The DeltaV Virtual Power Plant

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Presenter

- Todd Anstine
Introduction

- Objective: Describe the use of DeltaV Simulate Suite and MiMiC Simulation Software to create a virtual power plant for operator training
- Key Topics for Discussion:
  - Project Drivers
  - Technical Requirements
  - Project Development Process & Team
  - Training System Architecture
  - Key Technology Leverage Points
Project Description & Drivers

- Urban power station located in downtown area of mid-size, mid-western city
- Plant provides electricity, steam and chilled water for the city and a large hospital complex
- Operator validation and training records are critical to satisfy municipality and hospital requirements
- Customer faced with pending retirement of experienced operators
Technical Requirements

- Process is complex due to the multi-use nature of the facility
- Process models needed wide dynamic range to enable realistic simulator performance from cold startup to full steam conditions
- Use actual control system graphics within the training system
- 2 Boilers (gas & oil fueled), feed water system, fuel system, steam driven turbine, 2 chillers (1 electric, 1 steam driven), burner management system and other miscellaneous controls
Project Development Process

- Collect Relevant Process and Operational Data
- Project Kickoff Meeting
- Create Dynamic Simulator Design Specification
- Provide DeltaV Database
- Setup DeltaV & MiMiC HW/SW
- Low Level Model Development / MiMiC & DeltaV Integration
- Define Operator Training Scenarios
- Design Instructor Screens
- High Level Simulation Model Development
- Create Factory Acceptance Test Plan
- Model Acceptance Testing / Pre-FAT Review
- Factory Acceptance Testing
- On-Site Installation
- Training
# Project Development Process – Data Requirements

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Required for Project</th>
<th>Date Required</th>
<th>Date Received</th>
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</thead>
<tbody>
<tr>
<td>Process &amp; Instrumentation Diagrams</td>
<td>Yes / No</td>
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<tr>
<td>Process Flow Diagrams</td>
<td>Yes / No</td>
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<tr>
<td>Process Descriptions</td>
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<td>Operator Graphics Screen Captures</td>
<td>Yes / No</td>
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<tr>
<td>I/O List</td>
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<tr>
<td>Instrument Index</td>
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<tr>
<td>Instrument Data Sheets</td>
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<tr>
<td>Equipment Data Sheets</td>
<td>Yes / No</td>
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<td>Operator Manual</td>
<td>Yes / No</td>
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<tr>
<td>Startup / Shutdown Procedures</td>
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<tr>
<td>Control System Network Architecture Drawing</td>
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<td>Pump Curves</td>
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<td>Turbine Curves</td>
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<td>Compressor Curves</td>
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<tr>
<td>Historical Steady State Operational Data</td>
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<tr>
<td>Steady State Process Design Data</td>
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</table>
Project Team

- EPM Team Members
  - Project Manager
  - Simulation Developers
  - Control System Engineer
  - Project Support Technician
  - Account Manager

- Customer Team Members
  - Project Owner
  - Process Engineer
  - Operations Management
  - Operator
Training System Architecture

DeltaV SimulatePro Standalone

MiMiC Simulation Software
Training System Architecture

- Utilized existing DeltaV database (1 controller worth) and associated graphics
- Control system emulated in one PC via DeltaV SimulatePro Standalone
- Process models and trainer controls reside in the MiMiC server PC
- Pre-defined process excursion scenarios with performance scoring launched by the trainer
Training System Architecture

DeltaV SimulatePro Standalone Workstation

Simulation Network

MiMiC Simulation SW Server
Key Technology Leverage Points

- Utilized actual control system operator graphics
- Used control system production database to generate basic tiebacks as simulation starting point
- Implemented MiMiC advanced modeling objects to maximize simulation fidelity and minimize required time investment
- Took advantage of DeltaV SimulatePro snapshot, MiMiC training scenario and component studio functionality to customize operator training
DeltaV Operator Graphics

- Identical graphics, alarms, faceplates, controls
Simulation Database Generation

MiMiC 3.x Database Generator

Database Generation
- [ ] Generate new physical ID's (Fieldbus devices)
- [ ] Generate all Fieldbus devices in Standby State
- [ ] Only generate Models with Function Blocks
- [ ] Only generate used Sio tags
- [ ] Keep data for Encrypted Class XML file generation
- [ ] Handle Linked Composites (May significantly impact speed)
- [ ] Generate VIM I/O Definition
- [ ] Generate OPC I/O Definition
- [ ] Generate Readback Sio Tags

Database Modification
- Custom Modeling
Simulation Database Generation
Power Generation Modeling Objects
Fuel Function

- Gas, Oil, Wood, Coal or Other
- Composition by Weight or Molecular Weight
- Carbon, Hydrogen, Sulfur, Nitrogen, Oxygen analysis, heat capacity characterization
Power Generation Modeling Objects

- **Boiler with Furnace Block**
  - Five fuel feeds per furnace
  - Complete combustion model - flue gas composition, energy generated, full combustion characteristics
  - Water/Steam balance model - Steam Flow, Feed Water Flow, Drum Level
  - Primary Superheater, Desuperheater, Secondary Superheater, Economizer, Air Heater, Precipitator Models
Steam Header

- Handles saturated or superheated steam from multiple sources
- Models pressure, temperature and total steam mass
- Mass / energy balance across the entire header
- Up to 8 input streams and 8 outputs streams
DeSuperHeater
- Mass / Energy balance
- Water inlet configuration option

Pressure Reducing Valve
- Complete pressure and flow modeling between steam headers
- Valve performance characteristic is configurable via valve polynomial
Turbine

- Steam / Power Generation Balance
- Steam Inlet Extraction and Exhaustion Balance
- Turbine can be run in pressure control, power control, and extraction flow control modes
- Currently handled with MiMiC Simulation Model Template
Customized Operator Training

- Training scenarios of equipment failures
- Training scenarios of boiler conditions (fuel changes)
- Process Snapshots
- Instructor Screens
- Training Session Reports
Customized Operator Training

- Process Snapshots
Customized Operator Training

- Instructor station graphics in MiMiC Component Studio
- Consistent, measurable, documented training – MiMiC OTM
Business Results Achieved

- Plant now has the ability to train new operators, re-qualify existing operators and provide training documentation to meet the requirements of its customers.
Summary

- Operator Training Systems can be a valuable and cost effective investment if implemented in a practical, well-planned manner.
- The key is to use the right tools, involve the right people and follow an organized process.
- Questions?
Where To Get More Information

- Contact Todd Anstine
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- www.mynah.com, Knowledgebase
  - Application Notes
  - Technical Notes
  - Product Bulletins
  - White Papers
  - Pre-Recorded E-Seminar, Advanced Modeling Objects