Baseline Management Costs Reduced On Operator Training Systems With DeltaV SimulatePro

by Bill Sickinger
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Savannah River Site
Introduction

- Savannah River Site
- Dept of Energy – 50 yrs
- Aiken, SC
- 310 sq. mile site
Introduction

- Key U.S. Dept of Energy Nuclear Weapons Facility
- Current & Future Missions
  - Environmental Cleanup
  - Non-Proliferation
  - National Defense
- Annual Operating Contract - $2 Billion
- Approximately 11,000 employees
Who needs this?
If You Work Here
If You Work Here
Or If You Work at the DWPF
The DWPF Operator Training System
More SRS Operator Training Systems
Training System Not Development System

**Training Systems Must**
- freeze simulations;
- reset to predetermined plant states;
- replay predefined training scenarios;
- have remote trainer consoles;
- track results;

**Development Systems Must**
- Operate deterministically with real controllers;
- Actual dynamics with real I/O subsystems;
- Provide I/O simulation;
- Provide process Simulation;
Baseline Management Requirements

- Rigorous Configuration Management
- Extensive Verification & Testing
- Medium to large system configurations
Operator Training Requirements

- Individuals or large teams
- Emergency procedures
- Infrequently performed procedures
- Full Scale, Full Scope, Mock up control rooms
- Off-line procedure verification
- Multi-facility operator qualification program

Multi Facility?
Multi Facility/Area Transfer Training

Inter - Area Operator Training System (OTS)

Area simulation networks connected for Inter-Area transfer training scenarios.

Virtual Private Networks (VPN) over the site backbone eliminates the need for dedicated fiber optic connections.
Typical Baseline

- An example LWO production system baseline includes:
  - 5000 modules
  - 800 graphic items
  - I/O configuration

- Each requires an individual configuration item (CI) in CM
- Each requires specification, design, and verification
- There are six LWO operator training systems

The challenge…
The Challenge

- Minimize simulator code design, verification, and validation testing.
- Enable frequent updates
- Avoid import of many thousands of CIs
- Bypass rigors of CM
The Answer

- Require DCS vendors to maintain a one to one correspondence between production offerings and the virtual plant products.

- Developed low cost methods for frequent, easily performed, and quickly executed, direct transfers of the plant code to the OTS.
The Difference

- In 1992 - 8 engineers maintaining one training simulator.
- Now - six training simulators are maintained by four engineers.
- Redeployed 4 to LIMS, Cyber Security, Waste Characterization, Inventory Control, AMS, process support, information management, and many other engineering solutions.

How did we do it?

(Note: Statement by senior SRR subject matter experts.)
The Old Way

(Operator Training System)

Operator Console  Operator Console  Operator Console  Instructor Console  Simulator

OS-1 Graphics-Sim  OS-2 Graphics-Sim  OS-3 Graphics-Sim  Instructor Graphics  Control system & process Models (Hybrid)

CM for Training System
Simulator Configuration Items
Plant Design  Plant Verify  Plant Validate  Plant CM

(Production System)

Operator Console  Operator Console  Operator Console  Controllers  I/O

OS-1 Graphics  OS-2 Graphics  OS-3 Graphics  CM System For Process
Plant Configuration Items
Plant Design  Plant Verify  Plant Validate  Plant CM

The Process
The New Way

(Operator Training System)

Operator Console
- OS-1 Graphics
- OS-2 Graphics
- OS-3 Graphics

OPC Client
- (DeltaV) Virtual Controller

Instructor Graphics & Process Models Engine;

Process Simulator

CM for Training System
- Simulator Configuration Items
  - Plant Design
  - Plant Verify
  - Plant Validate
  - Plant CM

The Process

Plant Configuration Items
- Plant Design
- Plant Verify
- Plant Validate
- Plant CM

(Production System)
Bulk Transfer of Reusable Code:

- The Operator Training System servers and workstations are loaded with graphics and code gathered directly from the plant equipment.

- The I/O subsystem is replaced with an OPC interface to connect the controller logic to the process simulation.

- DeltaV Simulate Pro Multinode powers off-line virtual controllers on PCs.

Bulk Transfer?
The Basic Procedure – Bulk Transfer Plant to OTS

- Export the system configuration from the plant system to the fhx file.
- Unassign and delete all old modules in each plant area, at the virtual controllers.
- Import .fhx files into the OTS Virtual Controllers.
- Assign modules in each plant area, at the virtual controllers.
- Download the modules to each virtual controller.
- Add any process simulation changes that were made.
- Apply the DeltaV Simulate Conversion function.
The Basic Procedure – Bulk Transfer Plant to OTS

- Export the system configuration from the plant system to the fhx file including the:
  - Control Strategy.fhx
  - Alarm preferences.fhx
  - Name Sets.fhx
  - Engineering Units.fhx
  - Copy of PIC directory
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The Basic Procedure – Unassign All Modules
The Basic Procedure – Bulk Transfer Plant to OTS

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The Basic Procedure – Import .f hx files

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The Basic Procedure – Assign New Modules

