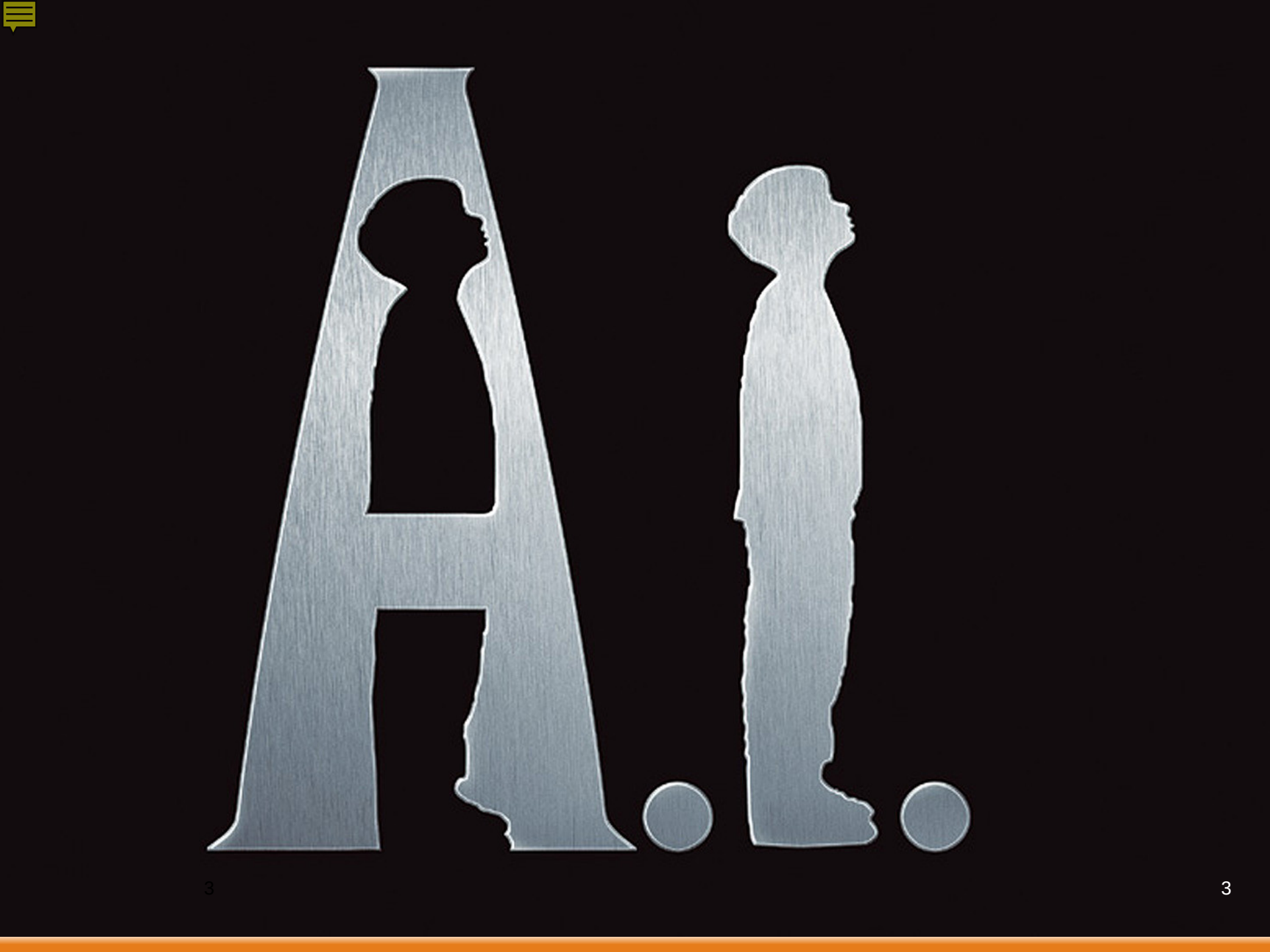
VERDANDE™
TECHNOLOGY

Helping people understand what drilling data is telling them.

Frode Sørmo, Chief Technology Officer

Artificial Intelligence



3


PIENSE
THINK
Ken
WATSON
BRAD


austriamicrosystems
a leap ahead in analog


SONY
Carl Zeiss
3X OPTICAL ZOOM
2,8-5,2/5,8-17,4
Cyber-shot
8.1
MEGA PIXELS

The Key to Deploying Artificial Intelligence

Computers do what computers are good at.

People do what people are good at.

