Versatile flow assurance solutions for the design and operation of challenging subsea developments

Priscilla Ujang

Deepwater subsea tieback

Kuching, Sarawak, MALAYSIA
24TH - 26TH January, 2011
Established: 1971
Headquarter: Oslo, Norway
Employees: 230+
Turnover: €42 million (2009), €36 million (2008)
Ownership: Altor, Cubera, Pipeflow Invest and employees

Software, consulting services, training and solutions...
Software to analyse flow dynamics – secures the highest production at all times

Dimensioning and specification to optimise production and minimise risk
SPT Group acquired NEOTEC

PRODUCTS

PIPESYS (integrated in HYSYS/ UNISIM Design)

Why?
Enable SPT Group to supply further value to the upstream Oil & Gas simulation market
  - Compliments SPT Group’s product portfolio
  - Enables development of Steady State to Dynamic work flows
The workflow

- PIPEFLO Dynamic enables dynamic simulation of select parts of a PIPEFLO network using OLGA's dynamic capability
- This introduces OLGA to new user groups and ensures that dynamic effects are uncovered; whereas conventional steady state approaches don’t simulate this.
- A link between PIPEFLO and OLGA allows you to create a model in PIPEFLO for the required steady-state work, then move onto addressing the full dynamic complex by transferring the model to OLGA.

Simulation of select dynamic scenarios through the PIPEFLO interface

Comprehensive reports for single flow-paths up to 20 miles (32 km) long and diameters up to 16”
OLGA - introduction

The worlds leading transient multiphase flow simulator

- The software that made multiphase transport possible
- The ‘De facto’ industry standard

Enabling technology for all multiphase field developments

Used throughout the project/field lifecycle

- Concept
- FEED
- Detailed Design
- Operations
- Optimisation

Offshore development

Subsea tieback

Onshore development
Flow Assurance

- Mature application but continued expansion of functionality
  - Module compatibility (Slugtracking, Compositional tracking,..)
  - Elastic pipewall (pressure surge)
  - New Graphical User Interface and HD flow model with OLGA 7
OLGA - Flow Assurance applications

- Advanced Blow out control (ABC)
- Multiphase flowlines
- Well optimisation
- Hydrate predictions
- Thermal calculations
- Wax prediction & pigging
- Inhibitor control
OLGA - Flow Assurance applications (cont)

- Compositional tracking
- Subsea processing
- CO₂ transportation
- Multiphase boosting
- Slugging prediction and control
- Corrosion prediction
Integration

- OPC Connection (replaces OLGA Server)
- Standard interface to Process simulators
- Excel interface
OLGA - why is the use increasing?

• **New fields using multiphase development plans**
  – Subsea tiebacks to existing processing facilities
  – Subsea production systems on deepwater projects
  – Long distance multiphase transportation

• **Multiphase issues on mature fields**
  – Conversion of single phase flowlines to multiphase
  – Dynamic production optimisation
  – New technologies to extend field life e.g. multiphase pumping

• **Increasing flow assurance challenges**
  – Hydrodynamic and riser/terrain induced slugging
  – Wax and hydrate management
  – Gas, liquid and inhibitor management
OLGA Value Chain through Field Life

**DELIVERABLES / VALUE**
- Feasibility
- Design / Engineering
  - Max. Operational Window
- Operating Philosophy
- Operator Training Procedures
- Monitoring, Advanced Warnings and Control
- Production Optimization
- Modifications
- Training

**MODELING TOOLS**
- OLGA Engineering Simulator
- Integrated Engineering Simulator
- Operator Training Simulator - OTS
- Online Flow Assurance Solution

**EVOLUTION OF OLGA MODELS**
- Estimations
- Accuracy, Robustness & Speed
- Tuned to Field Data
- Historical Database
€120 million investment in OLGA technology

Research Partners
- IFE
- SINTEF
- ConocoPhillips

Industry Partners
- StatoilHydro
- Eni
- Total
- ExxonMobil

User Community

Industry Partners
- OVG
- Horizon

1989 1999 2009
OVIP - OLGA Verification and Improvement Project

- **Scope**
  - Collect data and identify areas where more data is needed
  - Compare OLGA to laboratory and field data
  - Improve the code in areas found to need improvement

- **Joint project IFE and SPT Group**

- **Sponsors (current and past)**
  - BP
  - ENI
  - ExxonMobil
  - Petronas
  - Shell
  - Statoil
  - Total
  - Chevron
  - ConocoPhillips
  - GDF SUEZ
  - Petrobras
  - Saudi Aramco
HORIZON – Continued focus on development

• **Scope**
  - Long distance transport
  - Deep water risers
  - Tail end production
  - Associated flow assurance problems

