SIMULATION IMPROVES OPERATOR TRAINING ARTICLE FOR SEP/OCT 2011 INTECH

Table of Contents teaser: Although simulation is the best training method for preventing accidents and improving process control, until recently it has been prohibitively expensive for many plants. However, today’s low cost, high quality PC-based simulators make simulation training affordable for both new and experienced operators at all types of facilities.

Fast Forward Bullet Points:

- Process simulation enables actual unit operation problems to be depicted, and common and unique events can be recreated
- Simulators can be sped up or slowed down to build upon existing skills and boost operator confidence
- Observation of operator actions can be used to improve process operations and Human Machine Interface (HMI) screen designs

Resource Box:


Image 1, Process plant overview. Large process plants require well trained operators, and simulation is one of the primary tools for bringing operators up to speed.

Image 2, View of operators in a control room. Simulation training can be used to train new operators quickly and to cross train experienced operators, improving staffing flexibility and operator confidence.

Image 3. Operating training simulation is typically performed with two PCs, one to operate and process and the second to mimic actual plant operations.

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Simulation Improves Operator Training

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PC-based simulation cuts operator training costs while yielding superior results as compared to other training methods

Humans are visual creatures who learn more by seeing how something works than by just reading about it. Further learning improvements result by actually performing the tasks at hand. That’s why process plant operator training through simulation is practiced throughout the industry, albeit with varying degrees of success.

Simulation training is vital for preventing incidents and accidents. It also improves process control, resulting in higher throughput and quality with less downtime. Maintenance is reduced because equipment is operated closer to specifications.

In addition to immediate costs, operator errors and subsequent incidences can result in fines or even jail time for plant managers in some industries. These occurrences can be minimized or eliminated with the right training plan and equipment, of which off-line process simulation is a key component.

Why Simulate?

To understand the value of operator training through simulation, let’s rewind a couple of years. Remember your first day in the plant? There was a multitude of pipes, tanks, smells and equipment you hadn’t seen before—at least not in these particular configurations.

You went to the control room where you were promptly overwhelmed by the instruments covering the wall, for those old enough to remember panel boards, or by computer monitors showing myriad colored objects on their screens.

Your new plant personnel feel the same way; even more so with fewer mentors available now and more pressure to learn quickly combined with a lower tolerance for mistakes. Simulation training helps plant managers meet these demands and operators come up to speed quickly.

When process simulators were introduced in the early days of the Distributed Control System (DCS), they required extensive software engineering just to get their screens to look like the ones operators were using. Much more time was required to simulate the process itself, in addition to a very high level of process knowledge.

Simulator programming typically was done in UNIX, requiring personnel with special skill sets to program and maintain the simulator. If this sounds expensive, it was. Typically nuclear power plants and refineries, where simulation capability was absolutely critical to prevent incidents, were the only industries that could justify these costs.

The arrival of PC-based simulation has made simulation training affordable to a multitude of industries, and level of such training can be adjusted to meet the budget and the level of simulation requirements.

Levels of Simulation

Low fidelity, medium fidelity and high fidelity define the three levels of PC-based simulation. These terms loosely describe how close the simulated plant’s process and equipment responses are to the actual plant.

Let’s start with the basic process simulator that’s generally part of the engineering configuration software supplied with the control system, particularly with a higher-end process plant DCS. Basic process simulators provide software loop tie backs in which the output of a loop is taken back into the input through software in a virtual environment. This creates basic loop responses that give operators a fundamental feel for loop control, screen navigation and responses. Simulating more sophisticated loops isn’t feasible with this type of software.
The next level of simulation uses two PCs, one running the control software program, and the second supplying process simulation responses; the two PCs typically communicate via Ethernet. Sophisticated and realistic process dynamics now become an integral part of the simulation. Sizing of vessels, stroking times of a valve and dynamics of the process can be entered and adjusted. The properties of the process unit in the simulator PC can be adapted to include process noise, making the simulation more realistic.

This type of simulation isn’t meant to replicate exact plant processes, but can be modified on a tag-by-tag basis to yield required response levels. It can also be expanded to cover the entire plant.

The top level of the process simulation hierarchy is the high fidelity simulator. It can precisely replicate the process dynamics for every piece of equipment in the plant. If operator training simulation must closely mimic the actions of the process unit or plant, this is the route to take. Several types of industries require this level of simulation, and many others could benefit.

A well-designed, implemented and operated process simulation training program will provide many benefits as detailed in Table 1 and as described below.

1. Provides the least expensive operator training method
   
   The introduction of PC-based simulation into the process control industry made simulation training affordable. The PC hardware is inexpensive, and graphical programming methods created for the Windows operating system now enable plant personnel, instead of IT experts, to program and configure the simulator. Operators can now be trained on-site in smaller time blocks, instead of being sent to training classes at distant locations.

2. Improves quality of operator response and subsequent actions
   
   The process simulator can create scenarios that depict actual unit operation problems. Common and unique events can be recreated so that the operators’ responses can be seen and recorded. Senior operators’ responses can be used to establish best practices for less experienced personnel. Once best practices are established, the training system can be used to measure improvement.

