

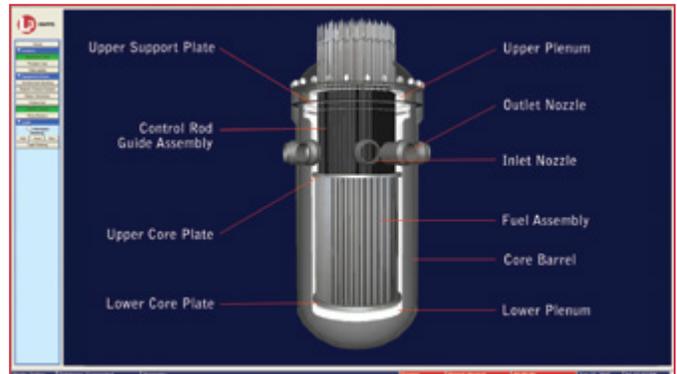
Full scope nuclear power plant simulators have become highly detailed and accurate training devices, serving as a cornerstone for operator training. While the simulator has been used mostly for procedural-based training, the amount of data can seem overwhelming to early learners (users trying to understand how systems work and what happens during transients). For this reason, L-3 MAPPS introduced Learning Simulators designed to bridge the gap between fundamentals training and operator training on full scope simulators. With Learning Simulators, L-3 MAPPS capitalizes on the use of the detailed and accurate models in full scope simulators, but instead of focusing on the step-by-step operational aspects, provides an environment designed to facilitate understanding of the plant's behavior.

The Learning Simulator

The Learning Simulator has been designed to assist teaching and learning of major plant transients and the associated power plant systems and behavior, by coupling 2-D and 3-D interactive graphic visualization with high-fidelity simulation. Focused primarily on Nuclear Steam Supply Systems (NSSS), the goal is to increase the student's understanding and retention of system behavior and major plant events by capitalizing on crucial teaching principles such as "seeing is understanding" and "interacting helps remember."

Understanding the NSSS Layout

The first user interface presented by the Learning Simulator is that of the containment building, populated to scale with the major components of the reactor, reactor coolant system and the emergency core cooling systems, where geometry and system layout affect their behavior. This 3-D view helps users understand the system's spatial orientation and geometry. Users can even look inside the equipment to see equipment internals and can turn on and off labels naming the various equipment or components. Understanding how the equipment and the system are built and laid out is the first step to understanding how the system works.



Inspecting the Reactor Vessel

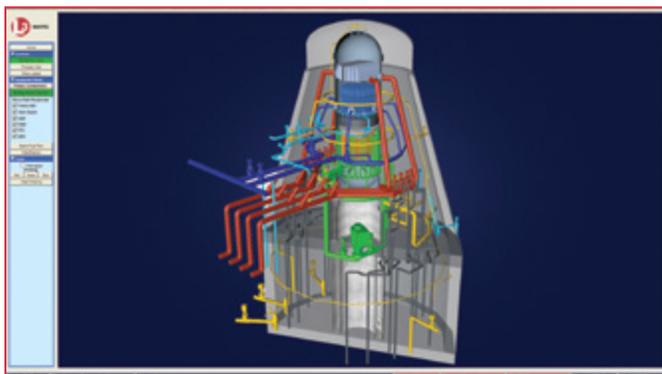
The same 3-D models are then used to show and explain the equipment and system's behavior with the help of high-fidelity simulation.

A New Way of Looking at Simulation

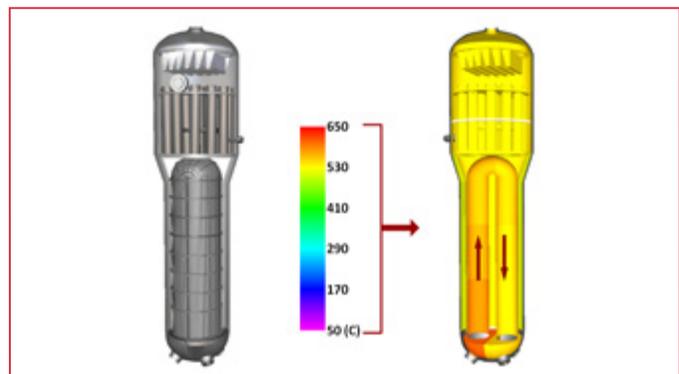
The Learning Simulator takes simulator-calculated nodal properties such as temperature, pressure and void fraction, and displays them within 3-D models of the plant piping and equipment using color maps. As system properties change, colors change accordingly, translating simulator data into colors on-the-fly. Dynamic, simulator-driven 3-D visualization provides a new way of looking at a system's behavior by presenting a comprehensive graphical representation of the complete system's state. Capitalizing on the concept of "Seeing is understanding," the Learning Simulator converts thousands of data points into a simple, easy to understand dynamic image. The Learning Simulator's 3-D models differ from ordinary static images or video animations by providing control to the user, who can interact with them at will by panning, zooming and rotating the models, or choosing what to look at, such as which physical property is displayed, focusing on particular parts of the system, etc.



