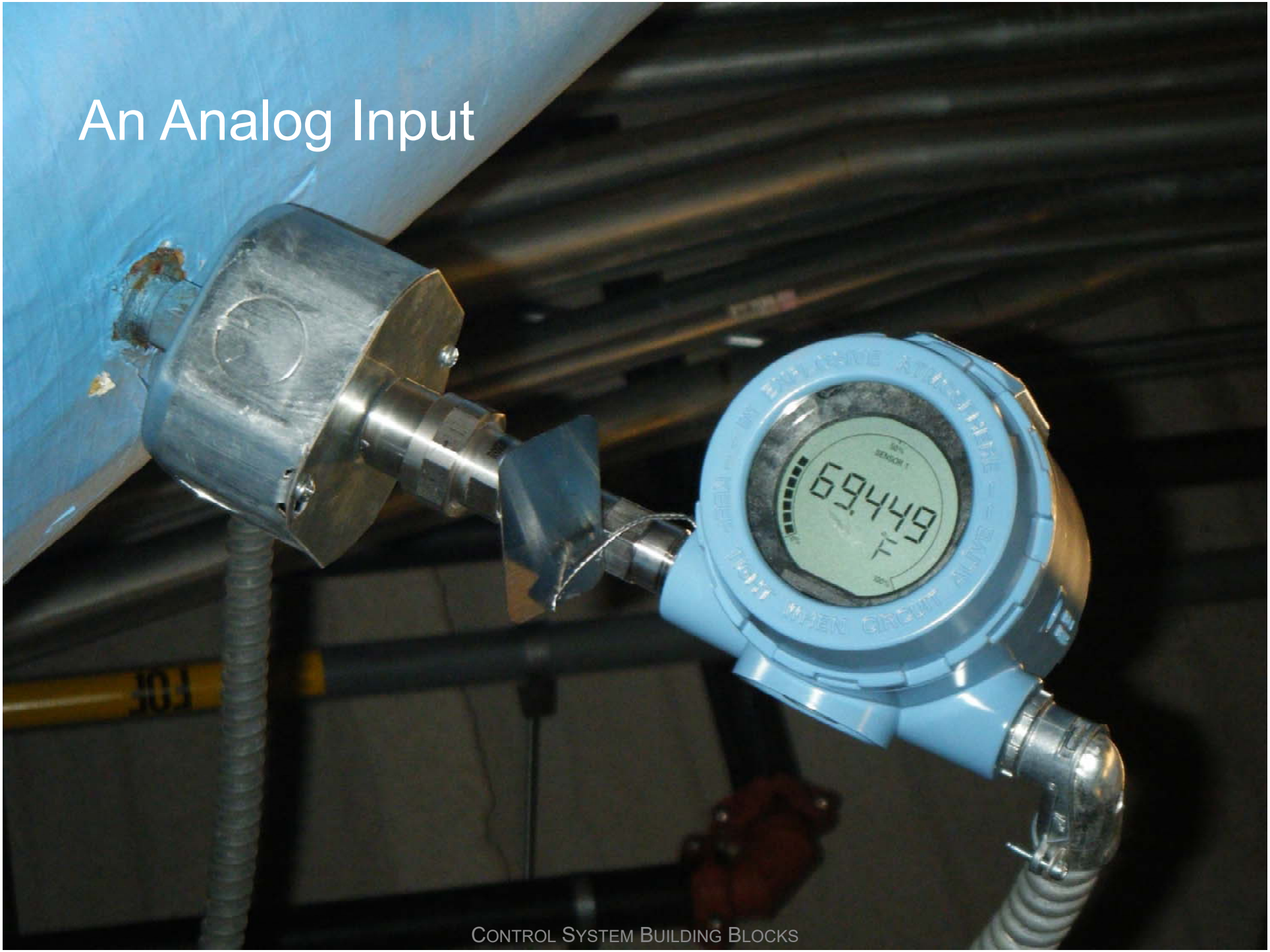
Tom McCarthy



An Analog Input



An Analog Input



Control System Building Blocks

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

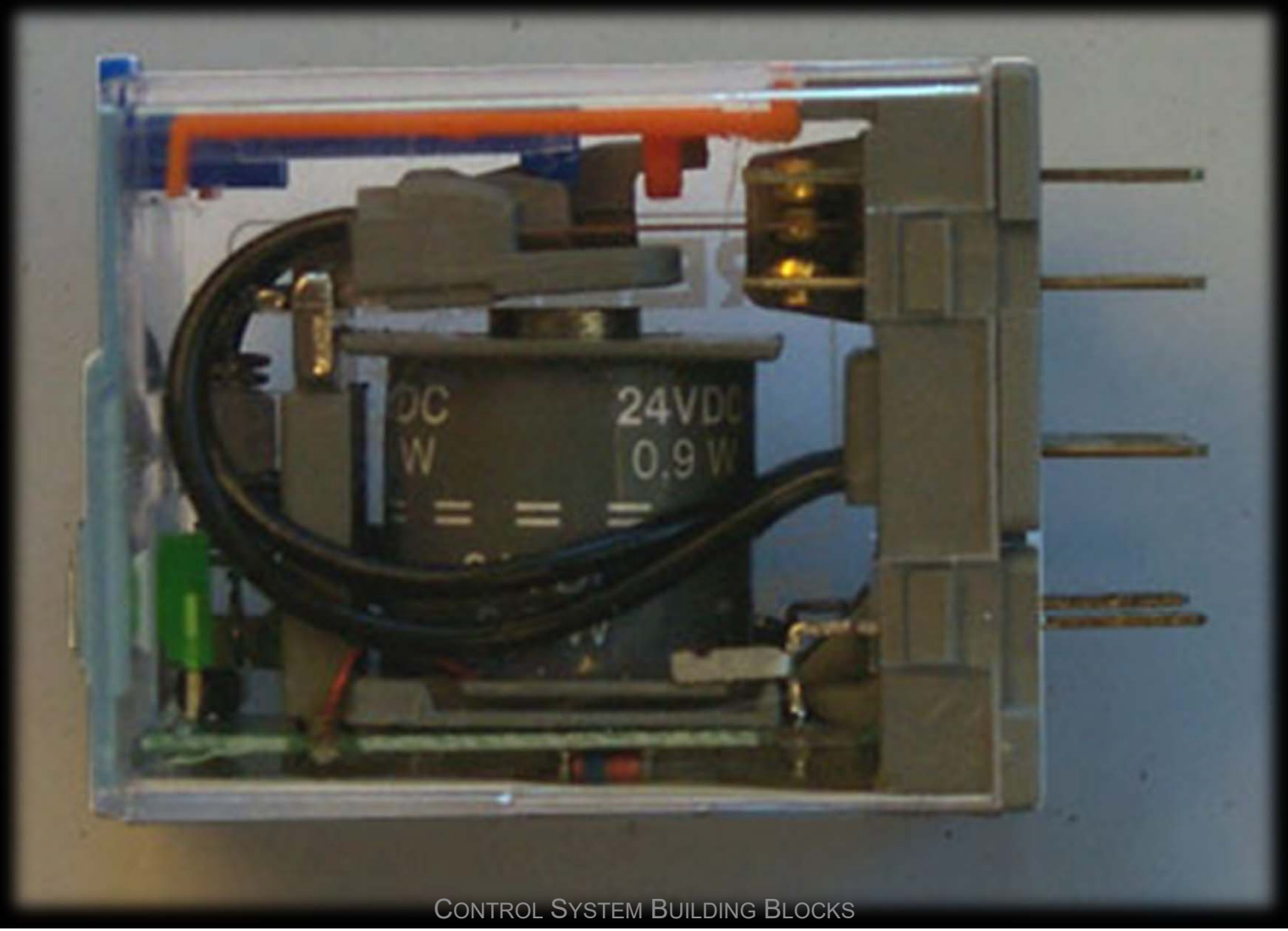
Inputs

Outputs

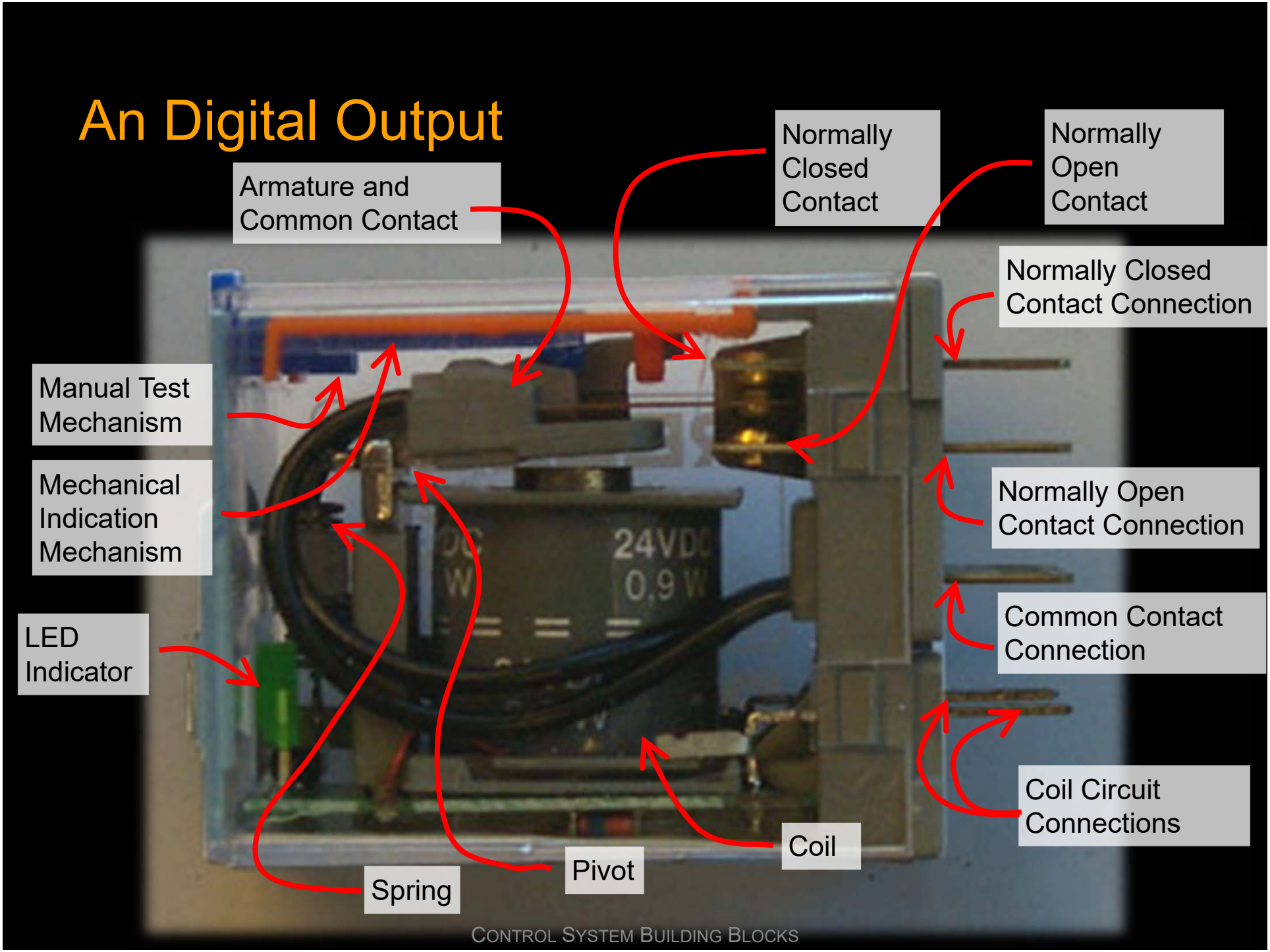
Measure the process variable