• **Joint project IFE and SPT Group**

• **Sponsors**
  - Chevron
  - ENI
  - ExxonMobil
  - Shell
  - Statoil
  - ConocoPhillips
  - SPT Group
OLGA and Flow Assurance
Throughout Various Field-Life Phases

• Expertise in Different Development Phases
  – Design Phase
  – Preparations for Start-up Phase
  – Operational Phase
Design

- **Production System Capacity Evaluations**
  - Flow line sizing (capacity and stability)
  - Lift curves input for wells and production lines
  - Effects of gas lift (down-hole, wellhead or riser base)

- **Thermal Evaluations**
  - Insulation requirements
  - Heated production lines
  - Flow line cool-down
  - Well start-up

- **Special Operations**
  - Start-up and shutdown
  - Depressurization
Preparation to Start-up

• **Design Verification**
  – Review design and philosophies
  – Evaluate need for, and perform additional / revised simulations

• **Operational Procedures**
  – Simulate normal operation in detail
  – Evaluate special operations
    • Hydrate control
    • Liquid handling
    • Wellhead / choke temperatures
    • Other specials like scaling, wax, etc.
Operation

• **Initial Field Start-up**
  – On-site flow assurance expertise
  – Ad-hoc simulations and evaluations
  – Model benchmarking and tuning
  – Advice on flow assurance in unforeseen situations
  – Troubleshooting

• **General Field Operation**
  – Production optimization
  – Optimization of chemical injection (inhibitors)
  – Model maintenance
  – Support in revision of operational procedures
> 150 projects with integrated simulators
> 30 projects with OLGA in Operator Training Simulators
> 35 projects with OLGA in Online Systems
e-Field Solutions

OLGA Online  Online Flow Assurance & Well Monitoring
OLGA OTS  Operator Training Simulators with OLGA
OLGA VFM  Virtual Flow Metering
OLGA Trainer  Multiphase Production Training Simulator

Solutions provided by SPT Group and Partners…
The Operating Envelope of Your Field...

OLGA Online enables operation closer to margins
OLGA Online
Online Flow Assurance Solution

e-Field Dynamic Production Management Systems
Online flow assurance for optimization and control through automated monitoring and prediction of oil and gas operations.
enabling unique added value to our customers in operation of oil & gas fields:

- liquid and pigging management
- stable and increased production
- reduces use of inhibitors and hydrate control
- optimized gas lift operation
OLGA Online
The modeling centerpiece for flow management in integrated operations

- Adopted as an industry standard, deployed in significant and challenging sites worldwide
- The next generation flow management solutions developed in close cooperation with innovative partners to ensure flexible, user-friendly and robust solutions
OLGA Online

The modeling centerpiece for flow management in integrated operations

- High fidelity dynamic flow model from well perforation to processing
- Expandable models and user-friendly interfaces
- Continuously validated with relevant field data shared by major oil companies
- Lifecycle modeling used from feasibility through start up to abandonment
Install Base of OLGA Online...

Online Dynamic Production Management Systems based on OLGA

40 Sites
The eField Thinking...

• **Drivers**
  – Safer operation and workplaces (HSE)
  – Increased production and regularity
  – Reduced OPEX

• **Combining key elements**
  – Fit-for-purpose TECHNOLOGY (incl. OLGA Online)
    • PC → Internet → Bandwidth (between assets and remote centres)
    • ICT and Oil & Gas integration
      – Improved effectiveness by accessing much more real-time data
      – Bringing information to the users (not the users to the information)
      – Better and faster decisions
  – Smart IMPLEMENTATION
    • Establish streamlined and more efficient work processes
    • Form cross-functionality / multi-discipline organisations
    • Integrate throughout oil company and services / expert companies
    • Extensive collaboration
OLGA Online – Model-Based Instrumentation

OLGA multiphase flow model
Valid for all operating scenarios
Tuned to real-time measurements

Available anywhere in the pipeline or production system

- Pressure
- Temperature
- Velocity
- Liquid holdup
- Flow regime
- Hydrate margin
- Inhibitor distribution
OLGA Online Architecture

Advisors & Managers
- Transparent Production System
- Virtual Instrumentation
- Slug Advisor
- Inhibitor Inventory Advisor
- Pig Tracking Advisor
- Choke Control Advisor
- Hydrate Advisor
- Leak Detection Advisor
- Ramp-Up Advisor
- Gas-Lift Advisor
- Cool Down Advisor
- Dead-Oil Inventory Advisor
- Slug Control Manager
- Inhibitor Injection Manager

