Drilling Performance
a multifaceted solution

GRC Annual Meeting & Expo 2018 – Drilling Panel

Presenter: John de Wardt, CEng, FI MechE, Dist Member SPE
President: DE WARDT AND CO
Program Manager: DSA Roadmap / DSABOK
Board Member: SPE DSATS
Guest lecturer / External PhD advisor: Colorado School of Mines
High Level Key Performance Indicators
Oil and gas drilling

• Net Present Value [NPV]
  • Time value of money – pay it / get it back

• Time to deliver production
  • Growth of income – revenue profile

• Drilling costs command a high percentage in projects
  • 50% to 70% of project costs – drilling and completion

• Relationship drilling time to drilling costs – double dipping
  • Time costs significant
  • Earlier delivery drives improved NPV

• Well value KPI’s – don’t forget the functionality and quality
  • Does the well do what was planned?
  • Does it cost what was planned to operate for 20 years?
So, what is ‘drilling performance’?

- **Schedule**
  - Duration of activities in critical path, shorter duration = more wells per rig year / earlier production / lower time based costs
  - Managing parallel activities (off critical path)
  - Rig release to release (spud to release)

- **Well Costs**
  - value based decisions
  - shorter durations (capital costs – CAPEX)

- **Functionality (quality)**
  - initial production
  - estimated ultimate recovery
  - operating costs (operating costs - OPEX)
Step change initiatives deliver far more than continuous improvement
Are you hungry?

Is your data big, bad or …?

Do you adopt best technology?

Do you use right processes?

Can you organize?
Are you hungry?

“let them eat cake”
Are you hungry?

• Hunger has driven revolutions
• Hunger drives the desire to cross the gap between now and the future
• But - what future?

• Crises is a natural hunger
• Stretch goals are an alternative to a crises
  • effective beyond belief (if collective and owned)
• Key Performance Indicators [KPI’s] can drive right results
  • airplane management or really effective change agents?
Roller coaster ride – oil price was king

- Stability: Revenues outstrip costs
- Instability: Costs dominate
- Very wary
Shale drillers took over marginal production from Saudi Arabia dominating global oil price.

Drilling efficiency is a key to staying in business.

USA Land – raising production with 1/2 rig count

Red line – the gas story
Lots of gas with low rig count

Green line – developing oil story
Lots of oil with low rig count
>2000 ft / day opposite sides of the world
Crises driven top performance

Rockies – 2005
Gas price crash
Offshore Thailand - 1990

350 ft / day
650 ft / day
Bankruptcy
Drop in sales price drives drilling performance

- S shaped wells 15,000 ft / sands from 8500’ TVD – 14,500’ TVD. 15.8 ppg BHP, 250 F BHT
- DWOPs, DTL, performance analysis / feedback, incentive pay. Process
- 6” PDCs instead of Impregs, 8 ½” PDCs. Technology
- Rotary Steerable instead of bent-motor BHAs. Technology
- EM-MWD. Technology
- UBD with OBM, Eliminated liners at 12,500’. Process
- Dual mud systems for WBM & OBM. Process
- Mitigating drilling dysfunction. Process
Wells have become more challenging in architecture
Parallel wells but where are they?

Uncertainty of position with standard MWD surveys.

Uncertainty too large
Best practices improve results

Uncertainty of position with a good survey plan.

Pay for certainty
Wellbore tortuosity and rugosity is a means to measure wellbore quality

(Courtesy Adrián Ledroz, Gyrodata)
Reduced effective diameter of the wellbore – passing a long, stiff assembly

(Courtesy Adrián Ledroz, Gyrodata)
True Value: Focus on Reducing Invisible Lost Time

![Diagram showing the concept of True Value and focusing on reducing Invisible Lost Time (ILT) and Non-Productive Time (NPT).]

- **Theoretical Well time**
- **Invisible Lost time**
- **Conventional Lost or down time**

**ACTUAL WELL DURATION**

**Industry Normal Well Time**

**REMOVABLE TIME**

**Technical Limit**

IADC / SPE 178850 • True Lies: Measuring Drilling and Completion Efficiency • John de Wardt, et al.
Drilling Efficiency Model provides alternative target time references

Theoretical Well time

Invisible Lost time (ILT)

Conventional Lost or down time (NPT)

ACTUAL WELL DURATION

Planned

Actual

NPT

Industry Norm Reported as Productive Time (PT)

MTP – Maximum Theoretical performance
TL – Technical Limit
BIC – Best In Class
BOB – Best of the Best

IADC / SPE 178850 • True Lies: Measuring Drilling and Completion Efficiency • John de Wardt
MTP applied to original plot of gas price driving drilling performance - spud to TD.
Case Studies of MTP Applications

Mid East Land Drilling – Lump Sum Project Managed

Phase 1: Lean Drilling™ Program Improvement - 26% well to well across 4 rigs
Major losses upper section
Metamorphic fractured reservoir with fluid losses, multiple bits, deviated wellbore, major drilling dysfunction
Major supply chain issues - terrorist activity