Adjust the controlled variable

An Digital Output

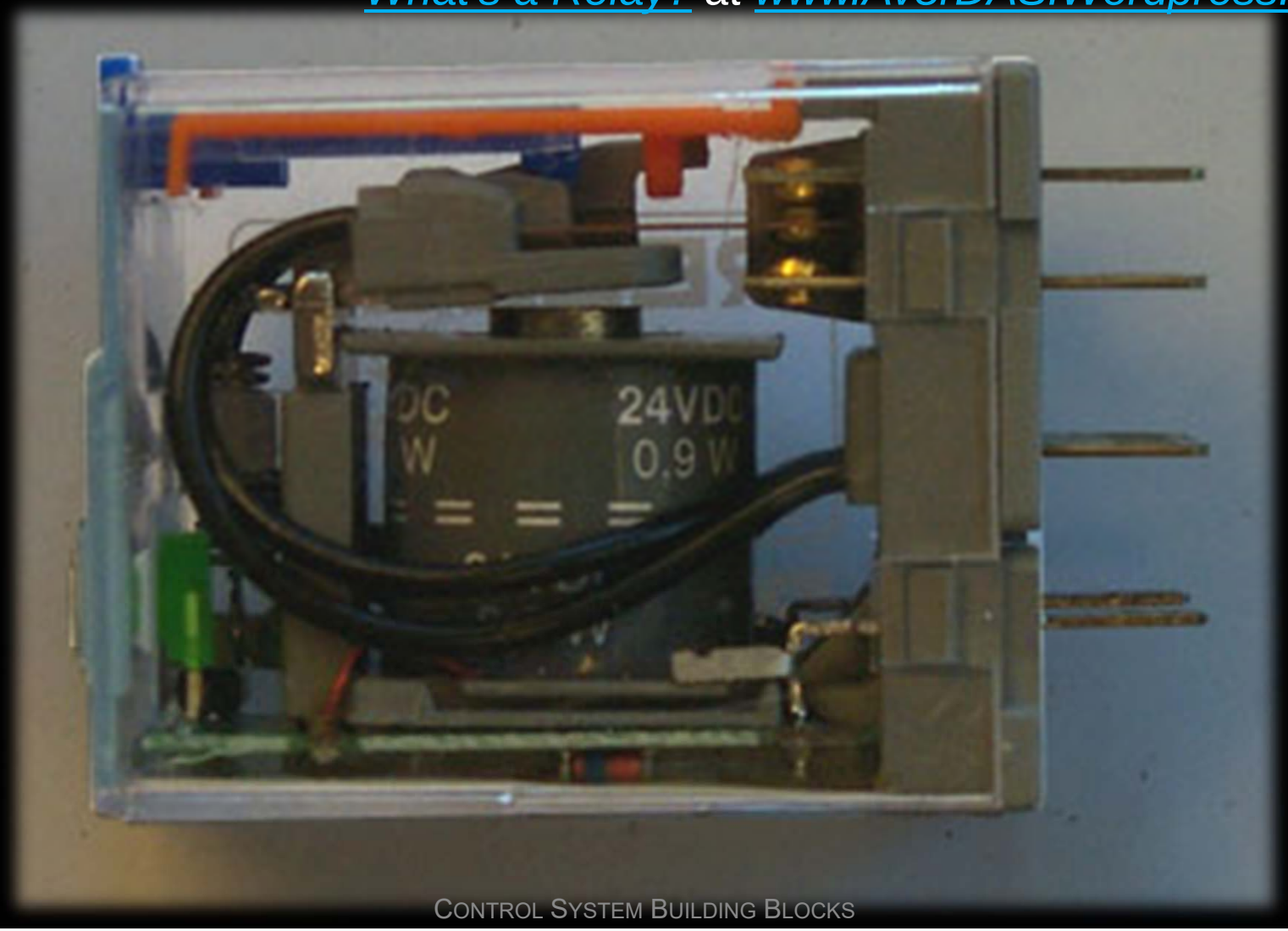


An Digital Output

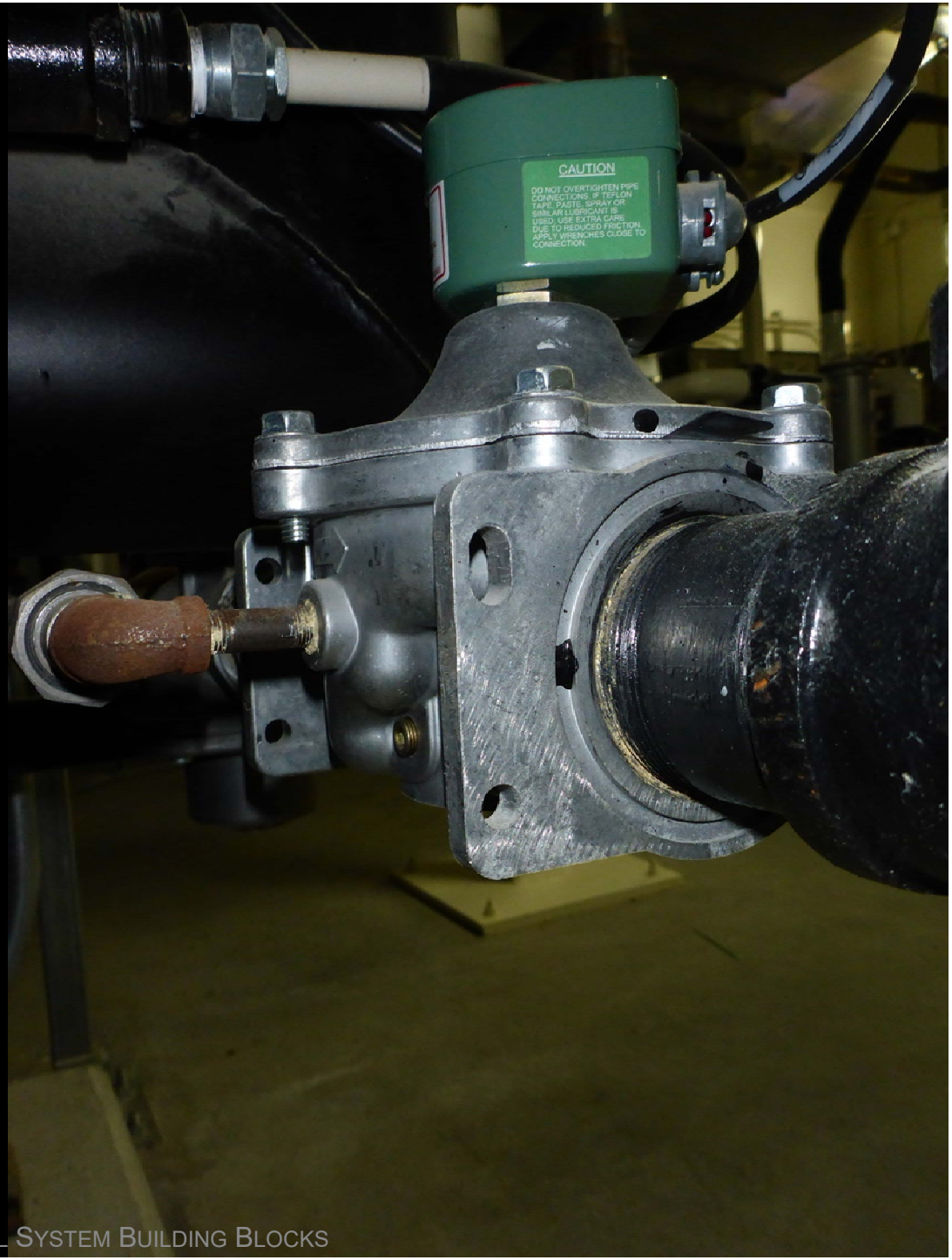


An Digital Output

For More on Relays, see [Learning about Relay Logic; What's a Relay?](www.Av8rDAS.Wordpress.com) at www.Av8rDAS.Wordpress.com

