MAXDRILL™
A Wholistic Approach To Drilling Efficiency

Graham Mensa-Wilmot
Drilling Engineering Advisor - CVX
Overview

- Performance Drilling - MAXDRILL
- Drilling System Design
  - Application Effects
- Benchmarking
- Continuous Improvement Cycle
- Efficiency Definitions
- Performance Qualifiers
  - Well to Well
- Dysfunctions
  - Solutions and Effects
Performance Drilling

- The Justification
- Expectations
  - Achieve Desired Results
    - Can it Be Done, How Well, Has Value Been Created
  - Sustain Continuous Improvement
- Current Status
  - Tools, Tools, Tools
    - New is NOT Necessarily Better

“The relentless flow of new tools and techniques to improve drilling efficiency is NOT having the desired effect, according to one operator”

Don Francis: Editor, E&P Magazine - February 2008

dfrancis@hartenergy.com
• Industry PUSH
• Components Vs. Systems
• Chevron’s Application Tools
• MAXDRILL
BHA/Drill String Modeling
- Static
- Dynamic
- FEA

Rock Mechanics
- Geologic and Mechanical Properties
  - Unconfined and Confined Compressive Strengths
- Failure Mechanisms

Drive Systems
- PDM, RSS, Turbine

Drilling Mechanics/Vibrations/Hydraulics
- Real Time, Stream Rates

Bit Modeling & Instrumentation
- Formation Types & Properties, BHA, Parameters
- Predictive Behavior - ROP, Wear, Run Length, Vibrations, etc
Performance Drilling:

The culture where decisions made to improve drilling performance are governed by detailed analysis of relevant data.

MAXDRILL

A practical and systemized data driven approach to drilling Performance Improvement, based on identification and remediation of drilling dysfunctions - during the planning phase or real time in the execution phase. It focuses on a continuous re-evaluation and re-categorization of the dysfunctions.
Benchmarking
*Trends, Behaviors, & Relationships*

- Historic Perspective
- Current Implementation
  - *What* Is Working
    - Stay the Course
  - *What* Is NOT Working
    - Change It - Get Bigger, Get New (It is Better !!!)
  - “What” Solutions focus on single issues or components
  - Introduces Compromising Effects
- New Implementation (After Definition of PD)
  - Must Address *Why* and *How* Issues
  - Focus on Drilling System and Behavioral Effects
  - Does NOT Initiate Compromising Effects
- *Formation Index (FI) & Drilling Index (DI)*
Efficiencies - Definitions

- Technical Efficiency
  - Can It Be Done

- Mechanical Efficiency & Reliability
  - Was It Fast and Safe

- Operational Efficiency
  - Can It Be Used

- Drilling Efficiency
  The Construction and Delivery of a Useable Well Bore at the Lowest Cost Imprint.
Performance Qualifiers

Definition

- Footage
- Downhole tool life
- Durability

- Vibrations Control

- ROP

- Directional Responsiveness
- Borehole Verticality & Quality
- Steering Efficiency
26” Interval - Deepwater Drilling
Dynamic PQ Evaluation and Re-Ranking

Older Projects
- Borehole Verticality
- Directional Effectiveness
- Vibrations Control
  - Prevention & Mitigation
- Single BHA run
- Functional Compatibility
  - Bit, Hole Opener, PDM and PD
- Longevity - Run Hours
  - Drive System, etc
- ROP

Newer Projects
- Borehole Verticality
- Vibrations Control
  - Prevention & Mitigation
  - Low RPM Effects (No PDM)
- ROP
- Functional Compatibility
  - Bit, Hole Opener, and PD
- Directional Effectiveness
- Single BHA run
- Longevity - Run Hours
  - Drive System, etc
MAXDRILL: **Objective & Scope**
Continuous Performance Improvement

- Achieve Operational Efficiency
  - PQs
  - Maximize On-Bottom Time
  - Same Section
  - Minimize On-Bottom Time
  - Well to Well

- Total time
  - NPT
  - Productive (PT)
  - Drilling
    - Geological
    - Operation
  - ILT
  - UE

Plan
Review
Revise
Execute

Data !
Data !!
Data !!!
Dysfunctions

**Flounders:** These are events, characteristics and/or relationships, resulting from the planning and/or execution of a specific drilling program, that compromises achievement of defined and ranked performance qualifiers (*footage, ROP, DG, Tool life, Borehole Quality, Directional Performance and/or vibrations control etc*)

**Categories**

- System
- Planning
- Execution
Dependent Parameters
(ROP, H, DP, Stabilization etc)

Independent Parameter
(WOB, RPM, Q, HSI etc)

Peak Performance (1)

Vibrations
WOB
RPM

Peak Performance (2)

• Vibrations
• Hydraulics
PQ Relationships
Rules of Thumb Vs. MAXDRILL

Figure 1: Rules of Thumb (ROT)

Figure 2: MAXDRILL Process
Field Execution
Critical Traces/Data

- Gamma Ray
- RMA and Formation Drillability
- MSE
- Torque
- RPM
- WOB
- **Vibrations**
- Flow Rate and HSI
- SPP
- ROP

MAXDRILL
- Formation Index
- Drilling Index
Formation Index (FI)
Drillability Analysis

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# Formation Index (FI) - Results

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<th>Country</th>
<th>Area</th>
<th>Field</th>
<th>Well Name</th>
<th>Depth In</th>
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![Formation Index Chart]

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### Drilling Index (DI) Normalized Performance Comparison

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**Cost** $22,000.00 USD

- **ROP**: 157.91 ft/Per Hr
- **Pump Pressure**: 4300 PSI
- **Mud Weight**: 9.2 PPG
- **Flow Rate**: 300 gpm
- **Bit HSI**: 0 hp/In2
- **Initial Inclination**: 0 Degrees
- **Final Inclination**: 0 Degrees
- **Build Up Rate**: 0 Deg/Per 100ft
- **Dog Leg Severity**: 0 Deg/Per 100ft
- **Delta Torque**: 0 KPI/In
- **Dull Grade Inner**: 1
- **Dull Grade Outer**: 1
- **Verticality**: 0 Degrees

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Drilling Index (DI) - Results
West Africa (8-1/2” Section) - Well A

- Hole Size Effects
  - 12-1/4” Performances - ROP & Dull
  - Balling
  - Flow Vs. HSI
- BHA Design
- Vibrations
- Drive Mechanism
- Well Profile
- Operational Parameters
- Bit Design Attributes
- Other Factors (fixed)

Dull Condition
6686ft @ 47 fph (TD)
West Africa (8-1/2” Section) - Well B

- Footage: 8285ft
- ROP: 108fph
West Africa (Performance Summary)
Bit Types and Dull Conditions

Well A

Well B&C

Well D

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North America (12-1/4” Section)
Performance Comparison
West Africa (12-1/4” Section)
Performance Summary
Finally !!!

Thanks to All Y’all