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Automating Procedures in Continuous Process Applications using ISA 106

YOKOGAWA

Dave Emerson
Director,
U.S. Development Center
Yokogawa

Leila Myers
Consulting Engineer
USMK
Yokogawa

2012 USERS GROUP CONFERENCE & EXHIBITION

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SUSTAINABILITY & ECO-EFFICIENCY - LEAN - METRICS & PERFORMANCE MANAGEMENT
INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MML
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

Do you know MESA?

Today's Goals

- Provide an overview of current standardization activities regarding automated procedures

- Explain how you can get started

Agenda

- Automated Procedures Introduction – Dave Emerson
  - Historical Perspective
  - ISA106 Standards Committee
  - Benefit Proposition
  - Examples
  - ISA-106 Technical Report Concepts

- Modular Procedural Automation (MPA) – Leila Myers
  - What is MPA?
  - Consulting Methodology
  - How to select the right tool for the job
  - Exapilot examples
  - CENTUM VP examples

Historical Perspective (1 of 3)

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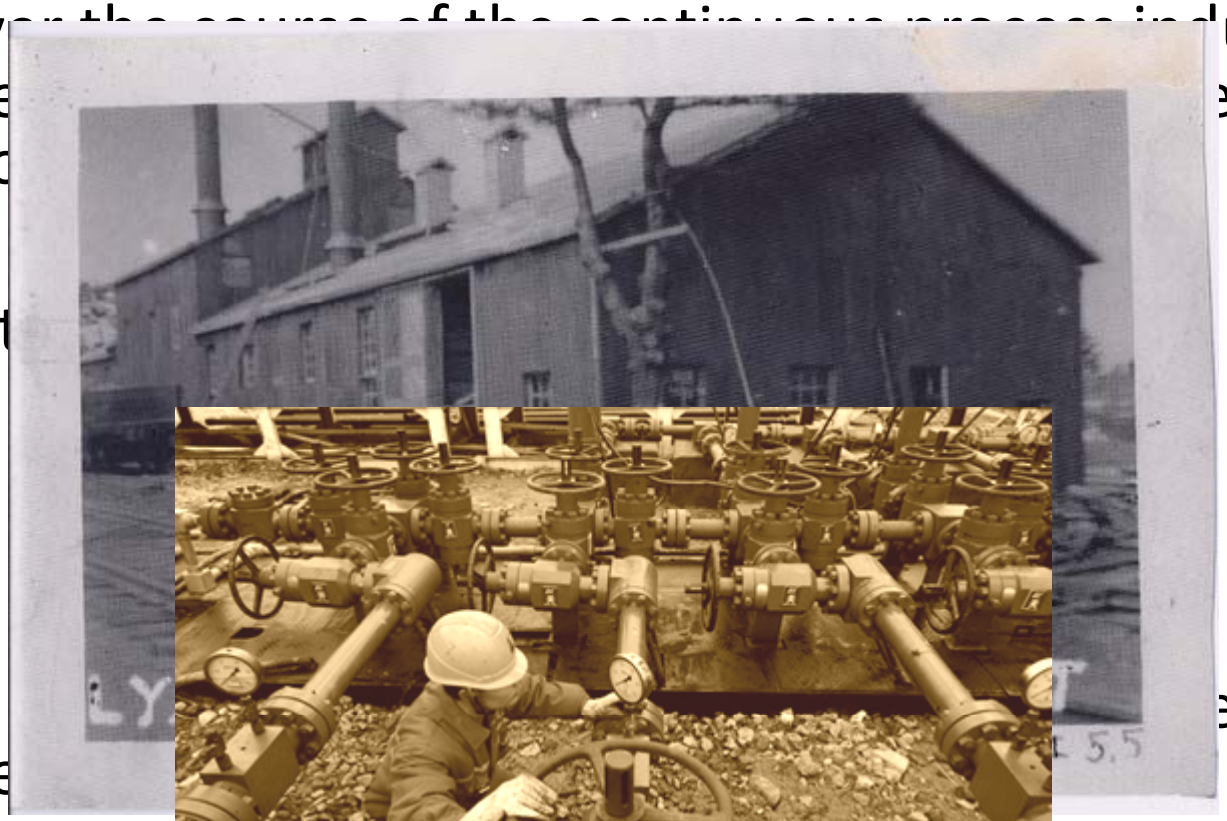

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Historical Perspective (2 of 3)

- Remote actuators on valves introduced
  - Operators could manage larger parts of the process
  - Fewer field operators

- PID controllers removed operators from the loop
  - Operators now supervised loops, no longer performed control
  - Operators could manager larger parts of the process

Historical Perspective (3 of 3)

- Computer based control systems…Distributed Control Systems…Centralized control rooms…Advanced Process Control
  - more pieces of process equipment are merged into larger and more complex control strategies
  - Additional layers of abstraction takes place

- But, in most continuous process plants operators still perform most procedures manually
  - Complex procedures
    - Starting a distillation column
  - Repetitive procedures the operator adds little value to
    - Starting pump sets by controlling individual values and pump controls

Why Not Just Use ISA-88?

- In the 17 years since ISA-88 has been a standard it has been widely adopted in the batch industry, but only used on an individual basis in the continuous process industries
  - When used for continuous processes “tweaks” had to be made, so not a perfect fit
- Continuous processes have different characteristics from batch
  - Ingredients not treated the same
  - Many different procedures used, not always tied in a nice “recipe bundle”
  - Equipment independence not a significant factor
- No significant adoption, Time for something different
  - ISA106 is an attempt to get the continuous process industries to discuss and standardize procedure automation holistically
  - Goal: Make procedure automation an expected part of any capital project

ISA-106

- ISA standards committee
- Creating a standard
  - Procedure Automation for Continuous Process Operations
- Membership
  - Owner/Operators, Suppliers, Consultants
  - Open to any interested person or company

Membership (partial)

- ABB
- Aramco Services Co
- AREVA
- Bayer MaterialScience
- BP Lubricants
- Braskem
- CDM Smith
- CH2M HILL
- Chevron
- Conocophillips
- DSM Corporate Operations
- DuPont
- Emerson Process Management
- ExxonMobil
- Herman Storey Consulting
- Honeywell
- Innovatia
- Invensys
- Mustang Automation and Control
- NovaTech Process Solutions
- PAS
- Prosys
- Rockwell Automation
- RSI Simcon
- Saudi Aramco
- Savannah River Nuclear Solutions
- Shell
- The Dow Chemical Company
- Valero Energy Corp
- Yokogawa

Committee Work Items

- Recently completed the first of three Technical Reports
  - TR #1 - Procedure Automation for Continuous Process Operations - Models and Terminology
  - TR #2 – Examples
  - TR #3 – Automated Procedure Life-cycle
- Standard will be produced based upon the Technical Reports and industry feedback