OLGA
- Real-time model
- Look-ahead model
- What-if model

Tuning System
Alarm System
Instrument Validation & Replacement

Real-time Data Archive
Historical Data Archive

OPC interface (client-server)

Field data
Control System
- ABB
- Emerson
- Honeywell
- Invensys
- Kongsberg
- Siemens
- Yokogawa
- Aker
- Cameron
- FMC
- GE

Historical Database
OSI PI - Aspen IP21

3rd party Applications
OPC interface
OLGA Online versus Integrated Field Models

- Training
- Planning
- What-if
- Procedures
- Verification
- Engineering

- Forecasting / Decline curves
- Well allocation / Optimisation
- Rate set-points (steady state)

OLGA Online Production Management System
Dynamic Models (sec, min, hour, day)

Integrated Field Model
Steady State Models (week, month, year, field life)
Petroleum Experts / Schlumberger

Office domain

Control domain

Basic Control Layer (PLC / SCADA / DCS)
ABB / Emerson / Honeywell / Inversys / Siemens / Yokogawa
Aker / Cameron / FMC / GE

P, T, Q
Control settings

Sensors
Instrumentation
Actuators

Reservoir and Production Facility

Production Well
Injection Well
## OLGA Online Base System and Managers

<table>
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<th>OLGA Online Base System</th>
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<tr>
<td>Transparent Production System</td>
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<tr>
<td>Virtual Instrumentation / Metering</td>
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<td>Instrument Validation and Replacement</td>
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<td>Well and Production Allocation</td>
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<td>Alarm System</td>
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<td>Scenario Planning System</td>
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<td>Tuning System</td>
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<table>
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<tr>
<th>OLGA Online Managers</th>
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</thead>
<tbody>
<tr>
<td>Inhibitor Injection</td>
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<tr>
<td>Slug Mitigation and Control</td>
</tr>
<tr>
<td>Choke Control</td>
</tr>
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</table>
# OLGA Online Advisors

## Gas-Liquid Management Advisors

<table>
<thead>
<tr>
<th></th>
<th>De-pressurization</th>
<th>User Defined Scenario</th>
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<tr>
<td>Flow Regime</td>
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<tr>
<td>Liquid Inventory</td>
<td>Shut-In Settle-Out</td>
<td>Well Routing Decision</td>
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<tr>
<td>Pig Tracking / Frequency</td>
<td>Ramp-Up Optimization</td>
<td>Well Kick-Off</td>
</tr>
<tr>
<td>Slug and Surge Volume</td>
<td>Gas-Lift Optimization</td>
<td>Well Start-Up Optimization</td>
</tr>
<tr>
<td>Slugging</td>
<td>Oil Production Optimization</td>
<td>Well Testing</td>
</tr>
<tr>
<td>Packing &amp; Survival Times</td>
<td>Subsea Processing and ESP</td>
<td>Well Performance Monitoring</td>
</tr>
</tbody>
</table>

## Thermal Management Advisors

<table>
<thead>
<tr>
<th></th>
<th>Annulus Pressure Management</th>
<th>Dead-Oil Inventory and Pigging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibitor Tracking and Inventory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibitor Shutdown</td>
<td>Warm-Up</td>
<td>Wax</td>
</tr>
<tr>
<td>No-Touch Time</td>
<td>Cool-Down</td>
<td>Hydrate</td>
</tr>
</tbody>
</table>

## Integrity Management Advisors

<table>
<thead>
<tr>
<th></th>
<th>Gas / Oil Quality Compositional Tracking</th>
<th>Liquid Contaminant &amp; Additive Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned Production Forecast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion Velocity</td>
<td>Leak Detection</td>
<td>Corrosion</td>
</tr>
<tr>
<td>Sand</td>
<td>Blockage Detection</td>
<td>Critical Event Training</td>
</tr>
</tbody>
</table>
Typical Deepwater Advisors (Oil-Based)

- Gas-Lift Advisor
- Cooldown Advisor
- Slug and Surge Volume Advisor
- Inhibitor Tracking & Inventory Advisor
- Hydrate Advisor
- Dead Oil Inventory Advisor
- Leak Detection Advisor
- Pig Tracking/Frequency Advisor
- Pipeline Blockage Advisor
- Depressurisation Advisor
- Wax Advisor
Typical Gas Condensate Advisors

- Liquid Inventory Advisor
- Pig Tracking/Frequency Advisor
- Gas Packing/Survival-Time Advisor
- Slug and Surge Volume Advisor
- Inhibitor Tracking & Inventory Advisor
- Hydrate Advisor
- Ramp-Up Advisor
- Leak Detection
- Pipeline Blockage Advisor
- Depressurisation Advisor
- Well Liquid-Loading Advisor
Typical Onshore Advisors (Oil Based)

