Galp
Petroleum
Engineering

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4th edition

Unlocking potential with Kongsberg Digital Production Performance solutions

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Kongsberg Digital

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Kongsberg

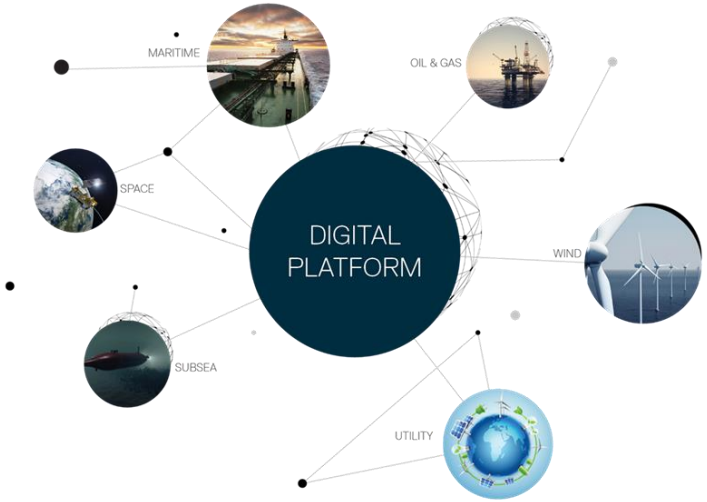
Over 200 years of innovation

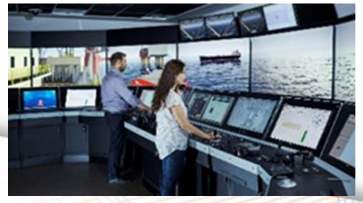
FROM DEEP SEA TO OUTER SPACE

7,500 employees

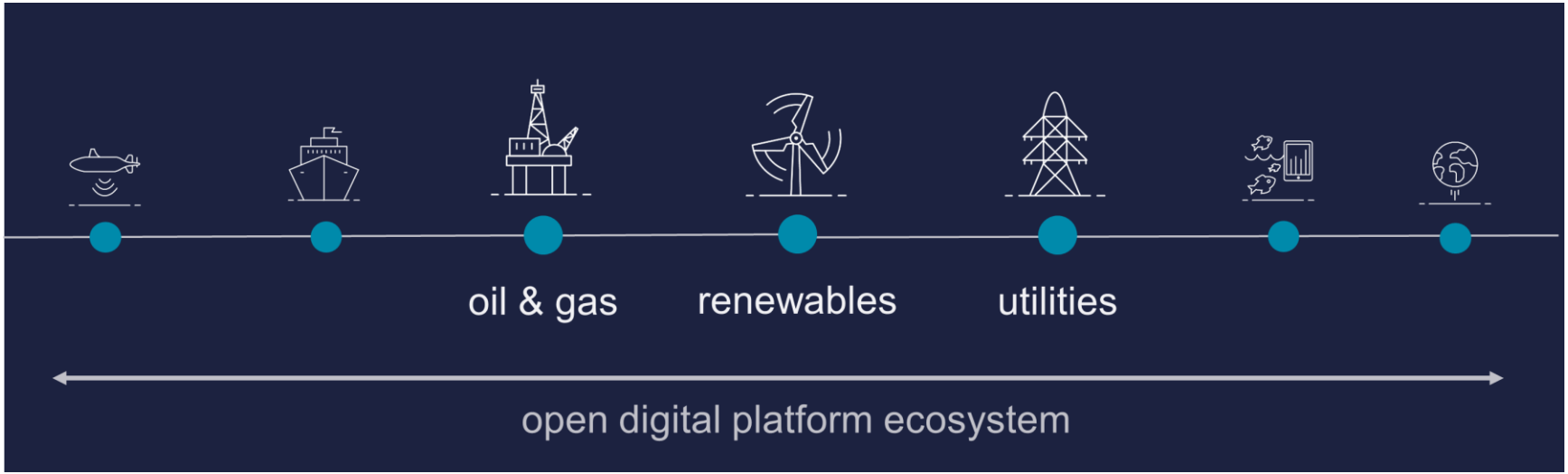
Kongsberg Digital

Key focus areas



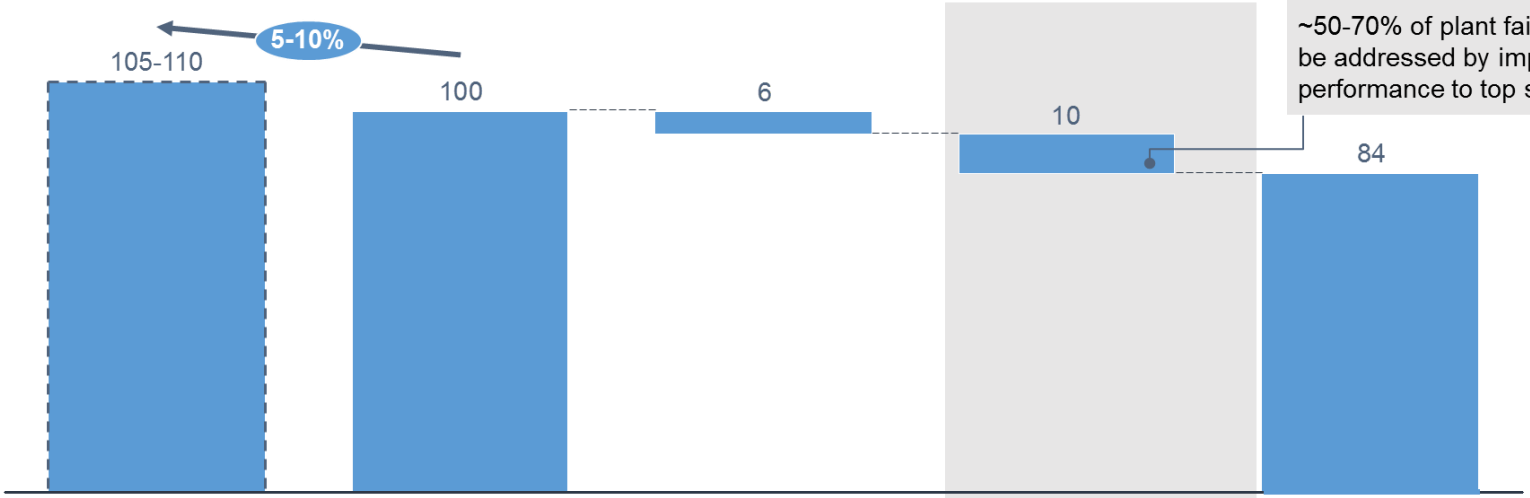


Kongsberg Digital - Energy



Production losses

Main driver is plant failure



1 Maximum production efficiency

SOURCE: North Sea 2015 – McKinsey Energy Insights Operations Benchmark; Expert interviews