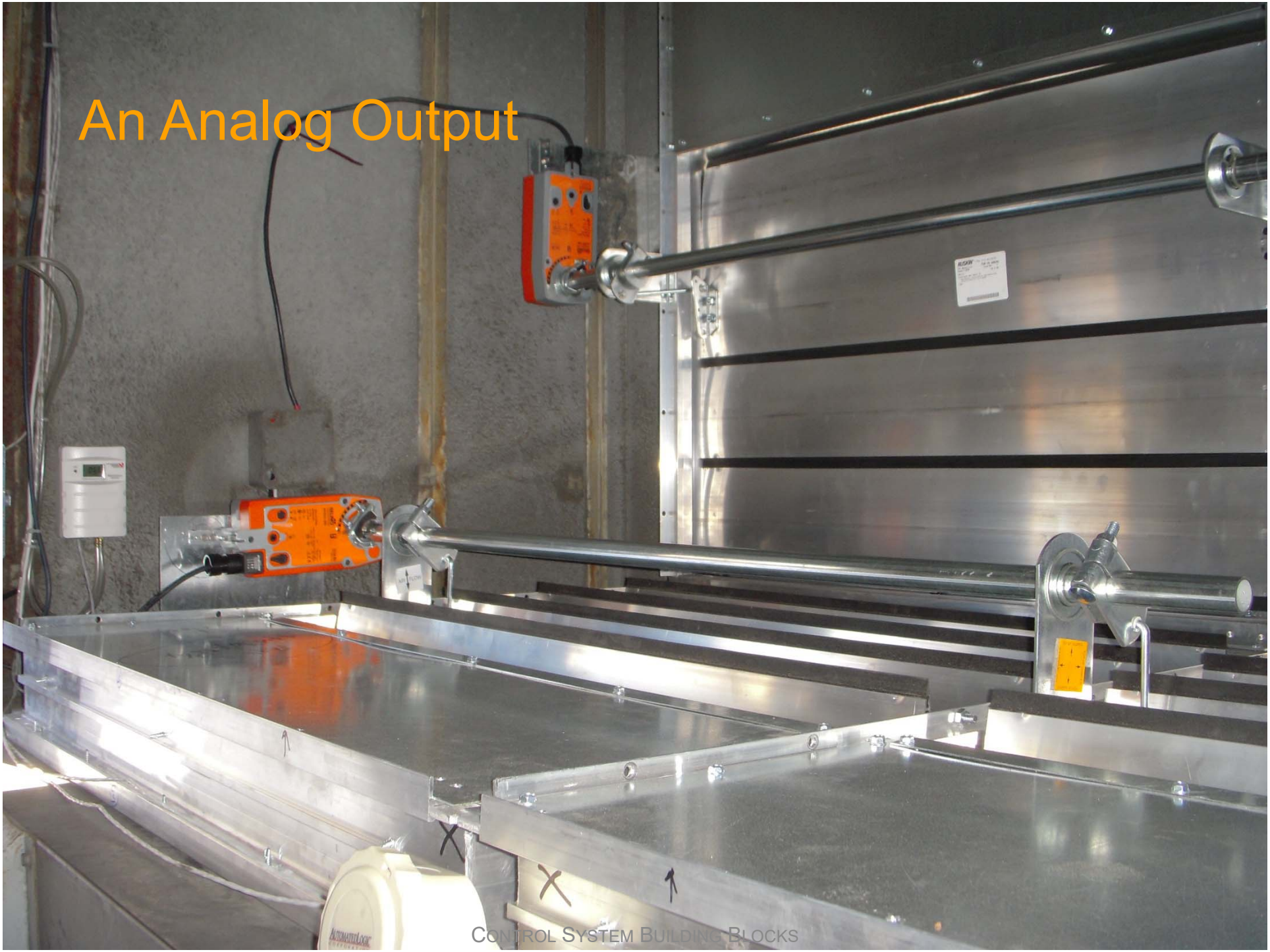


An Digital Output



An Analog Output

An Analog Output



Control System Building Blocks

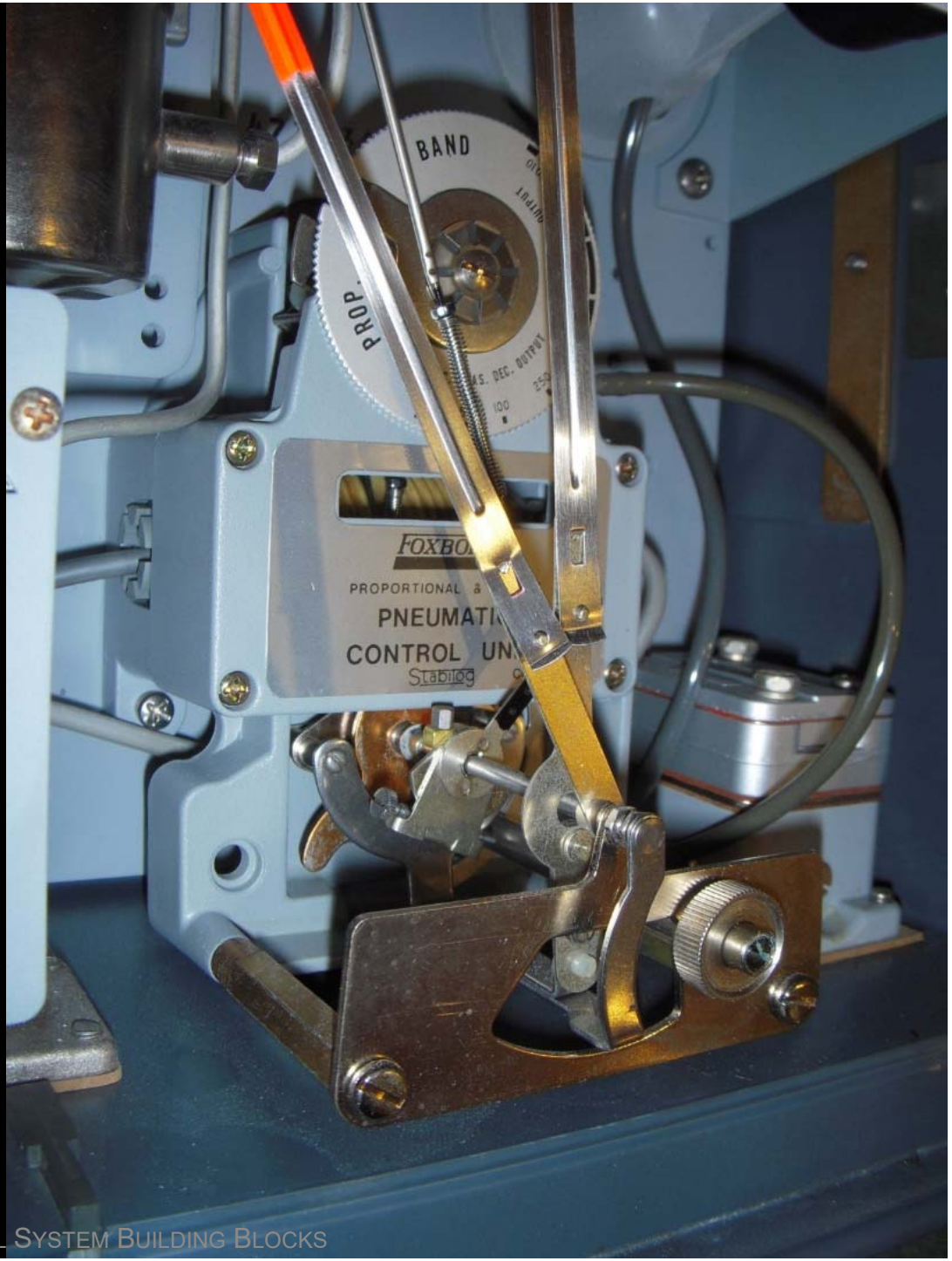
Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

Inputs	Measure the process variable
Outputs	Adjust the controlled variable
Control Process	Logic and algorithms that tries to bring the controlled variable into agreement with the set point

