Partial Reference Overview - Production

Process Simulation Solutions

K-Spice®
The Ultimate Dynamic Life-cycle Simulator
Case Study – Real-time Instrument Fault Detection

What benefits can be realized?

- The ability to proactively predict potential instrumentation conditions / faults before they occur including:
  - Loss of calibration
  - Instrument drift
  - Stick failure
- With a typical oil rate through a separator of 20,000 BPD, the avoidance of a production shutdown can be valued at $1.7 MM per day at a conservative oil price of $85/bbl for a single event.

Business challenge

- One of the largest global companies in the oil and gas energy industry needed the ability to provide early event warning of instrument faults to prevent unplanned production shutdowns.
- The company enlisted the services of KOGT to assist in developing a real-time system for the identification of fault detection conditions of all level transmitters located on the production separator for the company’s deepest offshore production facility.

Approach

- The simulation model of the production separator system was configured in KOGT’s proprietary dynamic process simulation program K-Spice™. The life-cycle simulator K-Spice™ has the ability to utilize the same dynamic model throughout the different project phases, from dynamic simulation studies during design to complete Engineering and Operator Training Simulators during commissioning to Real Time Solutions in daily operation.
- The instrument fault detection algorithm is based on calculations over 3 different time intervals. The time interval lengths can be tuned based on field condition observations to minimize nuisance alarms. Shorter time intervals are used to detect larger size faults, whereas the longer intervals are used to detect smaller size faults or faults that grow over a long period of time.
- The model was tuned with data from normal operations and then blind-tested with multiple datasets for validation by identifying fault conditions, fault detection & recovery times, and drift detection & recovery times, well in advance of it actually causing a shutdown.
Dynamic Simulation of Deep Water Electrical Submersible Pumps

Business challenge
- Ability to simulate first-of-a-kind high-powered ESPs in deep water GOM.
- Provide high fidelity dynamic simulation to assist flow assurance and production engineers create operating procedures for safe and efficient ESP operation.
- Provide plant-wide integrated simulator of combined subsurface and topside facilities for control system checkout and operator training.

What benefits can be realized?
- User can dynamically simulate well operations (including ESP start-up, shutdown and performance control), check-out operating procedures and control philosophy.
- Train operators on first-of-the-kind ESP operations and potentially avoid costly shutdowns or equipment damage during field operations.

Approach
- ESPs were simulated in KOGT’s proprietary dynamic process simulation program K-Spice™. ESP simulation results were validated against vendor data for early, mid and late life scenarios with varying water-cuts, reservoir conditions and pump speeds.
- Multiphase flow in wellbores was modeled using KOGT’s proprietary LedaFlow™ program. The two models are linked using KOGT’s LedaLink™.
- Topside facilities were modeled in K-Spice and integrated with subsurface model providing an integrated plant-wide accurate dynamic model.
- The model was linked to the actual process control system, emergency shutdown systems and operator graphics providing “near field-like” training experience.
Case Study - Virtual Flow Metering System – GoM Oil & Gas Field

Business challenge

- Provide virtual flow metering and Back-up of physical metering.
- Provide accurate "window-into-the-pipeline"
- Maintain accuracy even when subsea physical sensors fail.
- Create decision support tool to efficiently plan and manage production and assured flow.
- Provide historical data reconciliation.

Approach

- Integrated subsea/topside simulated in KOGT’s proprietary dynamic process simulation program K-Spice™ and third-party multiphase flow simulator.
- Three modes of operation provided – Online RealTime Simulator, Look-Ahead (predictive) tool, and Offline Planning (What-if) Simulator.
- Automatically calibrated online simulator provides real time virtual flow metering, back-allocation and accurate flow conditions in wellbores and pipelines.
- Methanol, LDHI, and Paraffin inhibitor tracking provided, which aids in Hydrate and wax monitoring.
- Capability to connect to OPC DA and HDA to receive real-time or past field measurements as well as to write unmeasured model calculated values back to operator screens.
- Planning HDA simulator developed, which can load and re-run past model/measured conditions for historical data reconciliation using update reservoir data as well as to investigate production issues.