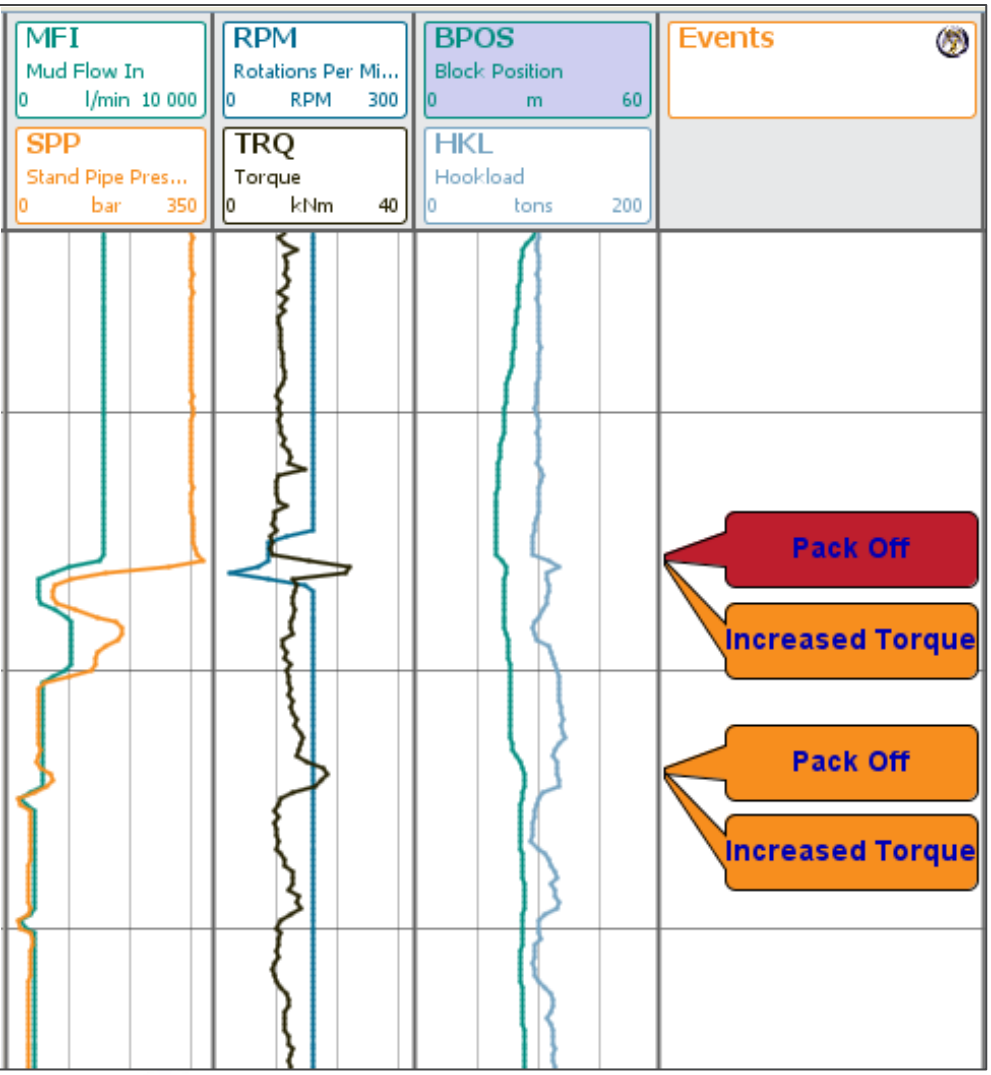
Artificial Intelligence in Drilling

1. Pattern Recognition
2. Case-Based Reasoning

Artificial Intelligence in Drilling

1. **Pattern Recognition**
2. Case-Based Reasoning

What is Pattern Recognition?



- Recognize symptoms as they occur in real-time drilling data.
- Automatically and consistently flag events and trends.
- Allows people to focus attention where it is required.
- Possible to monitor multiple wells efficiently and effectively.

