



K-Spice[®]

A New Dimension in Dynamic Process Simulation



Powerful Dynamic Process Simulation Tool
Improved Detail Process Design
Comprehensive DCS Check-Out
Realistic and Customised Operator Training
Online Simulation and Monitoring

Our Mission

Our mission is to develop and provide innovative, reliable technology and solutions to ensure that oil & gas resources are discovered, developed, and delivered in the safest, most efficient and most environmentally friendly way possible.

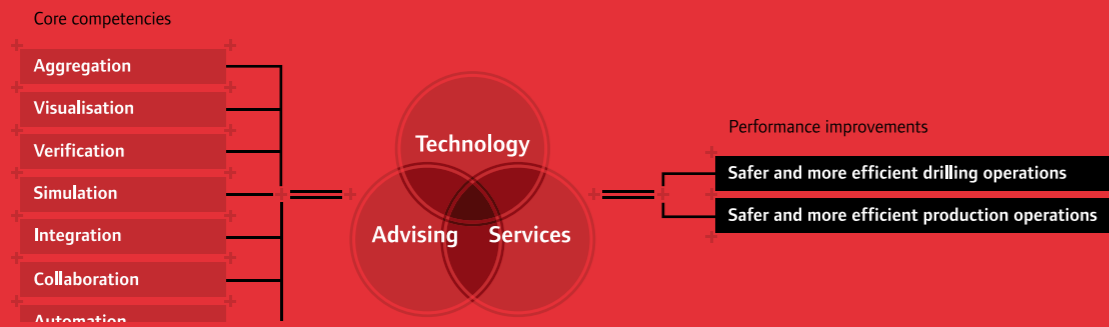
Our Role as Trusted Advisor

Your oil & gas operations require a unique blend of complex work processes, advanced technologies, environmental compliance and services from multiple vendors and service companies. Kongsberg Oil & Gas Technologies is focused on helping you manage this integration to achieve maximum operational efficiency.

Our Philosophy

We commit to adding value to your oil & gas operations by providing you with technologies, processes, and people dedicated to improving results through innovation and effective integrated operations. Through cycles of boom or bust, we strive to provide solutions that allow you to achieve much more, with less investment. Our people are the key to our success and we empower them to achieve.