Benefit Proposition

- Automating procedures
  - Improves business results
  - Reduces risk – fewer operational errors
  - Ensures compliance
- Studies have shown that procedure errors are a primary cause of many incidents

Procedural Operations

- ALL process operations in ALL industries have procedural operations
  - Normal, safe operation
  - Change of state e.g. Start up, Shut down, Transition
- Procedures may be:
  - Operator Knowledge (Tribal lore)
  - Manual via Written SOP's
  - Semi-Automated
  - Automated

Refinery Incidents - FAT/CATs

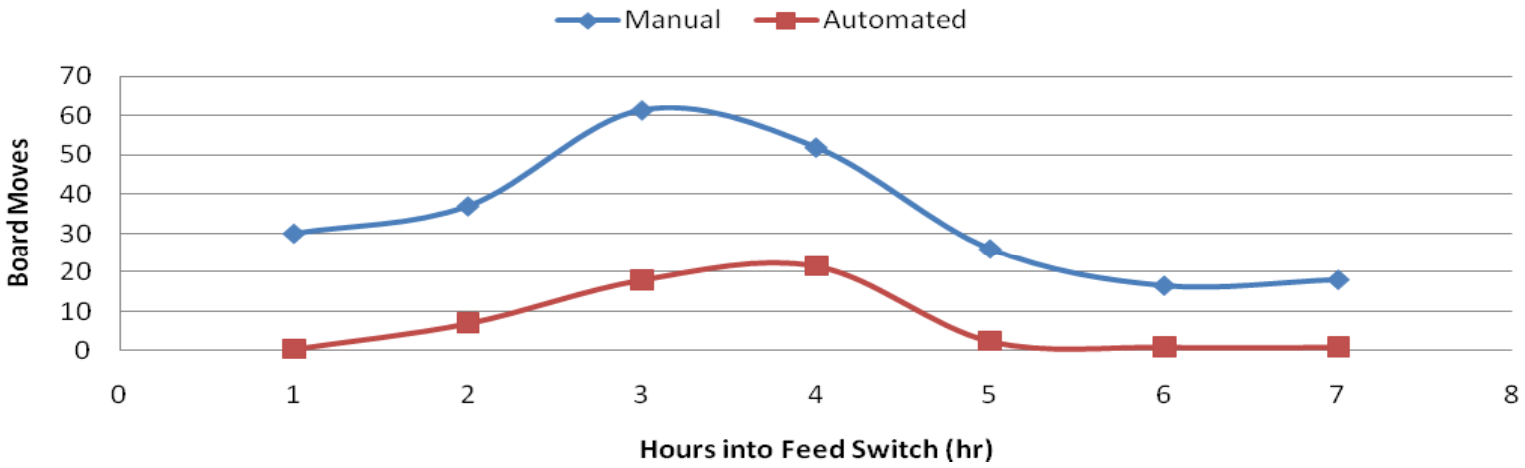
- Kern Oil Refinery in Bakersfield, California on January 19, 2005
  - Incident killed one employee and caused multiple injuries to other employees
  - Crude unit start-up
  - Workers over pressurized a pump casing which catastrophically ruptured, releasing and igniting hot oil that immediately exploded
- Giant Industries Ciniza Refinery, Gallup, New Mexico, April 8, 2004
  - 6 employees were injured, 4 requiring hospitalization with serious burn injuries
  - During hydrofluoric acid (HF) alkylation unit maintenance a shut-off valve was not closed as required, caused release of flammable liquids and vapors which caused subsequent explosions

Typical Targets for Automated Procedure

- Refining
  - Transition Management - Crude Switchover
  - Regeneration
- Petrochemical
  - Startup / Shutdown
  - Transition Management – Grade Changes
  - Line Switchover
  - Cleaning
- Polymers
  - Grade change
  - Switchover
- Furnaces
  - Decoking

Refinery – Transition Automation

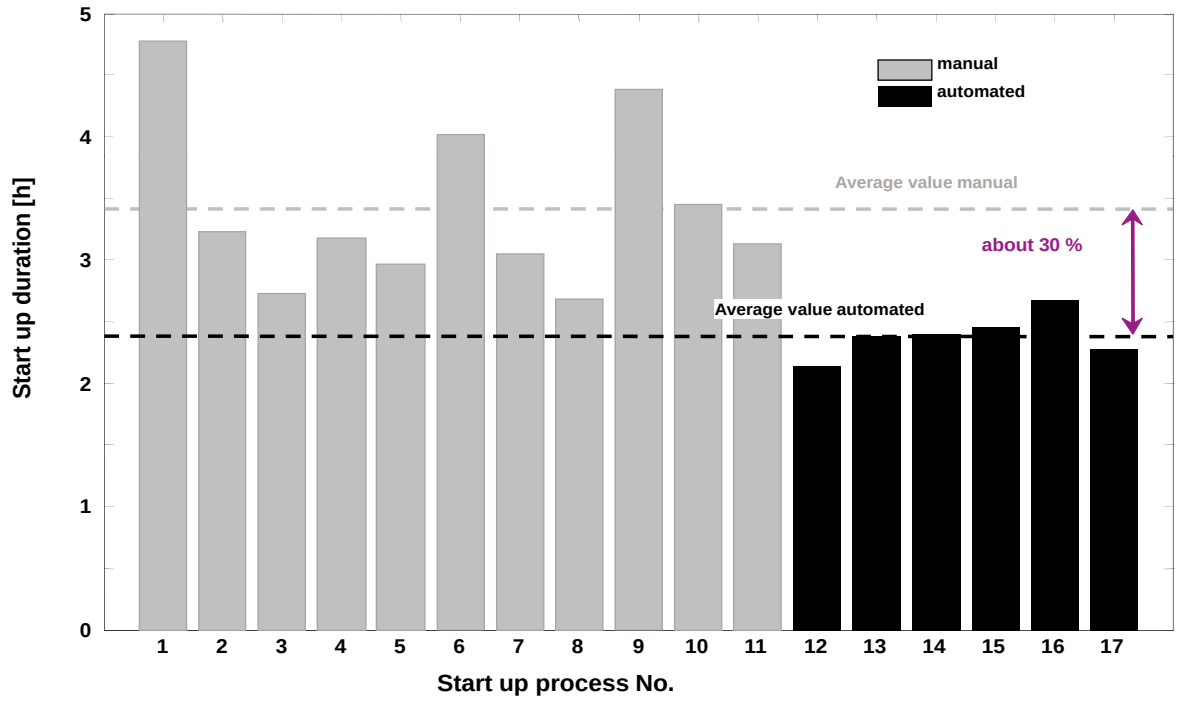
- Opportunity to automate a feed switch
- Benefits:
  - Operator workload reduced by 60%
  - A 42% reduction in product yield loss
  - Increased feed throughput during transition by 18%
  - Reduced feed switch transition time by 36%



