Data Science Applications In Oil & Gas

Jeremy L Graybill
Director of Data Science & Advanced Analytics

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Agenda

• About Anadarko & AAET

• Data Science Applications
  ➢ Seismic Interpretation
  ➢ Stratigraphic Top Correlation
  ➢ Real Time Drilling
  ➢ Real Time Completions
  ➢ Integrated Production Surveillance and Optimization (IPSO)

• Q&A
About Anadarko & AAET
Corporate Strategy

ENHANCING SUCCESS IN DWGOM
Advanced geophysical analytics to enable exploration with tiebacks to existing infrastructure

EXPANDING LOWER 48 FOOTPRINT
High density Lower 48 subsurface characterization to provide optionality

ENABLING DIGITAL OPERATIONS
“Intelligent” control and edge computing in Drilling, Completions and Production

FUTURE VALUE
Exploration & LNG

CASH GENERATION
DWGOM & International Oil

FOCUS AREAS
DJ Basin, Delaware Basin, DWGOM

TOTAL VOLUME
700 MBOE/D
CAPEX
$4.8B

About Anadarko & AAET
AAET: Advanced Analytics and Emerging Technology

**Team Demographic**
- Data Scientists
- Geoscientists
- Engineers
- DataOps & DevOps

**# Team Members**
- 50+ Person Core Team

**Project Portfolio**
- 50+ Projects

**Platform Deployment**
- 5 Domain Platforms

**Inception of Data Science Skills in APC**
- 2014 - 2015
  - DS Job Ladder
  - Dr. Sean Gourley appointed to Board

**Data Science Evangelism Across APC**
- 2016

**Productization Strategy Developed**
- 2017

**Stakeholder Engagement Focus**
- 2018
  - APC Announces Google Partnership

**Deployment at Scale Through Platforms**
- 2019
  - Montana Tech Conference

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*About Anadarko & AAET*

*Data Science Applications*

*Close / Q&A*
Data Science & Advanced Analytics

Advanced Analytics R&D

Center of Excellence

Fleet Performance Optimization

Technology Advancement

Data Science & Advanced Analytics

Data Strategy & Analytics

Machine Learning Operations

APC Data Scientist Profile
Typically from outside the industry
~80%+ PhD
Backgrounds in:

- Computer Science
- Mathematics
- Statistics
- Engineering (Aerospace, Electrical, CFD, Industrial, Civil)
- Astrophysics
- Geostatistics
Exploration
Identifying sweet spots where well performance is high and land entry costs are low can generate significant value to the company.

Development
Selecting the optimal well design – which involves choices in numerous areas such as completion size and well spacing – requires predicting the performance for each candidate design.

Operations
Monitoring and understanding asset behavior through the life-cycle of well construction (drilling) to extraction of underground resources (production).

ENHANCING SUCCESS IN DWGOM
Seismic Interpretation

EXPANDING LOWER 48 FOOTPRINT
Stratigraphic Top Correlation

ENABLING DIGITAL OPERATIONS
RTD & RTC
IPSO
Data Science Applications
Seismic Interpretation

- **Project Scope**
  - Seismic interpretation deep neural network model for image processing

- **Data Volume**
  - 100s GB – several TB
  - 1000s images/attributes
  - Training on 1% data
  - Inference across full image

- **Framework**
  - TensorFlow/PyTorch
  - 2 concurrent fault prediction models

- **Computation Environment**
  - NVIDIA DGX-1 (8x 16 GB Tesla V-100 GPUs)
  - NVIDIA DGX-2 (16x 32 GB Tesla V-100 GPUs)
Seismic Interpretation
• Project Scope
  ▪ Learn from identified tops propagate at basin scale

• Data Volume
  ▪ Training ~25GB
  ▪ Inference: Size varies, on the fly

• Environment
  ▪ CNN in TensorFlow Framework
  ▪ Dev/Train (on prem.):
    □ DGX-1 8x Tesla V-100 GPUs
  ▪ Inference/UI (on cloud):
    □ GCP V-100 and T4 GPUs
Real-Time Drilling (RTD)

- **Project Scope**
  - Drilling Ops: $M decisions
  - **Analytics and DL models** process real-time streaming log data & other non-streaming data
  - Rig states → Derive operational KPIs of drilling ops at very high resolution

### Real-Time Drilling

- **ROP**
- **Footage**
- **Time**
- **On Bottom Time**
- **Off Bottom Time**
- **Connection Time**
- **Connection Depth**

### Footage, Time, ROP, connection statistics

### Operational KPIs at high resolution

### 3D Trajectory
- Plan vs actual and offset trajectories

### 3D Plot – Plan vs. Actual
- Actual
- Plan
- Offset Well
Real Time Completions (RTC)

- **Data Acquisition & Visualization**
  - Connected to Frac vans
  - Job Monitoring Real Time calculations

- **Event Detection & Prediction**
  - Stage Start / End
  - Formation break
  - Screen Out
  - Frac Hits
  - Wellhead Pressure Prediction

- **Stage Classification**
  - Pressure Test, Pad, Acid, Proppant, Flush, ISIP

- **Optimization**
  - Cost (modify pump schedule given vendor costs structures)
  - Fracture Efficacy (Nirvana state)
Integrated Production Surveillance and Optimization (IPSO)

• Surveillance
  ▪ Field & Well Overview
  ▪ PVT (Fluid)
  ▪ BHP Calculation
  ▪ Event Reporting
  ▪ Map Based Trending
  ▪ KPI Dashboards

• Analysis
  ▪ Drainage, Recovery & Depletion
  ▪ Productivity Index (PI) Analysis
  ▪ Gas Lift Performance
  ▪ Forecasting (Deterministic & Probabilistic)
  ▪ Well Interference Detection & Prediction

• Optimization
  ▪ Gas Lift Optimization
  ▪ Choke Optimization
  ▪ Artificial Lift Lifecycle & Closed Loop Control
  ▪ Development Planning & Campaign Optimization

• IPSO Onshore
  ▪ ~1,100 Wells (64% Operated)
  ▪ 10+ Workflows
  ▪ 160k+ Events
  ▪ 50+ Users
THANK YOU

QUESTIONS?