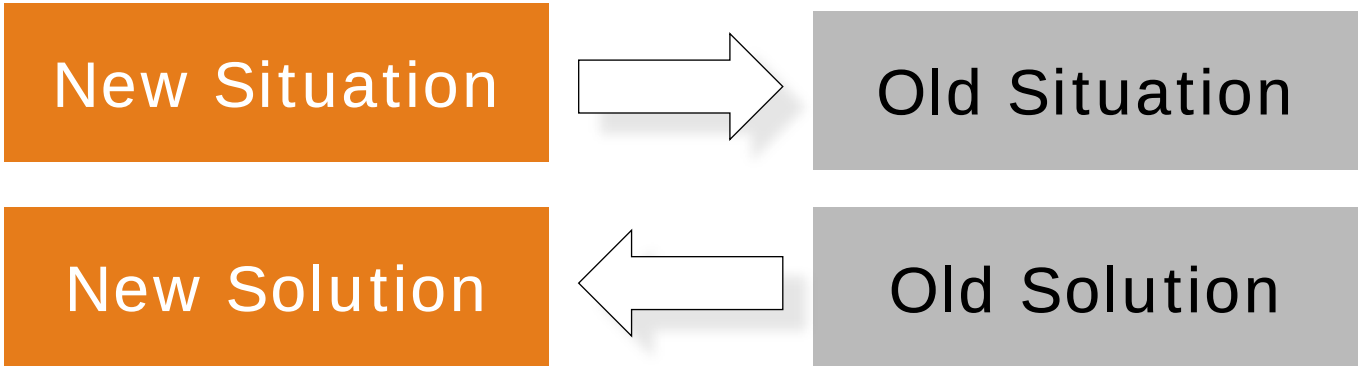
Patterns Currently Recognized

Problem Area	Events / Graphs
Lost Circulation	Mud Losses, Flow Back
Wellbore Restrictions	Overpull, Took Weight
Stick Slip and Vibration	Stick Slip, Erratic Torque
Twist Off	High Torque, Erratic Torque, Stalled Out, Maxed Out Torque
Formation Erosion	Hydraulic Erosion, Mechanical Erosion, Chemical Erosion
Hole Cleaning and Stuck Pipe	Pack Off, High ECD
Pore Pressure	Increased Pore Pressure, Increasing Connection Gas, Decreasing Connection Gas, Corrected D-Exponent
ROP Optimization	Mechanical Specific Energy
Formation Detection	Hard Stringer
Activity Detection	Rig Activities (Drilling, Connection, Tripping, Circulating, etc.)
Washouts	Pressure Drops

Artificial Intelligence in Drilling

1. Pattern Recognition
2. **Case-Based Reasoning**

What is Case-Based Reasoning?



- Actively bring relevant experience to the attention of users.
- Can predict problems before they occur, and help diagnose and correct problems after the fact.
- Captures new experience in a systematic way.

