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Well Placement: Where We’re Headed; Why Non-Drillers Should Care

John M. Clegg CEng FIMechE
J M Clegg Ltd
www.johnmclegg.com
Presentation Outline

• Key drivers for directional drilling and well placement. And why non-drillers should be interested!

• Where is directional drilling going? How can you influence it?
Quick Look Back In Time
100 Years of Directional Drilling

- Hardwood Wedges
- Jetting
- Motor and Bent Sub
- Measurement While Drilling
- North Seeking Gyro
- Adjustable Stabilizers
- Horizontal Drilling
- Magnetic Steering Tools
- Bent Housing Motors
- Rotary Steerable
- Extended Reach Drilling
- Barnett Shale Takes Off
- Rotary Steerable
- More Than 50% of Directional Drilling Spend

First Onshore-to-Offshore Well
Stabilizer Placement Rotary Drilling
Magnetic Steering Tools Bent Housing Motors
Rotary Steerable Extended Reach Drilling
Rotary Steerable More Than 50% of Directional Drilling Spend
Directional Drilling Drivers
Drilling Engineer’s View
What the Directional Driller Won’t Tell You
What the Directional Driller Won’t Tell You
Ultrasonic caliper logs showing reduction in tortuosity
IADC/SPE 194170 Clegg, Mejia and Farley, 2019
Why Does Tortuosity Matter?

Preparation: 7 to 14 weeks
Drilling: 2 to 4 weeks
Completions: 3 to 6 weeks
P&A: 2 to 4 weeks
Production: 5 to 70 years

“Well Development – How Long Does It Take?”
IADC Drilling Matters, 2016
Why Does Production Matter?

NOTES: Lines show the mean, and bars show the range of responses. Executives from 82 exploration and production firms answered this question during the survey collection period, 13–21 March 2019.
Why Does Production Matter?

*The breakeven price is the real Brent oil price that gives an NPV of zero given a real discount rate of 7.5%. The breakeven price only includes future costs. The boxes are an average of all fields within each category.*

rystad.com, October 2020
Total capex per well for US onshore = $4.9M to $8.3M
US Energy Information Administration, 2016

Typical Permian Basin Estimated Ultimate Recovery 500 to 750 Mbbls ($25M to $38M)
(Wood Mackenzie plus shale producer investor relations slides)
Tortuosity and Penetration Rate

SPE 196020 Shahri et al, 2019
# Tortuosity and Stuck Pipe

<table>
<thead>
<tr>
<th>Quartile</th>
<th>Vertical</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tortuosity Index average from 849 wells</td>
<td>% stuck pipe wells</td>
</tr>
<tr>
<td>BOTTOM</td>
<td>0.082</td>
<td>10%</td>
</tr>
<tr>
<td>TOP</td>
<td>0.287</td>
<td>50%</td>
</tr>
</tbody>
</table>

IADC/SPE 194182 Baumgartner et al, 2019
Tortuosity and Cementing

IADC/SPE 194101 Monterrosa et al, 2019
“As Tortuosity Index increases, the average rod pump failures per well increase. As Tortuosity Index increases, the average initial production decreases”

Ashok, UT Austin, 2018
Tortuosity and Production Equipment

SPE 185140, Ledroz et al, 2017
Tortuosity and Production Performance

Liquid Holdup

Bottomhole Pressure

URTeC: 2902309 Pradhan and Xiong, 2018
What About the Future?
Expert DD Systems – 1990

ODDA Offshore Directional Drilling Advisor

“module identifies the tool face setting required to reach [TD]”

SPE 20419 Amara and Martin, 1990
Expert DD Systems

SPE/IADC 194096 Pehlivantürk et al, 2019
Expert DD Systems

![Bar chart showing percentage of time sliding in Autonomous Sliding and Manual Control.](image)

*Figure 5: Percentage of Time Sliding in Lateral Section*

AADE-19-NTCE-081 Chmela et al, 2019
Automating DD Systems

SPE/IADC 194170 Clegg, Mejia and Farley, 2019
Managed Pressure Drilling

SPE 146644, Hannegan, 2011
Automation

- Gradual but continual automation of processes and equipment
- Evolution rather than revolution
- Adding automated processes in a piecemeal way (not suddenly waking up one morning to a fully automated system)
Big data, data analytics, machine learning, Artificial Intelligence
All combining with physics models and measurements (we still have physics!)
Optimization

Pressure and ECD
(prediction, measurement and automatic control)

T&D and Hydraulics
(physics-based models and real time measurements)

Wellbore Quality

Directional Tendency
(data-driven models and achieved through automatic control)

Drilling Dynamics
(data-driven models and real time measurements)
Reservoir Evaluation

ENI’s vision for optimal reservoir management, 2015
Geosteering

OTC-28992, Serry et al, 2019
Dreaming of a Holistic System

MD
10250 FT

ROP
120 ft/hr

DRILLING RISK
Hole Cleaning

VIBRATION
AXIAL

DTB UP 1: 5 ft
DTB UP 2: 8 ft

DTB DW 1: 3 ft
DTB OWC: 10 ft

Geological Risk:
Fault Proximity

Lithology:
Sand

Action:
Drop 1.5 deg INC
Reduce ECD 0.5 PPG

NPT
0%

Porosity
20%

Reservoir: 100 %

oil

Production:
1200 BOPD

33
Conclusions

We’ve come a long way in 100 years…
…but is drilling faster always better?

The future is more intelligent automated systems…
…but we need to optimize production and integrity
…not just what happens before TD!
“I think people defaulted to drilling fast. It is a simple measure that gets production earlier and reduced well costs because day rates are involved...

...We have to have KPIs for well construction related to the longevity of the well.”

John de Wardt, Journal of Petroleum Technology August 2017
Take-Away

How do drilling colleagues impact completions and production?

How do we benefit the overall value of the well?

How should we drill wells in the future?

Not cost per well

Not cost per foot

Cost per barrel
Your Feedback is Important

Enter your section in the DL Evaluation Contest by completing the evaluation form for this presentation

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Q&A