Console Operator Moves per Hour Comparison from paper "Improving Refinery Unit Transitions Using Process Automation Technology in a base Oil Hydroprocessing Facility. AIChE Spring 2011 Robert M. Tsai, Chevron, Richmond, CA

Acrylic Acid Production

Start up procedure of a column



- Start-up time to steady state was reduced by 30%
- Less variability in start-up time
- Reactors able to come on stream 70% faster
- Process safety margins, of explosive conditions during startup, were significantly increased

NPRA 2011: AM-11-67 New Developments and Best Practices in Automating Procedural Operations for Continuous Processes

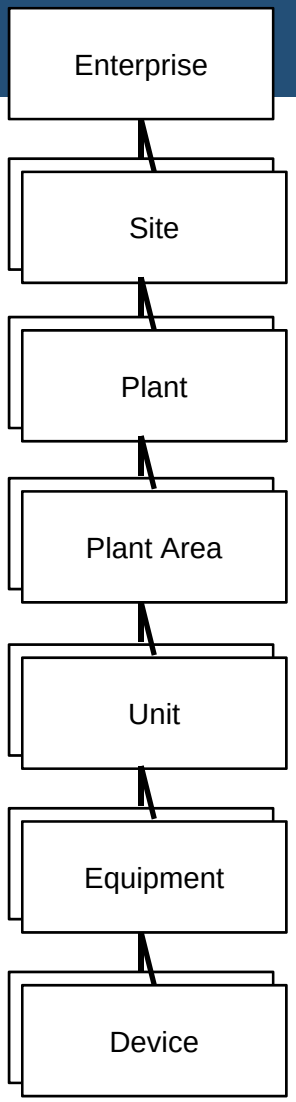
Benefits Derived from Automating Procedures

- Improved safety performance
- Improved reliability
  - More consistent operation
- Reduced losses
  - Fewer operator errors
  - Improved responses to disturbances
- Increased Production
  - Faster & more consistent startups and shutdowns
  - More efficient transitions
- Improved Operator Effectiveness
  - Automated procedures are tools for the operator
- Knowledge capture
  - Improved training
- Improved insight into the process
  - Design process can improve procedures

Models and Terminology

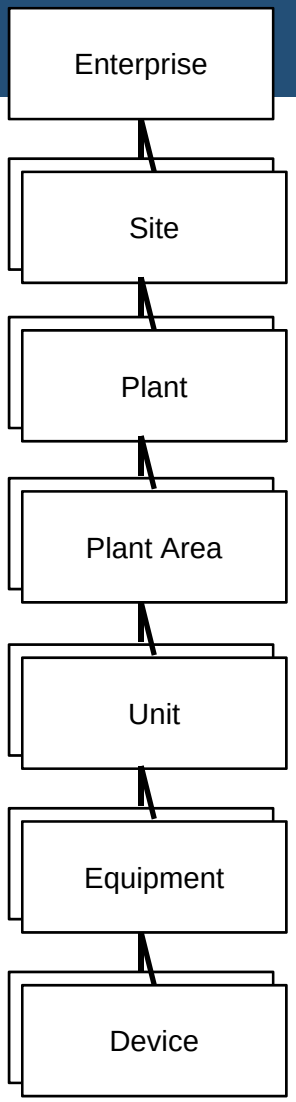
- 1st Technical Report
  - States committee's current thinking on how to organize and approach procedure automation
- Models
  - Concepts to give the industry a common mental model for automated procedures
- Terminology
  - Definitions to give the industry a common language for automated procedures

Physical Model



- Organizes physical equipment into a hierarchy
- Provides a common set of terms and equipment levels for companies & industries to map their terms to
  - Common terms enable products and people to work more efficiently with different owner/operators.
- Physical model is the foundation of the ISA-106 work
  - Each item in the model can have procedures

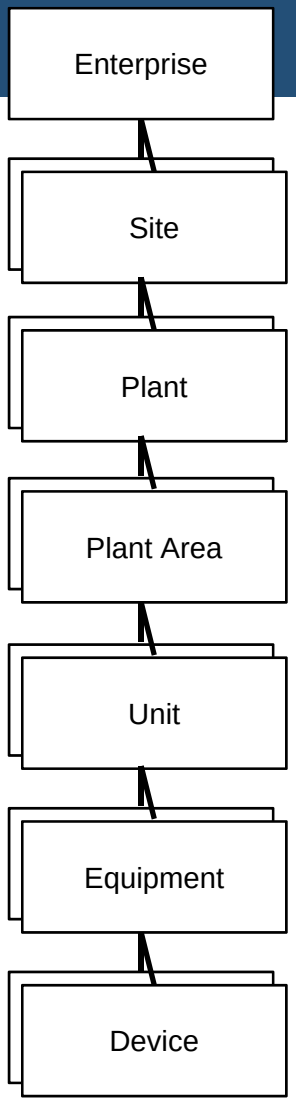
Physical Model - Today



Results of committee owner/operator terminology

ISA-106	Chemical Company	Oil Refinery	Offshore Oil Platform Example 1	Offshore Oil Platform Example 2	Paper Industry
Enterprise	Enterprise			Field	
Site	Site	Site	Platform	Platform	
Plant	Plant	Complex		Package	Mill
Plant Area	Area	Plant			
Unit	Unit	Unit			
Equipment	Equipment				
Device	Device	Device			