Intelligent Improvement

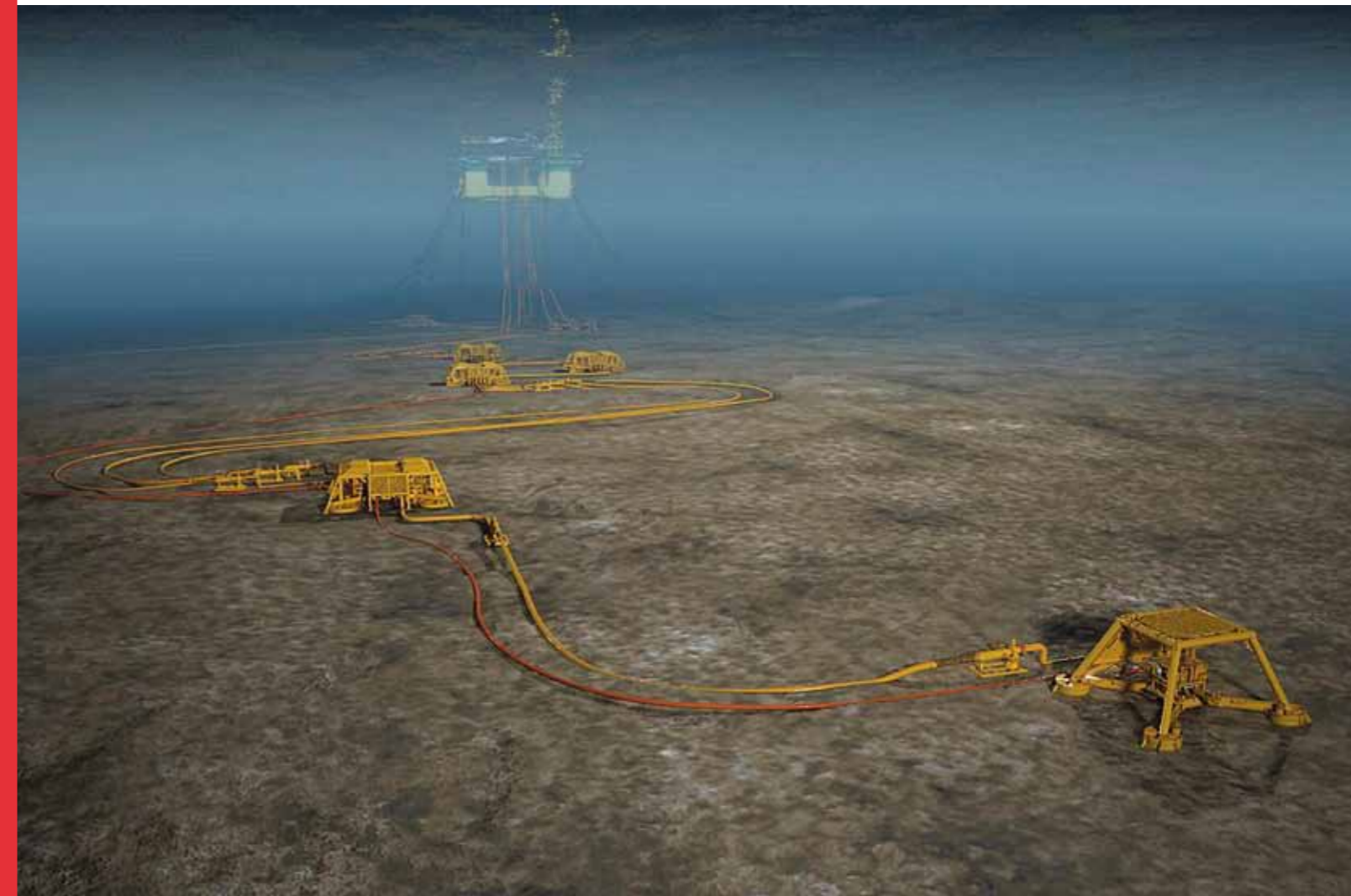


A new dimension in dynamic process simulation

K-Spice® is KONGSBERG's next-generation dynamic process simulator, for detailed design and verification of oil & gas processes and control systems at all stages of the Lifecycle process – the Lifecycle Simulation Concept.

K-Spice® combines the best features from KONGSBERG's existing process simulation tools ASSETT® and D-SPIICE® with new and improved features for system management, thermodynamics, numerical solvers and a flexible and intuitive graphical user interface.

Kongsberg Oil & Gas Technologies has been delivering dynamic process simulation models including multiphase pipeline simulation to the upstream oil & gas industry for over 25 years. KONGSBERG has delivered over 300 dynamic simulation studies, 100 customised Operator Training Simulators and over 40 online Production Management Systems to major oil & gas operators worldwide. This extensive and unique experience has been incorporated into K-Spice®, allowing KONGSBERG to provide field-proven, powerful dynamic process simulation solutions to the oil & gas market.



A design and verification tool throughout all phases

The Lifecycle Simulation Concept is based on continuous simulation runs throughout the development and operational phases of a project as both a design and verification tool. As the project progresses, the functionality of the simulator grows and develops in line with the project scope and requirements. The level of technical information available increases enormously from the conceptual phase through to commissioning. The simulator evolves in parallel, incorporating detailed technical information into the model as it becomes available.

Best practice

KONGSBERG's Lifecycle Simulation Concept has been a great success and has improved the working process for integrated field development projects. The concept has, over the years, developed to be a best practice in the market. It is used on many modern projects with high focus on cost, quality and effectiveness. The role of the dynamic simulator changes during the project lifecycle and includes activities such as:

- Process design verification
- Control system design and verification
- Process safety checks
- Operating procedure verification
- Operator Training
- Post start-up modification studies
- De-bottlenecking and optimisation
- Planning and production support

In the mid-1990's KONGSBERG started to offer Lifecycle Simulation to operators with new field development projects and today, the Lifecycle Simulation Concept is being used more and more in field development projects worldwide.



- The Lifecycle Simulation tool**
- Easier configuration
 - Better choice of thermodynamic calculations
 - Better appearance of applications
 - More reliable calculations
 - Easier data handling, reporting and interoperability
 - Tighter support of work practices
 - Online help
 - Faster implementation
 - Better quality models
 - Low-risk execution
 - Flexible user interfaces

Reducing risk and increasing returns

Shorter project schedules

The Lifecycle Simulation Concept ensures that there will be fewer faults in the process and control system design. It also ensures that the control and safety systems are tested before installation and perform as expected. The simulator provides a common test platform for the process, instrumentation and operation departments, and also helps to ensure that the operators are well-trained and familiar with the process before they begin to work on the installation.

Increasing levels of knowledge

The Lifecycle Simulation Concept is best practice for integrated field development projects. It involves all engineering disciplines in the development of a beneficial and cost-effective engineering tool: A living piping and instrumentation diagram (P&ID) of the facility and a repository for knowledge about the dynamic behaviour of the facility. The simulator incorporates increasing levels of knowledge and grows in accuracy as the lifecycle progresses. This increases the customer's confidence in their design, based upon the knowledge that the design is solid, that the control system has been thoroughly verified, and that the operating procedures are correct. This will secure higher plant availability, and reduce environmental emissions and hazards.

