Operational excellence through dynamic simulation
Operator Training Simulators
Presented by: Ramki Sethuraman
Agenda

• Dynamic Simulation throughout the Plant Lifecycle
• Control System Representation in an OTS
• Plant Equipment Representation in an OTS
• Project Execution
• References and Success Stories
• Innovations in Operator Training Simulators
Plant Lifecycle & Dynamic Simulation

- Validate Design
- Checkout Controls
- Train Personnel
- Improve Performance

1. PROCESS DESIGN
2. DCS CONFIGURATION
3. INITIAL START
4. PLANT OPERATION
Engineering Studies with Dynamic Simulation

Boiler Draft Evaluation – Implosion Study
- FGD retrofit affects controllability and exposes it to mechanical implosion damage
- Assess boiler implosion risk in single and parallel units
- Avoid unnecessary boiler stiffing and develop MFT logic to prevent implosion

Validate and Improve IGCC Design
- New technology with integrated units and shared power, steam, and hydrogen export
- Validate that integrated plant work properly together for failure scenarios
- Avoid field design changes and reduce commissioning time
Use Plant DCS Engineering and Graphics Applications on Simulator

- Identify control logic errors
- Identify graphics configuration errors
- Test signal ranges
- Pre-tune control loops
- Test coordinated or feed forward controls
Operator Training: Sharpen operator skills with minimum OJT

**Challenges**
- Operation errors is the 2nd leading cause of accidents
- Average cost per major incident related to operator error exceeds $80M
- Operators unfamiliar with DCS configuration and plant design
- Retiring Operators or large turn-over in operations staff
- Longer run time between shutdown limits startup training

**Training Benefits**
- Train on virtual representation of plant before plant commissioning
- Many years of OJT to make an operator “error free” without OTS
- Simulator training provides six (6) equivalent of years of OJT in one (1) year.

**Reference:**
Simulation Testbed: Improve Plant Performance

Ease of Process Model Changes + Ease of Control Model Changes = Testbed for process, control, and procedure changes

- Ease of model / instructor graphics changes through one integrated and familiar interface (DYNSIM GUI).
- Controls are loaded directly from the plant control system configuration files for Foxboro I/A to Evo and Triconex TriStation.
- Integrated cross referencing.
- Since simulator is easy to maintain, it does not become obsolete. Other vendor simulators become quickly outdated and costly to upgrade.
Control System Representation in an OTS

Foxboro and Triconex Virtual Controllers (SCP and TRISIM Plus)
SCP – Foxboro Virtual Controllers

- Fits seamlessly into Foxboro I/A Series and Foxboro Control Software
- Identical algorithms and communication services as a CP270 and CP280
- Easy to install, configure, and run
- One-to-one relationship CP270 / CP280 to SCP (No Mapping/No ‘super-CP’)
- Works with ICC, IACC & Foxboro Evo Control Editor
- Multiple SCPs running on a single Windows 7 workstation and utilizes multi-threaded capabilities inherent to 64-bit OS
- Able to switch between simulations that execute different control sets
Identical Control Feedback & Operator Interface
TRISIM Plus – Virtual Controller for Triconex

Triconex TMR controller ported to run on a PC

- Directly load TriStation 1131 Configuration (.pt2 files) on simulator
- Modify simulated configuration using TriStation 1131 Workbench tools (same as plant)
- Bi-directional import (modifications in plant or simulator)
- Use same HMI in the simulator as plant

Benefits of TRISIM Plus

- Dramatic reduction in commissioning and startup time
- Accurate analysis and troubleshooting of performance
- Superior operator training experience
- Ideal retrofit/upgrade design environment
Plant Equipment Representation in an OTS

Dynamic simulation models (DYNSIM)
Power Plant Specific Models

- Steam Turbine Models
  - Stop Valves, Governor Valves
  - Steam Chest
  - Turbine Stages & Extractions
  - Metal nodes (Turbine soak)
  - Exhaust Hoods
Power Plant Specific Models

• Fans
  – Primary air, secondary air, and induced draft.
  – Inlet guide vanes
  – Multiple curves
• Coal Fuel Systems
  – Hoppers
  – Slide gates
  – Pulverizers
  – Feeders

  • Expanded Electrical Systems
    – Generator with V-Curves
    – Exciter
    – Voltage Regulator
    – Synchronization Scope
    – Synchronization Key

• Specialized Heat Exchangers
  – Regenerative Air Preheaters
  – Feedwater heaters
  – Condenser

• Other Systems
  – Vibrations
  – Bearing temperatures
  – Lube oil systems
  – Feed water chemistry
  – Soot blowing
  – Emissions
Simulation Instructor Functions - Examples

Malfunctions

- Introduce equipment failures to test operator response. May be done in conjunction with TPM.