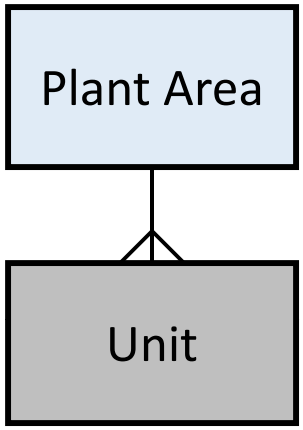
Physical Model - Examples

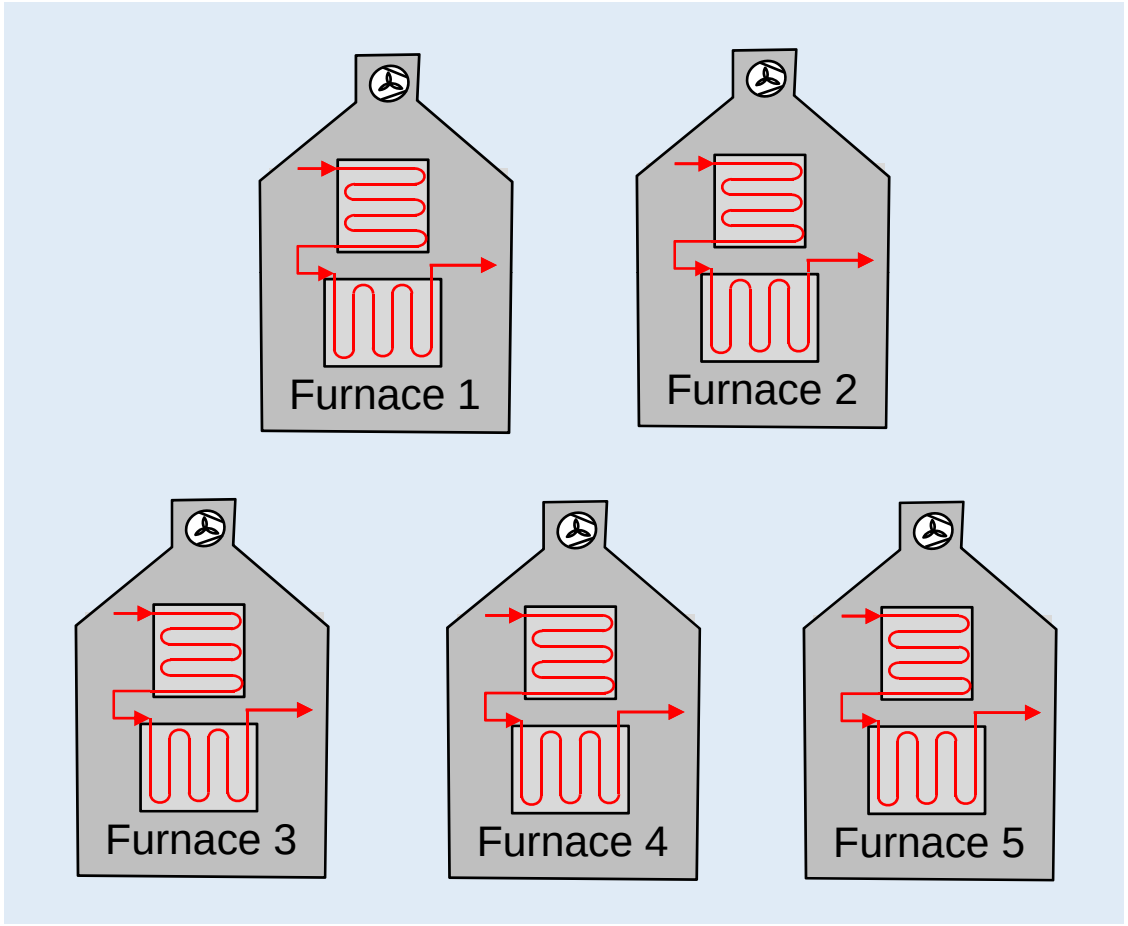


Results of committee owner/operator terminology

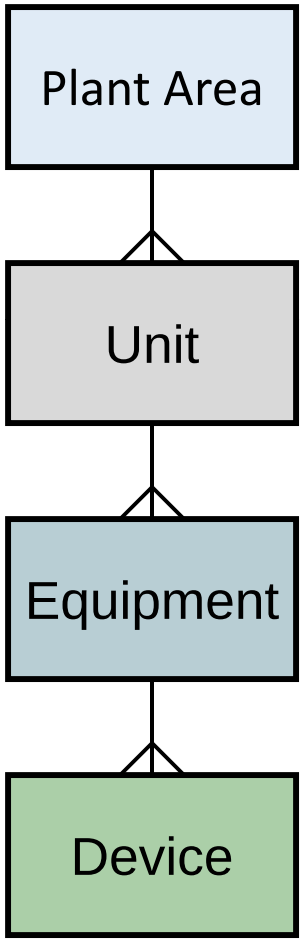
Enterprise	Corporate	Division	Business Unit		
Site	Complex	Train	Facility	Verbund	Field
Plant	Platform	Train			
Plant Area	Separation Injection	Train Utilities	Sub-sea Water Treating	Gas Compression Production Manifold	Dehydration Wells
Unit	Separator	Dry/Wet Oil Tanks	Pipeline Pumps	Hydrocyclone	Compressor
Equipment	Pump Set	Feed System	Reboiler	Sampling System	Compressor
Device	Control Valve	Transmitter	Pump	Analyzer	