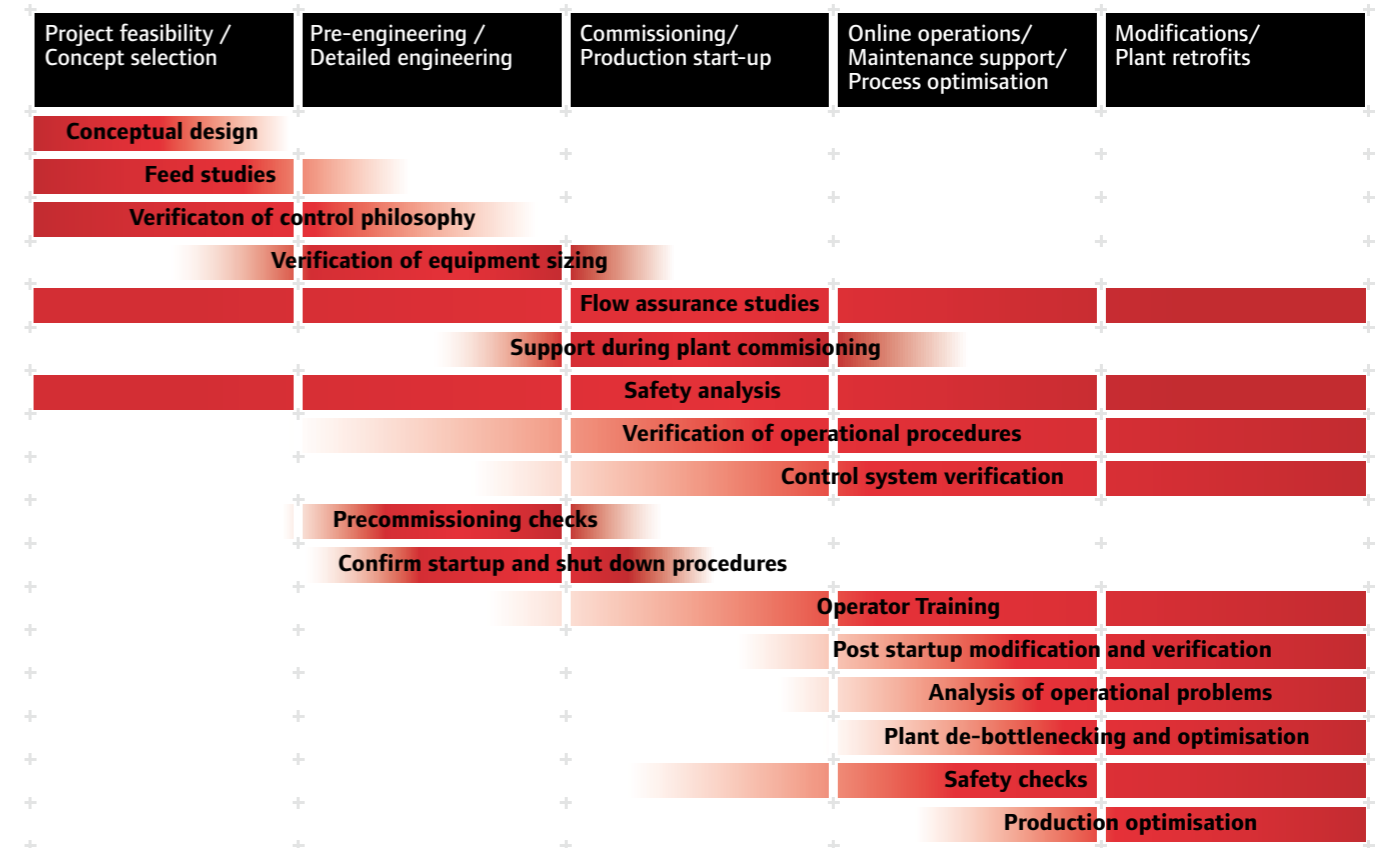




Photo: Dag Myrestrand / StatoilHydro

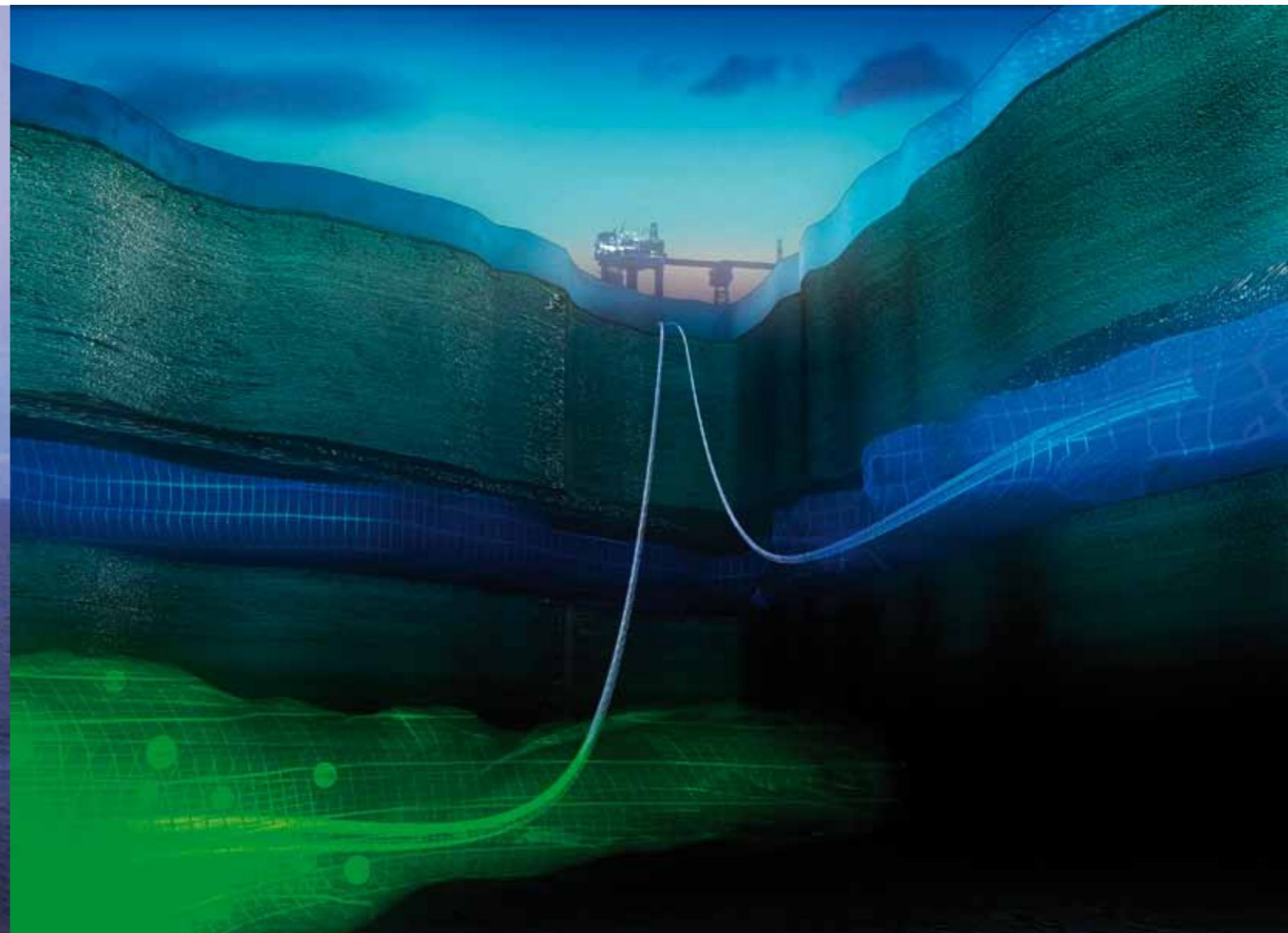


Illustration: Alligator film/BUG/ StatoilHydro

Project feasibility/concept selection

During conceptual design, it is common practice to evaluate transport and production alternatives using a multiphase simulator and a steady state simulator. This allows rapid evaluation of alternatives, but does not expose potential problems with the operation of the concept.

Often, the multiphase simulator is used alone. This means that the effect of the processing concept for transportation alternatives cannot be fully examined.

Modern processing concepts involve innovative technology, such as subsea separators, down-hole separators and subsea compression. Evaluation of process dynamics and control is critical for determining the applicability of these technologies.

K-Spice® allows engineers to evaluate operability in the conceptual phase. K-Spice® is tightly integrated with the LedaFlow® multiphase simulator. This allows the evaluation of production and transport together.





Pre-engineering/detailed engineering

The engineering and design phase starts with a steady state simulation model for the heat and mass balance, followed by a more detailed dynamic process simulator. The dynamic process model should be built as soon as possible so it can be used to improve and validate process design and control system design. The dynamic simulator also supports HAZOP studies: Allowing teams to objectively assess the effect of each scenario.

The dynamic simulator allows the design team to test the process dynamics, validate control designs and shut-down philosophy. The performance of HIPPS systems and compressor controllers can be verified and tuned. K-Spice® will include emulations of all common anti-surge controllers and support links to actual systems.

K-Spice® is used to evaluate and prepare operation procedures for start-up, shut-down, settle out, fuel gas switch-over, transfer from gas export to gas injection and compressor blow-down.

Dynamic simulation is used to design the process so that shut-downs are avoided. Closing times for valves are chosen to avoid pressure surges. Heat exchanger control is tuned to ensure that material temperature constraints are observed.

The simulator is built in parallel to the design basis. Experienced KONGSBERG engineers can work as dynamic simulation consultants in an integrated project team. As the design phase closes, the simulator is delivered for use in control system testing and check-out.



Commissioning/production start-up

DCS check-out

Best practice for commissioning and production start-up is to connect K-Spice® to a copy of the control system so that the actual control configuration can be tested. If desired, K-Spice® can also connect to emulated control systems, PLC and shut-down systems.

