Digitalisation and Advanced Analytics @ Shell

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Reserves: Our use of the term “reserves” in this presentation means SEC proved oil and gas reserves.
Resources: Our use of the term “resources” in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.
Organic: Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact.
Shales: Our use of the term ‘shales’ refers to tight, shale and coal bed methane oil and gas acreage.

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Agenda

- About Shell

- The Energy Challenge

- TaCIT & Our Digitalisation Strategy

- Our Innovation Process & the Advanced Analytics CoE

- Use of MatLab in Shell

- An example use case: Quest CCS

- Planned Next Steps
Business Overview

EXPLORATION
- Exploring for oil and gas: Onshore and offshore

DEVELOPMENT AND EXTRACTION
- Developing fields
- Producing oil and gas
- Extracting bitumen

MANUFACTURING AND ENERGY PRODUCTION
- Refining oil into fuels and lubricants
- Producing petrochemicals
- Liquefying gas by cooling (LNG)
- Converting gas into liquid products (GTL)
- Upgrading bitumen
- Producing biofuels
- Generating power

TRANSPORT AND TRADING
- Shipping and trading
- Regasifying (LNG)
- Supply and distribution

RETAIL AND B2B SALES

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New Energy Future by 2050

Rising energy demand, supply pressure, climate change

- **Population**: 9 billion people, 75% living in cities (2 billion more than today)
- **Vehicles**: 2 billion vehicles (currently 800 million)
- **Rising standards**: Many millions of people will rise out of energy poverty; with higher living standards energy use rises
- **Demand**: Energy demand could double from its level in 2000…but CO₂ emissions must be half today’s to avoid serious climate change
- **Efficiency**: Twice as efficient, using half the energy to produce each dollar of wealth
- **Renewables**: 4 times more energy from renewable sources
Technical & Competitive IT

- Partnering with the business and functions to drive innovation
- Product development through Research & Development to deliver differentiating solutions
- Maintain and enhance technology solutions across Upstream and Downstream
- Enable Projects & Technology division within Shell
What is digitalisation

Industry definition*
“The use of Digital technologies to change a business model and provide new revenue and value-producing opportunities”
*Industry definition has been sourced from Gartner

Shell context

Focus
- How Digital technologies can help address current business challenges
- Technologies that can have a substantial impact on our industry

Is not
- New
- An outcome
- One off thing
- Only in the future
Disruptive Digital Themes

TECHNOLOGY
INNOVATION THEMES

Mobile First

Everything to Cloud

Computational Technologies/HPC

Advanced Analytics

3D Printing

Wearables & New Realities

Internet of Things & Sensors

Robotics

Disruptive Future Technologies

Design for Mobility

Migrate to the Cloud

Enhanced algorithms/compute power

New business insights

Novel designs/parts manufacturing

Contextual interaction

Interconnected devices & people

Address the ‘human exposure bottleneck’

Innovate for the future

MATURITY OF THEME
Shell Innovation Process

D0 Ideation
100%

D1 Discover
40%

D2 Develop
20%

D3 Demonstrate
15%

D4 Deploy & Sustain

Estimated NPV (business approved)

Submitted NPV (business & finance approved)

External visits, conferences (C, O)

Universities (Pr, Univ, $)

Suppliers (S, Pr,$)

Innovation Advisors (O, S)

CCoE (FTE, Pr)

IT, PT, Trading, GF, US, DS

Delivery Verticals (Pr)
What does the Advanced Analytics Centre of Excellence do?

1. **Platform Development**
   - Scale & grow Production Platform to meet needs of Advanced Analytics community in Shell
   - License Analytics Lab to user communities for Proof of Concepts
   - Develop enterprise licensing agreements for Analytics software and drive convergence
   - Translate Proof of Concepts into supported Business Services leveraging standard Production Platform
   - Analytics Lab a test-bed for cutting-edge tools & techniques

2. **Value Identification & Delivery**
   - Validated pipeline of opportunities constantly updated & iterated
   - Robust valuation methodology
   - Execution of ★ Proof of Concepts
   - Inventory Optimisation
   - HSSE Incident Prevention
   - Market Basket
   - Processes to assess business impact & coordinate investment proposals
   - Assure & extend business cases by progressing ★ Proof of Concepts to production

3. **Network Co-ordination**
   - Raise profile of AA within Shell and develop greater sense of community with the support of senior leaders
   - Generate best practice benchmarks and materials for analytics delivery in Shell
   - Technical, Commercial, Data Science & Tooling streams
   - Single point of contact, advice & best practices relating to Advanced Analytics
   - Identify & attract relevant skills & capabilities, and coordinate interventions where appropriate

