Digital Transformation

Smart and Connected Oilfield Operations
Introduction

Digital

What is it : Why it Matters

Motivations

$: Technology : Culture

E&P

Lifecycle (Exploration, Drilling etc.) : Back Office

HAL

What’s Different and Why
THE TRANSITION TO NEW BUSINESS PARADIGMS THAT LEVERAGE DIGITAL TECHNOLOGY TO CHALLENGE PREVIOUSLY HELD ASSUMPTIONS ABOUT THE INDUSTRY
Digital Vision : E&P Business Outcomes

<table>
<thead>
<tr>
<th>What the business is</th>
<th>How the business invests</th>
<th>The way the business operates</th>
<th>The way the business interacts</th>
<th>...and the way every employee works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Development</td>
<td>Field Management</td>
<td>Surveillance</td>
<td>Optimization</td>
</tr>
<tr>
<td>Basin Analysis &amp; Leads Management</td>
<td>Discovery &amp; Appraisal Mgmt</td>
<td>Dev Concept &amp; Design</td>
<td>Development Execution</td>
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**Digital Leverage**
- Better fact-based decisions
- Manage costs
- Enable efficiency
- Shrink time
- Multiply productivity
- Predictable results
- Continuous learning

**Provide full-lifecycle economics visibility**
**Eliminate waste between technical and business organizations**
**Improve certainty of outcomes**
**Jump the learning curve**

Harnessing the NEW requires:
- Focus on business transformation, not technology
- Asset intimacy
- New relationships, partnerships, ecosystem
E&P Digital Transformation relies on Asset Intimacy

- Competitive edge for executives
  - ↑ return on capital
  - ↓ cost/BOE
  - ↑ reserves replacement ratio
  - ✓ HSE

- Enterprise metrics for LOB executives
  - Exploration Success
  - Reservoir Optimization
  - Deeper, farther & cheaper wells
  - Optimized production
  - Reduced cost & risk

- Improved decision making for asset teams
  - Exploration
  - Reservoir
  - Well Construction
  - Production
  - Petroleum Investment
  - Asset Maint.
  - Supply Chain
  - Finance / HR
  - CRM

- Learning & growth for individuals
  - Digital
  - Engagement
  - Alignment
  - Continuous Improvement
  - Culture
Represent | Know | Affect

E&P Digital Twin
What is Digital trying to do?

**Objective Function:** Hydrocarbon Recovery

**Constraints:** Cash Flow, ROI, Safety

**Ground Reality:** Complex, Interdependent, Simultaneous Optimization

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**EFFICIENCY**

(do more with less)

**SYSTEMATICALLY & REPEATEDLY**

**EFFECTIVENESS**

(be better)

**Objective Function:** Hydrocarbon Recovery

**Constraints:** Cash flow, Profits, Safety

**Objectives are:** Complex, Interdependent, Simultaneous Optimization
Smart and Connected Oilfield Operations
Enabled by Digital Solutions

ASSET INTIMACY
REAL TIME
AUTOMATION

CLOUD

ANALYTICS,
MACHINE LEARNING,
BIG DATA

OPEN PLATFORM
CO-INNOVATION
Digital Twin

The Physical Asset

Types of Reservoirs, Wells & Equipment

Telemetry, Smart Wells, Real Time Data

Actuators Feedback Controls

The Digital Twin

Prototypes modeling physical assets

Twin that simulates, models real data and creates advisory plan

“EVERGREEN” digital representation + SAP + Backoffice, updated in near real time on a single platform
Key components of the Well Digital Twin

Environment Powered by DecisionSpace®

- **Sub-surface**
- **Reservoir**
- **Wellbore(s)**
- **Tubulars**
- **Fluids**
- **Other surface equipment**
- **Downhole equipment**
- **Production**

Prototypes

Instances

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Cloud-Based Digital Platform

- Real time data historian through cloud-based services
  - Off-the-shelf technology
  - Flexible (logs, reports, unstructured context info)
  - Scalable nodes, replicas, active DC failover

- DecisionSpace® integration enables:
  - Multi-domain data integration
  - Workflow orchestration
  - Multi-well/job real time analytics
  - On-demand simulation

