Becoming Aware of the Drilling Situation

Odd Erik Gundersen, Development Director
Overview

- Motivation
- Situation awareness
- Situation awareness on the rig floor
- Situation awareness in the RTOC
- DrillEdge:
  - Perception of situational elements
  - Supporting comprehension of the situation
  - Projecting the future status
  - Supporting decision making
Motivation
National Commission Offshore Drilling

“It is no longer acceptable to rely on a system that requires the right person to be looking at the right data at the right time and then to understand its significance in spite of simultaneous activities and other monitoring responsibilities.”

“There is no apparent reason why more sophisticated, automated alarms and algorithms cannot be built into the display system to alert the driller and mudlogger when anomalies arise. These individuals sit for 12 hours at a time in front of these displays.”
Situation Awareness
Overview

Situation Awareness

State of the environment → Percept Situational Elements → Comprehend Current Situation → Project Future Status → Make Decision → Perform Actions
Situation Awareness on the Rig Floor
All Senses Help the Rig Crew to Become Aware of the Situation
Situation Awareness in the IOR
Manual Monitoring of Drilling Operations

<table>
<thead>
<tr>
<th>Time</th>
<th>DMEA</th>
<th>HKL</th>
<th>MFI</th>
<th>ROP1(1)</th>
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<tbody>
<tr>
<td></td>
<td>5 Hole Depth</td>
<td>7 Hook Load</td>
<td>25 Total Pump Output</td>
<td>3 Rate Of Penetration</td>
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<tr>
<td>0</td>
<td>2,044 m</td>
<td>7.121 tonne</td>
<td>80,558 L/min</td>
<td>0 m/h</td>
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<td></td>
<td>2,144</td>
<td>80,558</td>
<td>1,000</td>
<td>0</td>
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<td>DBTM</td>
<td>6 Bit Depth</td>
<td>WOB</td>
<td>SPP</td>
<td>RPM</td>
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<tr>
<td>0</td>
<td>2,042.1 m</td>
<td>0 tonne</td>
<td>67.268 bar</td>
<td>0 rpm</td>
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<td>220.77 bar</td>
<td>150</td>
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<td>BPOS</td>
<td>28 Block Height</td>
<td>0 tonne</td>
<td>63.6 m</td>
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<tr>
<td>50</td>
<td>71.8</td>
<td>71.8</td>
<td>71.8</td>
<td>32,131</td>
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</table>

3. Sep 2009 02:30:00
Building a Mental Model of the Drilling Situation

- Mud motor
- Stable flow
- High pressure
- Shale
- High inclination
- Drilling
- Varying torque
- Increased drag
- Mud losses
- Pore pressure
DrillEdge: Perceiving Situational Elements
Automated Recognition of Symptoms
Visual Verification of Recognized Symptoms
Situational Elements as Visualized in DrillEdge™

- Casing
- Mud Flow
- Rotation animation
- Hole depth
- Lithology
- Event
- Bit depth
- Formation

Diagram shows measured depth and events with pressure spikes.
DrillEdge: Supporting Situation Comprehension
Combining Information to Enhance the Comprehension
DrillEdge: Projecting Future Status
The Radar: The Right Information at the Right Time
Case-Based Reasoning
Comparing Drilling Situations
Comparing Drilling Situations
Comparing Drilling Situations
Capturing a Case
Capturing a Case

[Diagram showing measured depth, WOB, and events with labels such as Pack Off and Increased Torque]
Capturing a Case

Drilling Fluid
- Mud Weight: 1.6
- Type: OBM
- pV: 36
- Yp: 25

BHA
- Length: 90
- Stabilizers: 2
- Bit Type: PDC

Well Geometry
- Section start: 4280 MD
- Target depth: 6310 MD
- Bit Type: PDC
Capturing a Case
Comparing Cases

- Drilling Fluid
  - 78%
  - 52%
  - 31%
  - 78%
  - 74%
  - 64%

- BHA
  - 86%

- Well Geometry
  - 74%

Diagram showing comparison of various parameters between two cases.
Comparing Cases

Drilling Fluid
... 78%
BHA 52%
Well Geometry 31%

Drilling Fluid
...
BHA...
Well Geometry...

Comparing Cases

74%
67%
Verdande Technology’s Unique Real-Time CBR Cycle

1. Real-time data
   - Interpretation

2. Important events
   - Search and retrieve

3. Situational description
   - Took weight and hard stringer in “Ming” formation.
   - Case base
   - Learn

4. Situational description
   - Tight spots and hard stringer in “Hant” formation.
   - Experience and advice
     - Tight spots caused serious problems when running casing. Recommend reaming streamers.

5. Drilling engineer
   - Alert and advise

6. Situational description
   - Took weight while drilling. Reamed the stringers to avoid problems when running casing.
   - Experience and advice
     - New case
DrillEdge: Supporting Decisions
Providing Relevant Information

Case Description

Consequence:
Pack offs lead to mechanical stuck pipe two days later and around 150 m deeper.

Recommended Action:
Drill with controlled ROP to minimize overload of cuttings in the wellbore.

General Experience:
It has been repeatedly demonstrated that standing off bottom drilling at an optimum controlled ROP is better than drilling faster and using remedial action to clean up the wellbore.

Case Similarity Explanation

Depth View
Providing Relevant Information
Thank you!