Digital Logic

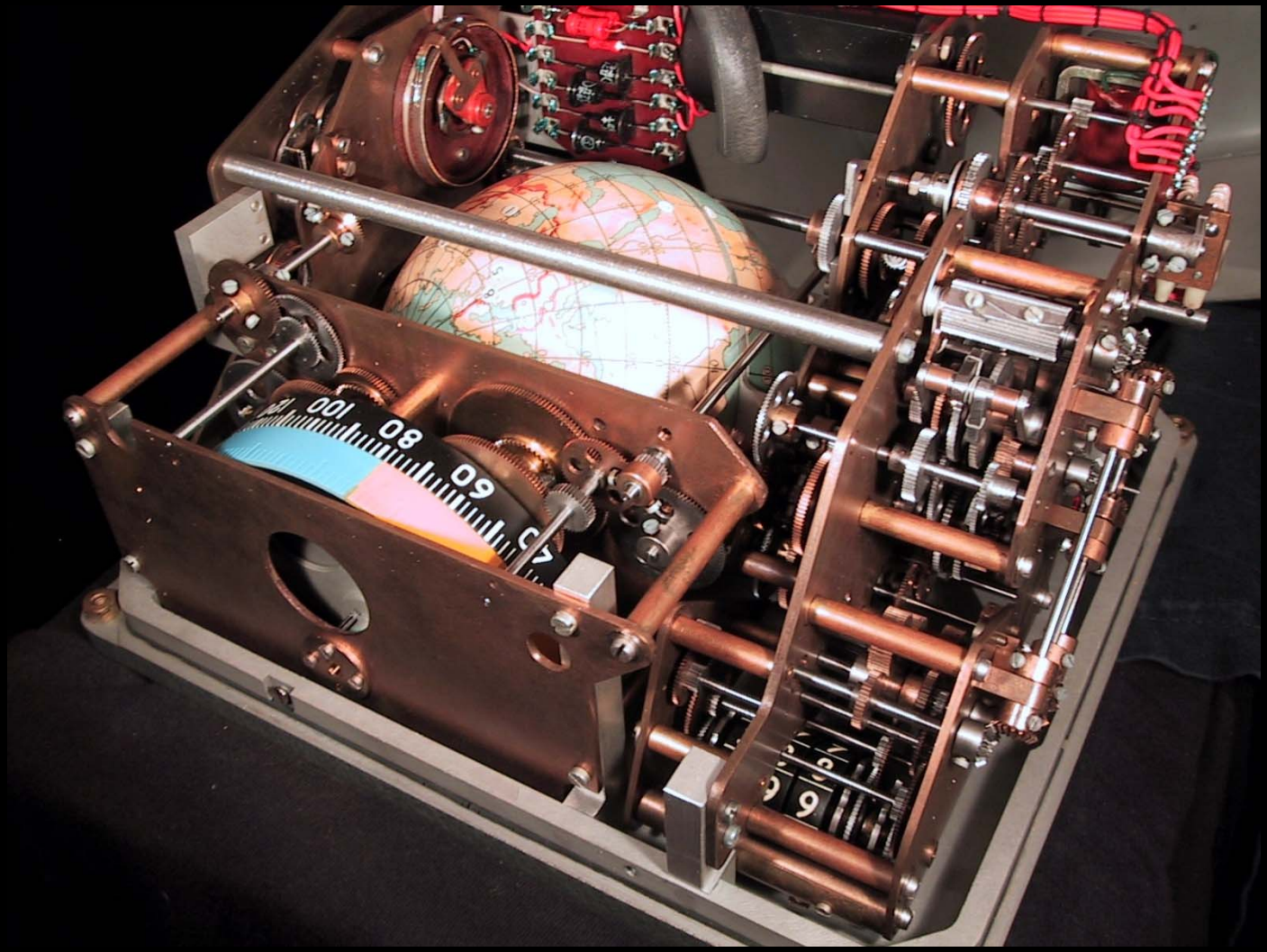
Digital Logic

Analog Logic

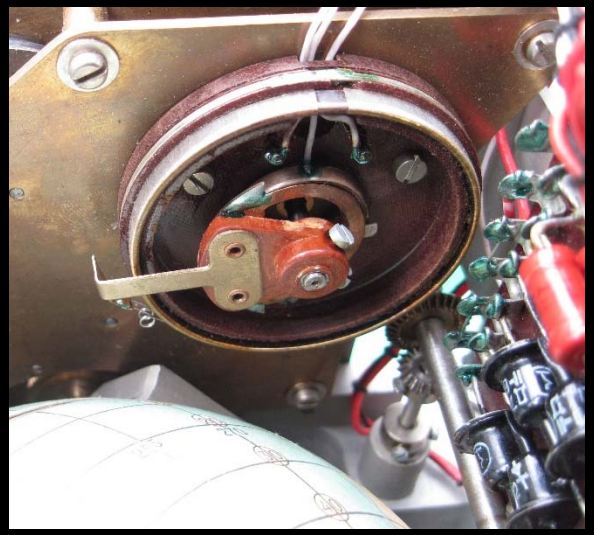


A Long, Long, Time Ago, in a Galaxy Far, Far, Away, Logic Was a Physical Thing

A Long, Long, Time Ago, in a Galaxy Far, Far, Away, Logic Was a Physical Thing

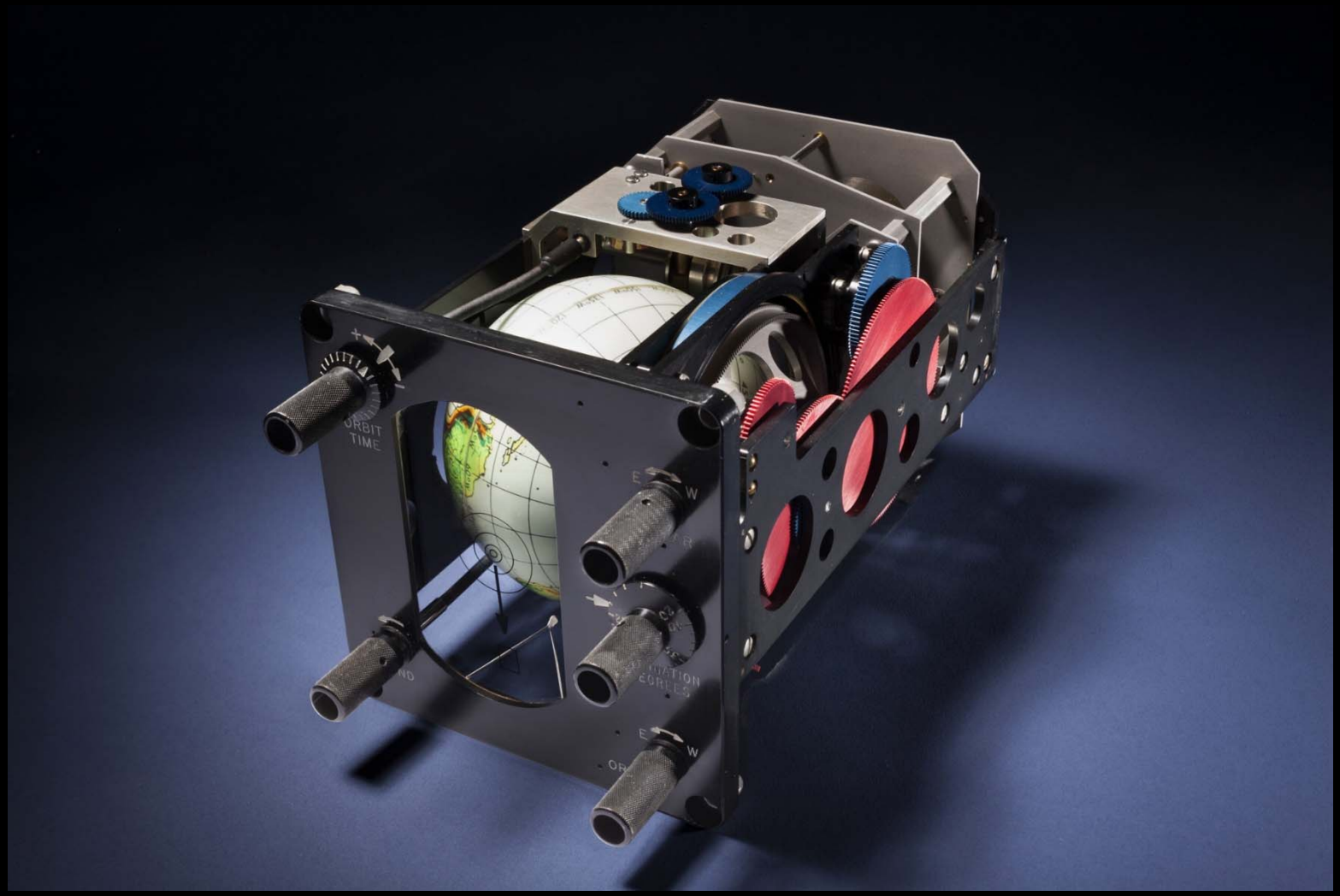


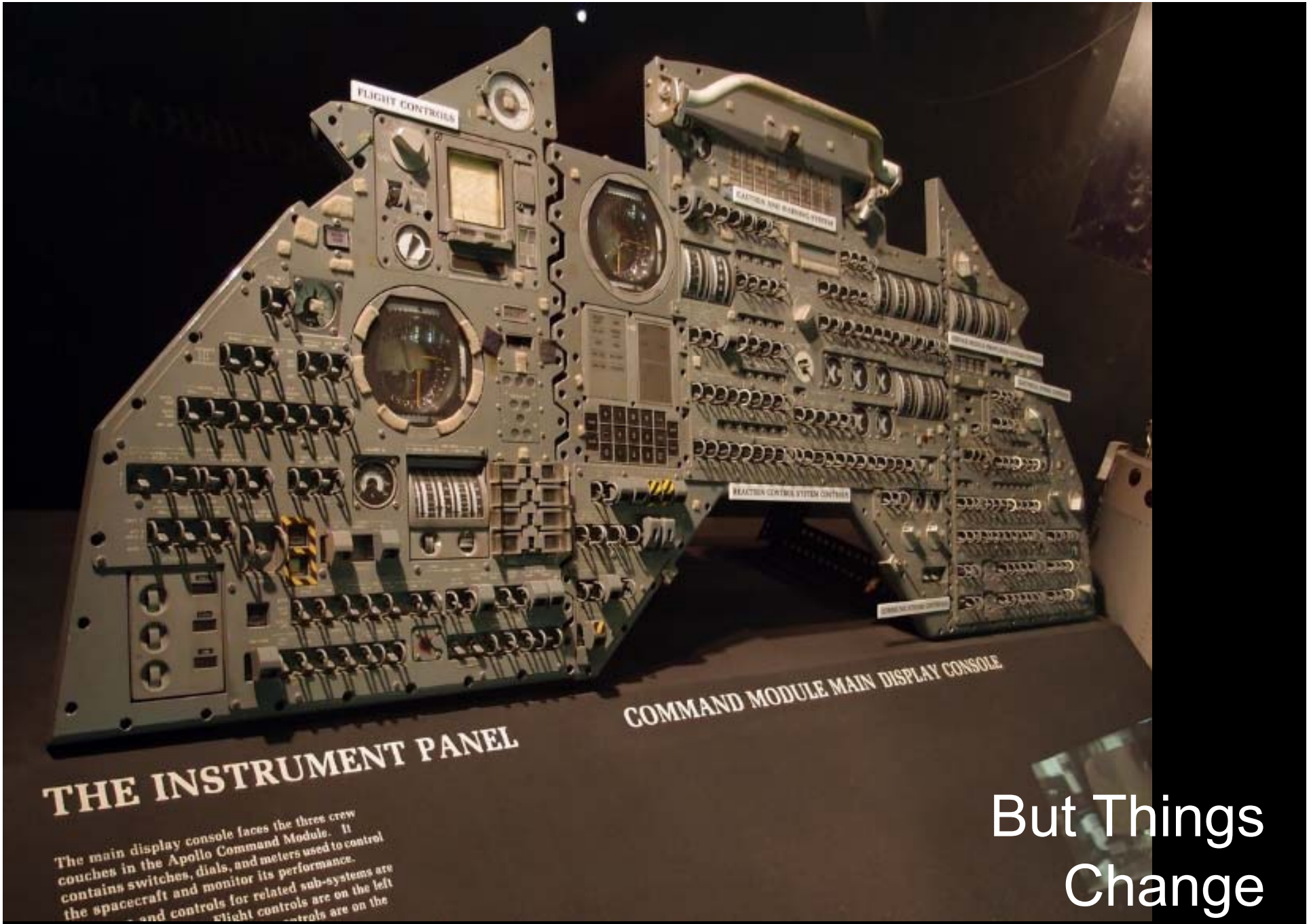
A Long, Long, Time Ago, in a Galaxy Far, Far, Away, Logic Was a Physical Thing