3. Improves operator response time to process upsets and incidents
   
   A process simulator can be set up to quickly change process operating conditions. Snapshots of the process running in specific conditions can be taken for instruction. Perhaps one operator needs to practice changing product grades on a static state process, but another needs to works on unit startup. PC-based simulation allows easy implementation of these scenarios.

4. Offers the fastest practical operator training method, particularly for inexperienced personnel
   
   With fewer experienced operators available to train new operators, simulation training can provide invaluable instruction to fill the training gap. Simulators can be sped up or slowed down. For a process with a large amount of dead time, the simulator can be sped up to compensate for the delay. For training of inexperienced operators, actual process conditions can be slowed to build confidence, and then gradually sped up.

5. Helps meet regulatory requirements
In general, the higher the potential environmental and safety impact, the more oversight involved from government agencies, with corresponding increases in required training. Process simulation training provides the extensive instruction and detailed training records required to meet regulatory standards.

6. Can be a mitigating factor in an incident does occur

In addition to direct costs, operator errors and subsequent incidences can result in fines or even jail time for the plant managers in some industries. If an accident does occur, simulation training programs and related records can be a mitigating factor to show the plant took precautions and performed due diligence.

7. Often leads to process improvements including increased uptime, more throughput and higher quality

Taking training a step further, observation of operator actions can be used to better the actual process control programs and the HMI screen designs. This can further enhance operator actions, reducing the possibility of incidences and improving general plant operation and output quality.

Implementation Challenges

Although PC-based process simulation for operator training provides affordable, tangible benefits, there are challenges to implementation (Table 2):

1. A simulator that must mimic actual plant operations is more expensive

All expenditures have an associated cost/benefit ratio, and operator training simulation is no different. Plant management must decide how closely the simulator needs to mimic the exact operation of the process because this is the primary cost driver. The closer the simulation to the actual response of the heat exchangers, reactors, process/product pressures and viscosities; the higher the cost, but the greater the potential benefit.

2. Simulator programming must integrated with existing systems and be kept up to date with changes

Once the right level of operator training simulation is selected and implemented, a common point of failure is a lack of ownership or assigned responsibility. Although today’s graphical software is much easier to use, simulation software must still be integrated with existing plant automation systems. Furthermore, every process undergoes changes as do most simulation software packages, and someone has to be the champion and own and implement these changes.

3. A regular training program must be instituted and followed, preferably with some type of certification

Before simulation can be incorporated into operator training, the training program itself should be examined. Operator training should revolve around certification and benchmarking. Certification verifies that specific skill sets have been met, and benchmarking creates best practices.

4. Time and money must be allocated for on-going operator training

The operator training simulation must have a champion who is supported by upper management. If it doesn’t, it will fall out of use, and the last thing any plant wants is an investment gathering dust. Horror stories abound about plants spending large amounts of money on a process simulator that
isn’t used anymore. That’s not a failure of operator training simulation failure, but rather a failure of plant training and operating procedures.

**From Theory to Practice**

The military and the airline industry have been using simulators for decades. They understand the value of first experiencing situations in a virtual environment before being plunged into reality. The goal is to get the trainee as close to the real world as possible. This is accomplished by training individuals so that if and when they experience a worst case scenario in real life, they have already implemented the solution via simulation. This gears trainees for success.

Experienced operators are retiring at many process plants, and new personnel must become competent quickly. Fewer experienced operators mean fewer opportunities to spread plant and process knowledge than in the past. This can lead to unscheduled shutdowns, costing millions of dollars. Shutdowns can also bring fines, plus unwanted government and media attention.

To ameliorate this situation, an on-going operator training simulation program that challenges operators, both new and experienced, should be considered. The results will speak for themselves as a process simulator allows competencies to be established in months, not years. Moreover, experienced operators can be trained in new processes, creating the ability to operate with a leaner staff. A smoother running process translates into a more profitable plant, yielding a quick payback on the simulation system investment.

No plant can risk training operators on actual equipment, but a good plant simulator will have the look and feel of the actual process, expediting the training of new and experienced operators without jeopardizing actual operations. The closer to the actual look and feel of the actual process, the more prepared operators will be when monitoring and controlling that process.

Often overlooked are the morale dividends created by investing in employee training. The time and expense involved with training on a process simulator isn’t lost on the plant employees as they know it’s an investment in their future, as well as the future of the facility where they work.

**Table 1: Benefits of Simulation for Operator Training**

1. Provides the least expensive operator, most life-like training method
2. Improves operator response time to process upsets and incidents
3. Improves quality of operator response and subsequent action
4. Offers the fastest practical operator training method, particularly for inexperienced personnel
5. Often leads to process improvement including increased uptime, more throughput and higher output quality
6. Creates better trained personnel to enable operations with a leaner staff
7. Can be used to meet regulatory requirements
8. As part of a comprehensive training program, can be a mitigating factor if an incident does occur

**Table 2: Challenges of Simulation for Operator Training**

1. The closer the simulator is to mimicking actual plant operations, the more expensive it becomes

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2. Simulation software must be integrated with existing plant automation systems, and it must change along with these systems and other varying conditions.

3. A regular training program must be instituted and followed, preferably with some type of certification.

4. Time and money must be allocated for ongoing operator training.