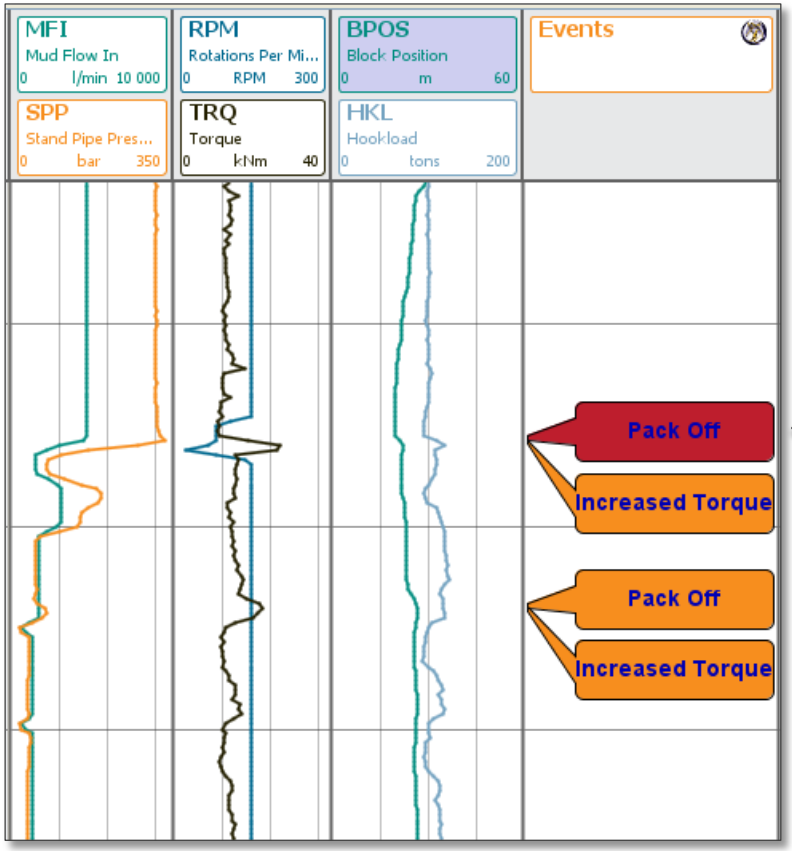
Case

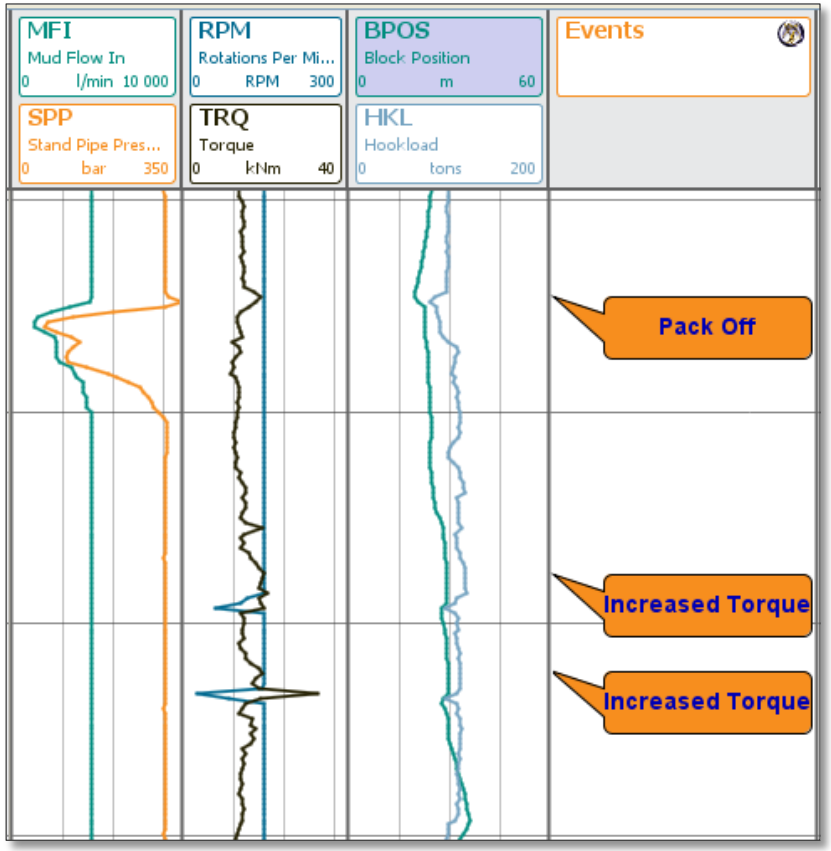
- Describes a real, concrete situation.
- For historical cases, it can include a diagnosis or prediction of what happened after this situation was observed.
- Includes advice and experience based on what the people on the ground saw.

We had pack offs while reaming in the Enconto shale formation.

The extended reaming damaged the formation so that we lost time whenever tripping and had problems getting the casing down.

Do not backream the Enconto formation – if there are hole cleaning issues, circulate instead.


MFI
Mud Flow In
0 l/min 10 000
RPM
Rotations Per Mi...
0 RPM 300
BPOS
Block Position
0 m 60
Events
SPP
Stand Pipe Pres...
0 bar 350
TRQ
Torque
0 kNm 40
HKL
Hookload
0 tons 200
Pack Off
Increased Torque
Pack Off
Increased Torque


