Affordable Web-Based Process Training To Improve Operator Effectiveness

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BACKGROUND

Many midstream executives today recognize that a source of great competitive advantage is the know-how their people possess. The ability to leverage a company's knowledge across its current and future employee base is often the difference between a successful company and a mediocre one. Today, some companies are deploying knowledge management systems to assess, capture, manage and leverage their company's information and core competence. These systems capture and disseminate company knowledge and can provide a basis to define and establish best practices. They have also proven to be successful strategies for providing education and job training.

Gas plants, like the commodities they manufacture, are often viewed today like commodities that can be bought and sold. While midstream assets are bought and sold on a seemingly weekly basis, the impact on the people who support and manage these assets has been dramatic. As a result of the consolidation and increased employment risk, many experienced operations personnel have left the process industries, pursued careers in other companies, or chosen to retire. In certain geographic regions, many of the operations personnel have remained, yet many of them will retire over the next three to five years. These demographic realities pose some serious challenges in keeping midstream operations running effectively, reliably, and safely. Ensuring operators are properly trained or training new operators to replace the experienced work force will be daunting.

Given the competitive nature of the industry, midstream companies have focused on reducing their fixed and variable costs, improving the efficiency of their assets, and improving the productivity of their workforce. As a result, the amount of operations personnel on shift has been reduced. In addition, internal training resources and the infrastructure that was once common in many companies have basically

disappeared. Many health, safety and environmental departments have been reduced to small or one man teams of professionals who have multiple roles, manage a large volume of administrative duties, and spend their remaining time auditing and validating compliance with required regulations. The role of operations training has been, for the most part, delegated to the site.

CURRENT PRACTICES

When there is a need to train a new operator or certify that an operator has the understanding and experience needed, the responsibility usually falls on the plant or operations manager and superintendent. Today, the most common operator training practices include:

- Learning the needed skills through on-the-job experience
- Spending a considerable amount of time on shift with an experienced operator to absorb as much knowledge of the plant and routine procedures through observation
- Reviewing process documentation including operational and maintenance activities and procedures, process safety information, piping and instrumentation diagrams, etc.
- Attending formal classroom instruction
- Subjectively validating, approving or certifying that operators possess sufficient knowledge

While all of these practices are necessary and even required to achieve a minimal level of training and knowledge, there are some serious weaknesses in limiting one's operator training practices to those listed above. Relying upon on-the-job training is risky and experience is usually achieved on a trial and error basis. Spending time with an experienced operator is valuable and can accelerate an operator's learning curve. However, new operators glean both good and bad habits or accept assumptions that may not be accurate. In addition, experienced operators may lack formal training skills needed to train a new employee in their job. Formal classroom training is excellent but a student may not retain the knowledge learned unless they apply it shortly thereafter.

Under OSHA 1910, gas plants are required to write and maintain operating procedures for each process unit. The focus or emphasis of these requirements are to inform operators or contractors on the specific safety and health hazards of the process, emergency operations including shutdown, and other safe work practices that apply to an employee's job tasks. These regulatory requirements have been a great benefit in helping operators understand critical tasks and procedures needed to operate gas plants. However, effectively troubleshooting many plant problems, or optimizing plant operations, requires process knowledge

and in-depth understanding of process parameter relationships that are not learned through task-based procedures.

Driven by the need within the industry, RWD Technologies and eSimulation have developed a suite of comprehensive courses, delivered through a learning management platform, to train new and experienced operators. The courses are highly interactive and are deployed over the internet to enable a self-paced approach to learning. The objectives of each course are to instill an in-depth process understanding and provide methods and skills needed to effectively troubleshoot and optimize plant processes.

OPERATOR LEARNING MODEL

Based on a comprehensive assessment and ongoing survey of operators across the process industries, a learning model (Figure 1) was developed by RWD Technologies that describes the learning curve or hierarchy of knowledge or skills operators possess. The assessment survey results were used to characterize the average operator competence and statistical distribution across this competency or learning model. The diagram below illustrates the range of operator competency and distribution of operator results from the survey.

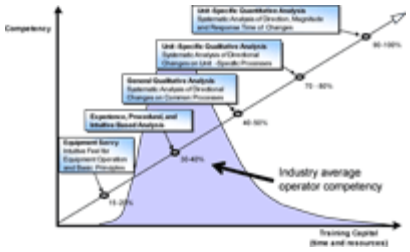


figure 1

Based on current training practices deployed across the process industries, almost all operators possess a working knowledge of equipment operation and understand basic process principles critical for plant operations as characterized by the 15-20% competency level of the competency learning curve. As mandated by OSHA, the average operator demonstrated an understanding of task-based operational procedures including startup and shutdown procedures, as characterized by the 30-40% range. It should be noted that the average operator attested to some basic operator training and often possessed many years of experience. From these findings, one can conclude that the average operator have sufficient skills to operate plants effectively.