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# MatLab Usage in Shell

## UPSTREAM
- Operated
- Joint ventures
- Deepwater
- Safety & environment
- Production excellence
- Exploration

## INTEGRATED GAS
- Venture development
- Production excellence
- Qatar
- Australia & New Zealand
- Russia
- Safety & environment
- Ventures
- Commercial/NBD

## DOWNSTREAM
- Refining
- Pipelines
- Chemicals
- Trading and Supply
- Retail
- Lubricants
- Business to business
- Biofuels

## PROJECTS & TECHNOLOGY
- Innovation, R&D
- Technical IT
- Project execution
- Global technical expertise
- CO₂ management
- Safety and environment
- Contracting and procurement

## FINANCE
- Finance
- IT
- Investor relations
- Tax
- Strategy
- Planning and appraisal
- Internal audit

## HR & CORPORATE
- HR
- Real Estate
- External Relations
- Shell Aircraft
- Health
- Security

## LEGAL
- Legal
- Compliance
- Intellectual property
Quest Background

- The Albian oil sands in Canada produce 255k barrels per day of heavy bitumen products which are upgraded at Scotford.

- Dense phase CO2 captured and compressed from the Scotford Steam Methane Reformer Units (around 1.2 Mt/yr).

- The CO2 is transported by pipeline to three injection wells near the Scotford Complex and stored approximately 2,300 meters underground in a deep geological formation.

- As part of Shell’s license to operate they need to monitor the site to check the CO2 is not leaking back into the atmosphere.
The Challenge

- Quest CCS is a critical innovation for Shell.
- CO2 is captured and stored underground and government funding is contingent on Shell proving the CO2 stays in the ground.
- Innovative sensors (based on lasers) have been installed at the plant to monitor the atmosphere for CO2 emissions.
- Algorithmic approaches are required to distinguish actual CO2 events from “background noise”
Technical Solution

- Over the past 8 years Shell’s remote sensing’ group have been developing surface monitoring algorithms for measurement the Quest monitoring verification (MMV) program:

- Primary objectives are to:
  - Ensure containment
    - Verify absence of environmental effects.
    - Detect early warning signs of loss of containment.
  - Trigger additional safeguards
  - Safety critical - ALARP
  - Ensure conformance - LightSource technologies to address ‘containment’ objective.
Solution – Advanced Analytics Lab

- Deploy the monitoring algorithm using the Matlab Production Server in the Advanced Analytics Lab (PoC).
- Provide daily monitoring and alerts depending on algorithm results.
- Improved visibility of algorithm results.
- Eliminate manual effort involved in running the analysis.
- Productionise Quest by embedding solution in a fully supported IT landscape (October 2016).

Value:
- Compliance with regulation assures access to government funding / reduced exposure to fines & penalties/license to operate.
Solution – Target Architecture

Externally Managed with:

- **BOSEAL LASER**
  - Surface Laser Sensors (x3 pads)
  - Atmosphere Monitoring (Specifically monitors for CO2)

- **Computer**

- **Cellular Modem**
  - Daily @ 12 am CST

IT Managed

- **Value Model** (SSP-S)

- **PI-AF** (SSP-S)

- **Super Collective**

- **PI UFL**

- **S-FTP**

- **DMZ**

- **Matlab**

- **Visualisation** (Process Book)

- **75 tags**
  - Fields: 3 Fields/Injection paths
  - Weather: 10 attributes
  - Ultrasonic: 6 attributes
  - Boreal: 8 attributes

- **Additional PI Tags required for write back**

**Additional Information**

- **External Monitoring**
  - Atmosphere Monitoring
  - Surface Laser Sensors

- **Integration Points**
  - DMZ
  - S-FTP
  - PI UFL

- **Visualization Tool**
  - Matlab

- **Informed Decisions about Assets**

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**August 2016**
Quest Visualisation  (Process Book & Power BI)
Shell & Matlab, the Future?

More explicit linkage to other Digital Themes:

- **Internet of Things** - Edge computing
- **High Performance Computing** - Distributive/Spark computation
- **Mobility** - Smart apps development/management

**Immediate Priorities for 2017**

- Enterprise licenses
- Continued deployment through MPS
- Prove the business value of current Matlab projects in innovation pipeline:
  - Bitumen image analysis
  - Excel trading
  - MADA
  - Acoustic sensing