Equipment Layout in a PWR Containment Building



Equipment Layout in a BWR Primary Containment Building



Displaying Real-time Simulator Data with Dynamic Colors



While the dynamic 3-D models present a dynamic yet instantaneous snapshot of the system's properties, the Learning Simulator's Analysis Screen completes the picture by providing additional engineering information on a 2-D representation of the system as well as pre-defined or user-defined plots to understand the evolution of the system's properties and behavior.



Learning Simulator Windows: Analysis Screen (left) and Interactive 3-D Visualization (right)

Real-time or Scenario-based Learning Simulator

The Real-time Learning Simulator reads data calculated by a connected simulator and displays it in real-time. This enables users to immediately observe the consequences of actions taken on the simulator, such as panel operations or the injection of malfunctions. Users can therefore continue to use existing simulator tools like automated scenarios or virtual panels in Orchid® Instructor Station while taking advantage of the Learning Simulator's unique method of displaying information.

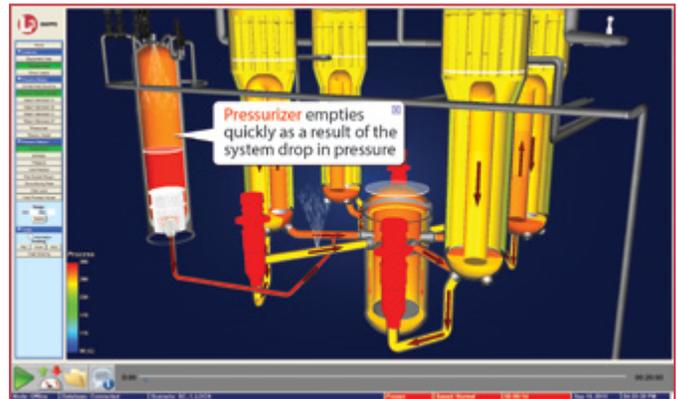
The Scenario-based Learning Simulator provides the same interactive visualization features as the Real-time Learning Simulator but without the need to be connected to a running simulation. Instead, the tool loads and replays previously recorded data, mimicking a real-time simulation. Users therefore have a choice of pre-defined scenarios to work with and have control over the scenario playback. Users can control the playback speed and can move freely back and forth within the scenario, allowing them to focus on any region that requires more time to be fully understood.

Dynamic Instructional Material

While the tool allows student to go through pre-recorded scenarios without the need for an instructor present, it allows instructors to guide the learning session by programming instructional material that explains to the student what is happening during the scenario of interest. This is crucial not only to ensure that the students recognize and understand what is happening in the transient, but also to ensure that their attention is focused on the right parts of the system at the right time.

The instructional material is provided in the form of captions which appear during the scenario directly on the 3-D model to direct the student's attention to particular areas and to explain what is happening. When setting up the instructional material, instructors can choose where a caption appears, what text

it contains, when it appears and for how long it is visible. Since the 3-D model is interactive, the user could be looking at the reactor vessel pressure when something important is happening to the steam generator temperature. Therefore, it is also possible to choose in which view the caption appears and which physical property to display during the caption.



Instructional Captions pop up during Pre-recorded Scenarios

Additionally, users can access further instructional material in the form of downloadable documents. These online documents explain each scenario in detail to support the overall learning experience.

One Tool, Many Uses

The Learning Simulator can be used in a classroom environment for instructor-led sessions, providing great visual support to complex concepts the instructor is trying to convey. But it can also be used outside the control room for individual student learning sessions, giving students the ability to focus on personal areas of difficulty and adapt the learning pace to their personal needs.

Aside from classroom learning-related activities, the Learning Simulator also a very valuable tool for operator training. In the full scope simulator or a glass-top virtual control room environment, the Learning Simulator adds a new dimension to operator training by actually showing operators the consequences of their actions. The tool helps develop an understanding of operations to complement and enhance traditional procedure-based training.

Enhance Your Training Program Today

For more information on L-3 MAPPS's Learning Simulators or for a detailed proposal addressing your specific needs, please contact us by email at power.mapps@L-3com.com.



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