The most significant finding in the assessment results was the fact that few operators demonstrated a qualitative or quantitative, analytical understanding of process parameter interaction characterized by the 40-50% and 70-80% competency level of the learning curve. Therefore, when it comes to operating plants in an efficient manner, or recognizing the root cause of an operational problem, the average operator lacks some critical skills and understanding. As current training practices and on-the-job experience may be insufficient to develop the level of understanding needed, different training methods must be considered. While some speculate that automatic control systems have added to this situation, it is clear that more process-focused training is critical to help operators develop troubleshooting and optimization skills and apply them.

There are a number of solutions that can be deployed to help operators develop troubleshooting and process optimization skills. Some companies hire specialists to perform individual training workshops at their sites to improve operator competence. Others send their operators to weekly classes or training courses with formal exams to certify their operators understand the material. Some even build rigorous, dynamic training models and require their operators to spend a number of hours on the simulator before they are allowed to operate the plant. All of these training methods are good but can be very expensive. RWD Technologies and eSimulation, Inc. have developed a suite of web-based, generic courses to address this need called eSim-Trainer℠.

eSIM-TRAINER

eSim-Trainer℠ is the name for a collection of hosted Web-based modules that assist in the training and certification of operators and engineers for the midstream industry. Interactive learning techniques are inherent in the eSim-Trainer design, making this a powerful "hands on" training tool to enable skill building, accelerate competency, and mastery of complex technical knowledge and decision-making capabilities. The objective of these courses is to enable operators to approach the 70-80% competence level on the Operator Learning Curve. Currently offered for the midstream industry are generic courses for cryogenic plants, fractionation plants, cryogenic plants with fractionation, and refrigeration plants (dew point plants).

These generic courses are ideally designed for operators and engineers who have a basic understanding of controls and instrumentation operation, are familiar with gas plant systems, equipment and processes, and have experience as an operator or operations engineering supervisor. A pre-assessment exam is given at the beginning of the courses to identify the knowledge or skills a student has in order to determine what aspects of the course would be the greatest benefit to the participant.

Each eSim-Trainer course consists of a set of self-paced learning modules. As each module is completed, the student's knowledge and skills are improved as they go through them. Student self-checks are embedded throughout the learning modules and formal testing is provided in support of a certification approach. Each course can be viewed as a training program, when it is taken in its entirety for a particular technology or plant. The courses are modularized and allow students to complete the training at their own pace and at times that are convenient for them. The primary delivery mechanism is the Internet, supported 24x7. All students need to launch eSim-Trainer is a Web browser and access to the Internet.

The student uses a browser to view all course information, complete interactive exercises, take knowledge reviews, complete what-if and troubleshooting exercises, and complete the final exam. The course is asynchronous, allowing users to start and finish at their own pace. Both linear and open navigation are used to accommodate both students who need a sequential presentation and learners who prefer to select their own path through the course content. For example, linear navigation requires that the student complete each module in the course before moving on to the next module. A tracking function, called a bookmark, gives students an "at-a-glance" view of their progress in the course. Knowledge checks give periodic feedback to the learner on their mastery of individual topics. An indicator marks each of the sections that the learner has completed.

The complexity and difficulty of each module increases throughout the course. As the student completes each module, a minimum level of understanding or grade can be established before proceeding to the next module. Each course is organized into five modules:

- Overview of the plant
- Operational analysis tools and methods
- Plant unit operations and fundamental concepts
- Plant operations and controls
- Plant process troubleshooting and optimization

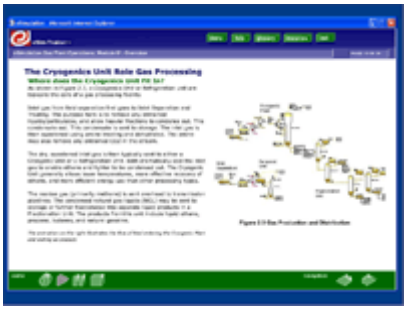
EXAMPLES AND EXERCISES

There are a number of methods and learning techniques deployed by eSim-Trainer to improve operator effectiveness. What follows are some simple examples from the cryogenic plant course that demonstrate some of the techniques, exercises and methods used by eSim-Trainer.