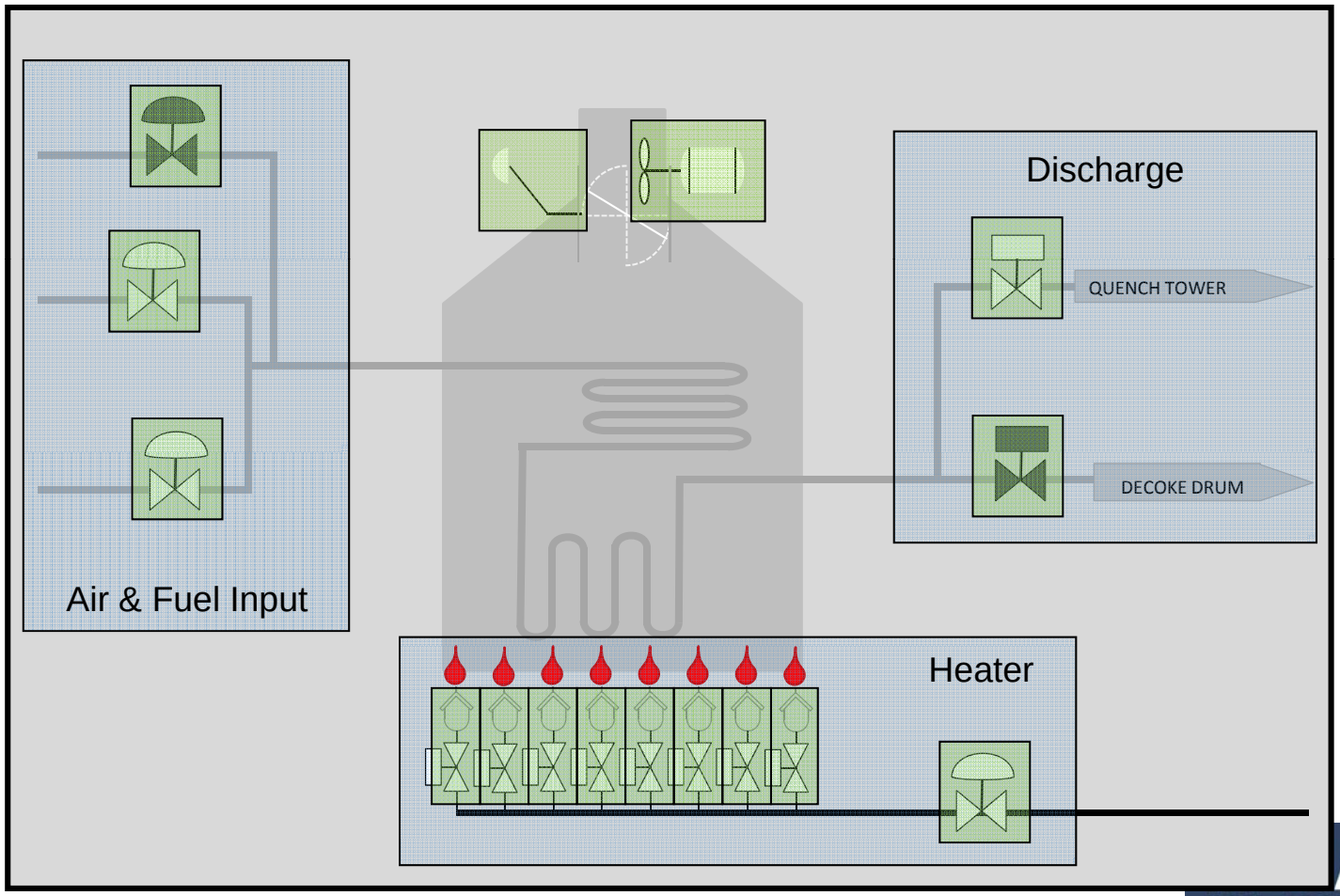
Ethylene Furnace Example



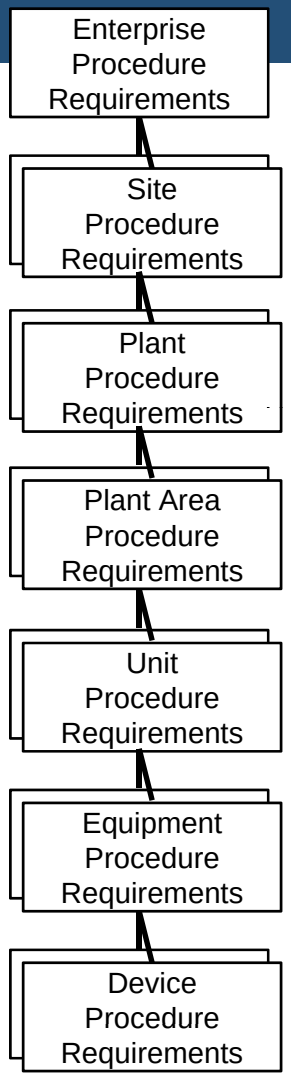


Ethylene Furnace Example



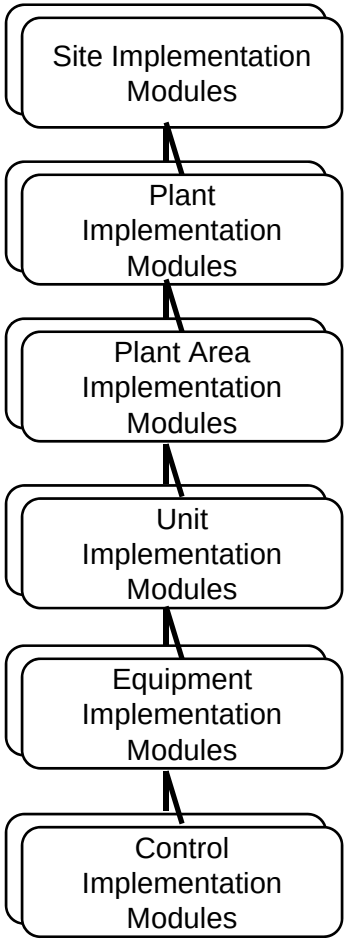


Procedure Requirements Model



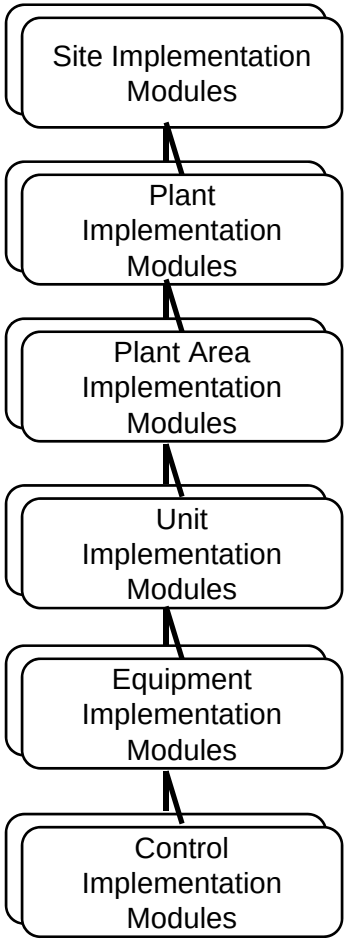
- Procedures are associated with objects in the physical model
  - Most common for units, equipment and devices
- Definition of the procedure
  - What must be done to accomplish it's objective
  - Functional requirement for the automated procedure

Procedure Implementation Model

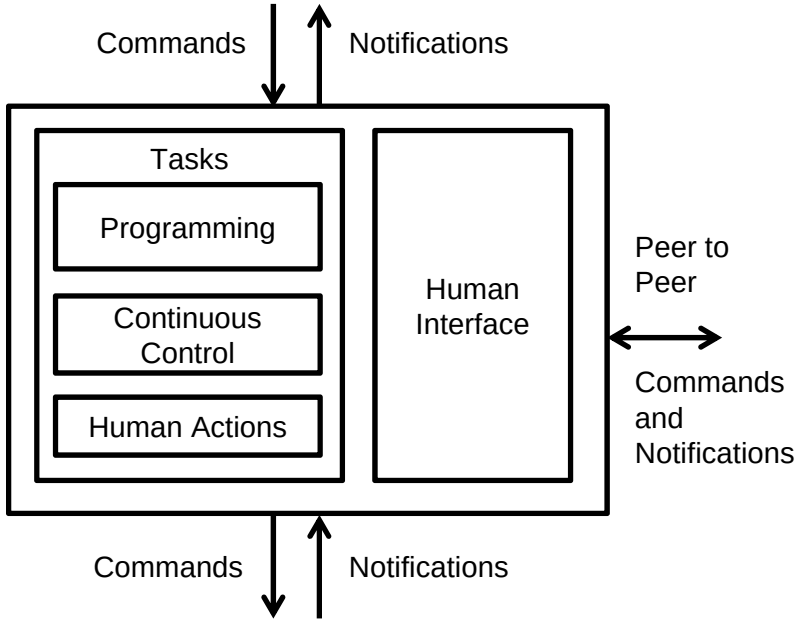


- The actual automated procedure
  - Program, function block, sequential function chart, flowchart,…
- The design of implementation modules is an engineering process
  - Procedure requirements are the specification
  - Not always a 1:1 mapping with procedure requirements