MFI
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0 l/min 10 000
RPM
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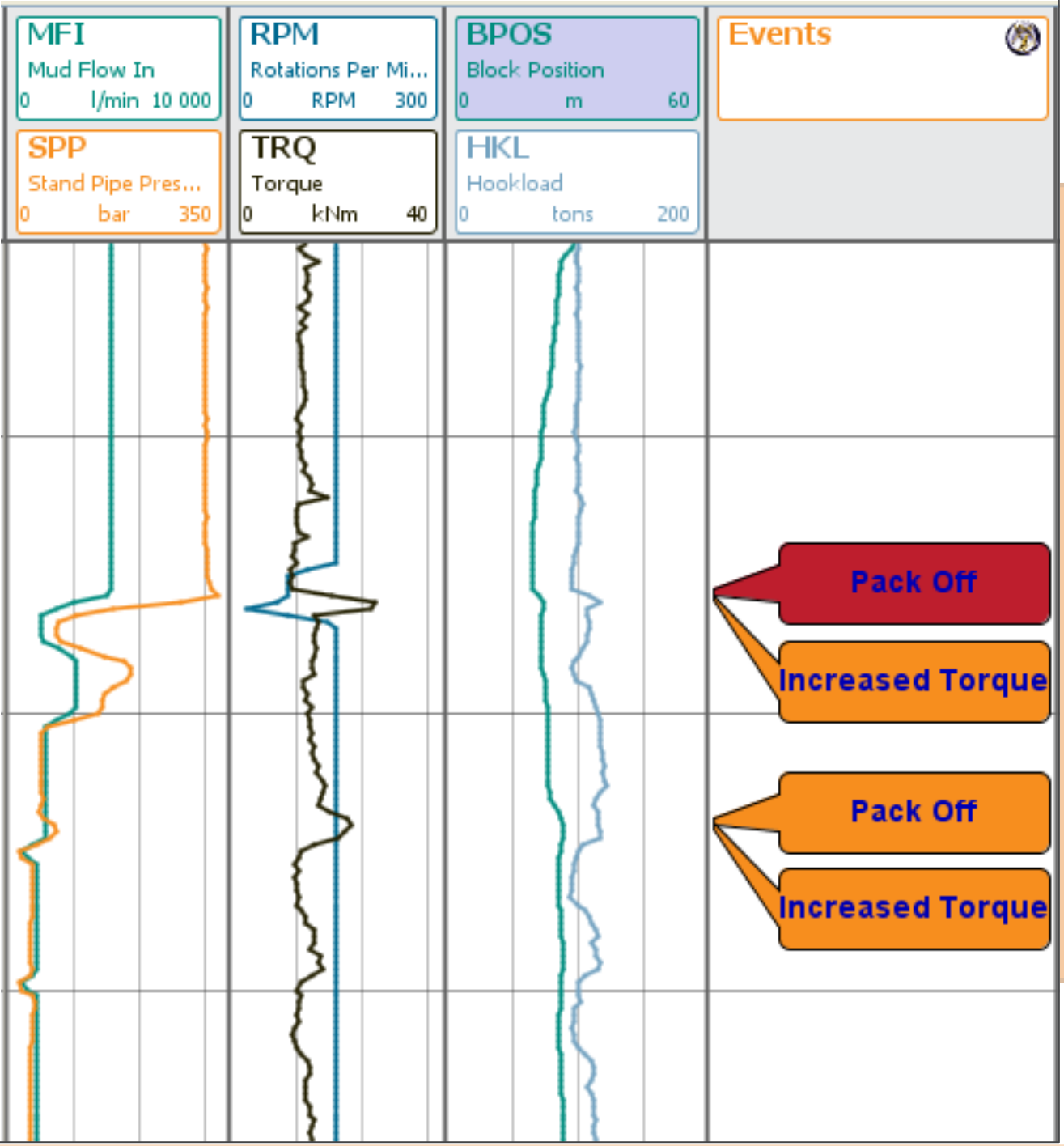
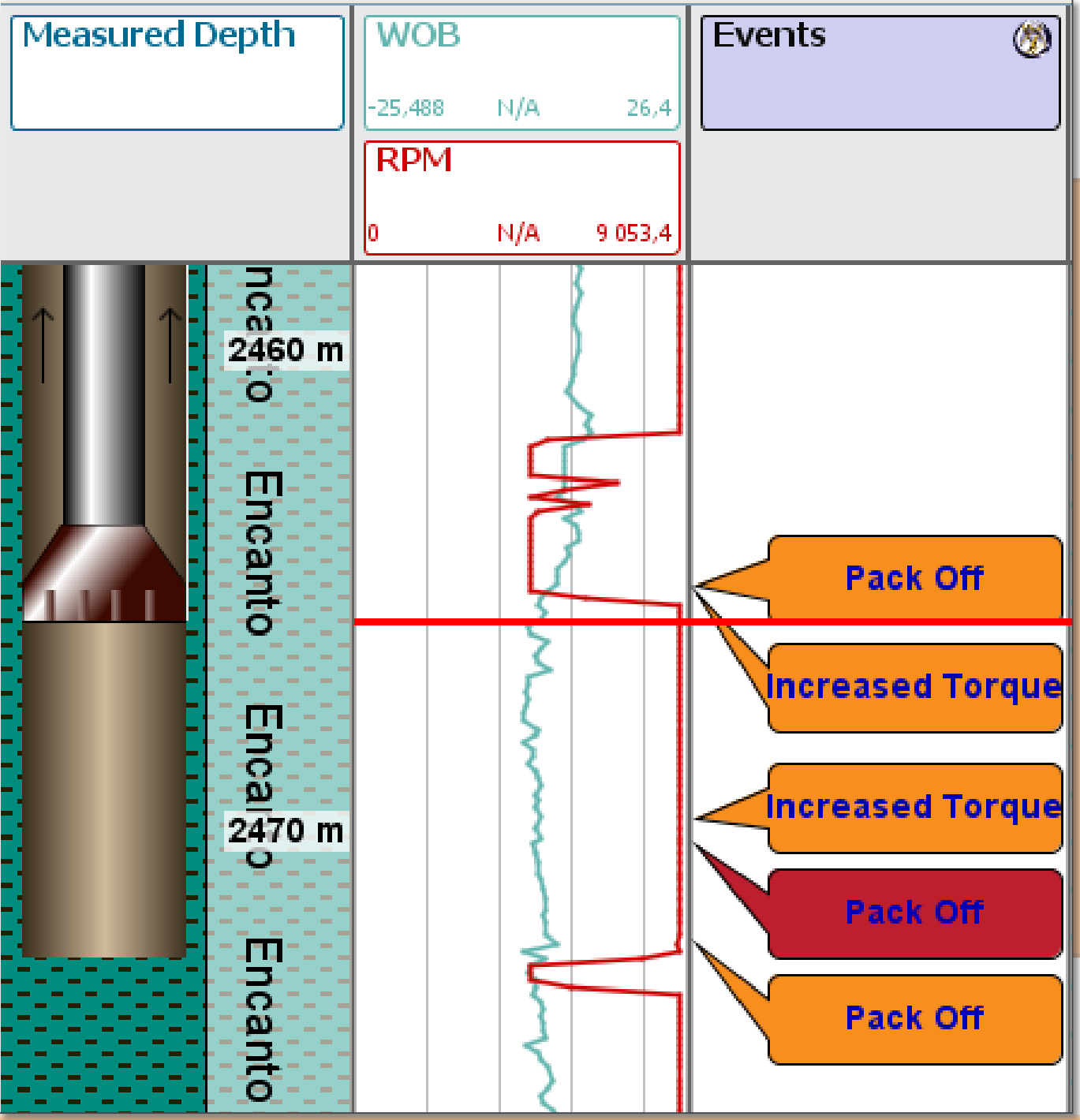
BPOS
Block Position
0 m 60
Events
SPP
Stand Pipe Pres...
0 bar 350
TRQ
Torque
0 kNm 40
HKL
Hookload
0 tons 200
Pack Off
Increased Torque
Increased Torque