- Plans for engineered, private-cloud solution

- Post job available for big data analytics
Halliburton Solutions for Digital Twin: \( f\text{c}^2 \)
Halliburton Field Appliance™

**Edge Analytics enabling Intelligent Operations**

- Executes real time analytics data close to the operation
- Provides a “reflex” capability to the well/facility, giving it a greater degree of autonomy.
- Enables events/failure detection and prediction
- Enables real time optimization
- At the same time guarantee the integration through the cloud with the field analysis and simulation systems
- IoT gateway, self-discovery simplifies configuration
- Integration w/ 3rd party rig equipment, automation support
Halliburton Solution: Well Construction 4.0
Well construction lifecycle

**PLAN**
Field & Wells

**DESIGN**
Wells

**EXECUTE**
Operations
Digital Leverage: Drilling Automation
Optimize Objective Functions for Real Time, Advisory and Planning

Optimize drilling time, reduce NPT, improve quality and reliability

- **Drilling Optimizer**: ROP Optimization Engine, Geosteering/Trajectory
- Surface (Advisory): conventional/smart rigs (PASON, EDR, NOV, NBR) through **open standards**
- Subsurface: **Real time control** / geosteering

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**Telemetry Rig Automation**

- Closed Loop Smart Rigs
- Advisory Conventional Rigs - EDR

**Downhole Measurements**

LWD, MWD
Rotary Steerable, Electronic Bit

**Real Time**

- Rig Controller
- Drilling Optimizer

**Well Engineering**

Drilling Xpert™ software
- DecisionSpace®
- Well Engineering
- Torque and Drag

**Real Time Optimization**

**Real Time Analytics**

**DecisionSpace™ Platform**

Office

Customers

RTO / ROC
Enhancing Voice of the Oilfield

Combining OPT’s best of breed petroleum and production engineering with DecisionSpace® Production
Continuous Reservoir Optimization with The Voice of the Oilfield™
Digital Twin in Action with The Voice of the Oilfield™

1. IIoT enabled instrumentation and Automation
2. Edge Analytics running at well site
3. Platform running on the cloud
4. Production workflows and applications
Case Study: Digital Well Pad PoC

Complete and integrated view of all relevant information from the well pad to enable optimized production management

- Co-innovation PoC with major operator
- Digital Transformation of 2 Well Pads located at Bakken and Eagle Ford Assets
- Targets: Increase Well Pad Regularity by 50%, Reduce Driving time by 50%, Reduce Spills and Emissions by 30%
Digital Leverage: Connectivity, Integration
E&P’s Only Open, Cross-Domain Platform

DecisionSpace Platform

OPEN INTEGRATION
- Landmark Databases
- 3rd Party Databases
- Unstructured Data

EASY ACCESS
- One Virtual Database
- 3rd Party Connectors
- Data Transfer
- Data Clean-Up
- Universal Search
- Dashboard Analytics
- Workflow Engine
- File Sync Dropsite

Management
Geoscientists
Data Management
External Users
The Open Earth Community
Lowering cost and accelerating the pace of innovation
A free, global and open community of scientists, engineers and software developers in oil and gas companies, service companies, software providers, data vendors and technology developers committed to producing an open and shared E&P software platform to rapidly lower the cost and accelerate the pace of innovation in the E&P Industry.
Co-Innovation, Co-Engineering, Partnerships

- Shared vision for E&P transformation from field to board room
- Accenture’s business / IT transformation expertise
- Complementary capabilities

- Joint collaborative solutions (December 2016)
- Commitment to open, standards-based integration
- Real-time digital representation of assets: Technical, Operational and Economic insights

- Develop intelligent cloud solutions for Oil & Gas Operations
- Collaborate, Co-innovate on technologies for machine learning, AI, AR/VR, IoT
- DecisionSpace 365™ on Azure, enable real-time streaming for drilling, production solutions

- Development of 4D seismic, unconventional workflows
- CGG software integrated with DecisionSpace™ platform
- Machine learning for seismic quality
- Collaboration across Wireline, PE for frac analytics, unconventionals