K-Spice® is used in this phase to:

- Test and check-out the control and safety system:
 - Test inputs and actions for shut-down logic (K-Spice® supports cause and effect, SFC and ladder logic)
 - Check operator graphic performance and response
 - Test and pre-tune process controllers and logic
- Test and check-out the compressor anti-surge and speed control
- Test of inter-system communication. K-Spice® acts as a broker between the control system and the safety system
- Test and check-out sequences and procedures:
 - Duty/standby logic and switching
 - Compressor start and stop sequences
 - Process start-up from empty and de-pressurised process
 - Complete planned process shut-down



Operator Training

The key benefit of using K-Spice® for Operator Training is that new personnel can obtain knowledge they need to operate the facility before start-up. Experienced personnel are drilled in handling routine operations optimally and in handling emergencies. Risk is reduced and returns are maximised. Here are some examples of possible applications that K-Spice® supports for Operator Training:

K-Spice® is used in this phase for:

- Process and control system familiarisation
 - Process and control philosophy
 - Navigation in the operator graphics
 - Using the alarm and trend systems
- Complete start-up of the process using standard operation procedures
 - Reset shut-downs (PSD/ESD)
 - Start-up of utility systems
 - Lining up the process for hydrocarbons
 - Start-up of the complete process
- Planned process shut-downs and production changes
 - Production ramp down
 - Closing down the process in the correct sequence
- Unplanned shut-downs and emergencies
 - Fire and gas emergencies
 - Process shut-down
 - Emergency shut-down
 - Loss of containment

Online operations/maintenance support/ process optimisation

K-Spice® provides comprehensive support for engineers and operators of operating facilities. An engineering model is used to analyse process upsets and evaluate process and control modifications. Once modifications have been approved, they are tested using a test and check-out system. This reduces the risk of the changes causing production upsets and decreases offshore installation time.

An online simulator – running in synchronisation with the real process – is an excellent source of real-time data for use in process monitoring, operator guidance, environmental reporting and production reconciliation. The online simulator is also a master model for the facility. This means that engineers and trainers always have access to an updated model of the process.

The K-Spice® online simulator is the core of KONGSBERG's Production Management Solutions for managing operations of multiphase subsea production facilities and long pipeline networks.

What does it give me?

