“Honing the Zone” or “Just Let Me Drill It”*

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Abstract

The personalities of engineers and geoscientists are typically very different. And when it comes to corporate risk/reward assessments, company incentives for these individuals are often counter to the overall end goal: higher IP and superior well performance among their peer group. For example, drilling team metrics and operating personnel objectives are often counter to maintaining geological target objectives (staying in zone) and achieving maximum overall production (highest possible EUR). As a result, these divergent drivers may create dichotomies between individual personas due to personalities, personal motivation and company goals, and therefore create conflict between otherwise closely aligned asset team members.

We will explore the trade-offs of staying in the targeted zone (sweet spot) by carefully steering the well and monitoring every move along the way versus drilling ahead for maximum ROP (rate-of-penetration) and less NPT (non-productive time). The goal of the paper is to provide a basis for better understanding what makes the drilling team itchy and uncomfortable versus the overall benefits of staying in zone … sometimes the extra deliberations or seemly costly modifications in a drilling plan do in fact pay big dividends … or do they?

What both engineers and geologists need to know!
Reference

“HONING THE ZONE”  
OR “JUST LET ME DRILL IT!”

Eastern Section AAPG Meeting  
November 6, 2012

KC Oren  
Horizontal Solutions Int’l
Acknowledgements

Thanks to these content & thought providers

• Content references
  – Ken Bowdon, Founder of Horizontal Solutions (HSI)
  – SPE Paper # 79917 (Stockhausen and Lesso)
  – HSI website (www.HorizontalSI.com)

• Graphics
  – Dilbert – by Scott Adams
  – Tundra – by Chad Carpenter
  – HSI – TrueTime Operations Center
  – others
Introduction

The Tradeoffs in Drilling the Perfect Horizontal Well

• Goals of every E&P company essentially the same
  – But how they get ‘there’ is very different
  – Some do it better than others

• Collaboration across the team is critical
  – What are the compromises ... and what is the payback?
  – Continuous improvement for refining processes

• Understanding each team member’s motivation
  – Working together as team
  – Leveraging individual personas and available technology
  – Best practices to ensuring for continual success
Every E&P company’s annual report

Company’s achieving common metric for ‘success’

1. Safer, Lower Cost Wells
2. Less NPT
3. Faster ROP
4. Exceptional IP
5. Rewarding EUR
Every operating company is different

How does your company stack up?

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<th>Benchmarks</th>
<th>EUR Barrels</th>
<th>IP Barrels/Day</th>
<th>Drilling Cost</th>
<th>Completion Cost</th>
<th>ROI %</th>
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</table>
‘The Agony of Defeat’

Pilot

Well

Plan

Well Plan
‘The Agony of Defeat’

- Original Hole
- Second Sidetrack
- First Sidetrack
- Well Plan
‘The Agony of Defeat’

Let’s examine four possible ‘lessons learned’

Guidelines for safely navigating those uncertainties:

1. Assume the Bottom Hole Assembly (BHA) will most likely not perform as planned

2. Wellbore position uncertainty exacerbates the problem of landing the well

3. Targeting methodology is critical to staying in zone

4. Effective cross-domain communications are essential
Horizontal Drilling is a lot like life ...

... it’s full of uncertainties!
Planning the Perfect Horizontal Well

Uncertainty planning ... or is it planning on uncertainty?

• “Horizontal drilling is a lesson in humility for the entire asset team”
  — Ken Bowdon, founder of Horizontal Solutions (HSI)

• When a pre-drill model that has been worked on for months proves incorrect before the well is even out of the curve, it can be very frustrating for everyone!

• The only way to prevent frustration from leading to poor decisions is to plan for the unexpected
1. Bottom Hole Assembly Selection

*Understanding mechanical uncertainty is essential*

- The Bottom Hole Assembly (BHA) will most likely *not* perform as expected.
- Formation Heterogeneity *will* affect the BUR of the BHA.
- High Build-Up Rate BHAs *may* cause more problems than they cure.
2. Understanding Wellbore Position

**Ellipses of Uncertainty – systematic errors**

Magnitude of error for well-maintained survey instrumentation (MWD systems):

- **Inclination:** 0.25 to 0.75
- **TVD:** +/- 2 to 4’ per 1000’
- **Azimuth:**
  - **E/W:** +/- 3’ per 1000’
  - **N/S:** +/- 6’ per 1000’

Greater error in azimuth

And human-introduced errors can far exceed the survey tool’s intrinsic error!