- Flow Regime Advisor
- Liquid Inventory Advisor
- Slug Detection and Tracking Advisor
- Scraper Tracking/Frequency Advisor
- Active Slug Control Manager
- Leak Detection Advisor
- Ramp-Up Advisor
- Pipeline Blockage Advisor
- Corrosion Advisor
OLGA Online – User Modes

- **Real-time**
  - Monitoring
  - Watchdog
  - Control

- **Look-ahead**
  - Forecasting

- **Planning**
  - Planning
  - What-if
  - Analysis
  - Training

**Transparent pipeline / production system showing:**
Liquid inventory during pigging and low flow operation
OLGA Online – User Modes

- **Real-time**
  - Monitoring
  - Watchdog
  - Control

- **Look-ahead**
  - Forecasting

- **Planning**
  - Planning
  - What-if
  - Analysis
  - Training

Online monitoring and virtual instrumentation

Looking into the future

Information shared continuously

LAM initialised automatically or at operators request

WIM initialised on request or from database

Offline decision making

OLGA Online – User Modes
OLGA Online – Look-ahead and Planning

OLGA® Online modes and example predictions

- Slug catcher pressure
- OLGA Online Look-ahead mode
- OLGA Online Look-ahead mode with scenario
- OLGA Online Planning mode

Slam catcher pressure with change in gas export rate

$t = t_{\text{current}}$  $t = t_2$

$\Delta t$

$t = t_1$  $t = t_{\text{current}}$

OLGA Online – Look-ahead and Planning

OLGA® Online modes and example predictions

- Slug catcher pressure
- OLGA Online Look-ahead mode
- OLGA Online Look-ahead mode with scenario
- OLGA Online Planning mode

Slam catcher pressure with change in gas export rate

$t = t_{\text{current}}$  $t = t_2$

$\Delta t$

$t = t_1$  $t = t_{\text{current}}$
## OLGA Online Utilisation / Typical Users

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow assurance specialist</td>
<td>Design and verification of production system from concept stage to start-up throughout design activities.</td>
</tr>
<tr>
<td>Start-up team</td>
<td>Preparation and verification of operational procedures prior to start-up by using OLGA Online planning mode.</td>
</tr>
<tr>
<td>Operator</td>
<td>Extensive training prior to start-up utilising OLGA Pipeline Trainer. Daily monitoring and control of production system by using real-time and look-ahead modes.</td>
</tr>
<tr>
<td>Production and subsea engineer</td>
<td>Daily support of operations. Using what-if / planning modes. Production optimisation, e.g. gas lift and MEG injection.</td>
</tr>
<tr>
<td>Remote support centre</td>
<td>Remote monitoring and advisory of field assets. Integration with total field models and multi-disciplines. Use all modes of OLGA Online.</td>
</tr>
<tr>
<td>Instrument engineer</td>
<td>Validation of field instrumentation. Fall-out strategy. Instrument calibration.</td>
</tr>
<tr>
<td>Planners</td>
<td>Analysing historical data. Checking out planned operation.</td>
</tr>
<tr>
<td>Integrity manager</td>
<td>Monitoring of key parameters pertaining to corrosion, erosion, blockage, leak detection, pressure, temperature etc.</td>
</tr>
<tr>
<td>SPT engineer</td>
<td>Training and knowledge building of end user. System maintenance and tuning. Flow assurance services on demand.</td>
</tr>
</tbody>
</table>
OLGA Online Real-Time GUI
– Field Overview
OLGA Online Real-Time GUI – Production Well
Combined Real-Time and Look-Ahead trends
OLGA Online Real-Time GUI
– Flow Line and Riser
OLGA Online Real-Time GUI
– Process Inlet Facility
OLGA Online What-If GUI – Flow Line and Riser
OLGA Online What-If GUI
– Controller Display

**Controller settings**

**Automatic**

- **Controller gain**: 1.00
- **Integral time**: 500.00 s
- **Derivative time**: 0.00 s