Implementation Modules

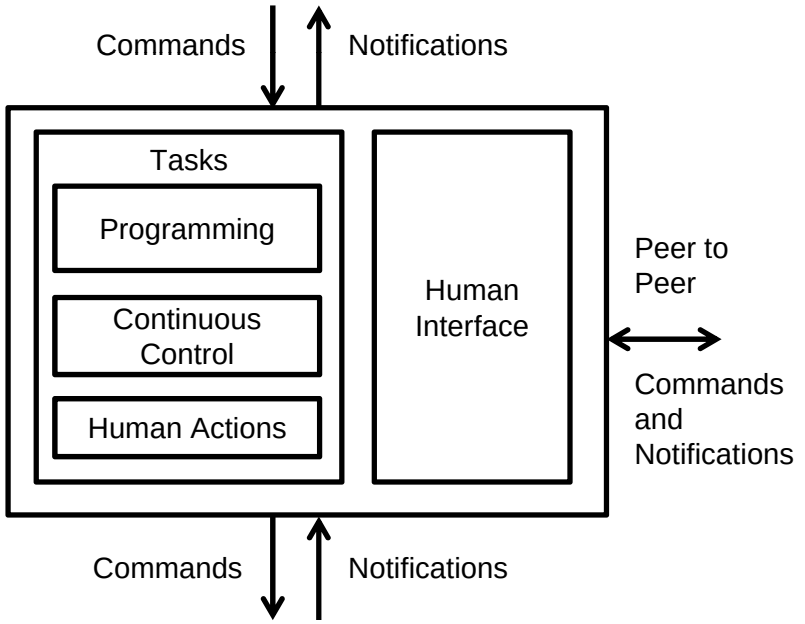


- Consist of a set of ordered tasks
  - Tasks may contain tasks
- Tasks perform step by step actions

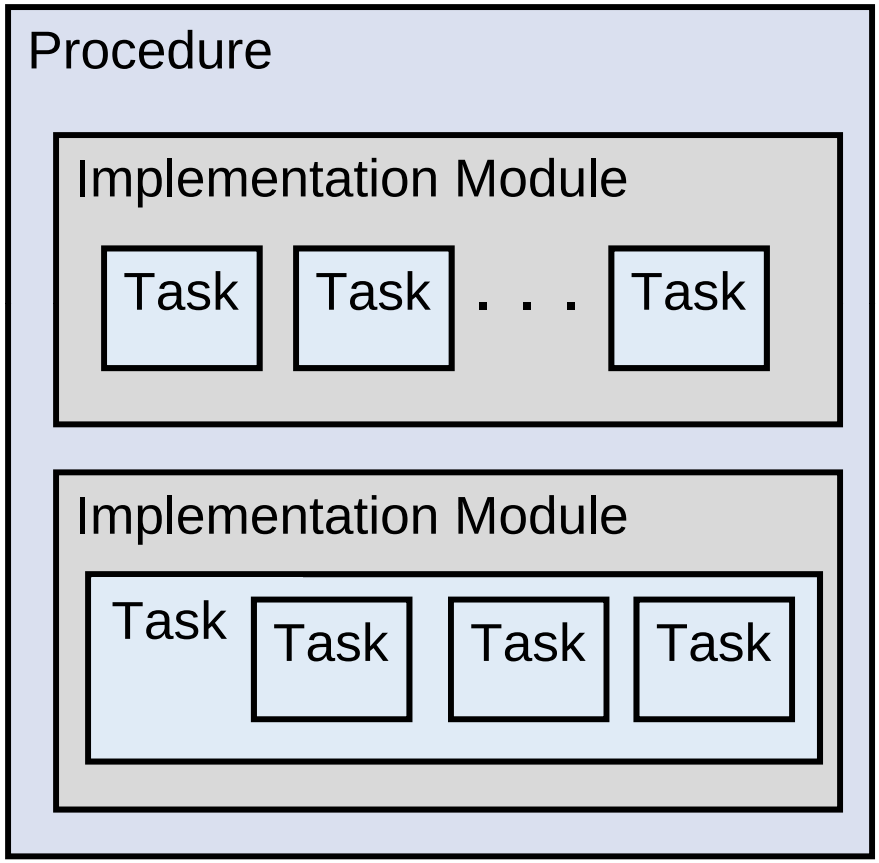


Implementation Modules

- Implementation methods are any type of tool used to create a task.
  - Programming
  - Continuous Control
  - Human Actions.
- Examples of programming types
  - Computer programs
  - Configurable function blocks
  - Continuous control functions
  - Executable flowcharts.
  - Procedure Function Charts (PFC)
  - Sequential Function Charts (SFC)



Procedure Execution



- Each Procedure, Implementation Module & Task has 3 execution work items
  - **Command** – Trigger
  - **Perform** – Actions
  - **Verify** – Success/Failure
- Computer/Human Mix
  - C-P-V work items can be done by a computer or human

Command ›››› Perform ›››› Verify

Implementation Module Execution

- Three work items are typically used for implementation module execution:
  - Command – The trigger to initiate the implementation module. When received this causes the implementation module to perform its tasks.
  - Perform – The execution of an implementation module's tasks.
  - Verify - Verification that the implementation module's tasks were performed successfully or failed.

Automation Styles

- Organization of the structure of the implementation module such as using procedure sections or process states
- Use of computer or operator action for command, perform, verify
- Amount of precision used for verification
- Human machine interface philosophy
- Degree of automation from minimal automation to complex automation

Automation Style Examples

- Manual
  - The Operator is responsible for the command, perform and verify work items, minimal automation is used
- Computer Assisted
  - Operator and computer share responsibility for the command, perform and verify work items. The amount of automation used may vary.
- Fully Automated
  - Computer is responsible for the bulk of the command, perform and verify work items.