A Long, Long, Time Ago, in a Galaxy Far, Far, Away, Logic Was a Physical Thing

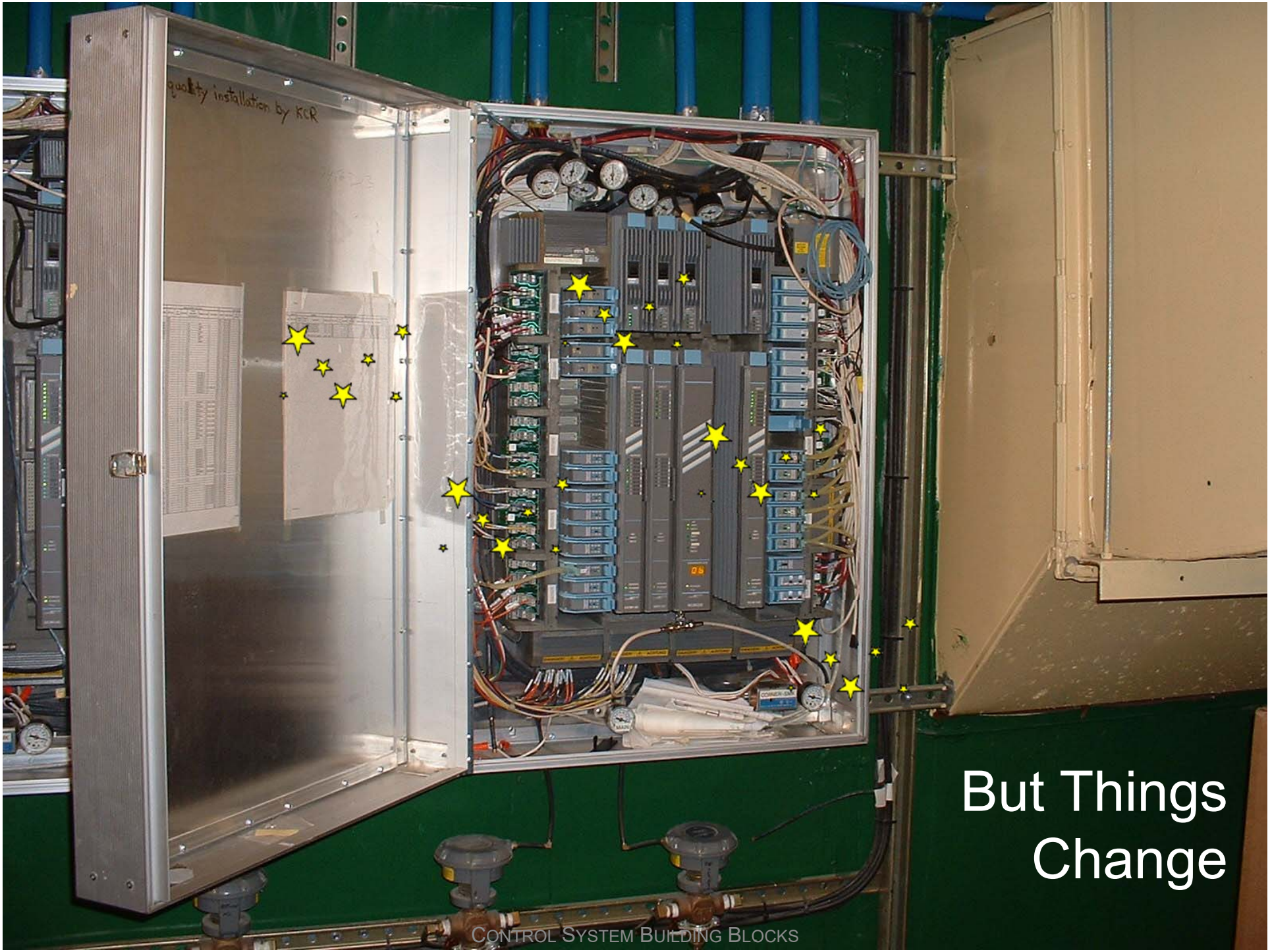
A Long, Long, Time Ago, in a Galaxy Far, Far, Away, Logic Was a Physical Thing





But Things Change

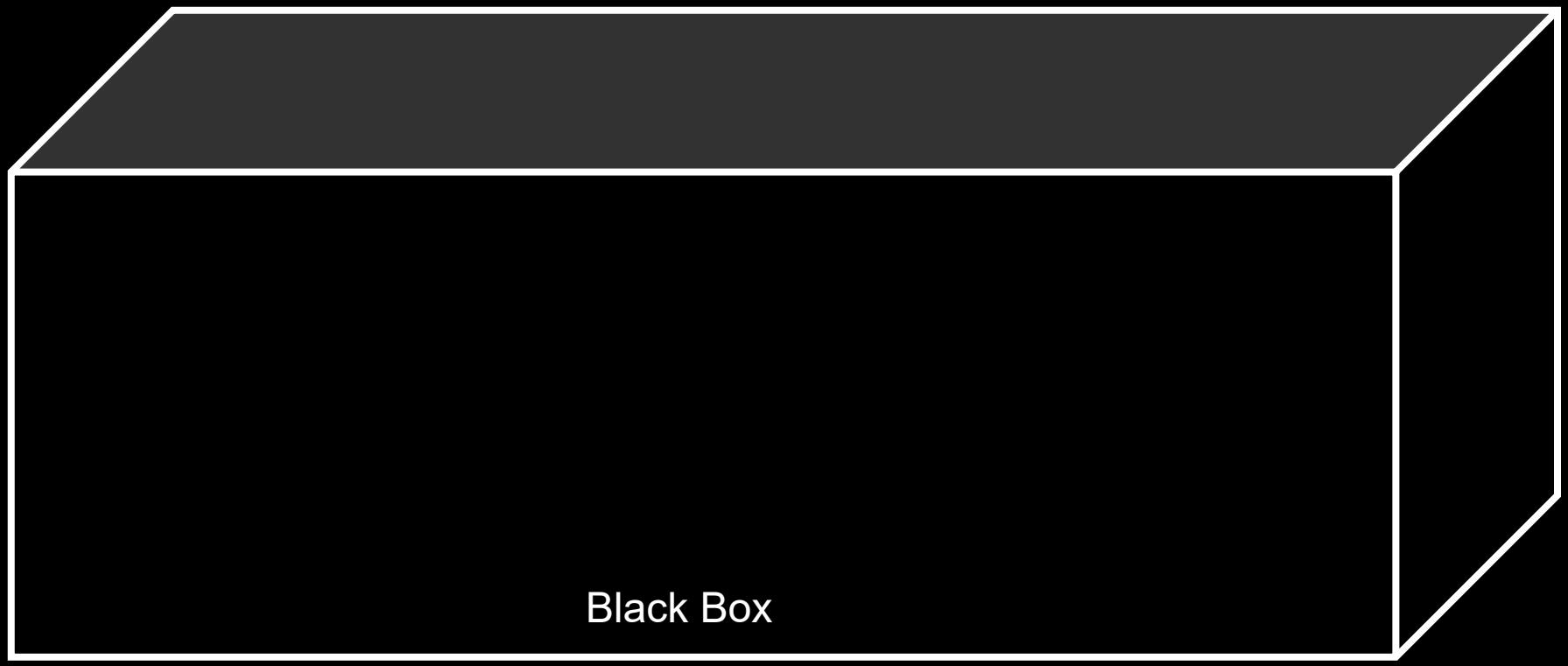
But Things Change



But Things Change

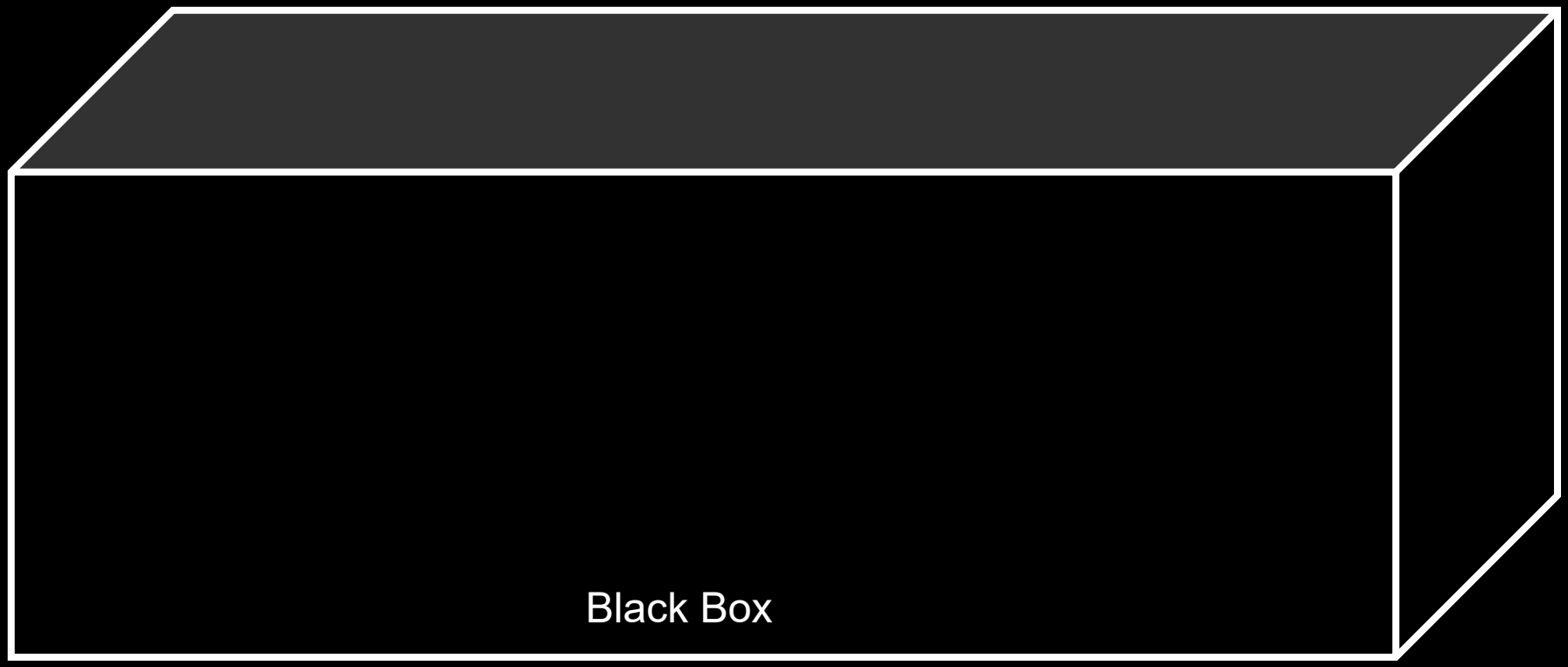
Not Being Able to See or Get Your Hands on What's Going On