*Used by Permission - based upon SPE 79917 Stockhausen and Lesso*
2. Understanding Wellbore Position Uncertainty

Survey positioned at START of the slide section

A slide section with a short radius of curvature followed by a rotary section (no curvature). The actual wellbore position will be shallower than calculated.

Used by Permission based upon (SPE 79917 Stockhausen and Lesso)
A rotary section is drilled first, followed by a slide section. The actual wellbore position will be deeper than calculated.
2. Understanding Wellbore Position Uncertainty

Survey positioned symmetrically on either end of slide

A slide section is placed between two rotate sections. The actual wellbore position will be close to the calculated.

Survey Position
Model 3

Used by Permission based upon (SPE 79917 Stockhausen and Lesso)
2. True Stratigraphic Position (TSP) Model

*HSI-pioneered methodology adopted by many cos.*

TSP is the position of the Wellbore, relative to a reference Stratigraphic Horizon such as the Top of Target. TSP is negative (-) when well is above datum and positive (+) when well is below datum.

TVD is the depth of the wellbore below the surface datum.
2. True Stratigraphic Position and Log Correlation
2. True Stratigraphic Position (TSP) log

*Haynesville Shale: Louisiana, USA*
2. Wellbore Plot: Vertical Section View

*Haynesville Shale: Louisiana, USA*

- Apparent Dip
- MWD Gamma Ray
- Wellbore Plot - Vertical Section View
  - Wellbore Example #1 - H
Geo-Navigation Principles – Basic 101

**Recommended Best Practices ... our “Rules of Thumb”**

- Do not over react – let your data tell the story
- Believe average dip BUT don’t expect to see it!
- Do not be trapped by preconceptions
- Acquire more data when appropriate
- Use all available data, especially real-time data, for a well informed decision
- Drill to a target line **NOT** to a point in space
“Geo” Navigation that didn’t work

Well targeting is an art ... and a science

Blindly following “Miss Direction” into the drink – is not a perfect science!
3. Common Target Change Techniques

*Stick with the plan! – not recommended*

“Follow the plan regardless of geology!”

A plan that does not change gives a false sense of security
3. Common Target Change Techniques

**Stick with the plan! – not recommended**

“Follow the plan regardless of geology!”

A plan that does not change gives a false sense of security

Rarely will you land or stay in zone

Few plans survive first contact with the formation

They followed the plan ... so why is my well not producing!
3. Common Target Change Techniques

The “Point in Space” method – not recommended

“Hit this TVD at this vertical section”

Will cause overshooting of target
Overshooting and correcting may jeopardize hole
Reduces the directional driller’s flexibility
More work for the Geosteering team
3. Recommended Target Change Method

*Vector-based targeting – recommended best practice*

“Land on this line …
… at this inclination
… with these tolerances”

Create smooth target transitions
Gives directional driller flexibility to land a target
Only method which has Stratigraphic content
3. Recommended Target Change Method

Vector-based targeting – recommended best practice

“Land on this line …

… at this inclination

… with these tolerances”

Create smooth target transitions
Gives directional driller flexibility to land a target
Only method which has Stratigraphic content
Simple and less confusing to Directional Driller
Targeting methodology based upon TSP model
Avoiding ‘The Agony of Defeat’

In Review – just 3 of the recommended best practices

1. The Bottom Hole Assembly (BHA) will most likely **not** perform exactly as expected
   - Formation heterogeneity will affect the BHA response
   - Aggressive BHAs can exacerbate drilling problems

2. Wellbore position uncertainty exacerbates the problem
   - intrinsic error in spatial position calculations
   - TSP modeling methodology mitigates uncertainty risks

3. Vector-based targeting methodology is critical

4. Clear, concise, timely and effective communications
The art of working as a team

Clear, concise, timely and effective communication

... and team communications gone wrong

I DON'T KNOW WHERE THAT STUPID DOG WENT TO! HE SHOULD HAVE RETRIEVED THAT DUCK HOURS AGO!

Duck?
Create a ‘truly collaborative’ environment ...
... sharing of all information to leverage the domain
skills and individual knowledge of every asset team
member ... AND include your service providers

- Create and nurture an environment of free exchange of
data and information (infrastructure, best practices)

- Encourage/Reward displays of free thinking and individual
  expertise (harvesting your knowledge-base)

- Consider and leverage everyone’s perspective and
  experiences (attaining common end-goals)
Communications across the **entire team** is essential

Well defined processes ensuring collaboration across the entire asset team stakeholders to ensure optimal results

**Collaboration between all Members**

- Drilling and Completions Engineers
- Directional Drillers
- Company Man
- Field Operations Geologists
- Service Company Personnel
- Mud-Loggers and Mud Engineers
- Office Development Geologists
- Production Engineers
- Reservoir Engineers

**Learn from experience and repeat best practices in future wells**
Collaboration ... and your team's personas

Are you still seeking that ever so elusive "Holy Grail"

IS CROSS-DOMAIN COLLABORATION ALIVE IN YOUR ASSET TEAM?