IEPC Vendor:

- I can be more confident in the design
- I can specify and buy process equipment that gives optimal dynamic behaviour
- I can design in operational stability
- I can design and test detailed control logic early in the design phase
- I can test innovative designs and control philosophies
- I can hold more precise, objective HAZOP meetings

DCS Vendor:

- I can test the dependencies between control and safety systems (control-ESD-PSD or control-fire and gas). This can save up to 50 hours per control node, and 500 hours for typical topside control system
- I can test the performance of the system before installation. This can save 100 hours per control node, i.e. 1000 hours for typical topside.
- I can verify the requirements given to me before implementing them. I can simulate the SCD and sequences to ensure that they are correct and complete. This can save millions of dollars. For example, modifications of gas compressor control on the Snorre B platform were simulated before installation. The test showed that comprehensive changes were needed. If these problems had been discovered during start-up, a delay of three weeks would have ensued. This would have cost USD 2 million in labour costs alone – not counting delayed production.

Operating Company

“We have exceptionally large benefit from the simulator during the test phase. Many errors were found in a number of process elements. To find and correct these errors so early resulted in a painless and much faster start-up.”

- I can expect a fast and painless start-up of the facility
- I can cultivate the skills of my operators and engineers
- I can cope with the generation change in the oil industry
- I can avoid process upsets
- I can drill personnel in handling emergencies
- I can evaluate and test process and control system modifications
- I can support Integrated Operations with top-quality engineering assessments

Remember, one day of lost production due to a failure in loading new, untested control logic offshore can result in huge losses. With a production rate of 100,000 barrels/day and oil price at 40 USD/barrel the loss of income would be 4.0 M US dollars per day.

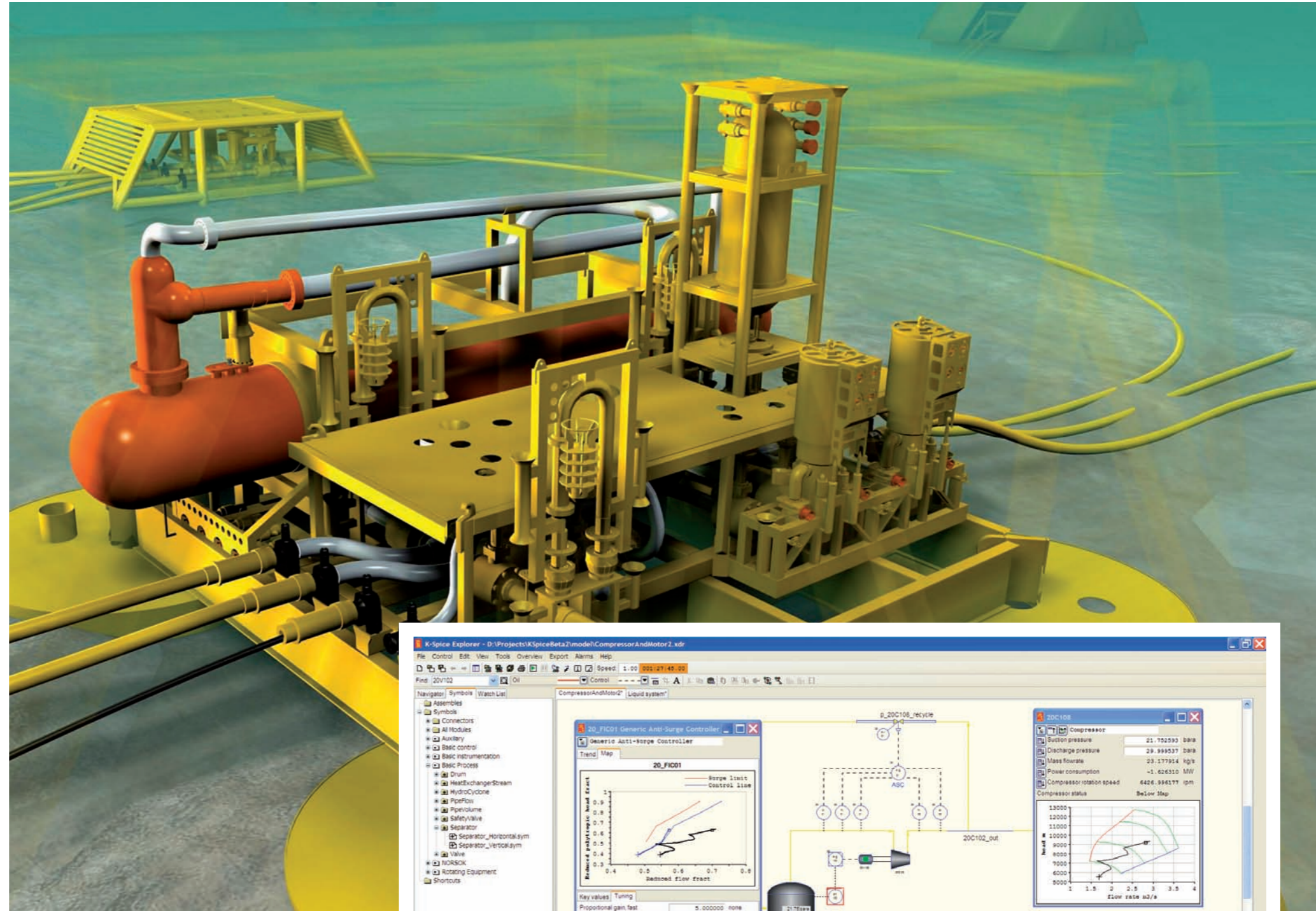
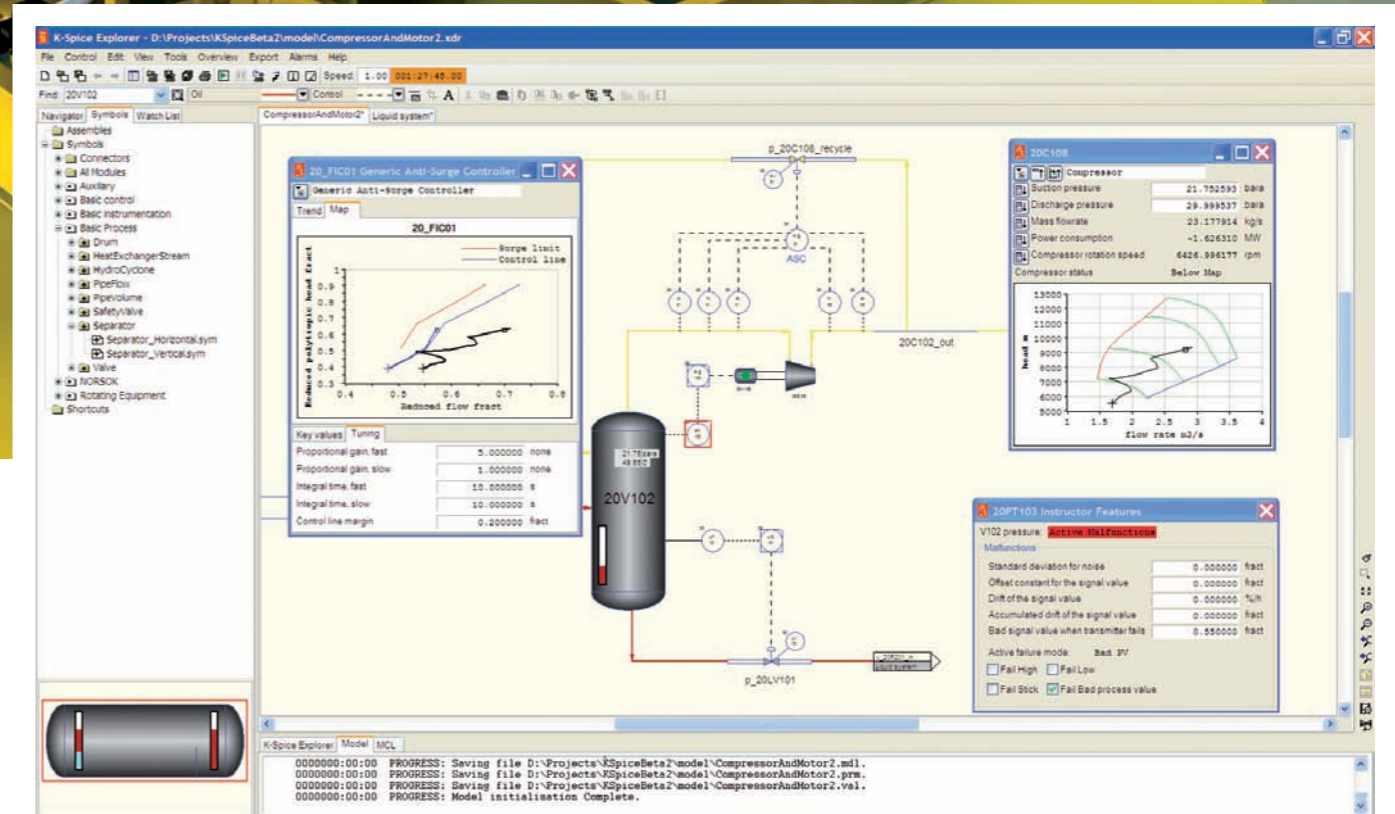