What benefits can be realized?

- Accurate real-time virtual flow rates and pipeline flow conditions are available irrespective of the status of field MPFM (most subsea MPFMs and down hole gauges failed during first year of production.)
- VFMS aids engineers in reservoir planning and production optimization – well re-routing, pigging, hydrate inhibition, choke setting.
- Event-driven Look-Ahead tool allows operators to take corrective actions before production disruption – slugging, hydrate issues.
- Planning HDA allowed investigation into oil pipeline wax blockage and remedial plan.
Case Study – Enterprise OTS Concept

Business challenge

- Offshore Organizational Design Project led to various operational changes
- Certification of Control Room Operators
- Need for Integrated training infrastructure with asset independent software licenses and common hardware. Simulation models and process automation software are installed on virtual machines rather than physical servers. This enables use of the facility for multiple training sessions for the same hub or separate training sessions for different hubs.

Approach

- Multiple simulator instances for the same hub can be started easily
- Simultaneous training instances of multiple operators
- Training in a team environment
- Option to use OTS for individual operator assessment or team training
- Facilitates conformance to operating procedures
- Enterprise OTS becomes more Future Proof
- Hardware can be updated easily
- Hardware is scalable - additional memory and storage can be easily added/replaced
- New hubs can be added easily to the training infrastructure
- Enterprise OTS can be replicated to a Data Center

What benefits can be realized?

- Knowledge Management
  - Integrated training environment that enables sharing of lessons learned across assets
  - OTS as a collaboration center for different disciplines – topsides process, subsea, automation, marine, flow assurance, etc.
  - Consistency in operator assessment and training program development
  - Enables simplified remote access for different users to the OTS environment via single gateway. (future)
- Single point of contact for training simulator and updates
  - Ease of simulator software maintenance and system update support
  - Ease of updates for process MOC changes
  - Reduced vendor interfaces and contractual complexity

K-Spice®

The Ultimate Dynamic Life-cycle Simulator
Business challenge

- Internal corrosion in transportation systems and processing units represents one of the significant loss of income in oil & gas exploration and production (estimated to $1.372 Billion, NACE international). A recent 2012 US DOT study found pipeline control rooms identified leaks in hazardous liquid and natural gas transmission lines only 17 percent and 16 percent of the time, respectively.
- Major types of corrosion include CO₂ and CO₂/H₂S corrosion in petroleum pipelines. In gas condensate lines, Top-of-Line corrosion may be encountered when condensed water forms at the top of the pipe.

Approach

- A model of the pipeline is constructed using LedaFlow®, a new dynamic multiphase simulator, which provides more accurate predictions of multiphase flow.
- One of the key modeling differentiators for LedaFlow® is the prediction of phase temperatures. Along with the predicted average temperature of the mixture, LedaFlow® recognizes that the temperature in the phases (gas, oil, water) can be quite different from one another.
- LedaFlow® Buried Pipe Model incorporates an improved heat transfer model which allows for a more accurate representation of heat-transfer to the surrounding.
- LedaFlow® implements Ohio University’s mechanistic models for Corrosion. These models represent a step change in accuracy in comparison with empirical models, such as De Waard and Williams (1976).
- The combination of three Energy Equations, Buried-pipe model and mechanistic corrosion models result in the best prediction of Top-of-Line corrosion.

What benefits can be realized?

- The ability to more accurately identify and predict potential corrosion hot spots provides:
  - Proactive corrosion management, robust preventive maintenance strategy and reduction in unplanned maintenance
  - Improved compliance with Safety, Health and Environmental policies
  - Predictive technology to enhance existing inspection and testing techniques
Real-time Production Assurance

Case: TOTAL Canyon Express

Benefits achieved
- Optimised injection rate of chemical inhibitor
  - decreased production of aqueous phase
- Verified production chokes blocked (scaling), basis for calculating the ROI for replacement
- Improved well allocation and flow routing
- Improved monitoring of water cut from production wells
- Virtual Flow Metering (VFM) on wells – for partners revenue calculations
- Testing and improving operating procedures