Trainee Performance Monitoring (TPM)

- Objective monitoring, evaluation and reporting of trainee performance using objective numerical scores
Project Execution

Stakeholders, project duration and data requirements
Typical DCS Project Timeline

- **PROJECT DEFINITION**: 4 MONTHS
- **CONTROL CONFIGURATION**: 3 MONTHS
- **HDWR/SFTWR TESTING**: 2 MONTHS
- **SHIPMENT/INSTALLATION**: 1 MONTH
- **SITE WORK**: 2 MONTHS
DCS Project Timeline with OTS Support

- 4 MONTHS: Project Definition
- 3.5 MONTHS: Control/Model Configuration
- 1.5 MONTHS: Software Testing
- 1.5 MONTHS: Shipment/Installation

- COMPLETE 1.5 MONTHS EARLIER
- MUCH FEWER ERRORS IN THE FIELD
OTS Project Stakeholders & Data Requirements

Client
- Project Manager
- Simulation Instructor(s)
- Process Engineer(s)
- Experienced Plant Operators
- Plant C&I Personnel

Schneider Electric
- Project Manager
- OTS Lead Engineer(s)
- OTS Model Engineer(s)
- Graphics Emulation Engineer(s)

Data Requirements
- Heat and Material balance
- Feed Analysis
- Process description
- P&IDs
- PFDs
- Control Narrative
- Equipment data sheets
- ESD configuration & logic
- DCS control configuration & graphics
References and Success stories

Proven track record
Over 850 Entries in Experience List

Control System Vendor

Yokogawa, 62
Siemens, 5
ABB, 44
Emerson, 71
GE, 24
Honeywell, 109
Rockwell, 22
OTHER, 73

Schneider Electric, 437

Industry

Power, 262
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Chemicals, 67
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Other, 73
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## Schneider Electric Simulation Background - Power

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<tr>
<td>• Riley</td>
<td>• Other</td>
<td>• IGCC</td>
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<tr>
<td>• Other</td>
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<td>• CFB</td>
<td>• Metso MaxDNA</td>
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### Invensys Simulators in Asia / Pacific

- **DVC Mejia - 500 MW** – BHEL drum boiler / BHEL turbine / BHEL maxDNA DCS
- **CGPL Mundra – 830 MW** – Doosan Supercritical Boiler / Toshiba turbine / Foxboro DCS
- **Adani Power Mundra – 660 MW** – Harbin supercritical boiler / DongFang turbine / Foxboro DCS
- **TPCIL Krishnapatnam – 660 MW** - Harbin supercritical boiler / DongFang turbine / Invensys Foxboro DCS
- **Reliance Sasan – 660 MW** – Shanghai Electric Company supercritical boiler & turbine / Foxboro DCS
Success Story: First Energy, OH (USA)

About the Client: SAMMIS Generating Station

- Unit 1-4 (180MW), Unit 5 (300MW), Unit 6-7 (600MW).
- Foxboro DCS.
- High-Fidelity Virtually Stimulated Operator Training Simulator
- Furnace Implosion study to verify Bechtel’s design for new booster fan system
- Upgraded existing simulator with Scrubber model.
- DCS checkout of the new controls using the simulator.

Extensive Benefits / Cost Analysis

- Identified relief damper sizing by running various implosion study scenarios.
- Identified numerous controls issues on the simulator saving startup time.
- Operator training and familiarization before unit commissioning.
- Per Bechtel: Just the electrical issues identified on the simulator paid for the simulator
- Tuned the controls on the simulator before putting on the unit.
Innovations in Operator Training Simulators

Immersive Virtual Reality Based Field Operator Training (EYESIM) and OTS on the Cloud (SimSci Online)
But What About Team Training?

Traditional Operator Training
Simulators train console operators in the control room.

What about Field Operators?
What about Maintenance staff?

Safety & Performance Depends on Teamwork
Immersive 3-D Field Operator Training Simulator

LOGIN Screens

DCS Console Screen and 3D World

Interactive Environment (Full Immersion Possible)

Augmented Reality

Score

Guided Steps

Training Courses and Record
Integrate EYESIM into OTS

One Platform – Many Applications

- Procedural Training
- Safety Scenarios
- Maintenance Planning / Training
- Hazop Design Evaluation
- Equipment Understanding
- Crew Training
SimSci Online: Simulation on the Cloud

We want a collaborative workspace

Content file version control in a central repository

We want the simulation system to be highly available for many years

Security is the driving principle of the platform design

Subscription based pricing packages

We want to design and train over a corporate network

We need simulation modelling software to be more affordable

Multi-tenancy. Intuitive client user management. Create user groups, control privileges on the fly

We want products that are easier to use and to maintain

Automated system health check and failure mitigation

DYNSIM Online
The power of Dynamic Simulation modeling is now web accessible on-demand, anytime, anywhere.
SimSci Online: More than VM Farm

Virtual Machines
- Choices of
  - CPU
  - RAM
  - DISKS

Applications
- Choices of
  - SimSci DYNSIM
  - Wonderware InTouch
  - Moodle
  - Excel
  - Foxboro

Networks
- Subnets
- Firewalls
- Gateways

Content Store with Version Control
- Core IP files used in the Application
  - Example: SimSci models
  - aaa*.s4m
  - bbb*.prz
  - *

Automation & System Health Failure Mitigation