3rd Party Real-Time Monitoring Providers:

Dr. Eric van Oort

Genesis Real-Time Systems

Houston, Texas
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Introduction

- **Eric van Oort**
  - B.J. Lancaster Professor at University of Texas - Austin
  - Co-PI, OESI
  - CEO, EVO Energy Consulting
  - Chairman, Board of Directors, & Co-Founder Genesis RTS
  - 20 year veteran of Shell Oil Company, former RTOC lead

- **Genesis RTS**
  - Collaboration of oil & gas subject-matter experts, ex.-NASA engineers, and KM specialists
  - Founded in April 2012

*Houston Chronicle, Sept 19, 2010*
Activities at UT Austin

Activities:

- Undergrad & grad student projects analyzing real-time and historical well data provided by operators using UT - RTOC facility
- Industry-sponsored graduate R&D on data-quality improvement, data-analytics, pattern recognition, drilling automation, robotics (drilling.utexas.edu)

Paper SPE 170323, Kyle M. Carter et al.
Questions - 1

1. Describe the role of third-party providers?
   - Provide enabling tools, processes and people (SME’s) to help operators achieve operational excellence (safety and performance) in onshore and offshore well construction

2. How do you interface with industry customers, and how do you view this relationship?
   - Primarily through SME’s: in-house optimization engineers, 24/7 monitoring specialists
   - Collaborative relationship that allows the operator to take full ownership (of data-integration, decision-making etc.)

3. What services do you provide?
   - Design & build RTOC’s
   - GenesisCORE™ – set of tools and applications
   - Genesis360™ – people and processes
   - K(NOW) – Knowledge Management framework
Questions - 2

4. How do the services lend themselves toward operational decision making?
   - Tools provide the ability to rapidly analyze (patterns in) complex data that indicate dysfunctional hole or drilling behavior (e.g. formation influx or stuck pipe trend)
   - SME’s are able to quickly transfer industry best practice on real-time monitoring workflows and subsequent decision-making processes to the operator

5. What about accountability between the Operator and your firm?
   - Accountability for operational decision-making should always reside with the operator, but contractors should be accountable for the quality of the data and accuracy of the information they provide.

6. What level of automation and remote control is appropriate to balance accountability, responsibility, and operational efficiency?
   - Up to Level 5 “Decision Support” seems appropriate for now, but R&D progresses towards full automation with (remote) supervisory control using RTOC’s

Levels of Automation, Endsley and Kaber, 1999
Macondo Real-Time Data Pattern Analysis

(Adapted from Deepwater Horizon Study Group Report)
Questions - 3

7. What are your suggested protocols for remote oversight and the established chain of command?

- Typically green / yellow / red flag “interactions” for remote monitoring observations
- Communication and decision-making protocols may have some standard features, but need to be customized to fit the operator’s chain of command and need for involvement of both internal and external subject-matter experts

8. Are there critical operations and specific parameters that are typically monitored?

- Operators: safety and performance-critical parameters: pressures, loads/torque, volumes, flow rates, temperatures, operational readiness of equipment, etc.
- Regulators: parameters associated with regulatory compliance and prevention of catastrophic events (particularly blowouts and associated spills), NOT day-to-day drilling operations and performance management

Example of a hookload plot used for prevention of stuck pipe events
US Offshore Blowouts – Contributing Factors

Drilling Event
Formation Strength
BOP Reliability
Casing & Cement
Casing & Cement
Drilling Event
Drilling Event

Barrier verification to help prevent major well control incidents:

- BOP Reliability Verification
- Casing & Cement Evaluation
- Formation Strength Evaluation
- Drilling Event Detection

Paper SPE 170323, Kyle M. Carter et al.

U.S. Offshore Blowouts – Contributing Factors
1992-2006
(by percent occurrence)

Note: Some incidents had multiple contributing factors. (From Booth, 2010)
Questions - 5

10. Does your company rely on any automation and predictive software in real-time monitoring?

11. What role could automation and predictive software tools play in real-time monitoring?

12. What role could CBM play in real-time monitoring? Describe how operating equipment using condition-based monitoring could be tailored and/or used for real-time monitoring.

- Automation, predictive data analytics, “big data” and CBM are the future of our industry! They can - and will - have a strong positive effect on safety (“taking people out of harm’s way”) and performance optimization (NPT/ILT reduction). They should play (are already playing) a prime role in RT monitoring.