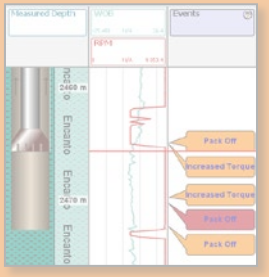
VERDANDE™ TECHNOLOGY

Case



Case


Measured Depth
WOB
-25,488
N/A
26,4
Events
RPM
0
N/A
9 053,4
2460 m
Encanto
Encanto
2470 m
Encanto
Pack Off
Increased Torque
Increased Torque
Pack Off
Pack Off



Case

Drilling Fluid

Mud Weight:	1.6
Type:	OBM
pV:	36
Yp:	25

Bottom-Hole Assembly

Length:	90
Stabilizers:	2
Bit Type:	PDC

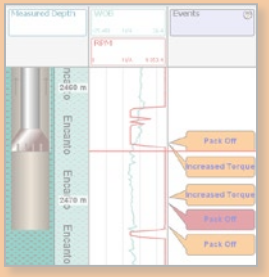
Well Geometry

Section start:	4280 MD
Target depth:	6310 MD
Inclincation:	42 deg

Drilling Fluid
...

Bottom-Hole Assembly
...

Well Geometry
...



Shared Experience

Case Name

Pack Offs while Reaming in Encanto Shale

Problem Area

Hole Cleaning

Situational Description

While reaming the Encanto shale formation, experienced pack off tendencies …

Lessons Learned

Reaming in this formation can cause damage to the formation.

Instead of reaming, circulate ….

