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Operator Training Simulation Implementation

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Having proactively tracked operator performance since 2004, DuPont began to notice a clear trend developing a few years ago. Their operator performance was declining—an issue that coincided with an increasing number of their operators having less than three years of experience.

Recognizing the need to improve their operator training methods, DuPont set out to create an operator training simulation (OTS) system that combined the capabilities of the company's proprietary simulation technology with Siemens SIMIT simulation software to capture experienced workers' knowledge and better prepare their operators to deal with events. DuPont™ TMODS uses chemical engineering principles to simulate real-life operating chemical plants and connects to an offline DCS for process configuration development, assessment and training.

The ongoing development of this combined system was highlighted for attendees of Siemens Automation Summit 2018. Ramesh Kommu and Ariel O. Vargas of DuPont's Sabine River Works plant in Orange, Texas, shared details of how this project is being piloted in Sabine so that it can be rolled out to other plants.

"Our objective with this OTS is to be able to provide three to five years' worth of operator experience in two to three weeks," said Vargas. "We want this system to serve as both refresher training for rare events and as a way to assess control changes prior to live system download (of those changes)."

The roadmap DuPont created for the ongoing development of this OTS begins with a pre-work stage that combines the conceptualization for what will be needed from the model and the hardware setup for OTS. This stage is used to describe training scenarios, define the scope of the simulation, determine which areas and units need to be simulated, agree on the fidelity degree of the OTS, and determine what kind of hardware will be needed to create a successful system.

Addressing the coordination of DuPont™ TMODS with SIMIT in this pre-work stage, Kommu noted that, despite the depth of detail offered by DuPont™ TMODS (i.e., its high-fidelity models accurately match actual plant behavior), they didn't want to simulate the entire plant. Instead, they decided to focus on three core areas relevant to the development of the OTS. They separated the simulation model into the reactor model, the back model, and the front model with a bridge model to connect the three.

With the ability to divide a plant into specific areas of operation, Kommu said that smaller models were placed in SIMIT, allowing for the use of DuPont™ TMODS models to develop the events on which operators will be trained. "We combine them—SIMIT

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and DuPont™ TMODS—to develop the complete operator training station," he said.

Following the pre-work stage, model development and OTS hardware setup took place concurrently.

The principal work of the simulation setup for this project at the Sabine plant "involved use of SIMIT based on the actual SIMATIC PCS 7 project we completed for our autoclave operation, with process modeling done in DuPont™ TMODS," said Kommu. DuPont's OTS uses SIMIT for simulation of signals, devices and plant response; input and output simulation of test signals for an automation controller; and testing and commissioning automation software.

The hardware included an HP ProLiant DL380 server for the VMware ESXi server host, a Siemens SCALANCE XR324-4M switch, a Siemens SIMIT Virtual Controller Dongle, an AnywhereUSB Box for USB-to-Ethernet connections, and several thin clients.

With the model and hardware setup complete, the OTS work turned to the communication setup, training scenario development and turnover for actual use in operator training.

Kommu said that all control outputs and setpoints come from a Siemens WinCC OPC server. Process variables are passed from DuPont™ TMODSto PCS 7 via OPC, with SIMIT acting as a gateway. Virtual controller couplings are used for transferring data to/from PCS 7 inputs and outputs in SIMIT, while an OPC server coupling is used for communication of values between SIMIT and DuPont™ TMODS.

"The virtual controller is very easy to set up and use. Exporting the hardware configuration from devices and importing them into SIMIT means that, when you start simulations, you don't have to start the virtual controller manually; or when you activate the play button, the virtual controller will be started too," said Vargas. "Likewise, when you shut the simulation down, all controllers will be closed."

In the DuPont™ TMODS SIMIT Switch visualization created by DuPont, separate charts show how signals can pass in and out of the model via SIMIT. DuPont uses this to test the transfer of data between devices, simulation systems and couplings.

For training scenario development process, Kommu said the idea is to determine and describe process events in which an operator action can have a critical impact. Such as:
• Plant shutdowns/startups;
• Loss of a hyper compressor;
• Deviations on a reactor pressure interlock; and
• Deviations in feeds from one extruder to the other.

"Training scenarios can be tricky, so we first have to determine what kinds of events to focus on," said Vargas. "Then we decide how to tackle the models for them."

To showcase an OTS example used at DuPont to test operator reactions, Vargas and Kommu walked Siemens Automation Summit attendees through the creation of an OTS representing the loss of a refrigeration machine due to an unexpected shutdown. "The correct operator response to this situation requires restarting an auxiliary refrigerator to maintain temperature," said Vargas.

Creating this scenario, Vargas said, "You have to think about what you want the trainee to see. With this in mind, we don't simulate everything—just what we want the operator to focus on. Even though the screen the operator sees in the OTS is a simulation of the screen they would actually see on the plant floor, we gray out areas that the operator should not focus on. Only the controls for the refrigeration system appear in color."

To test operator response, DuPont can manipulate the refrigeration machine factors—such as its temperature or its controllers—while the simulation is being conducted with the operator in training.

"DuPont™ TMODS allows us to save machine operation states so we can start with whatever state we choose for the simulation," said Vargas. "We can grade operators on their reactions, too. We do this by first capturing expert operators' reactions to these scenarios to set a baseline. This incentivizes the operators in training to work toward getting a better score as they continue their training."

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Order No.:CHAR-00118-0918