Photo: FMC Kongsberg / StatoilHydro



Solutions based on K-Spice®

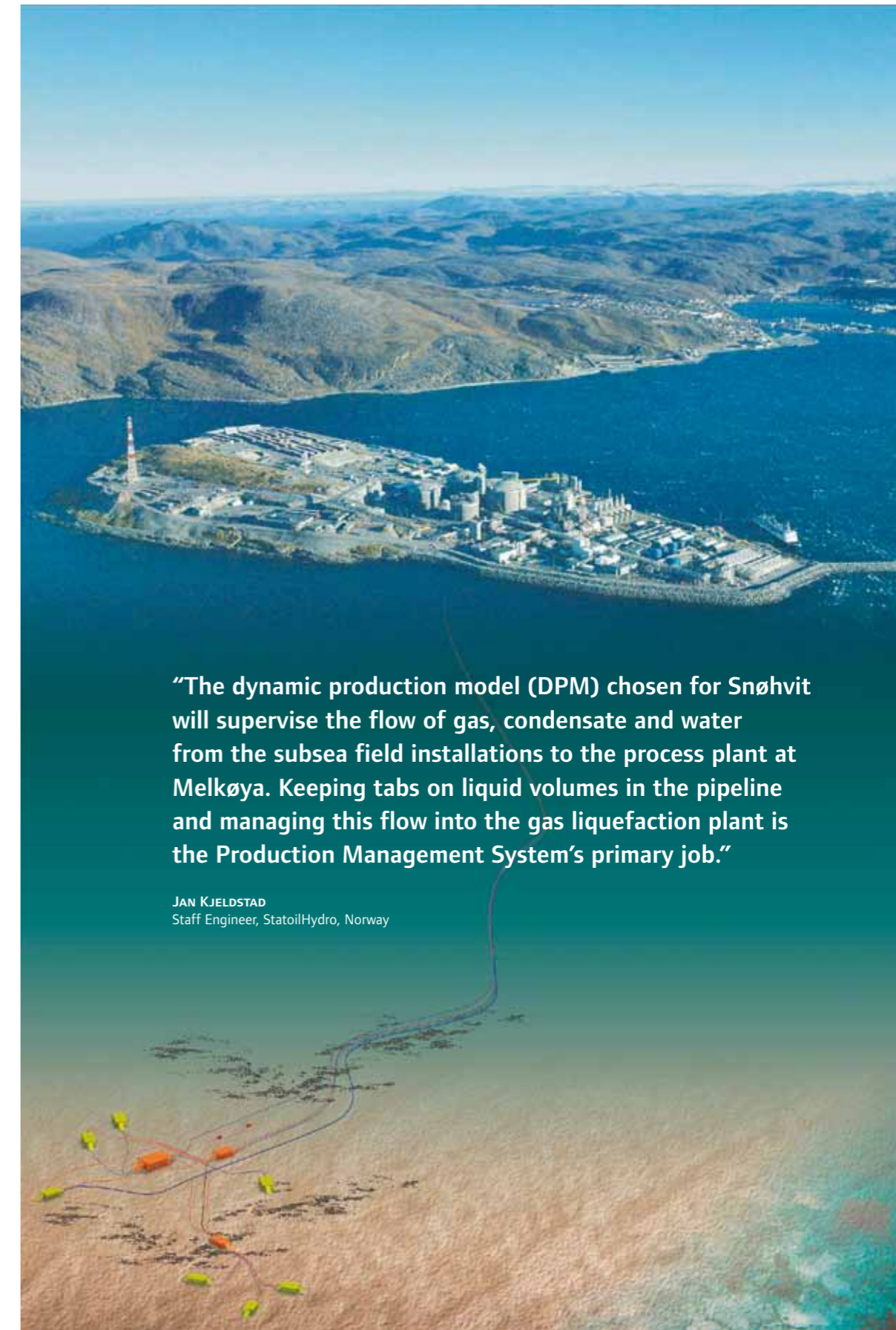
KONGSBERG supplies a wide range of services using K-Spice®. These extend from conceptual process studies, engineering verification, control system checkout and Operator Training to real-time production monitoring systems. The range of applications is steadily growing in order to meet new trends in the industry – in particular Integrated Operations (IO).