Process Overview and Knowledge Check Example

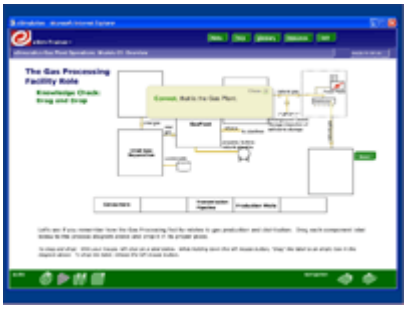
eSim-Trainer provides high level process overviews that help the student understand the typical gas processing supply chain, the process objectives of unit operations, and where the gas plant is located in reference to production and distribution. As the learner navigates the course, knowledge checks are embedded throughout the course to reinforce knowledge retention.

Figure 2



After the process overview is introduced, an interactive graphic (Figure 3) is introduced as a knowledge check where the participant is asked to label the process overview. As the student labels the process overview diagram, eSim-Trainer provides immediate corrective feedback that reinforces whether the student has labeled the diagram correctly.

Figure 3

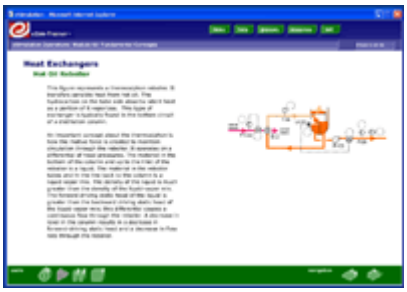


This exercise deploys a drag and drop method to actively engage the student, which adds to the effectiveness of the learning experience.

Introducing a Fundamental Concept and related What-If Exercise

eSim-Trainer recognizes the importance of educating operators on fundamental process concepts that aide in building logical understand of key parameter interactions. The following example (Figure 4) introduces the hot oil, thermosiphon reboiler, a common piece of equipment on a demethanizer column.

Figure 4

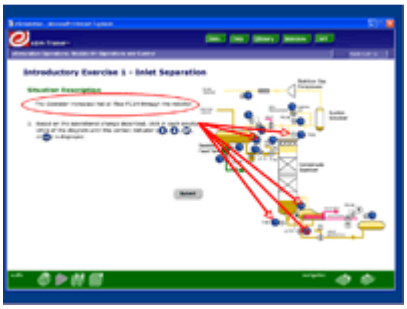


Course content and supporting knowledge checks help the student recognize fundamental process interactions associated with process heat and material balances. Process interactions between a hot oil reboiler's key process parameters like feed rate, temperature, pressure and composition, etc. are discussed. Later, the student is asked to indicate how changes to these process parameters affect other process conditions.

While simple to more complex What-If examples reinforce the learner's understanding, supporting knowledge checks help validate their understanding and provide feedback to the correct response. What-If exercises are further enhanced through the lack or addition of various temperature, pressure and feed flow control schemes.

Below (Figure 5) is an example of a What-If exercise that asks the students to identify directional changes and account for process interactions, given an increase in hot oil flow.

Figure 5



As fundamental process concepts or building blocks are understood, they are further reinforced and leveraged with more complex examples, as the process scope is expanded. In later course modules, the student is presented with more complex systems. While the number of process interactions increase significantly, the student is able to build on the knowledge learned earlier because they understand how parameter changes among component pieces interact.

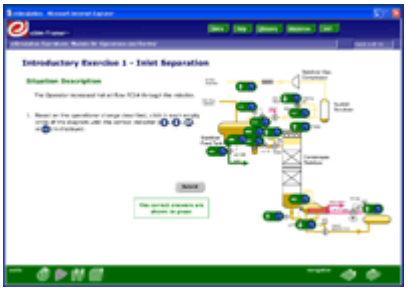


Figure 6

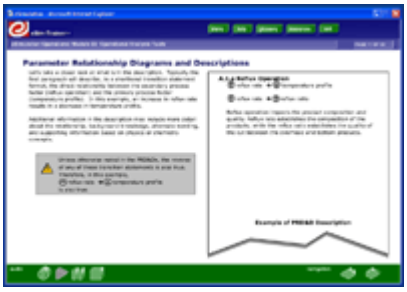
At the completion of the What-If exercise, knowledge checks are presented (Figure 6) to the student to give comparison/contrast feedback which allows the student's to evaluate their responses in light of the correct response.