**Measurement**: 2.35 m

**Setpoint**: 2.35 m

**External setpoint**

**Actual setpoint**: 2.35 m

**Manual input**: 24.29 %

**Controller output**: 39.81 %
## Benefits Achieved – Example Projects

<table>
<thead>
<tr>
<th>Region</th>
<th>Benefits</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>Optimised use of expensive LDHI, reduced OPEX</td>
<td></td>
</tr>
<tr>
<td>North Africa</td>
<td>Optimised injection of MEG, reduced to 50%</td>
<td></td>
</tr>
<tr>
<td>Gulf of Mexico</td>
<td>Extended field-life with more than 10 months</td>
<td></td>
</tr>
<tr>
<td>North Sea</td>
<td>Increased accuracy of Virtual Metering System</td>
<td></td>
</tr>
<tr>
<td>West Africa</td>
<td>Increased production and regularity</td>
<td></td>
</tr>
<tr>
<td>North Sea</td>
<td>Superb transparent window into the subsea production system, proved increased operability and uptime</td>
<td></td>
</tr>
<tr>
<td>Gulf of Mexico</td>
<td>Payback time less than a month</td>
<td></td>
</tr>
<tr>
<td>West Africa</td>
<td>System paid back with 1-hour saved cooldown time (typical for large deepwater fields)</td>
<td></td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>Improved operability of mature gas field</td>
<td></td>
</tr>
</tbody>
</table>
Oil Field
Pipeline Management System

Client/Operator: Confidential
Site: APAC
Delivery: 2010

System Integration:
- ABB Industrial IT and OSI PI Historian

Model (OLGA):
- Crude pipeline from offshore platform to onshore processing plant
- Crude includes varying amount of water

Modes:
- Real-time
- Look-ahead
- Planning (what-if)

Applications:
- Transparent production system
- Liquid inventory advisor
- Slug and surge volume advisor
- Pig tracking advisor
- Oil quality advisor
Deepwater Oil Field
Online Flow Assurance System

Client/Operator: Confidential
Site: Angola
Delivery: 2010

System Integration:
• OSI PI Historian

Model (OLGA):
• Production wells
• Flowline loops
• Tiebacks and risers
• Separators
• Gas injection
• Fluid displacement

Modes:
• Real-time
• Look-ahead
• Planning (what-if)

Applications:
• Transparent production system
• Pig tracking and fluid displacement advisor
• Slug and surge volume advisor
• Hydrate advisor
• Cool-Down advisor
• Wax advisor
Shallow Water Oil Field
Hydrate Prediction Tool

Client/Operator: Confidential
Site: Caspian Sea
Delivery: 2010

System Integration:
• ICSS (Integrated Control and Safety)

Model (OLGA):
• Production chokes
• Multiphase pipelines
• Separators

Modes:
• Real-time
• Look-ahead
• Planning (what-if)

Applications:
• Transparent production system
• Methanol tracking system
• Hydrate formation advisor
• Cool-down advisor
• Warm-Up Advisor
• Blockage detection advisor
• Pig tracking advisor
Gas Gathering Network
Pipeline Management System

Client/Operator: Confidential
Site: Angola
Delivery: 2010

System Integration:
- Emerson DeltaV control system

Model (OLGA):
- Risers and pipelines
- Subsea manifolds
- Methanol injection

Modes:
- Real-time
- Look-ahead
- Planning (what-if)

Applications:
- Transparent production system
- Virtual metering
- Liquid inventory advisor
- Gas packing / survival time advisor
- Gas quality and compositional tracking advisor
- Hydrate advisor
- Blockage detection advisor
- Methanol tracking advisor
Gjøa
Flow Assurance System

Client/Operator: GDF SUEZ
Site: Norway
Delivery: 2010

System Integration:
• OSI PI historical database

Model (OLGA):
• Production wells (13)
• 5 subsea manifolds
• 1 loop (one flowline dedicated for oil and one for gas wells)
• 1st and 2nd stage separators topside
• Gas lift and gas warm up dynamics

Modes:
• Real-time
• Planning (what-if)

Applications:
• Transparent production system
• Virtual metering
• Liquid inventory advisor
• Slugging advisor
• MEG tracking advisor
• Planned production forecasting advisor
• Tuning system

Includes flow assurance service contract for 5 years plus options for 3+3 years
Gjøa
Flow Assurance System

Purpose:
• Decide production routing of individual wells to gas or liquid flowlines
• Provide virtual flow meters for each well as back-up system for the subsea multiphase flow meters
• Predict forming of slugs
• Monitor critical operational parameters like temperature
• Provide production planning and advice tool
• Validate operational procedures
Gjøa
Flow Assurance System

“GDF SUEZ Integrated Operations ambitions are to increase Hydrocarbon recovery factor, increase preventive maintenance and reduce operational expenditures through better and faster decisions through collaboration with external vendors and service companies like SPT Group”

Terje Overvik, Managing Director for GDF SUEZ E&P Norge
System Purpose:
- Monitor under-balanced drilling process in one well

System Integration:
- WITS, OPC and Modbus

Model (OLGA):
- Dynamic model of the wellbore

System Features:
- Monitoring pressure while drilling (open loop control)
- Controlling the UB (Under-Balance) by adjusting chokes on the wellhead (closed loop control)
- Estimating reservoir inflow while drilling (on-line reservoir characterization)
Managed Pressure Drilling
OLGA Online System