The following products and services are available:

- **Specialist studies**
 - Flow assurance studies
 - Process & control design and verification studies
 - Optimisation studies for process & control
- **High fidelity facility-specific process simulators.**

One model is developed throughout the project and is used for:

 - Flow assurance studies
 - Process & control design and verification studies
 - Control system check-out
 - Operator Training Simulator
 - Operations support
 - Online simulation
- **High fidelity generic process and control simulators**
 - Generic Oil & Gas Production Simulator
 - Generic Ammonia Production Simulator
- **Production Management System**
 - A high fidelity model-based real-time application connected to the production process
 - Continuously receives live measurements from the plant
 - Simulates the production process in parallel with the actual process
 - Presents results in customised HMI and/or on DCS
- **Applications for Integrated Operations/digital oil fields**
 - Online simulation: process monitoring and KPI reporting
 - Remote support
- **Operations support organisation**
 - Operations, modifications & maintenance support
 - Training
 - Service & post-market sales
- **Custom simulator development and support for users of special-purpose simulators.**



“The dynamic production model (DPM) chosen for Snøhvit will supervise the flow of gas, condensate and water from the subsea field installations to the process plant at Melkøya. Keeping tabs on liquid volumes in the pipeline and managing this flow into the gas liquefaction plant is the Production Management System’s primary job.”

JAN KJELDSTAD
Staff Engineer, StatoilHydro, Norway

Photo: Even Edland / StatoilHydro

“It has been mostly a pleasure and I can honestly say I have been thoroughly impressed with the dedication and professionalism of all of your staff there at Kongsberg. I will have no hesitation in recommending your product/company for future projects and hope this will not be the last time we do business together”.

PAUL G. MCCONNELL
 Technical Training & Competency Specialist, ConocoPhillips

“The Snøhvit simulator is probably Statoil’s most complex dynamic simulator and I am very satisfied with what the Kongsberg team has delivered. I am sure that the simulator will be invaluable throughout the life of the project: In verifying the process design and control strategies, in troubleshooting the plant automation systems prior to start-up and as a high fidelity training system to develop our operators’ competence. Following start-up we intend to use the simulator to optimise plant operation and test advanced control applications.”

GUNLEIV SKOFTELAND
 Snøhvit Project Lead Instrument and Process Control, Statoil, Norway

“D-SPICE® has been a truly pleasant experience among the process simulator tools I’ve used. It steps up to the complexity and great challenges of modelling a complete base-load LNG plant with elegant simplicity, great robustness and impressive level of detail. Our simulator is in daily use and is an invaluable tool for testing and reviewing operational procedures, testing process and control design and for Operator Training. Kongsberg’s training and support have been top-notch, which translates to user confidence and a noticeable improvement in productivity and added value for Hammerfest LNG Operation.”