XYZ Well
Difficult Development
Routine Development
NREL / CSM study on Geothermal Drilling and Completions Petroleum Practices Technology Transfer – land wells USA

FY14 AOP 3.3.0.6 SURGE

Previous example Slide 21

Geothermal

Oil and gas
Performance gap recognition
Team owned highly aggressive stretch goal (MTP)

Great substitute for hunger
Can you organize?
Organization re-design

• Oil and Gas drilling typically uses old, outdated business (contract) models
  • Where did we start, where are we now
• Transitions happen by needs and by design
  • Which is better
• Re-designed organization architecture
  • Delivery systems aligned to objectives
  • Similar to Systems of Systems / Systems of Interest construct
• Culture change / Team building
  • Vision, values, equal players, common objectives
  • Whole team – across disciplines and including suppliers
Organize to deliver objectives with high performance

Not as typical contracts
Do you use right processes?

Definition of Insanity
   Doing things the same way expecting a different result
Best performance uses right processes

• Processes that deliver performance and defined outcomes through Front End Loading (FEL), detailed planning and tracking
  • Well Delivery Process
    • Proposal, Basis Of Design, Drilling Program
  • Detailed scheduling
  • Risk management
  • Cost estimation and control
  • DWOP / CWOP / Pre-spud

• Processes that improve rate of penetration
  • Drill in, friction test, hole cleaning, hydraulics, swab / surge, torque plot ..... 
  • Minimize drilling dysfunction - MSE

• Processes making connections
  • Right practices for drill floor and bore hole
    • 2 minutes slip to slip becomes 20 minutes weight to weight – cut the 20 minutes
Map all the processes, apply them and instill discipline to action on both in the office and on site

Learn to talk, then walk the talk
Do you adopt best technology?

As a solid value proposition
Oil and gas drilling technology staircase
a driver of performance

- Drilling rigs mechanical ➡ DC Electric (SCR) ➡ AC VFD drives
  - VFD drive equipment enables significant control options
  - Control options enable automation

- More power:
  - Bigger mud pumps, bigger top drive, more power generation

- Mechanization of handling equipment

- Sensors and telemetry from downhole
  - Mud pulse / EM – hard wire

- Robotics downhole
  - Rotary Steerable System

- Application of automation advancing rapidly
  - Rate of penetration
  - Steering trajectories
  - Drill a stand
  - ..........
Identify and adopt technologies in a progressive manner that deliver value

Go grab from outside Geothermal Drilling
Is your data big, bad or .....?

Yup – it is probably all of those
Issues facing oil and gas drilling data

• Data quality ranges from very good, high frequency, low latency to inaccurate, inferred, high latency

• Data sources (sensors) are missing or unattainable
  • Use models and simulations

• Data is highly valuable
  • How good is it?

• Remote data centers
  • We call them Real Time Operating Center’s – but they are not
  • Analysis benefits are great – how effective is feedback
  • Need to differentiate between ‘operating’ and ‘analysis’
Data Science has a maturity progression

**Basic foundation is Data Quality:**
- Need to understand quality and usage before progression is robust
- Some data needs to be fixed

**Descriptive Analysis:**
- What does the data tell us

**Action selection:**
- Decide the action to take

**Diagnostics:**
- Valuable on envelopes of quality data (machines)
- Misleading results based on lack of understanding quality data

**Predictive:**
- Are we mature enough
- Maybe yes / but also NO

**Optimize:**
- Big Data starts here
- Are we ready yet?

Based on: Competing on Analytics, Davenport and Harris, 2007: Adapted by SAS
Drilling data has a maturity progression

**Equipment analytics**
- Excellent sensors
- Life cycle data
- Certainty on failure modes

**Supplied Systems – RST, MWD, Mud Log:**
- Good sensors
- Life cycle data
- Challenging failures impacts

**Rig delivered Drilling Data**
- Poor sensors
- Life cycle only for repetitive wells
- Uncertainty in failure modes

---

Based on: Competing on Analytics, Davenport and Harris, 2007)
Oil and gas drilling is in a learning phase on data analytics

Some effective practices and some ‘vapor ware’
Are you ‘still’ hungry?
So, what can we transfer to Geothermal Drilling?

• Your rocks are harder than out rooks
  • We do drill metamorphic and granite in Yemen, Vietnam and West of Shetland

• You suffer some major fluid losses while drilling
  • We have encountered similar issues and used fluid systems, Managed Pressure Drilling and Casing Drilling to solve this

• High temperature – I think you have got us beat
  • But – we have progressed and there may be some technologies and processes that fit
Don’t let this guy get in your way

Mr. Can’t
Thank you

Questions?

References available at www.onepetro.org
SPE 178850: Drilling Efficiency
SPE 173148: Well Cost Management
SPE 167933: Drilling Business Model
SPE 128716: Well Delivery Process
SPE 97269: Risk and Uncertainty Management
SPE 87117: Distinctive Drilling Performance

Follow up:
john@dewardt.com