DELTA V SYSTEM
  + Library
  + System Configuration
    + Recipes
    + Setup
    + Control Strategies
      + Unassigned I/O References
      + External Phases
      + ADAPT_MULTIPLE
        + AREA
          + TANK-101
  + Physical Network
  + Decommissioned Nodes
  + Control Network
    + CTRL1
    + RS3-NODE
    + USAUST-DOWETAIL
      + Batch Executive
      + Batch Historian
      + Continuous Historian
      + Campaign Manager
      + Assigned Modules
        + ADA_SREGION_1
        + ADA_SREGION_2
        + ADAPT
        + ADAPT_1
        + ADAPT_2
        + ADAPT_STICK01
        + ADAPT_STICK02

DELTA V EXPLORER
The Basic Procedure – Bulk Transfer Plant to OTS

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The Basic Procedure – Download New Modules

[Image of software interface showing module templates and download options]
The Basic Procedure – Bulk Transfer Plant to OTS

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The Basic Procedure – Attach Process Models
The Basic Procedure – Bulk Transfer Plant to OTS

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- Add any process simulation changes that were made.
- Apply the DeltaV Simulate Conversion function.

What is DeltaV Convert??
The Basic Procedure – Conversion Function

Simulate Conversion Command in DeltaV Explorer
The Noted Exceptions - FFB

- **Foundation Fieldbus configurations** provide a special challenge to the achievement of the direct import goal. Modules that contain Fieldbus function blocks such as DI, DO, AI, FFPIID, and AO will not run in the virtual controller.

- Emerson has provided a compensating utility, DeltaV Conversion Function, to mate Fieldbus logic modules to their OPC interfaces out of the box.
Conversion Function

How Does It Work??
Function blocks that have been assigned to Fieldbus devices are replaced with equivalent DeltaV blocks by the Convert Function.

I/O references are given a suitable data destination.

The block name, parameter values, and links to other blocks are preserved.
The Simulate Conversion command converts these blocks to the equivalent DeltaV function blocks.
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DeltaV Simulate Pro Simulate Conversion function

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DeltaV Simulate Pro Simulate Conversion function

The Simulate Conversion command converts these blocks to the equivalent DeltaV function blocks.
If an equivalent block does not exist, as is the case for the Foundation Fieldbus Multiplexed blocks, (FFMAI, FFMAO, FFMDI, FFMDO), composite blocks are substituted to support off-line simulation.
Composite Block Substitutes

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</tbody>
</table>

SIMULATE_IN1

#1
Enable simulation:
Sets the SIMULATE parameter to Enabled on all blocks;

Disable simulation:
Sets the SIMULATE parameter to Disable on all blocks;

Save – Save the current state of the simulation. Add a description. The file is stamped with the date and time.

Restore – Restore the simulation state from a saved state. This button opens a dialog from which you select a time and date to restore.

Real-Time Execution Multiplier Slider Bar – sets the execution rate for the simulation node.
The Bottom Line for an Easily Maintained OTS

- Use virtual I/O, not real I/O
- Use virtual controllers not actual controllers
- Maintain code purity, don’t use hybrid systems
- Load the virtual controllers and the mock control room equipment with direct transfers from the on-line system to the training system
- Build an easily managed, stand alone, process simulation; (The process simulation contains the only system CIs from CM)
Summary

- DeltaV Simulate gives virtual controller capability
- Plant code becomes reusable
- Design, Verification, and Baseline management tasks for the OTS are minimized (process simulation only)
- SRS experienced reduction of manpower requirements to ½+ over hybrid systems
Where To Get More Information

Thank You

Any Questions?

Reference:
Waste Solidification
DWPF, Saltstone, & 512-S
Training Simulator Technology
FSS-WSPC-2006-0015
The DeltaV Simulate Conversion function must be used to convert modules in the database so that Fieldbus blocks and I/O references can be simulated for operator training systems. The Simulate Pro Simulate Conversion function prepares an FHX file to be processed by the Process Simulation code.

1. Function blocks that have been assigned to Fieldbus devices are replaced with equivalent DeltaV blocks within the .fhx export file.

2. Parameters and function block expressions that perform I/O references are given a suitable data destination by the conversion function.

The block name, parameter values, and links to other blocks are preserved. If an equivalent block does not exist, as is the case for the Foundation Fieldbus Multiplexed blocks, (FFMAI, FFMAO, FFMDI, FFMDO), composite blocks are substituted to support off-line simulation.

Note: The Simulate Conversion function is a tested, automated, procedure, an official Emerson DeltaV utility being used all over the world. Under controlled conditions a very strong argument may be made that the resulting OPC simulation is a faithful representation of the original logic.
Some SRS systems use parameters and function block expressions that perform I/O references for *serial bus interfaces* to Modicon Quantum I/O and other serial communication devices. These interfaces may call for special solutions requiring simulator support code, augmentations to production system loads. Device Net and ASI Bus present the same problem.

The problem with serial interfaces is that most process simulation conversion utilities do not recognize the serial data points as I/O.
Notes: Case Study in Serial Bus

SRS connected banks of Quantum I/O to a DeltaV DCS.

On import of the field control strategy it was discovered that the hundreds of device parameters could not be accessed by the process simulation OPC interface.

For each serial interface I/O value the import utility reported unresolved references errors.

Giving each external I/O reference a floating point value allowed connection to the OPC interface of the process simulator.

This operation had to be performed for hundreds of values each time the code was brought from the plant.

What to do?