SIVERT VIST
 Staff Engineer, Hammerfest LNG Operations, StatoilHydro, Norway

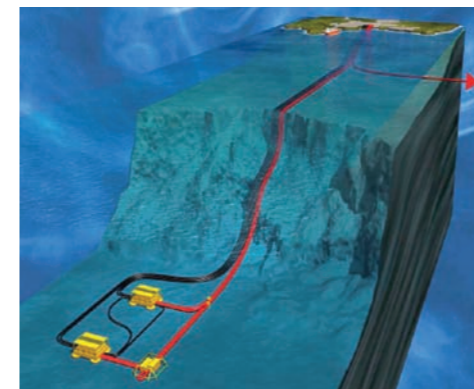
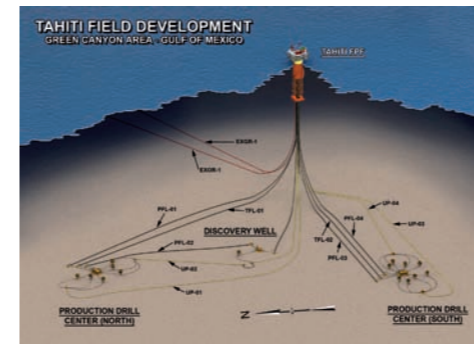


Photo: Eiliv Leren / StatoilHydro

Selected references

Bohai Phase I Penglai

Operator Training Simulator
 Client: Emerson Process Management
 Operator: ConocoPhillips
 Owners: ConocoPhillips, CNOOC (China National Oil Offshore Corporation)
 Main contractors: Fluor Daniel
 The Bohai Bay is located in the north eastern part of China, approximately 200 kilometres east of Beijing and is the largest discovery made offshore of China to date.

Tahiti

Engineering and Training Simulator
 Operator and Client: Chevron
 Owners: Chevron 58%, StatoilHydro 25%, Total 17%
 The Tahiti Field includes 15 subsea wells in Green Canyon, located approximately 190 miles southwest of New Orleans in 4000 ft of water. Gas is exported to the Discovery Gas Pipeline, while Oil is exported via the Amberjack Pipeline.

Naikika

Lifecycle Simulator for complex deepwater project
 Client: Shell
 Operator: BP
 Na Kika consists of six oil and gas fields tied back to a central production facility, located in the Gulf of Mexico, Mississippi Canyon area. A KONGSBERG simulator ties together wells, subsea systems and topside facilities.

Ormen Lange

Lifecycle simulator
 Operator: Shell, Norway
 Owners: Shell Norway (17,0375%), StatoilHydro (28,9169%), Petoro (36,4750%), Dong: (10,3420%), ExxonMobil (7,2286%).
 Ormen Lange is the second largest gas field on the Norwegian continental shelf. The gas field is located approximately 120km northwest of Kristiansund (Norway), almost 3000m below seabed. Gas and condensate are transported to an onshore gas plant, where they are separated. The gas is exported through Langeled, a 1200km long subsea pipeline (longest subsea gas pipeline in the world) to Easington, England.

Snøhvit

Lifecycle Simulator for subsea fields and LNG plant
 Operator: StatoilHydro, Norway
 Engineering contractor: Linde, Germany
 The Snøhvit development area comprises three fields: Snøhvit, Albatross and Askeladd, at depths ranging from 250-345 meters. The Barents Sea installations (subsea) are remotely operated from shore while gas-condensate is transported through a 143 km multiphase pipeline. The onshore installation at Melkøya Island is near Hammerfest in the north of Norway.

An optimal process and control solution

K-Spice® includes the necessary features to create, study, and modify a process plant model in order to reach an optimal process and control solution.

Important and new features include:

- **Windows-enabled**
 - Supports Windows XP, Vista, Server 2003 and Server 2008
 - User interface uses XP and Vista user interface styles.
- **Highly flexible and intuitive graphical user interface**
 - New symbols for equipment, including 3D process equipment
 - Standard, informative, summary and configuration panels
 - Multiple images opened in separate tabs
 - 24 bit colour support for improved look and feel and improved DCS emulation
 - XML file formats for data interchange
 - Multi-screen support
 - Remote connection to the model server
 - Comprehensive online help and documentation
- **High fidelity unit model library**
 - Standard defaults and concise user feedback for simple configuration
 - Rigorous algorithms that simulate stably in all operating states
- **Flexible thermodynamics interface**
 - Highly efficient reduced-model thermodynamic system
 - Connection to third-party thermodynamics packages
 - Option for direct calls to thermodynamic packages if needed
- **Management of training and engineering scenarios**
 - Create as many initial conditions as required (disk space dependent)
 - Re-use conditions for engineering runs or training sessions
- **Snapshot support for rewind and replay**
 - Rewind the process model and re-run through a scenario for engineering studies and training sessions
- **Trending and report generation**
 - 2D and 3D trends
 - Trajectories and performance maps for rotating equipment
 - Profiles of properties in pipes, columns and heat exchangers
 - Create and save custom trend groups and displays
- **Powerful script manager for studies and training sessions**
 - Create scripts to run training scenarios
 - Create scripts to run/re-run engineering study simulations
 - Supports all model actions available through the explorer
- **Alarm and event handling**
 - Full alarm system implemented in the simulator
 - Supports alarm levels, acknowledged/unacknowledged
- **Typical process and control malfunctions for Operator Training**
 - Standard malfunctions on valves/pumps/transmitters etc
- **Integrated OPC server**
- **Automatic model creation for emulation of common control and safety systems**



We are There, Whenever You Need Us

The Kongsberg Oil & Gas Technologies customer services organization is committed to providing easy access to service and support, and to responding promptly to your needs. Activities are supervised from our headquarters in Norway, with centers at strategic locations around the globe – where you are and the action is. As part of our commitment to total customer satisfaction, we offer a wide variety of services to meet our customers' specific operational needs. We can adapt to the level of support required by offering service agreements and fast on-site response arrangements.



Global and local support
 Service and support work is carried out under the supervision of your personal account manager, who will ensure that you receive high-quality service and support where and when you need it. Your account manager will ensure continuity and work closely with your staff to improve and optimize system availability and performance. Under the direction of your account manager, our well-qualified field service engineers will be able to help you quickly and effectively, wherever you are and regardless of the levels of support required.

www.kongsberg.com/kogt

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