Unlocking potential with Kongsberg Digital Production Performance solutions

Mike Branchflower, Global Sales Manager – Flow Assurance
Kongsberg Digital
Kongsberg
Over 200 years of innovation

FROM DEEP SEA TO OUTER SPACE
7,500 employees
Kongsberg Digital

Key focus areas
Production losses

Main driver is plant failure

- 6-10% of plant failure could be addressed by improving performance to top shifts

Theoretical improved MPP: 105-110

MPP: 100

Planned losses:
- Wellwork (2%)
- Full shutdown (2%)
- Partial shutdown (2%)

Unplanned losses:
- Plant failure (7%)
- Export capacity issues (3%)
- Reservoir events (1%)

Production efficiency: 84


1 Maximum production efficiency
## Contributors to production losses

### From plant failure

<table>
<thead>
<tr>
<th>Contributor category</th>
<th>Example issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression train</td>
<td>- Unplanned maintenance of compressor&lt;br&gt;- Compression failure due to suboptimal settings</td>
</tr>
<tr>
<td>Pipelines and risers</td>
<td>- Slugging causing production disturbances, flaring and shutdowns&lt;br&gt;- Deposition</td>
</tr>
<tr>
<td>Instrumentation and controls</td>
<td>- Limits exceeded</td>
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<td>Power generation and distribution</td>
<td>- Down time due to generator not running at full capacity</td>
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<tr>
<td>Annual shutdown over run</td>
<td>- Larger problems uncovered (e.g. broken equipment), or trouble starting up process plant</td>
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<tr>
<td>Pumps</td>
<td>- Pump failure</td>
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<tr>
<td>Tanks and vessels</td>
<td>- Suboptimal maintenance / inspection intervals</td>
</tr>
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</table>

**SOURCE:** Oil & Gas UK PILOT PETF, IMechE; Expert interviews
Dynamic simulation is the closest you can get to predicting performance of the actual process plant… during the design phase, before commissioning and through operations.
LedaFlow

Advanced Transient Multiphase Flow Simulator

• 1D Transient multiphase flow modelling

• Wellbore Sandface to Processing Facilities

• Improved accuracy in multiphase flow modelling with slug capturing, three energy equations and nine mass equations

• Seamlessly connects to K-Spice

• Owned by LedaFlow Technologies DA
K-Spice

Dynamic Process Simulation

• A dynamic process simulator and platform for model-based decision support application

• Builds on 35 years of experience and two world-class dynamic simulation tools (ASSET and D-SPICE)

• Specialised for Upstream Oil & Gas and LNG operations

• Seamlessly connected to LedaFlow
Multipurpose Dynamic Simulator (MPDS)

Digital Twin

Engineering Simulator
- Flow Assurance with LedaFlow®
  - Subsea wells
  - Flowline
  - Riser
- Engineering Studies K-Spice®Design

Operator Training Simulator K-Spice®Train
- ICSS Check-out K-Spice®Verify
  - ICSS OPC Link
  - I/O Database

Online Simulator
- Production Assurance K-Spice®Assure
  - Look-ahead predictions
  - Slug management
  - Scraper management
  - Leak detection
  - Hydrate prediction
  - Inhibitor management
  - Measurement
  - Reconciliation
  - Multi-well virtual metering
  - Production allocation
  - Sensor validation
  - Environmental monitoring
  - Condition monitoring

Online OTS K-Spice®Match
- Model validation
- Model tuning
- Analysis of process upsets
- Modification studies
- OTS initialization
Unlock the potential – next level in production efficiency

**North Sea project**

1. **Operator issue**
   - Several elements of the control system were identified to have a potential to increase production
   - One example was slug handling
     - Manual handling reduced production and caused a high stress factor in the operational team
     - Production disturbances
     - Reduced gas export
     - Gas flaring giving increased emission and CO2 tax

2. **What we did**
   - Each of the main issues with the control system were addressed to increase production
   - What did we do to addressslugging?
     - Production data analyzed using a digital twin representing the production facility (K-Spice and LedaFlow)
     - New control solution designed together with the operational team
     - Solution tested for robustness and stability using the digital twin and implemented on the offshore platform