Best Practice

In order to ensure good hole cleaning while drilling in circumstances where …

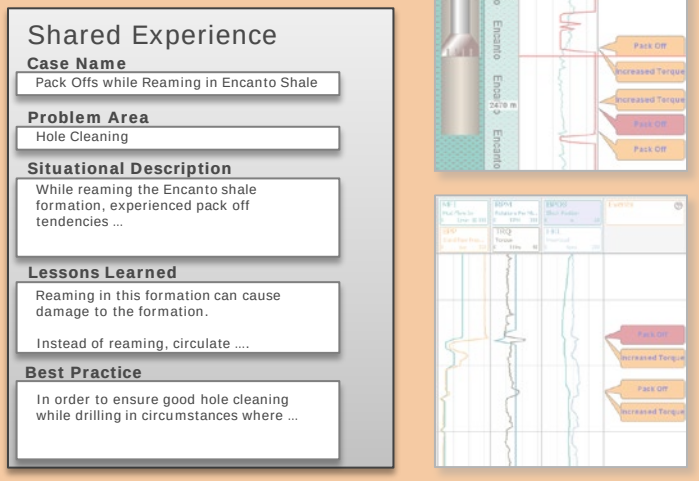
VERDANDE™ TECHNOLOGY

Case

Drilling Fluid
…

Bottom-Hole Assembly
…

Well Geometry
…

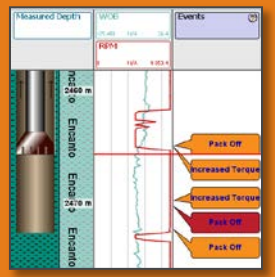


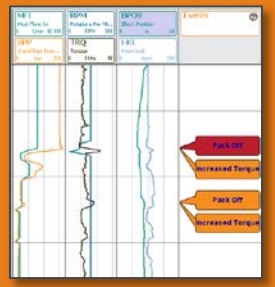
Case

Drilling Fluid
...

Bottom-Hole Assembly
...

Well Geometry
...





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Case

Current Situation

Drilling Fluid
…

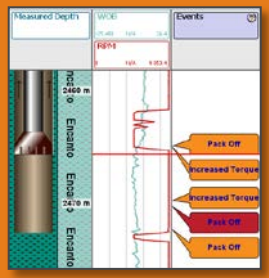
Bottom-Hole Assembly
…

Well Geometry
…

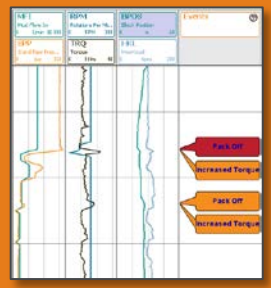
78%

52%

31%



86%



74%

Shared Experience

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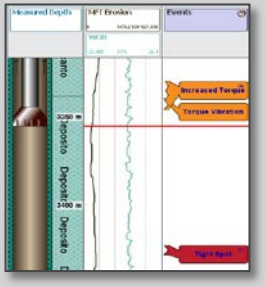
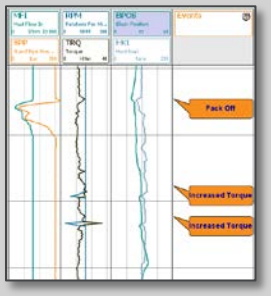
Drilling Fluid
…

Bottom-Hole Assembly
…

Well Geometry
…





64%

Case

Current Situation

Drilling Fluid
...

Bottom-Hole Assembly
...

Well Geometry
...

78%

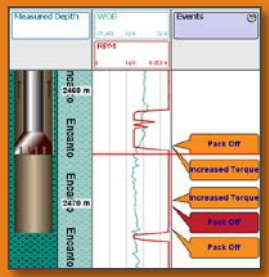
52%

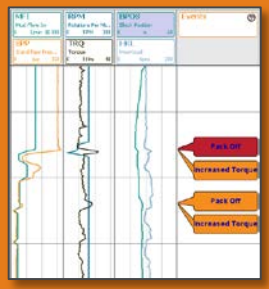
31%

86%

74%

59 %





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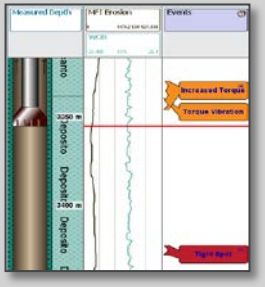