Contributors to production losses

From plant failure

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

SOURCE: Oil & Gas UK PILOT PETF, IMechE; Expert interviews

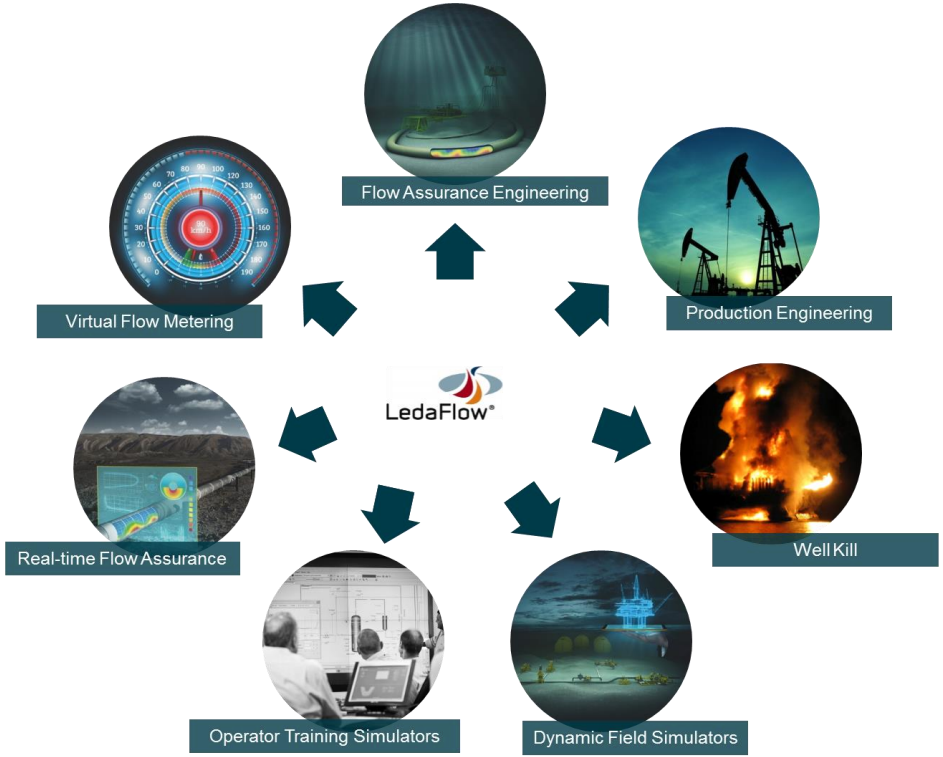
Dynamic simulation

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

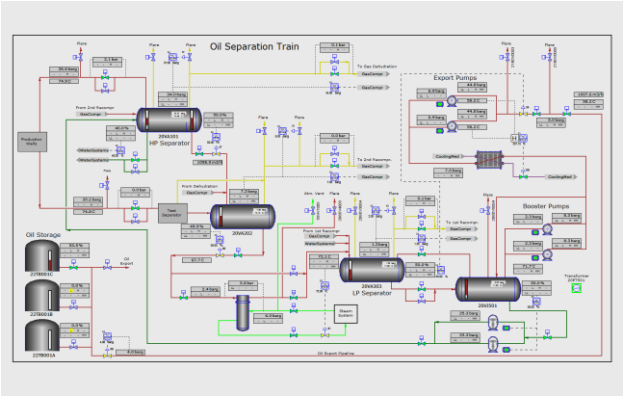
- 1D Transient multiphase flow modelling
- Wellbore Sandface to Processing Facilities
- Improved accuracy in multiphase flow modelling with slug capturing, three energy equations and nine mass equations
- Seamlessly connects to K-Spice
- Owned by LedaFlow Technologies DA

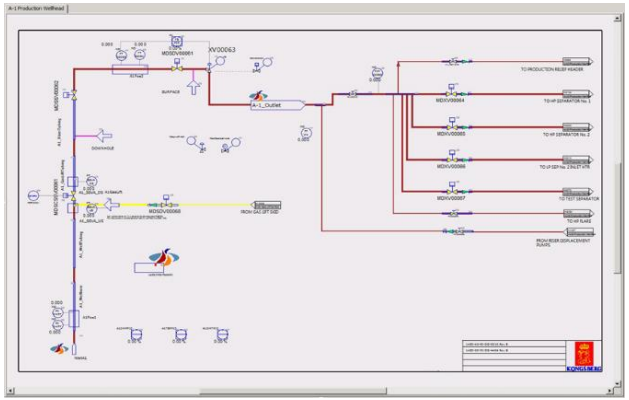


K-Spice

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

Online Simulator

Engineering Simulator

Flow Assurance with LedaFlow®

Subsea wells
Riser
Flowline

Engineering Studies
K-Spice®*Design*

LT
LC

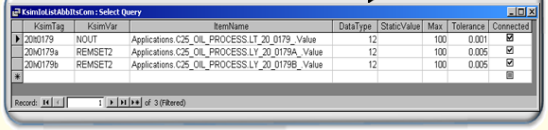
Operator Training Simulator
K-Spice®*Train*

ICSS Check-out
K-Spice®*Verify*

ICSS OPC Link
I/O Database

ICSS Logic

LI
XY
LY
LIC



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

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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 address slugging?
  - 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 C02 tax

