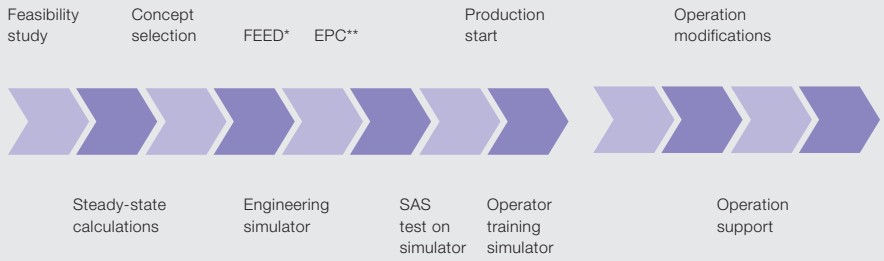
An expanded role

ABB's 800xA Simulator is now being used throughout the complete life cycle of an automation system

LARS LEDUNG, RIKARD HANSSON, ELISE THORUD – **The combination of stringent safety demands and complex processes in industrial plants has led to the increased use of simulator solutions in recent years. Oil and gas producers as well as nuclear power plants have used simulators for decades, but now also other segments such as fossil power and minerals and mining are using simulators [1]. ABB's 800xA Simulator continues to improve safety and productivity in automated industrial processes and yet it can now be used for a great deal more, generating benefits during the complete life cycle of the automation system. One customer in particular is benefiting from the 800xA Simulator as operators master processes in a safe and realistic environment and engineers test control modifications before transferring to the actual plant environment.**

Title picture
ABB's 800xA Simulator is playing a key role in the development and operation of Ormen Lange, one of Europe's largest and most technologically advanced natural gas projects.

1 800xA Simulator life cycle



* Front end engineering and design
** Engineering, procurement and construction

The simulator's first stage of use with ABB's Extended Automation System 800xA is as a simulator for engineering, design and testing. It can then follow up with control system checkouts to verify and if necessary modify the control logic before the commissioning. Then the 800xA Simulator becomes part of an operator training simulator for training on an identical control system interface for plant familiarization, safety system operation, startup, shutdown, response on malfunction, emergencies and safety procedures. Finally, plant modification and optimization studies can be done on the simulator before costly installation.

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Stimulated simulation

Two different types of process simulators exist. With stimulated simulators, the control system and its human machine interface (HMI) are identical to the real control system, and only the process and instrumentation are modeled. With emulated simulators the control system and instrumentation as well as the process itself are modeled. The look and feel of an emulated simulator may be similar to the real system, which may be good enough in some training situations. However, for life-cycle purposes the stimulated simulator is the only choice since an identical control system is needed. Also certain parts of System 800xA are too complex to emulate correctly, eg, sequences and advanced Alarm Management.

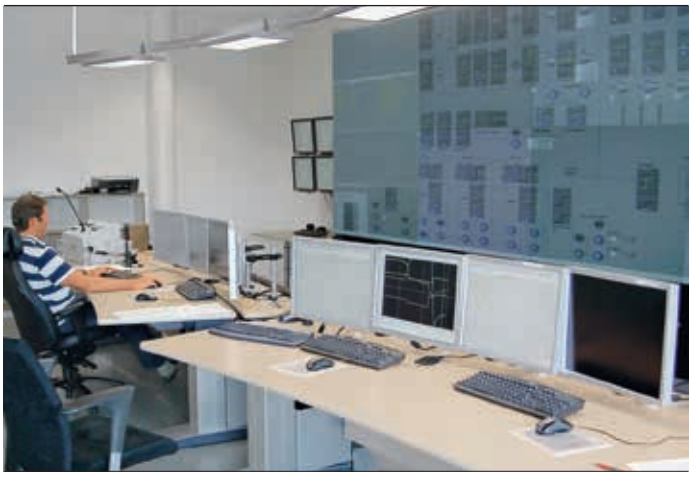
With 800xA Simulator, it is possible to create a simulator system with the same view and logic as the safety and automation system (SAS) of the running plant. The plant's System 800xA configuration can be copied to an identical operator training simulator environment for both testing and training, and the operator interactions with the control system become equal to the running plant.

800xA Simulator is the SAS part of a stimulated simulator system. Linked to a plant-tailored dynamic process model, it becomes a powerful life-cycle simulator system.

2 Life-cycle concept of 800xA Simulator

Life-cycle phase	Usage	Benefits
Planning and design	Design and engineering simulator	Improved and verified design through dynamic simulator model
Engineering	Safety and automation system test simulator	Integration of the model with SAS; verification of process control and operator dialogs
Virtual commissioning	Test plant design and SAS functionality in real scenarios	Validation of plant; reduced commissioning time
Production start	Operator training simulator	Operators prepared with training before plant startup
Operation	Training of new operators, hazard training, new operation strategies	Well-trained operators who can handle upsets in the process; verification of SAS changes and training operators before implementation on plant

3 Ormen Lange 800xA Simulator



The concept of the life-cycle simulator is to enable the customer to benefit from the investment throughout the complete life cycle of the automation system [2]. Therefore the simulator can easily be maintained to follow the plant life-cycle changes from beginning to end → 1–2.