Client/Operator: Ocean Riser Systems (ORS)
Site: New Drilling Concept
Delivery: 2006

System purpose:
• Support Managed Pressure Drilling (MPD) operations

System Integration:
• OPC Client-Server

Model (OLGA):
• Dynamic model of the ORS-LRRS system (Low Level Riser Return and mud-lift pump System)

System Features:
• Monitoring and control riser hydrostatic head while drilling
• Constant bottom-hole pressure (BHP) while drilling and during connections

ORS MPD System Features:
• Improved well control
• Drill longer sections
• Faster & more efficient drilling
OLGA Online System Integration

• Typical measurements utilized by OLGA Online
  – Pressure
  – Temperature
  – Flow
  – Valve positions

• OPC client-server communication is standard
  – OPC DA (Data Archive)
  – OPC HDA (Historical Data Archive)
  – OPC AE (Alarms and Event)

• Supports dual redundant communication setup

• Dedicated links may be offered optionally
  – Modbus
  – WITS

• Links directly to control system or to historical database

DCS:
• ABB
• Emerson
• Honeywell
• Kongsberg
• Invensys
• Siemens
• Yokogawa

Historian:
• OSI PI
• Aspen IP21
• Honeywell PhD
OLGA Online
Real-Time & Historical Data Archive

• Advanced Plant Information System (APIS)
• Real-time kernel
• High performance database
  – 100,000 I/O per second
• Large capacity data historian storing values, quality and time stamp
  – Including storage of vectors (e.g. pipeline profiles)

*Internal databases for OLGA Online
(in addition to plant Historian)*
OLGA Online
Graphical User Interface (GUI)

• User-friendly
  – Web-based and flexible
  – Key decision parameters
  – Warning symbols
  – Flow assurance / Expert analysis

• Accessible anywhere
  – User defined access control
  – Runs on
    • Controlnet
    • Intranet
    • Internet
OLGA Online Interface to 3rd Party Applications

• Open system exposing useful and invaluable information
• Plug-ins to 3rd party applications
  – Process simulators
  – Reservoir and well simulators
  – Corrosion and pipeline integrity packages
  – Sand detection and monitoring applications
  – Optimizers for production wells, pipelines and processing plant
  – Slug controllers
• Data available for presentation in control system
  – Model-based information
  – Pipeline profiles
  – Look-ahead predictions
  – Critical information (leakage, slugging, hydrate, etc)
• Excel plug-in
  – Evaluation of historical data
OLGA Online
Alarm System (Advanced Warnings)

• **Real-time Mode**
  – Additional to the conventional alarms in control system
  – Alarms triggered by model-based instrumentation or Advisor
    • Pipeline Leakage
    • Risk for Hydrate formation
    • Pig arrival (e.g. 20 minutes away from pig receiver)
    • Lack of inhibitor
    • Arrival of slugs or liquid surges (e.g. in riser bottom)
    • Too fast ramp-up
  – Alarms available in OLGA Online Expert GUI and/or integrated in control system Operator Station

• **Look-ahead/Forecasting Mode**
  – Simulations into the future including operational changes
  – Early alarm predictions
    • For example separator high liquid level occurs in 3.5 hours
OLGA Online Tuning System

- **Automatic Tuning**
  - Pipeline friction
  - Pipeline heat transfer / ambient temperature
  - Reservoir pressure, temperature and composition
  - Automatic flow tuning

- **Manual Tuning**
  - Encompass variation from design input and actual plant
  - Account for larger model discrepancies
OLGA Online
Data Validation and Replacement

• Data validation
  – All data is validated against predefined ranges (for each data)
  – Validation package secure reliable and quality checked data before entering the online model/system
  – The data signal is stamped “bad” if violating one or more of the defined limits in the validation check
    • Minimum value
    • Maximum value
    • Maximum rate of change

• Data replacement
  – Unreliable data is replaced by a fixed value
Operator Training Simulators (OTS) with OLGA
Operator Training Simulator (OTS) with OLGA - Why OLGA in OTS

• Key value added of OLGA in OTS:

  • Ensures that interactions between multiphase production network of wells & pipelines and processing plant are represented realistically
    • Design verification and improvement
    • Reduced commissioning time
    • Efficient knowledge building
    • Higher production
    • Safer operation

• Value added for:
  • Training efficient, accurate and realistic
  • Procedures validation and improvement
  • Flow assurance increasing challenge with field operation
  • Control system subsea control, process control and safety
Operator Training Simulator (OTS) with OLGA - Typical OTS System Architecture
Operator Training Simulator (OTS) with OLGA - Well-Proven Interface