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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

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Introducing Kognifai

Digital Platform Ecosystem Approach

PARTNERS & CONSUMERS

kognifai

RESEARCH & ACADEMIA

AppStore
1st party
Partner
ISV

Digital Twin Fabric

INDUSTRY APPS | INDUSTRY SOLUTIONS | DIGITAL TWIN INNOVATION ARENA

Digital Platform

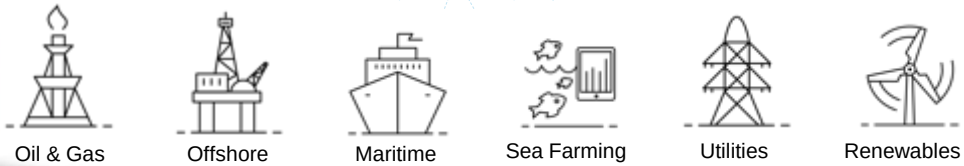
INDUSTRY PAAS	MICROSERVICES	API'S	OPEN SOURCE FRAMEWORK
DATA CATALOG	TECHNICAL CAPABILITIES	ADVANCED ANALYTICS	INTEGRATION FRAMEWORK

DATA | SEMANTIC | HISTORIAN

IOT GATEWAY

IT
IMS

Industry cluster



IMS
SAS
OT

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Smart Apps

Onshore and Offshore Production Efficiency

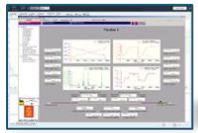
Catalog of Applications

Condition Monitoring

K-Spice Match

Performance Monitoring

K-Spice Analyze

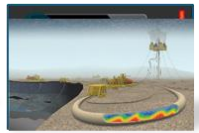


Production Planning

K-Spice Assure

Enterprise Reporting

K-Spice Meter



Software as a Service

K-Spice Train
LedaFlow SaaS

Digital Platform

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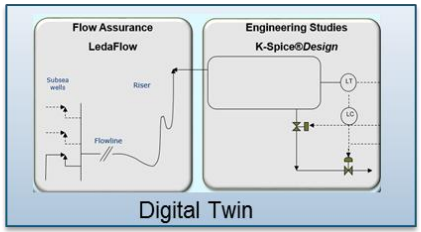

Digital Twin

Advanced Analytics

Historic Data

Real Time Data

Production Facility

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Supporting Operators globally