Life-cycle concept

800xA Simulator supports each phase of the plant system life cycle, beginning with the design and engineering phase. A dynamic process model is developed in parallel with process design and used for verification. By doing this the quality of design is verified, major rework during the construction period is avoided, and control and safety philosophy is tested.

The SAS is developed in the engineering phase. The simulator is sequentially updated with process parts that are ready for control and operator dialog testing and integration with the model. The control strategy is verified. Using the simulator for realistic testing reduces commissioning time and increases safety during the commissioning phase. At this point the testing continues after the real control system is shipped to site for commissioning.

With the next phase the simulator is used for a wide range of realistic training purposes before plant startup to increase safety and reduce the number of unplanned shutdowns. Hazard and critical training can be repeatedly performed in a safe environment. Without the simulator option, this type of training is very expensive or not even possible. Training activities can include plant familiarization, operating and maintenance procedures, plant startup and shutdown, SAS operation, response on malfunction and emergency situations, as well as safety procedures.

Training can be for either new operators or for operators in new process areas. The simulator can be used in a certification program for production operators or technicians within new process areas or production lines. Also the simulator can be used for recertification to assure that operators retain and improve their skills.

The simulator can be used to study the modification impact of updating control logic and libraries, including the impact of applying updates while the process is in a producing state. It can also be used to verify changes to new or modified process areas, and to train operators accordingly. Testing software updates of System 800xA and control system firmware is also possible.

Process and control system optimization can also be simulated. With the simulator, optimization studies can be done by running scenarios and then applying improvements to the running plant. “What if” engineering analysis can be performed where required to optimize unit design.

Due to overlapping engineering and training activities customers often request more than one simulator system. This can often be the case before plant startup and in modification phases. For these occasions additional simulators can either be purchased or leased.

800xA Simulator uses the process graphics and control logic of the site’s safety and automation system to provide an identical operator environment and identical process.

In an extensive study looking at the use of training simulators, over 90 percent of respondents evaluated the simulator use at their plant as successful or very successful, none as unsuccessful.

Ormen Lange project

800xA Simulator is playing a key role in the development and operation of Ormen Lange, one of Europe's largest and most technologically advanced natural gas projects → 3. The simulators were instrumental to production starting three weeks ahead of schedule in 2007 and are central to the continuous improvement and expansion of the field.

The field is located in the Norwegian Sea 120 km off the coast of Norway. The reservoir lies some 3,000 m below the seabed and contains recoverable gas reserves of some 400 billion m^3. The gas wells are located on the seafloor at depths of 800 to 1,100 m and are the world's largest wellheads to date. The gas is transported from the reservoir through two multiphase pipelines to an onshore processing plant at Nyhamna, Norway, where it is dried and compressed.

ABB process control, safety and information management systems monitor and control the gas processing plant. The plant subsea installations and the flow of gas through the pipeline are also monitored and controlled with ABB process control, safety and information management systems.

800xA Simulator uses the process graphics and control logic of the site's safety and automation system to provide an identical operator environment and identical process control. The dynamic process model is delivered by Kongsberg Oil & Gas Technologies.

From the very beginning of the Ormen Lange project, emphasis was made on training the operators and performing final testing of the control logic in parallel with construction of the onshore and offshore production facilities. Each of the many process sections was analyzed and tested in the simulator before construction was completed. One engineering and two operator training simulators were used in parallel.

The Ormen Lange project is under constant development and expansion. 800xA Simulator is playing a key role in its growth and evolution by enabling new processes and subsystems to be designed, engineered, corrected and tested before they are integrated into the plant control system.

In 2011 ABB delivered a fourth 800xA Simulator for the site's groundbreaking subsea compression project. The purpose of this full-scale pilot project is to determine the feasibility of using subsea compression rather than topside compression to maintain a stable flow of gas when the natural pressure in the field begins to drop.

This is the largest subsea compression development and qualification project ever undertaken. The control system for the full-scale subsea compression project is being designed and tested in 800xA Simulator and is expected to be fully operational in 2015.

Customer experiences and achieved benefits

The Ormen Lange project is not the only project reporting such positive results from actively using simulator systems. In an extensive study evaluating the use of training simulators among major oil companies on the Norwegian shelf, conducted by Oslo and Akershus University College of Applied Sciences [3], some major results were:

- Ninety-seven percent of the respondents used plant-specific simulator systems, ie, no generic simulators
- Eighty-nine percent used the simulator systems also for engineering purposes
- Over 90 percent of the respondents evaluated the simulator use at their plant as successful or very successful – none as unsuccessful.

Other noteworthy findings from the survey include a 31 percent estimated increase in operator effectiveness and a reduced time for commissioning and startup by 18 days for a new facility and 2.2 days after modifications. Simulator training can help avoid an average of three unplanned shutdowns per year. The average total estimated annual savings in the study were $15.3 million per plant.

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