- OLGA is **seamlessly integrated** in all the main process simulator architectures
  - Controlled and fully **synchronized** with Process Simulator environment
  - The Process Simulator **GUI** is used also for the OLGA/subsea part
  - Look-and-feel as **ONE** simulator

- **Key performance indicators for an integrated OTS**
  - **Robustness** uptime is required to be high, but less than for online
  - **Speed** 2-5 times real-time
  - **Accuracy** comparison
    - +/- 2% in steady state
    - +/- 10-20% during dynamic scenarios
Operator Training Simulator (OTS) with OLGA - from Well Perforations through Processing

• An integrated subsea, process facility and control & safety system simulator model
  – Incorporates the impact of wells & pipeline transients on process facility and interaction with the control & safety system
  – And vice versa…

• The OLGA subsea model covers entire multiphase facilities
  – Wells (from perforation), subsea wellheads and manifolds
  – Subsea processing
  – Flowlines, loops and risers
  – Injection of inhibitors

• The process and control system model
  – Topside / onshore inlet arrangement, e.g. choking
  – Separation, compression, pumping and other processing facilities
  – Utility systems like flare, heating and cooling medium modules
  – Controllability, safety logic and sequencing
  – MEG regeneration and injection system impacting the subsea part (e.g. water and gas injection, gas lift, inhibitor injection and dead-oiling)
Operator Training Simulator (OTS) with OLGA
- Typical Training / Operational Scenarios

- Start-up of wells and processing
- Shut-down (planned and unplanned)
- Blow-down (depressurization)
- Hydrate region awareness
- Topsides and Subsea team interactions
- Hydrate inhibitor injection and tracking
- Well annulus pressure management
- Switching wells into test
- Checking out well start-up order
- Slug arrival and slug control
- Varying separator operating pressures
- Pressure equalization using chemical injection
- Adjusting production with wells into HP/IP/LP headers

Mainly the same Operational Scenarios as handled in an online system…

- Normal operation
- Liquid management
- Ramp up rates
- Bull-heading
- Pigging
- Dead-oiling
- Cool-down
- Gas-lift
Operator Training Simulator (OTS) with OLGA - Some Examples of Benefits

Sable OTS (offshore complex with multiphase pipes – Canada)
- Proven very valuable for overall engineering and design
- Added hands on experience to control room operators prior to start-up
- Validation of operating procedures

Snøhvit OTS (subsea-to-beach wet gas field – Norway)
- Saved more than 4 months commissioning time at site by using OTS as test bed for control system and logic
- A high number of operators and engineers were trained prior to first gas

South Pars 2&3 (offshore-to-onshore gas condensate field – Iran)
- Prediction of the sealine liquid hold-up volume
- Planning of mechanical pigging frequencies
- Glycol inventory control
- Ensure optimal and safe production

Na Kika OTS (deepwater oil and gas field – Gulf of Mexico)
- New DCS verified and debottlenecked on OTS prior to start-up
- Operational procedures improved and verified at OTS
- Increased expected uptime from 82 to 96% the first 6 months of operation

Goldeneye OTS (remote-controlled gas-condensate field – UK)
- OTS ensured flawless start up of field
OLGA in OTS (Operator Training Simulator)
Selected Project References

Oil Fields

1. Dalia (Total)
2. Greater Plutonio (BP)
3. Lobito Tomboco (Chevron)
4. Agbami (Chevron)
5. Akpo (Total)
6. Bonga (Shell)
7. Atlantis (BP)
8. Blind Faith (Chevron)
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15. Yme (Talisman)
16. Block 31 (BP)
17. Gumusut (Shell)

Gas-Condensate Fields

1. Carina Aries (Total)
2. Sable (Exxon)
3. Taurt (BP)
4. KG-D6 (Reliance)
5. South Pars 2&3 (SPGC)
6. South Pars 6,7&8 (SPGC)
7. Pohokura (Shell)
8. Ormen Lange (Shell)
9. Sleipner (StatoilHydro)
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13. Troll-Kolsnes (StatoilHydro)
14. Corrib (Shell)
15. Goldeneye (Shell)
16. Umm Shaif (ADMA OPCO)

From well perforations, manifolds, pipelines and risers throughout processing facilities…
Operator Training Simulator (OTS) with OLGA - Value added

- The value added for operator training:
  - Realistic and detailed hands-on operator training
    - Includes entire production system: wells, manifolds, flow lines, risers, inlet processing, main processing and utility systems
    - Encapsulate full dynamics and interactions between well / pipeline and processing plant and correct response times