… a down side to DDC



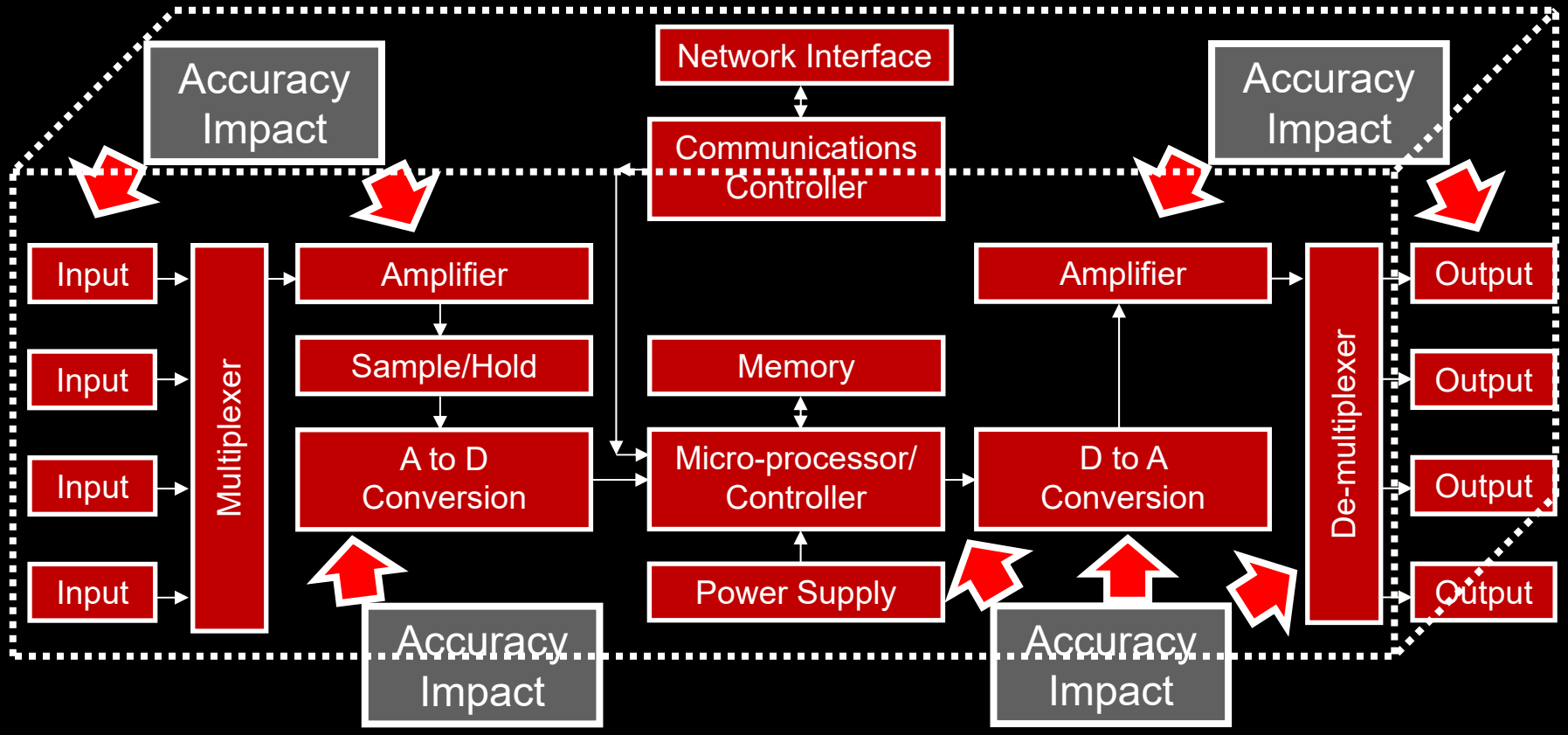
Even Though You Can't See Them …

… the inner workings and controlling software of a DDC controller are critical to success



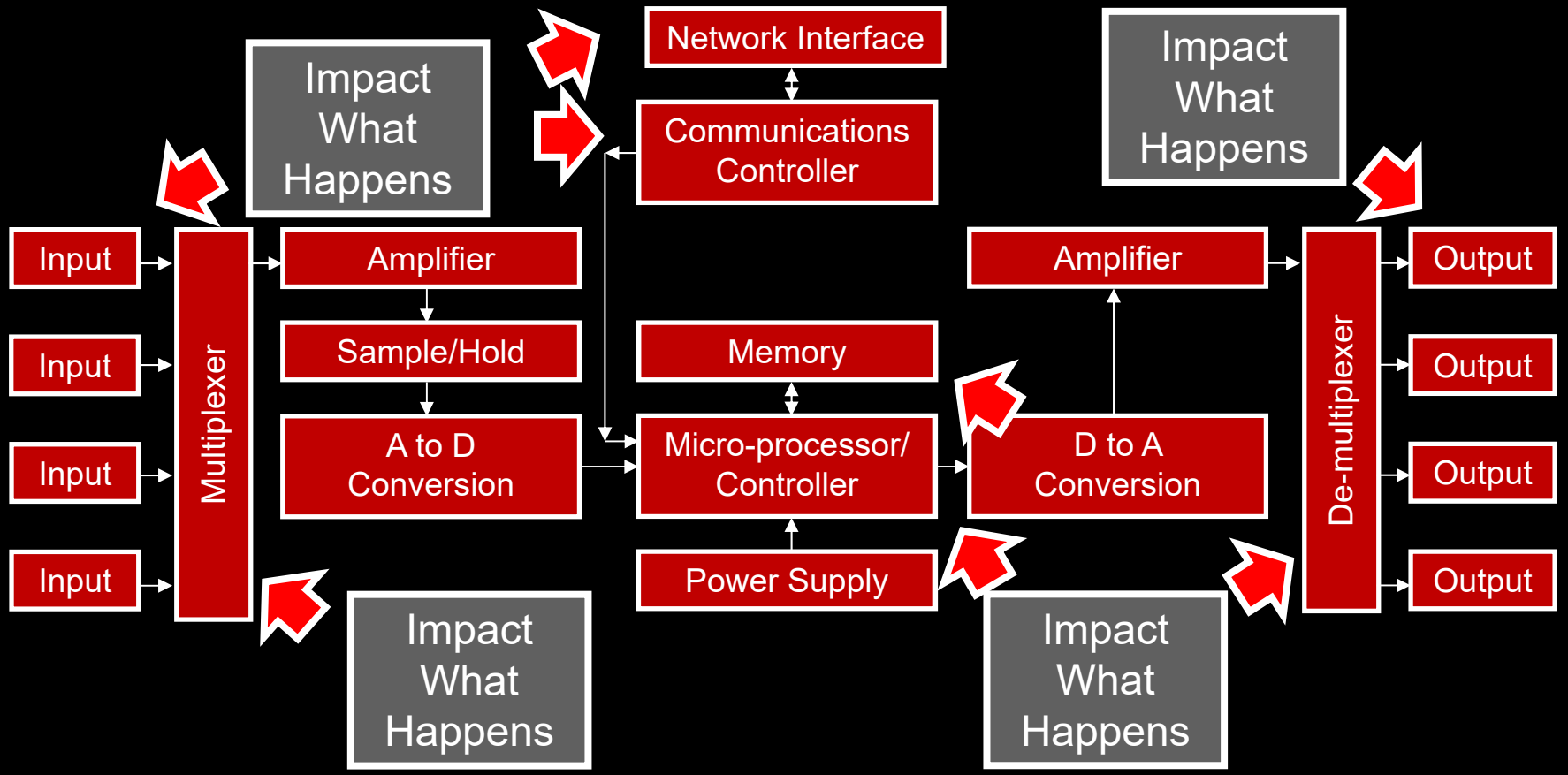
Even Though You Can't See Them …

… the inner workings and controlling software of a DDC controller are critical to success



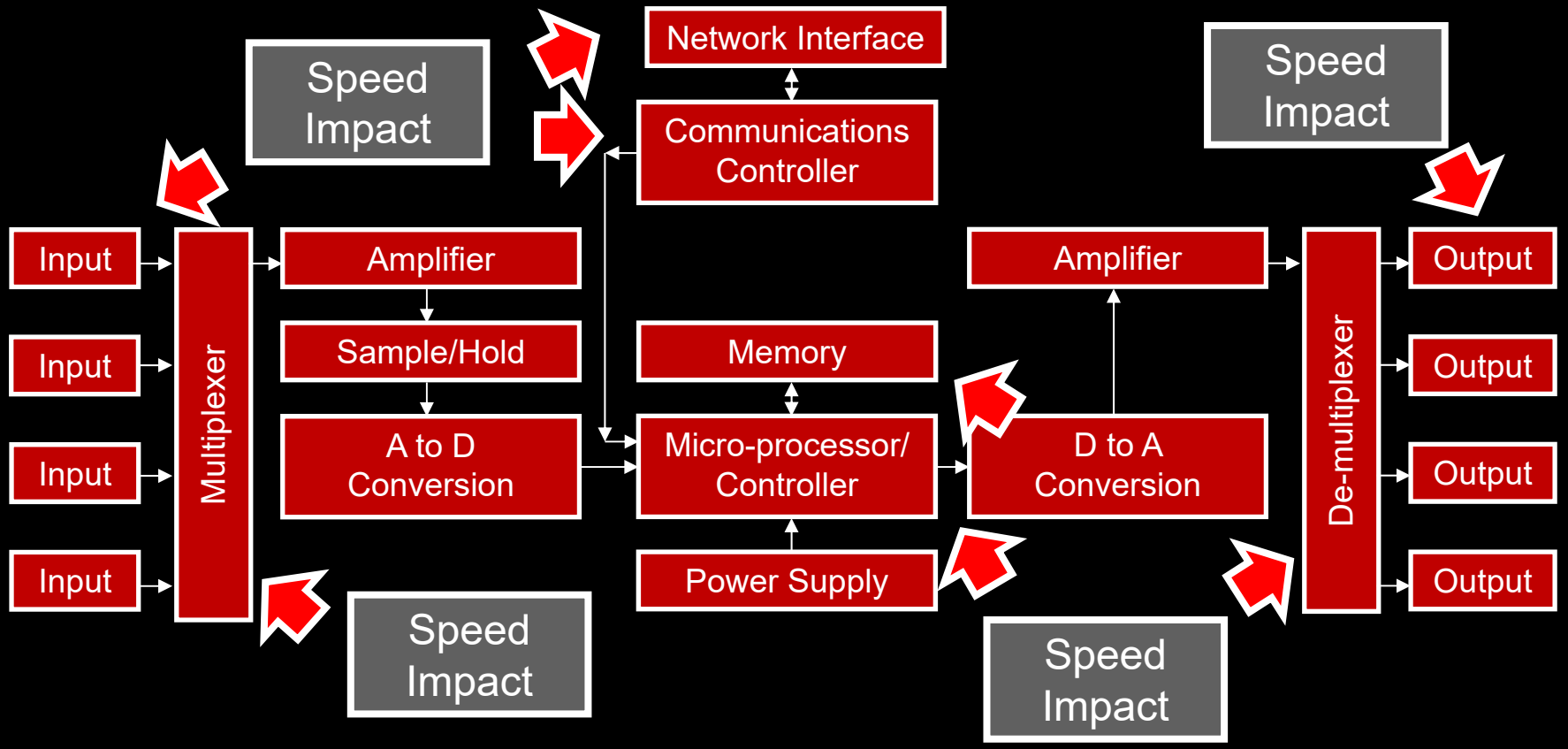
Even Though You Can't See Them …

… the inner workings and controlling software of a DDC controller are critical to success