3. **What we achieved**
   - The different improvements led to a 10% production increase
   - A robust and fully automated control system for handling slug flow was implemented:
     - Eliminated requirements for manual operations
     - Reduced shutdown risk
     - Maintained high and stable gas export rates
     - Prevented gas flaring giving a reduction in CO2 tax
Unlock the potential – next level in production efficiency

Gulf of Mexico project

1 Operator issue

- Need for virtual flow metering as back-up of unreliable physical multiphase flow metering
- Need to report well production rates when subsea physical sensors fail.
- Decision support tool to efficiently plan and manage production
- High wax deposition in flowline resulted in a need for frequent pigging
- Expensive offshore vessel based pig monitoring system

2 What we did

- Integrated subsea/topside digital twin (K-Spice and LedaFlow)
- Automatically calibrated online simulator with composition tracking
- Enabled capability to receive real-time or past field measurements
- Developed a planning simulator
- Developed a pig locator and arrival time estimator

3 What we achieved

- Accurate real-time virtual flow rates and pipeline flow conditions
  - Irrespective of the status of the physical multiphase flow meters
- Virtual flow meter and decision support tool aids engineers in reservoir planning and production optimization
  - Well re-routing, pigging, hydrate inhibition, choke settings
- Real-time monitoring of pig location and arrival estimates
  - Alert and prepare platform operations
Introducing Kognifai

### Digital Platform Ecosystem Approach

**PARTNERS & CONSUMERS**  
**RESEARCH & ACADEMIA**  
**AppStore**  
**1st party Partner**  
**ISV**

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<th>Digital Twin Fabric</th>
<th>INDUSTRY APPS</th>
<th>INDUSTRY SOLUTIONS</th>
<th>DIGITAL TWIN INNOVATION ARENA</th>
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<td>**DATA</td>
<td>SEMANTIC</td>
<td>HISTORIAN**</td>
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**Industry cluster**

- Oil & Gas
- Offshore
- Maritime
- Sea Farming
- Utilities
- Renewables
Smart Apps
Onshore and Offshore Production Efficiency

Catalog of Applications
- Condition Monitoring
  - K-Spice Match
- Performance Monitoring
  - K-Spice Analyze
- Production Planning
  - K-Spice Assure
- Enterprise Reporting
  - K-Spice Meter
- Software as a Service
  - K-Spice Train
  - LedaFlow SaaS

Digital Platform
- Advanced Analytics
  - Historic Data
  - Real Time Data
- kognifai
  - Digital Twin

Production Facility
Supporting Operators globally

- Anasuria
- Brent B/C/D
- Corrib
- Curlew
- Dragon
- ETAP
- Glenmavis
- Goldeneye
- Isle of Grain
- Knock Taggart
- Nelson
- Maria-Armada
- Goldeneye
- Atlantic & Cromarty
- Mariner
- Tormore Laggan
- Frovie North
- Statford A/B/C
- Tjeldbergodden
- Troll A/B/C
- Ula
- Valemon
- Valhall
- Varg
- Veslefrikk
- Visund
- Yme
- Åsgard A/B
- Alvheim
- Balder
- Draugen
- Ekofisk
- Fjella
- Gjea
- Grane
- Gudrun
- Gullfaks A/B/C
- Heidrun
- Heimdal
- Kristin
- Kvitebjorn
- Kårsta
- Nord
- Ormen Lange
- Oseberg Sør/Ost
- Oseberg FC
- Skarv
- Sleipner
- Snorre A/B
- Snøhvit LNG
- Johan Sverdrup
- Aasta Hansteen
- Gina Krog

Atlantic
Blind Faith
Na Kika
Norco Ethylene
OP-III Ethylene
Tahiti
Thunder Horse
Canyon Horse
Mirage
Mirage Express
NCMA
Frade
Agbami
Akp
Pazflor
Greater Plutonic
Kauther
Saih Nihaya
Saih Rawl
Korchagin
Dangzit
Bohai Bay
Petronas FLNG
Coral FLNG
Moerdijk
Simian/Sienna & Sapphire
Scarab/Saffron
WDDM4
NCMA