By Scott Adams © 2012 Scott Adams, Inc.
Collaboration ... and your team's personas

Are you still seeking that ever so elusive "Holy Grail"

DILBERT’S GEOLOGIST ... IN YOUR MORNING ASSET TEAM MEETING

WHY ARE ALL THE ENGINEERS IN THIS MEETING SQUIRMING WHEN I TALK?

DID YOUR BOSS ORDER YOU TO ACT LIKE TEAM PLAYERS DURING THIS MEETING AND LATER THwart ME BY INACTION?

ANSWER ME!

SQUIRm

SQUIRm
What are *your* Asset Team’s Personas?

**CEO/Asset Mgr.** – Follow the trail ... what’s missing?

**CTO/IT Mgr.** – Find, protect & deliver the data

**Geologists/Geophysicists** – Pointers staying in zone

**Drillers, DD** – Stay on plan, Reduce drilling time

**Rig Super./Mudloggers** – Rig safety and danger alerts

**Co. Man** – Keep everyone communicating and moving in the right direction
Personas and Motivation

**Geosciences Team**

- Geologists & Geophysicists
  - Identify the “sweet spot”
    - Determine the best targets geographically
    - Determine the extent of pay, maximize well locations
    - Define the best petrophysical marker
  - Identify geo-hazards/structure
  - Plan the optimal well path
  - Leverage your investment in seismic
  - Stay in Zone!
Personas and Motivation

Drilling & Completions Team

• Drilling Manager, Co. Man, Directional Driller, Rig Personnel
  – Stay on target
    • Pick up the right BHA to achieve BUR, make corrections
  – Fastest ROP
    • Tuned bit/BHA combination; good hydraulics are key
  – Reduced NPT
    • No unnecessary trips
  – Beat the plan!
  – Well delivered on plan ... and on budget!
Collaboration through Team Integration

Not all horizontal well programs are equal

- Qualified drilling and geosteering team to meet your specific project requirements
  - Right level of geosteering expertise
  - High levels of geoscience experience
- An appropriate collaboration platform
- Robust geosteering software
- Proven, timely communications channels and protocols including best practices
- Advanced 24/7 Surveillance

How much of each depends on the complexity, challenges and risks of the play
Scalable Geosteering Services

Every horizontal project has unique challenges – select your tools and service solutions accordingly.

Scale your service solution to meet your project demands.
Elements of Scalable Geosteering

How to be most successful in your horizontal project

TrueTime™ Surveillance

- 24/7 LWD/MWD data monitoring of the entire process
- Monitoring trends is as important as immediate, real time data
- 24/7 geosteering is greatly enhanced by critical drilling data monitoring
- Using all well data all of the time
Elements of Scalable Geosteering

Data integration and relevance when needed

Comprehensive and integrated geosteering and drilling data management systems

– Well data management and interpretation platforms designed specifically to enhance team collaboration
Collaboration all the time ... from anywhere

Well defined processes ensuring collaboration across the entire asset team stakeholders to ensure optimal results

Conducting Best Practices Workflows 24/7 from Anywhere
Collaboration all the time ... from anywhere

Well defined processes ensuring collaboration across the entire asset team stakeholders to ensure optimal results

Drilling well site

TrueTime™ Optimization Center

Utica Shale Play, Anywhere OH

Dallas, Texas

Conducting Best Practices Workflows 24/7 from Anywhere
Follow your plan to Success

Bring to bear the appropriate arms to win the battle

- Experienced Geologists with relevant expertise
- Robust geosteering software
- An appropriate collaboration platform
- Tried and true company best practices
- Proven, timely communications channels and protocol
- Advanced surveillance with well grounded best practices in play

How much of each depends on the complexity, challenges and risks of the play
Achieving your company’s goals

The Tradeoffs in Drilling the Perfect Horizontal Well

1. Safer, Lower Cost Wells
2. Less NPT
3. Faster ROP
4. Exceptional IP
5. Rewarding EUR
The Trade-offs of Drilling the Perfect Horizontal Well

for a copy of this presentation go to:
www.HorizontalSI.com