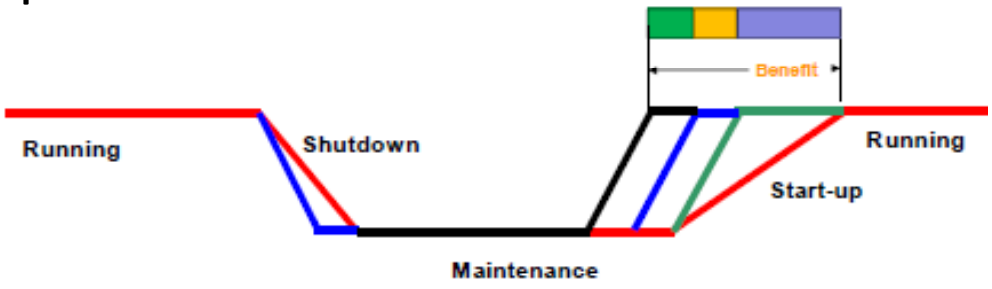
Operator Notifications

Operator Notification Types	Operator is expected to take an action	Operator might need to be aware but is not required to take action
Arises from an abnormal process or equipment situation (ISA-18.2)	**Alarm**	**Alert**
Arises from a normal situation (ISA-106)	**Prompt**	**Status Notification**

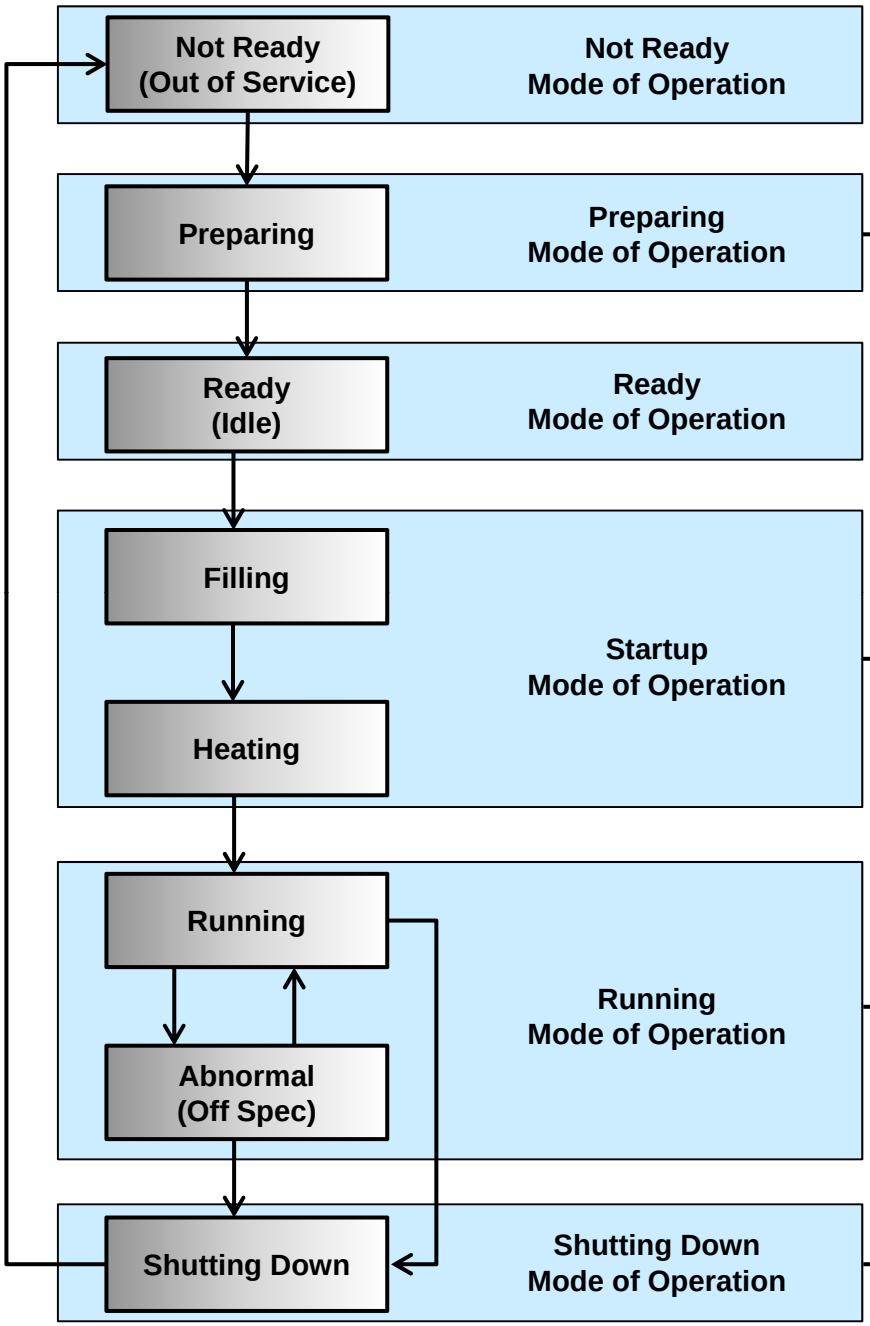
ISA-106 has worked with ISA-18.2
which has published an alarm management standard

State-based Control

- A plant automation control design technique that assigns process states and defined transition procedures
  - Most effective at the unit level
  - Provides a high degree of automation
    - Startup, Shutdown, Transitions, Abnormal Situation Responses

