Drilling Automation

MULTIDISCIPLINARY MODELLING APPROACH TO: PLANNING, MONITORING, AND OPTIMIZATION OF WELL CONSTRUCTION
Introduction

- Automation is an incremental process, reducing human interaction with the processes and targeted to:
  - reduce complexity, operational risk, and manpower;
  - improve efficiency and safety;
  - minimize human factor induced errors;
  - reduce communication, data transfer and aggregation errors;
  - consolidate experience and continuously improve practices;
  - facilitate training and knowledge transfer;
Introduction

- Integration of the surface and downhole measurements with predictive models is a cornerstone of drilling automation
- Drilling automation requires integration of the 3 stages
  - Planning: pre-engineering and training
  - Execution: monitoring and operation
  - Learning: post job analysis and simulation
Analysis capabilities

- **Geo-pressure**
  - Pore pressure prediction
  - Wellbore stability and fracture gradient estimation

- **Drillstring analysis**
  - Drillstring design
  - Torque & Drag

- **BHA analysis**
  - Static analysis
  - Vibrational analysis

- **Hydraulics**
  - Snapshot analysis
  - Parametric analysis
  - Bit optimization
  - Tripping

- **Influx simulation**
  - Circulate influx
  - SBP schedule
Monitoring implementation

- Perform data aggregation from multiple sources
  - Direct sensor measurements
  - Rig network (WITS)
  - Remote servers (WITSML)

- Determine rig operations and activities

- Define custom warnings and control algorithms

- Analyze and report KPI
Monitoring implementation

- Compare planned vs. actual
  - Formation pore and fracture pressure prediction
  - Wellbore stability analysis
  - Torque, drag, and buckling analysis
  - Hydraulics

- Predict ahead, based on real-time calibrated models

- Predict NPT events and downhole loads

- Custom calculations and on-demand drilling engineering analysis
Operation implementation

- Designed to satisfy both rig and office personnel
- Equipment controls
- Time-based and depth-based profiles
- Live Well display
- Identifies status of well and operations
Simulation implementation

Simulation capabilities

- Model well control scenarios by simulating rig equipment and using real-world control software
- Access to real-time engineering tools
  - Hydraulics analysis
  - Formation pore pressure prediction and WBS and fracture pressure calculations
  - Torque, drag, and buckling analysis
- Predict ahead and play what-if scenarios, based on the current well state
- Training field real-time monitoring, and drilling optimization personnel
Application Examples

- Managed Pressure Drilling provider requires:
  - integrated and automated control of equipment

- Drilling Optimization requires:
  - BHA optimization and selection of drilling parameters during planning stage
  - monitoring and real-time prediction models

All applications utilize single software platform:

- Office engineering
- On site operations execution
- Monitoring remotely in Real Time Operation Centers
MPD Concept: Drilling Undrillable

BHP = SMW + Friction + Surface Backpressure

MPD Closed Loop System enables to drill with CBHP
# Software Platform for MPD

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Pre engineering for MPD

- Geomechanic analysis
  - Defines safe drilling window:
Pre engineering for MPD

- **Hydraulic analysis**
  - predict pressure distribution
  - detects equipment limitations,
  - hole cleaning issues,
During operation: managing pressure

- **During connection**

  Holding SBP at 4500 kPa to maintain constant ECD
During operation: Dynamic Leak-Off Test

SBP increased until flow out slightly deviates from flow in
Operation example: kick mitigation

- automatic influx detection and control

Flow Out > Flow In

SBP increased to control influx by closing choke

Flow Out = Flow In
Drilling optimization while planning

- Torque, Drag and Buckling
  - Evaluates drillability of a well within operational limits
Drilling optimization while planning

- BHA optimization and optimal drilling parameters
NPT detection while monitoring: stuck pipe example

- Hook Load actual less than predicted, axial friction increases
- actual Surface Torque higher than predicted one, rotational resistance increased
- Measured SPP started to deviates from predicted due to reduction of flow area
Conclusions

New Software Platform provides:

- System approach to designing and engineering of drilling operations
- Setup, configuration, and database shared between different applications with a common interface
  - Planning
  - Monitoring
  - Operation
  - Simulation
- Automated Control of MPD operations