Major contributor to
- Increased production through new and innovative production strategy
- Prolonged life of production
- Increase of the ultimate reserve recovery
Na Kika – Gulf of Mexico

• Field Data
  – Tie-back distance: 118 total miles
  – Water Depth: 5,800 to 7,600 feet
• Integrated dynamic simulator and multiphase model
  – Wells, subsea equipment, flowlines
  – Topside process facility
• Engineering Simulator
  – Improvement and verification of processes and control design
  – Troubleshooting before startup
  – What if – scenarios
  – Validation of control system
• Operator Training Simulator
  – Nearly 500 control issues resolved during integration
  – All 238 control loops pre-tuned
  – Further 158 control configuration issues identified during training

Business Value
Saved more than 5 weeks commissioning time
Increased uptime from expected 84% to 96% production

More Details in OTC 16572 (2004)
North Sea Operated Asset

The line is a 3-phase, 18-inch ID oil flow line, running 3.7 km from a wellhead platform to a central processing platform. The line drops approximately 6.0 m over the last 3 km before flowing up a 130 m long riser.

The prediction data has been further analyzed for the slug size distribution when the flow enters the central processing platform. The slug sizes are classified by volume, and was measured during the period when the volume rate exceeded the average rate, and until it falls below the average rate; in this way the slug size distributions, seen in Figures 1 & 2, have been generated. The volumes of the largest liquid slugs - up to 200 m³ - are in accordance with the observations from the field. Also, the distribution of slugs appears similar to other field measurement campaigns (Brill et al., 1981).
Use of Real-time Drilling Data
Case Study -- Statoil Integrated Environmental Monitoring

**Business Operations**
- Planning
- Decision making
- Workflow

**Knowledge Sharing & Analytics**
- Learning
- Analysis
- Sense making

**Information & Collaboration**
- Virtual interaction
- Coordination
- Shared awareness

**Intelligent Infrastructure**
- Access
- Connect
- Sense

**Asset control room**

**Central support functions**

**Emergency response**

**Domain experts**

**Information & work processes**

**External organisations**

**Sensors & sensor platforms**

**Existing sensors & sources**

**Stationary ocean observatory**

**Mobile**
Subsea Contracts in US (Houston)
Geospace Technologies/Statoil

Geospace Technologies provide the 4D Seismic – Ocean bottom cable for two Statoil Fields in North Sea. Total length 700 km

KOGT provide the subsea cable connector structures including Fishing Trawling Protection

First Field delivery:
1 off DUTA adaptor - delivered mid march Mobile Alabama.

1 off DUTA structure - delivered Dusavik, Norway beginning of June 2013

10 off SAT Modules complete with GRP mudmats and protection structures - delivered Dusavik Norway beginning of June 2013
Riser Remnant Life Assessment
ExxonMobil Zafiro Field

ExxonMobil Objective:
Extend flexible pipe operational life to 2025 for:
- Zafiro Producer spread moored FPSO, 30 dynamic risers, installed 1996
- Serpentina turret moored FPSO, 9 dynamic risers, installed 2003

Scope of Work:
Phase I:
- Methodology definition
- Data collection – design, history and inspection
- Status assessment

Phase II:
- Full riser system reanalysis
- Status assessment
- Deliverables:
  - Remaining life of riser
  - Critical findings
  - Inspection frequency
  - Monitoring and testing
Umbilical and riser system design
Chevron Rosebank Development

SOW:

• Assist Chevron in developing the tender documents through:
  – Umbilical configurational design optimization
  – Umbilical cross-sectional design and fatigue analysis
  – Riser and umbilical system interference
Umbilical and riser system verification (IVA) - Chevron Frade

Frade oil field located in Brazil, Capos Basin. Turret moored FPSO in 3,700ft of water. Production start up in 2009. Vessel modification triggered need for complete system re-analysis.

- 18 flexible risers
- 4 umbilicals

SOW:

- Complete IVA service for Frade riser and umbilical reanalysis:
  - Verify contractors global and local re-analysis
  - Document review
  - Independent extreme and fatigue analysis