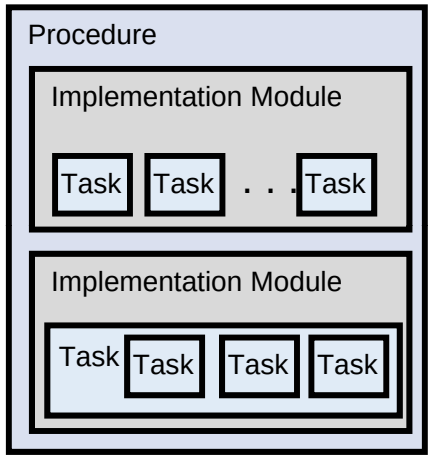


State-based Control Example



Prepare Procedure

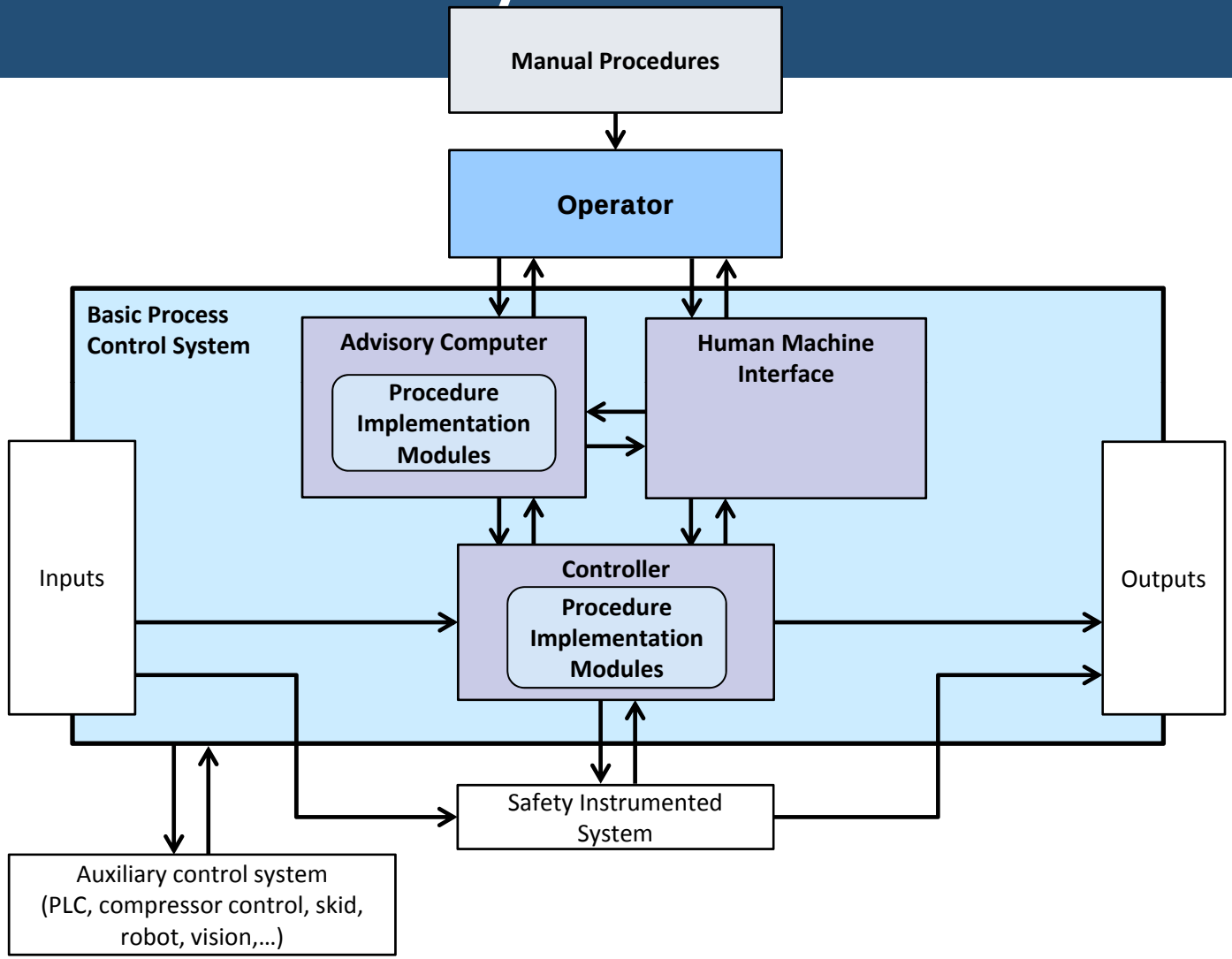
Startup Procedure



Production Rate of Change Procedure
Abnormal Condition Handling Procedure

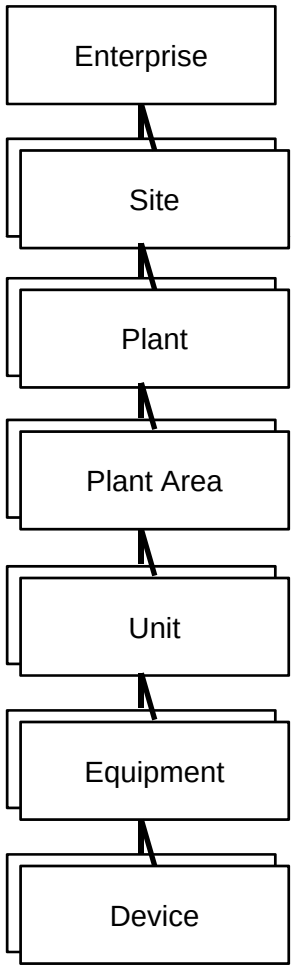
Controlled Shutdown Procedure

Control System Architecture

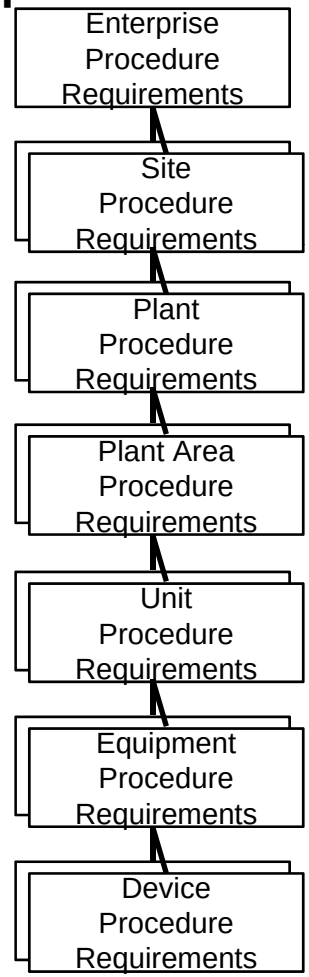


ISA-106 Key Models

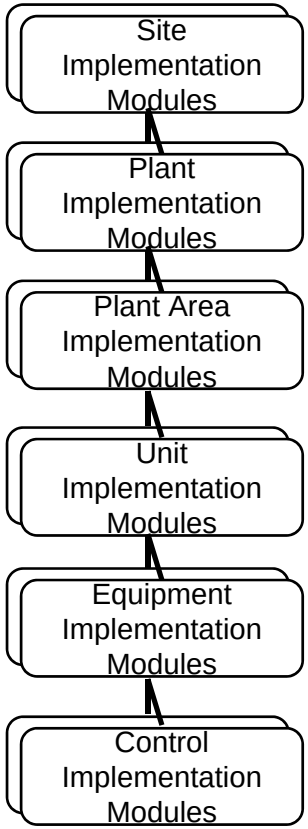
Physical Model



Procedure Requirements Model



Procedure Implementation Model



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Part 1 Summary

- Automated procedures in continuous process operations can help make a plant safer & more competitive
- Automated procedures are not widely used today
  - Great opportunity for improvement
- ISA-106 is open to all interested parties
  - ISA membership is not required
- TR #1 is the first step
  - We need more industry input

Thank you

20 YEARS & KNOWING

OUR MEMBERS ARE THE MOST AGILE COMPANIES IN THE WORLD.
THEY KNOW THEY HAVE A RESPONSIBILITY TO INDUSTRY AND TO ONE ANOTHER.
THEY KNOW THE CONSEQUENCES OF AVOIDING A SINGLE IMPROVEMENT CAN MEAN MILLIONS OF DOLLARS AND A POSSIBLE GLOBAL IMPACT.
THEY KNOW THE POWER OF KNOWING WHAT MESA KNOWS.

"We saved $2.4 million because our operations team was able to make a case for improvement with resources from **MESA**."

Global Education Program

MESA has trained over 500 professionals and provides 800+ pieces of content valued at over $13 million dollars.

"At the Global Education Programs, I learn from mistakes and successes of other manufacturers, I network with the best, AND the cost is credited to my membership fees. Becoming a member was a no-brainer."

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MESA International Headquarters 107 S. Southgate Drive, Chandler, AZ 85226 USA
+1 480 893 6883 | hq@mesa.org | www.MESA.org