- The value added for procedures:
  - Making of the operating procedures
  - Testing of procedures prior to commissioning and start up
  - Reduce commissioning time
  - Testing of a wide range of operating procedures:
    - Verify start-up & shut down procedure (ramp-up, pigging, gas lift)
    - Modify start-up & shut down procedure
Operator Training Simulator (OTS) with OLGA - Value added

• The value added for flow assurance:
  • Ensure optimal and safe production
  • Offline prediction of flow assurance issues
  • Determine the flow regime in the flow lines
  • Possible to see the effect on the topside system when changing the subsea operating conditions
  • Prepare for unplanned situations like slugging, shut down etc.

• The value added for control system:
  • Validate control strategies
  • DCS verified and debottlenecked on OTS prior to start-up
  • Optimized controller settings (tuning to run optimal)
  • Added hands on experience to control room operators prior to start-up
  • Check the ability of control systems to provide stable control over full range of flows during steady state & transient operation (is the control system capable of controlling the plant under varying operating conditions)
Operator Training Simulator (OTS) with OLGA - Value added

• The Conclusion:
  • Efficient, accurate and realistic training in operating interacting multiphase production network of wells & pipelines and processing plant (slugging, gas lift, chemical injection, ramp-up, dead-oiling, etc.)

• Value added for:
  • Training
  • Procedures
  • Flow assurance
  • Control system

• Full transient behavior from well performance throughout multiphase production network and processing facilities
Typical Modeling Scope for OLGA Online and OLGA OTS
It is important to **understand** the dynamic interaction from well perforations through separator to capture the **true dynamics** of the production system.
Typical Scope: **Wells**

- Detailed wellbore modeling, annulus, inflow performance
- Individual well performance
- Dynamic interaction between wells feeding the same flowline(s)
- Liquid loading, unloading, flow instability / slugging, gas lift, cool down, inhibitor injection etc.
- Start-up of well from shut-in conditions, warm-up
- Production allocation
- Dynamic well testing
- Virtual instrumentation, hardware backup
Typical Scope: **Flowlines**

- Liquid management; oil, gas and water
- Slugging and rate change instabilities
- Flow assurance factors such as hydrates, wax etc.
- Cool down time, depressurization
- Routing of wells from production lines to test lines
- Virtual instrumentation, hardware backup
- Pigging
- Dead/hot oil
- Inhibitor injection
- Integrity management; pressure, corrosion, leakage, blockage, sand, erosion, etc.
Typical Scope: Facilities

- Separators, liquid levels and backpressure
- Slugging, surge management
- Dynamic interaction imposed by facilities on upstream system
- Flaring
- Pumping (inhibitor)
- Compressors, gas lift/injection, water injection
- Inhibitor storage tanks
Reference Projects
OLGA Online and OLGA OTS
## OLGA Online

### Selected References

Delivered by SPT Group

<table>
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<tr>
<th></th>
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# OLGA Online

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OLGA in OTS (Operator Training Simulator)
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From well perforations, manifolds, pipelines and risers throughout processing facilities…
OLGA Pipeline Trainer

A training simulator dedicated multiphase flow pipelines and production systems
OLGA Pipeline Trainer for Multiphase Production Systems

- High-fidelity training on flow assurance issues
- Generic or plant-specific systems
- Runs on standard PCs
- Building-block for online system and alternative / supplement for full-scope OTS

Model:
- Wells with reservoir interaction
- Valves and flowlines
- Pipeline(s) to platform or shore
- Inlet processing facilities
- Inhibitor injection
- Instrumentation and control system

Graphical User Interface:
- User-friendly operator-type (web-based)
- Window into the pipeline
- Highlights non-instrumented values
- Alarms on criticalities

Users:
- Operators
- Planners and supervisors
- Flow assurance and production engineers

Increase the understanding of transient multiphase flow...
OLGA Advanced Blowout Control
Well Control

- 20 years of Well control simulation with OLGA
- OLGA ABC - Well control specific interface to OLGA
Well Control

Essential part of emergency response planning

- Blowout rate estimation
- Relief well design
- Dynamic kill parameters
  - Kill Rate
  - Pump Pressures
  - Horsepower Requirements
OLGA for Wells
OLGA for Wells

- Specific interface to OLGA for Production Engineers’ needs
- Dynamic simulation of well scenarios
- Gives critical understanding of wells performance
OLGA for Subsea Wells

- Thermal Transients
- Liquid Loading
- Artificial Lift
- Cross flow
- Slugging & Surges
- Near Wellbore Effects
- Liquid Accumulation
- Stagnant Mud