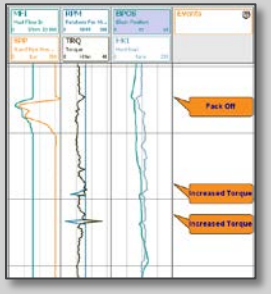

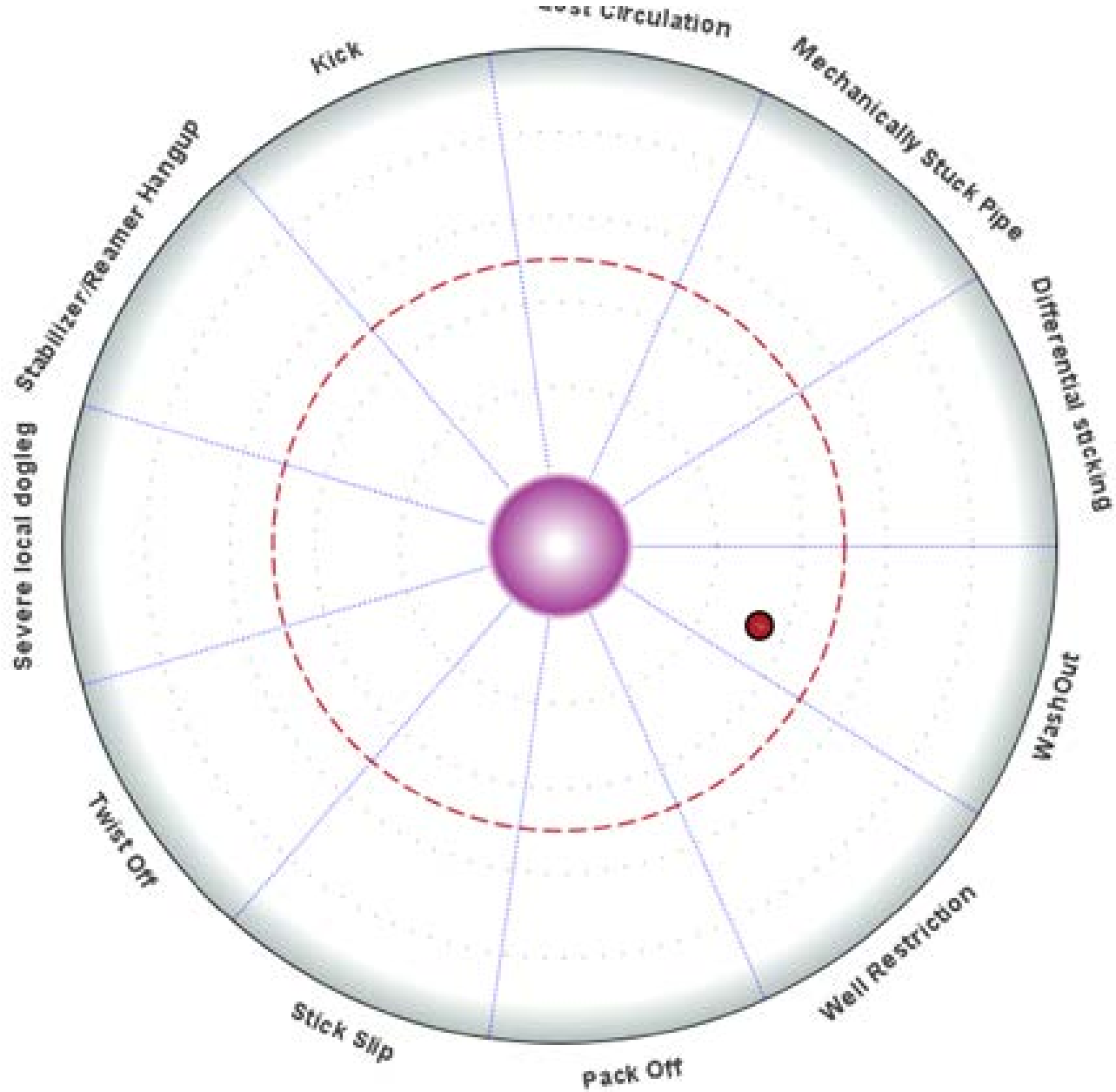
Kick
Mechanically Stuck Pipe
Differential sticking
WashOut
Well Restriction
Pack Off
Stick Slip
Twist Off
Severe local dogleg
Stabilizer/Reamer Hangup

Local Cases

vs.

Generic Cases

- DrillEdge comes with a set of Generic Cases – cases that do not contain customer-specific data but represent generic situations.
- These cases allow the system to recognize problems «out of the box».
- The can and should be adapted to the best practise of the organization – but this is low cost.
- During the operation of DrillEdge, new cases from the operator and the local field can be captured, expanding the library.

DrillEdge software - proven globally

"Our testing with DrillEdge technology produced compelling results and **demonstrated that unscheduled events don't happen immediately.**

We learned that there are predictable and repeatable symptoms in **advance of each event on the order of hours, or sometimes even days.**

By applying DrillEdge technology, **we hope to recognize these symptoms much sooner**, allowing corrective action to be taken by leveraging Shell best practices to reduce their occurrence."

Eric van Oort
Shell Well Performance Improvement Manager

"The DrillEdge platform is expected to help operators lower risk, increase their rate of penetration and **reduce non-productive time while drilling**.

The technology is expected to **help our customers expand their understanding of their wells without increasing their workload** as they continue to drill more demanding and technically challenging wells."

Scott Schmidt
President of Drilling and Evaluation