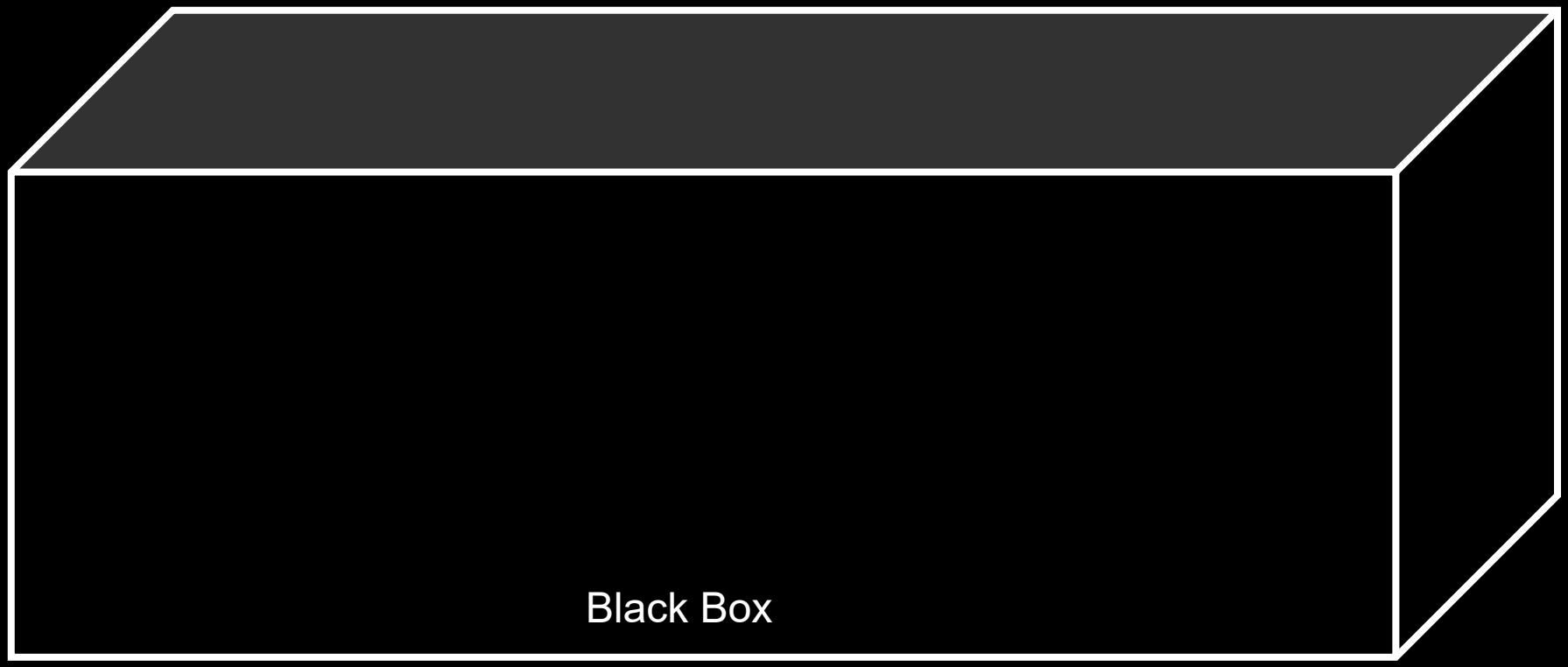
Even Though You Can't See Them …

… the inner workings and controlling software of a DDC controller are critical to success



Logic Diagrams

A Way to Communicate What Goes On in the Black Box

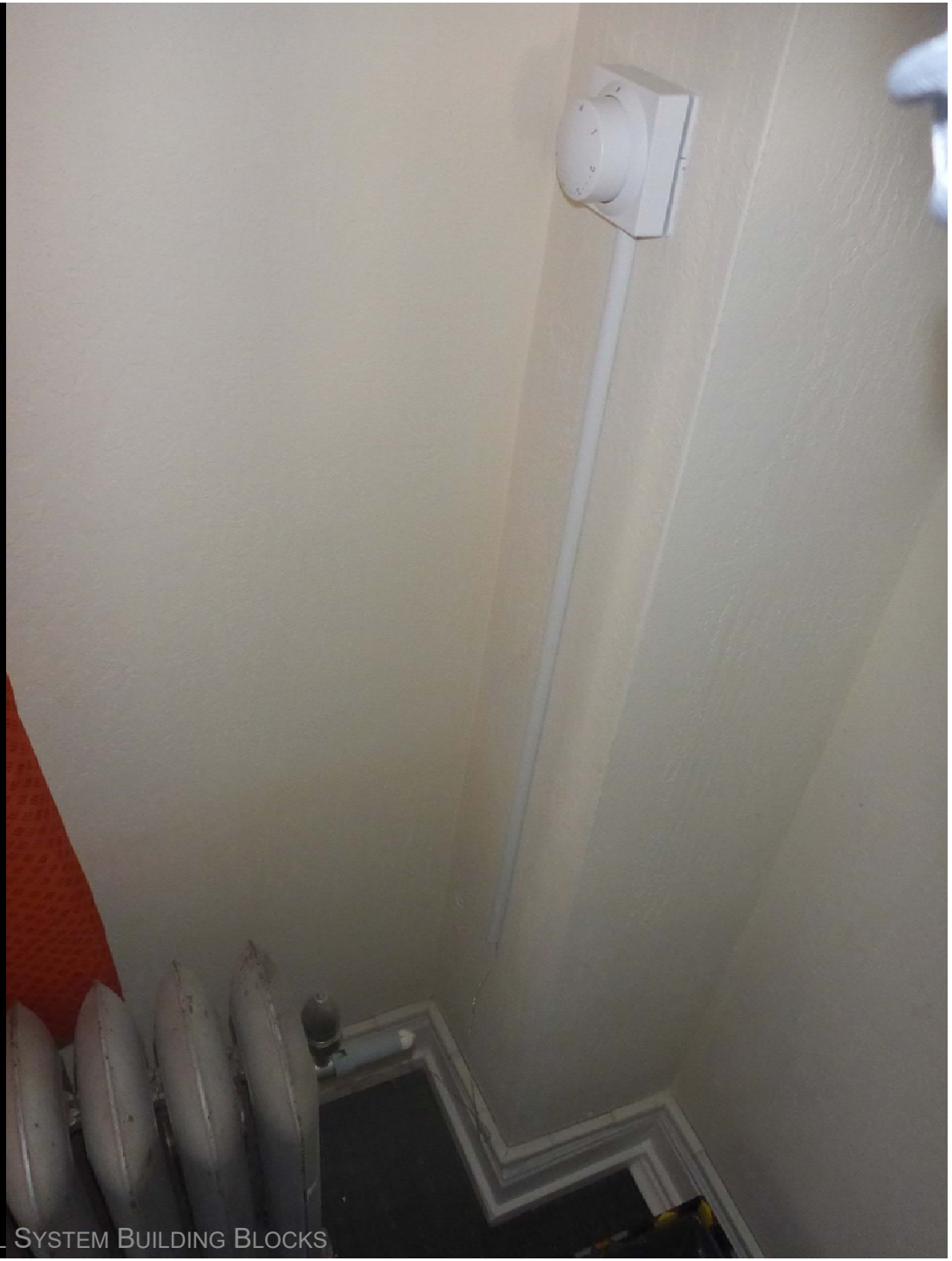


Control System Building Blocks

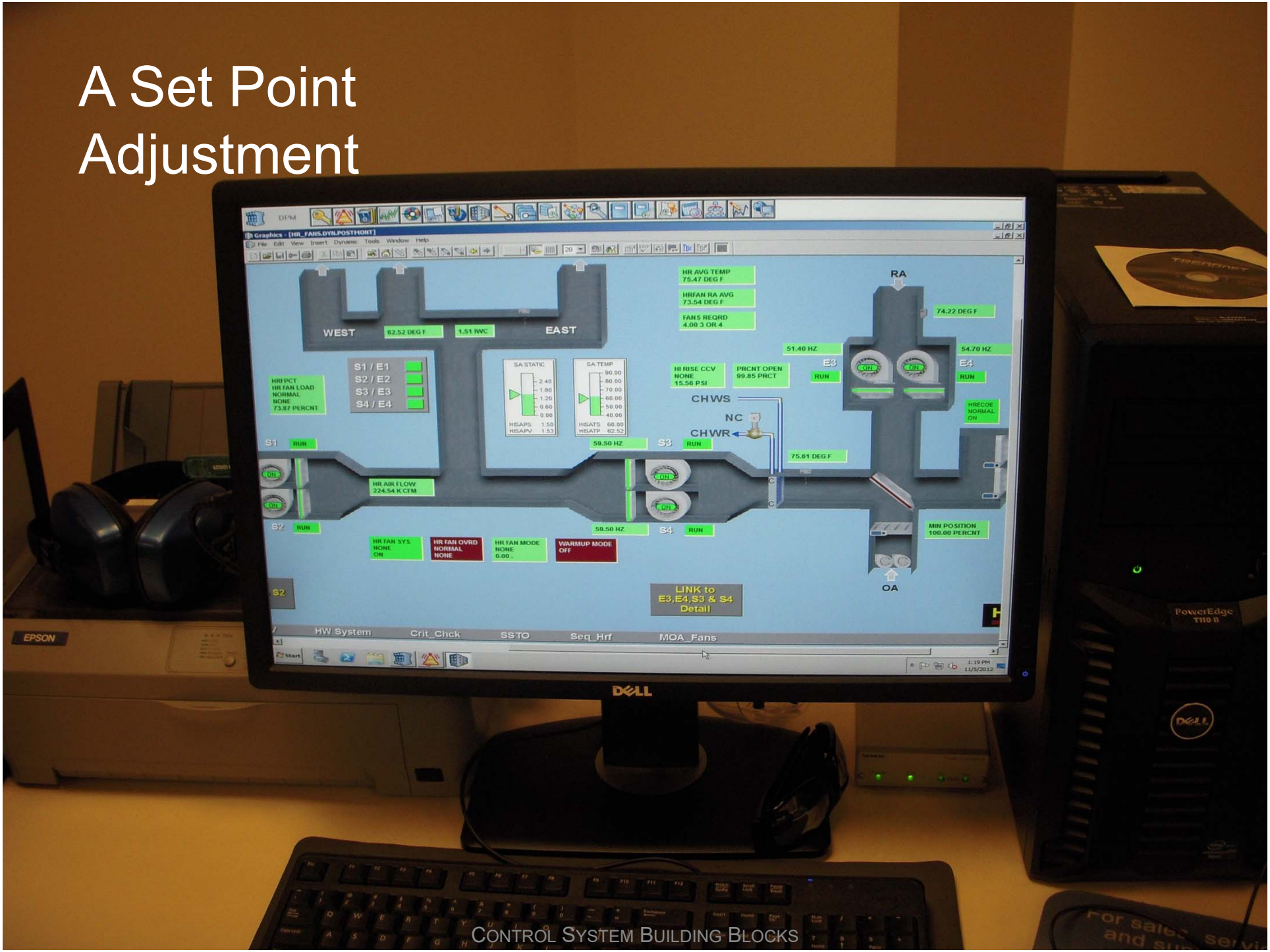
Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

Inputs	Measure the process variable
Outputs	Adjust the controlled variable
Control Process	Logic and algorithms that tries to bring the controlled variable into agreement with the set point
Set Point	Our requirements for the process that is under control, which can be fixed or variable