Troubleshooting Exercises

While What-If exercises may be simple to complex system training drills that challenge students to apply their knowledge and understanding of process parameter interactions, Troubleshooting exercise are quite different. A Troubleshooting exercise tests a student's knowledge of the root cause and affects of parameter changes or interactions. For example, a student is presented a problem where several variables have changed, a control scheme is in place, and the demethanizer column pressure is rising resulting in poor recoveries. Much like a doctor diagnoses a disease or illness to recommend treatment, the student has to evaluate the process conditions and determine what has caused the problem and what is needed to improve the situation.

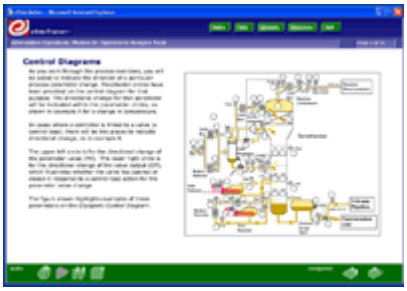
Parameter Relationship Diagrams and Descriptions (PRD&D)

Another analytical tool or methodology used in the course is the PRD&D (Figure 7). This tool describes how parameters react to changes in one or more parameter. As the student is able to logically relate directional changes among process parameters, this knowledge can be applied to troubleshoot process problems and optimizing unit operation.

Figure 7 

Control Diagram

Another analytical tool utilized to visualize and represent process equipment, controls and instruments needed to perform exercises, visualize process conditions, and teach process and control concepts is the Control Diagram (Figure 8). Below is an example of a Control Diagram for the liquid recovery section of a Cryogenic Control Diagram.

Figure 8 

Post-Assessment and Certification

eSim-Trainer performs pre- and post-assessments to measure a student's knowledge base and measure their ability to apply course concepts proficiently. Each course module contains post assessments or exams that grade the learner to ensure they grasp critical concepts before moving on to a more challenging and in-depth modules. Module progress, assessment results and certification are tracked and can be reviewed by the student and course administrator, as required.

BENEFITS OF eSIM-TRAINER

There are many benefits that can be accomplished through the deployment of eSim-Trainer. The most important benefit is reducing the instances of inappropriate operator responses that operators may execute routinely. While these occurrences are often not measured or identified, they may have a significant impact to the bottom line. A summary of benefits are detailed below:

Training Benefits:

- Provides a means to measure operations competence (one cannot improve something you do not measure)
- Increases time-to-competency and shortens time to achieve on-the-job effectiveness
- Improves training productivity by taking "free time" whenever that occurs at any time of day or night
- Ensure more effective learning through structured interactive content and exercises specifically targeted for operators and engineers
- Provide sound learning objectives and embedded knowledge checks give constant feedback
- Offer extremely effective and highly technical training that will enhance the competency of your best and more experienced operators – raise operators to a competence level greater than 30-40% on the competence curve
- Deliver a convenient and practical self-paced course available 24x7 via the Internet

Regulatory and HSE Benefits:

- Support OSHA/PSM regulatory requirements
- Provides a means to certify and track operator progress
- Improve the ability to avoid accidents and environmental incidents

Business Benefits:

- Increases profitability by giving operators knowledge, skills and decision-making tools to avoid problems
- Improves optimization skills maximizing skills needed to keep the unit at optimal performance within acceptable process parameter ranges
- Enhances troubleshooting skills, enhancing use of the best recovery strategy more quickly
- Helps bring operators to the level of your most accomplished operators in less time
- Reduces training time and cost by augmenting and accelerating existing approach

CRITICAL SUCCESS FACTORS

There are several critical success factors in deploying training solutions like eSim-Trainer to improve operations effectiveness:

- Senior management must view operator training as a key component to long-term profitability or cost avoidance.
- An effective assessment methodology must be provided to measure the competency gap that exists at each site.
- The system should be integrated with existing training and business practices like PSM or PHA regulatory requirements.
- A sponsor or champion should be committed to keep the initiative visible, report on results, and ensure the training course content stays current.
- Success should be documented and publicized

CONCLUSION

The gas processing industry recognizes the need to train and maintain competent operators to ensure operations are reliable and stable. However, many companies lack the ability to assess the competence of their operations personnel and may not be investing the resources to effectively educate and train them. Current practices rely mostly on site personnel to train their own. Through enabling technologies like eSim-Trainer, RWD Technologies and eSimulation, Inc. are offering midstream operations the ability to assess their needs, improve the capability of their operators and engineers, and instill knowledge and methods to troubleshoot and optimize their plant operations.