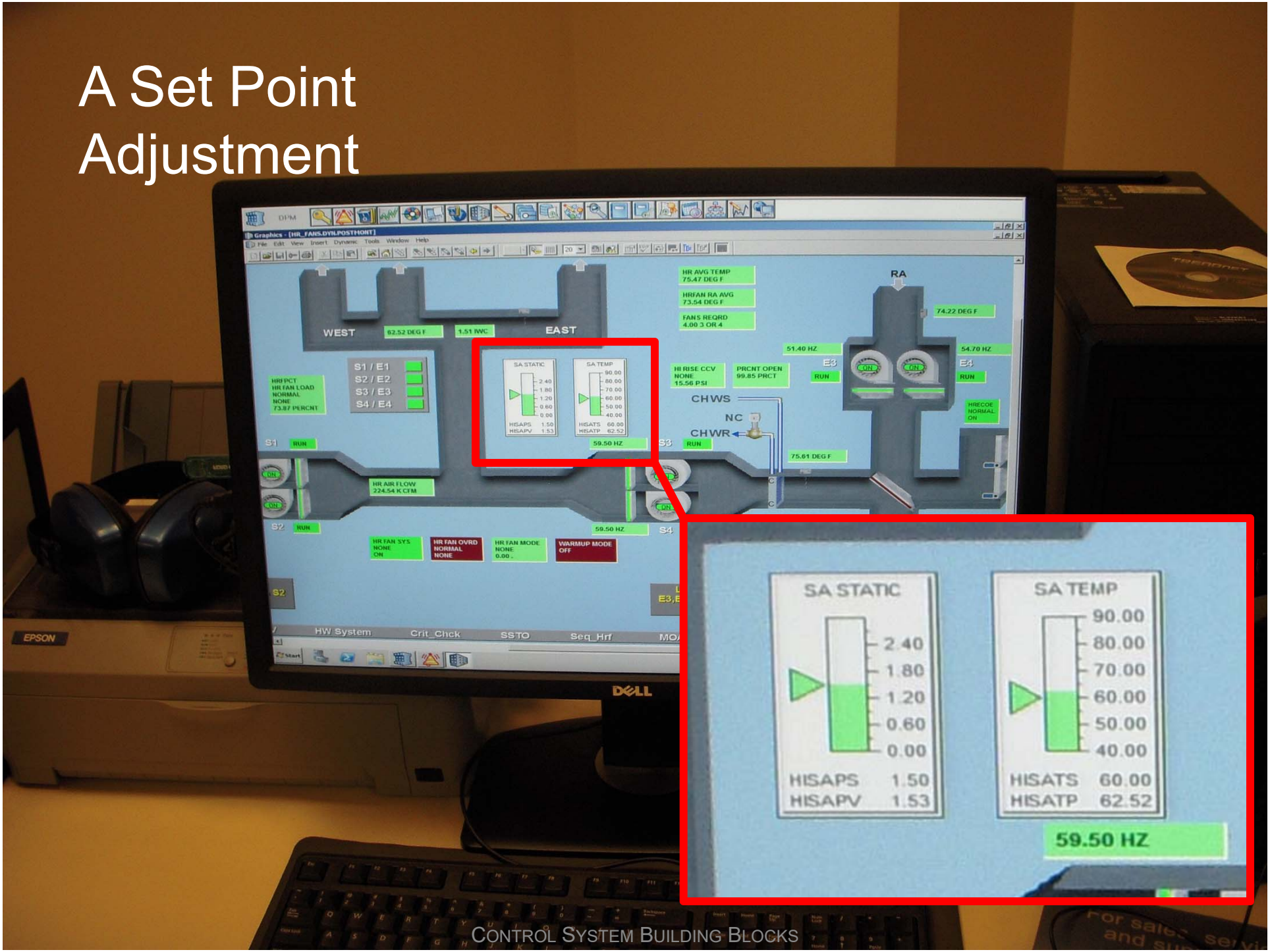
A Set Point Adjustment



A Set Point Adjustment



A Set Point Adjustment



Control System Building Blocks

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

Inputs	Measure the process variable
Outputs	Adjust the controlled variable
Control Process	Logic and algorithms that tries to bring the controlled variable into agreement with the set point
Set Point	Our requirements for the process that is under control, which can be fixed or variable

Control System Building Blocks

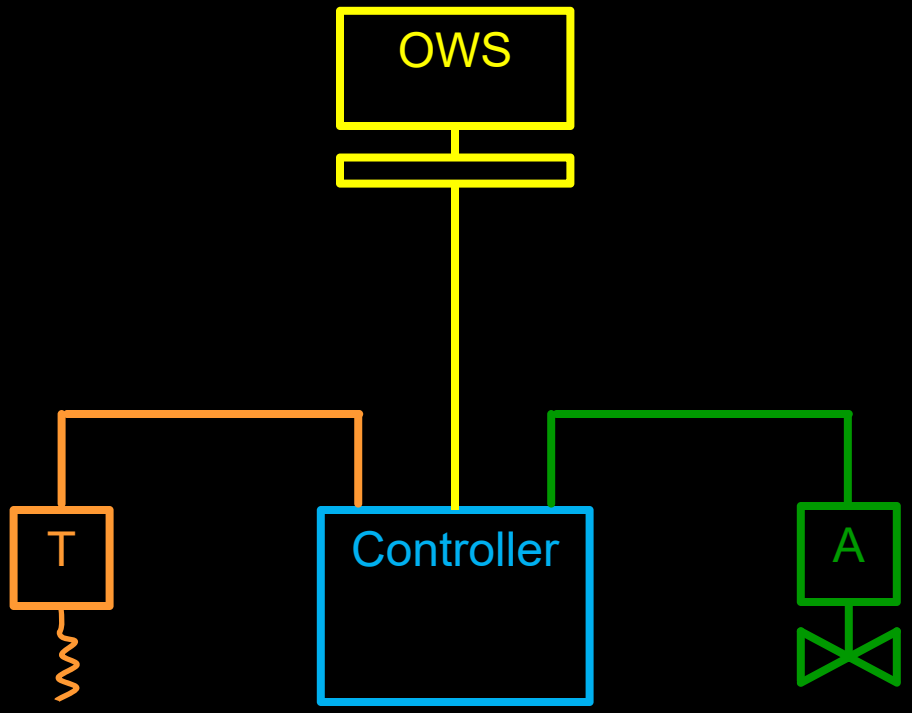
Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

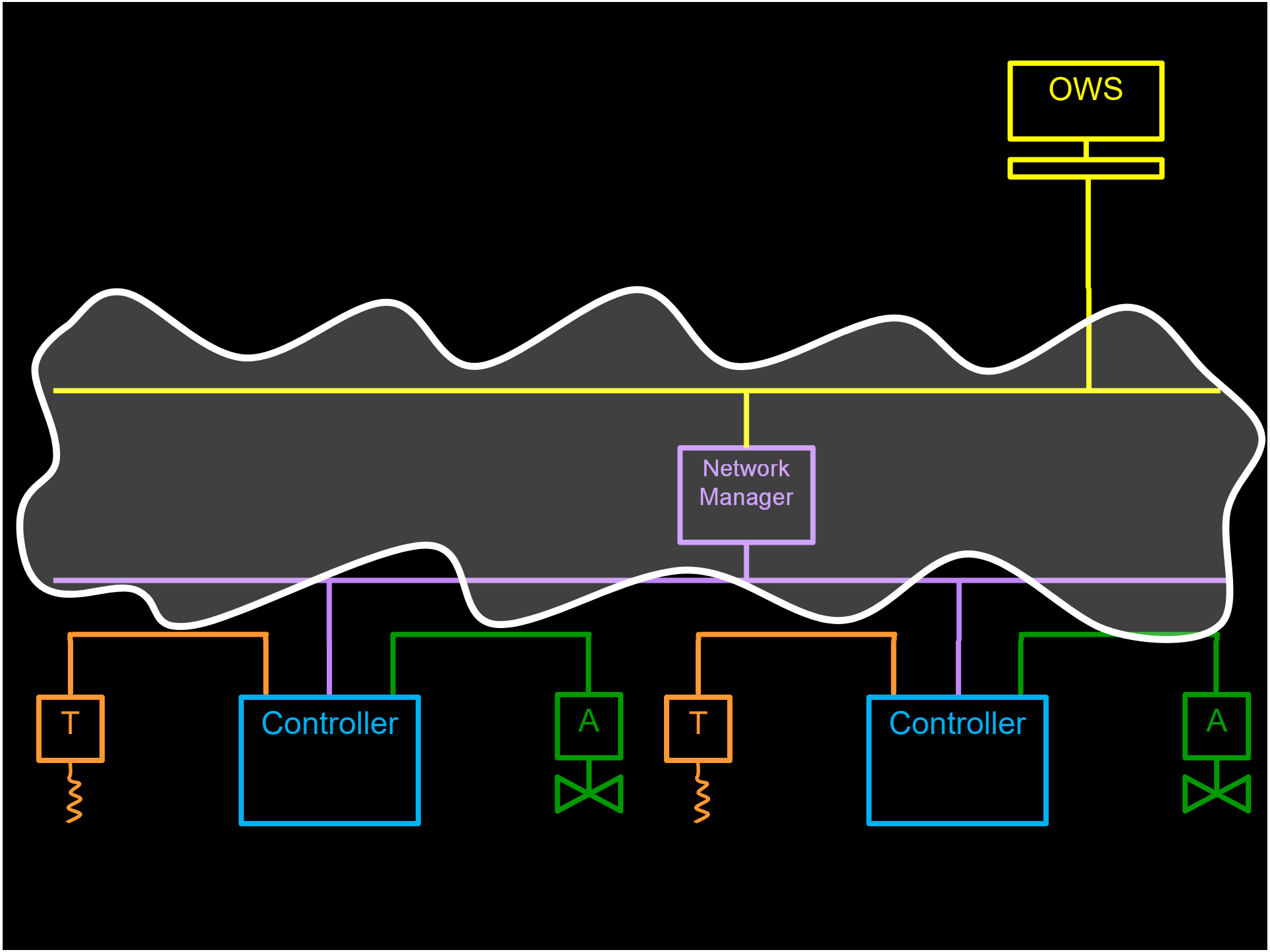
Inputs

Outputs

Control Process

Set Point




OWS
Network
Manager
T
Controller
A
T
Controller
A

Bottom Lines

- Repeatable, Reliable, Robust control sequences and logic are essential to successfully capturing the design intent
- To be successful:
  - Capture all of the details associated with the design intent
  - Support the logic with repeatable, reliable, robust hardware
  - Support the logic with a physical configuration that will allow it to work as intended

Logic diagrams are a tool in the Cx, EBCx and Old Timers tool box that can help ensure that the control sequence meets the design intent