- CBM of critical equipment (BOP’s and their control systems), top drives, mud & cement pumps etc. should augment monitoring of critical well test information (BOP tests, casing & shoe tests, production casing high and low tests, etc.)

- All will require subject-matter expertise, reliable input data, state-of-the-art modeling algorithms, and they ability to minimize false positives (leading to “alarm fatigue”)

[Image of computer screens with charts and graphs]

20 April 2015

3rd Party Real Time Monitoring Providers

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**Sentinel™ - Data Quality Tool**

Sentinel™ is a “behind the scenes” rig data watchdog – if you have bad data...and you do...you need improved fidelity in your well plan execution decisions - the results: improved well safety and faster well delivery through improved ROP, reduced NPT/ILT

<table>
<thead>
<tr>
<th>Tool</th>
<th>1st Rig</th>
<th>2nd Rig</th>
<th>3rd Rig</th>
<th>4th Rig</th>
<th>5th Rig</th>
<th>6th Rig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary Torque</td>
<td>17%</td>
<td>17%</td>
<td>22%</td>
<td>24%</td>
<td>21%</td>
<td>18%</td>
</tr>
<tr>
<td>Makeup Torque</td>
<td>23%</td>
<td>11%</td>
<td>12%</td>
<td>17%</td>
<td>60%</td>
<td>13%</td>
</tr>
<tr>
<td>Rotary RPM</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Pump Rate</td>
<td>1%</td>
<td>32%</td>
<td>1%</td>
<td>1%</td>
<td>40%</td>
<td>1%</td>
</tr>
<tr>
<td>Block Position</td>
<td>6”</td>
<td>&lt;0.5”</td>
<td>&lt;0.5”</td>
<td>6”</td>
<td>&lt;0.5”</td>
<td>&lt;0.5”</td>
</tr>
<tr>
<td>Hookload</td>
<td>11%</td>
<td>18%</td>
<td>12%</td>
<td>12%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pit Volumes</td>
<td>15%</td>
<td>12%</td>
<td>18%</td>
<td>16%</td>
<td>15%</td>
<td>22%</td>
</tr>
<tr>
<td>Pump Pressure</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>3%</td>
<td>5%</td>
</tr>
</tbody>
</table>

- Relational Bayesian networks allow for real-time autonomous sensor fault detection
- Adaptive technology maximizes redundancies – minimizes missed and false alarms and differentiates between sensor and process failures
- Sentinel can actually correct faulty data
- Minimal rig-to-rig re-configuration required

Actual SPE and Chesapeake study of numerous rigs and contractors –with noted sensor errors
Questions - 6

12. How could BSEE leverage RT technologies? What advice could you give to BSEE?
   – Learn from experienced real-time operators, build collaborative relationships, understand and address their concerns about situational awareness, etc.
   – Adopt commercial-off-the-shelf solutions for maintenance, upgrades & versioning
   – Adopt vendor-neutral IT infrastructure, data-collection / integration / archiving systems; look beyond WITS & WITSML (e.g. OPC-UA) data-protocols
   – Adopt state-of-the-art KM systems for knowledge retention & training
   – Focus RTM activities on those events that historically have caused blow-outs

13. Which activities could real-time monitoring supplement or replace?
   – Reduce frequency of offshore inspections
   – Reduce labor-intensive inspection / test paperwork
   – Leverage limited number of BSEE / Coast Guard staff amidst growing offshore / Arctic activity
   – Attract and recruit talent to BSEE / Coast guard interested in working with advanced technology
Additional Slides
Information Technology Design Components

- Implemented high reliability, availability, and maintainability factored into the design.
- Open architecture, vendor neutral, and easily configurable/scalable
- Cost effective design, utilizing commercial–off-the-shelf (COTS) components
- Standards based design Support WITS, WITSML, and OPC data-standards.
- Flexible scalable data storage and archival
- Cyber security planning
- Operational health and status monitoring.
- Incorporates data & information virtualization
- A state-of-the-art audio and video capability
RTOC Architecture

EXTERNAL INTERFACES:
- Rig Communications Link
- Internet
- Other External Networks

RIG INTERFACE:
- Switch Server
- Timing Server Data Aggregation SW

SUBSYSTEM LEGEND:
- SERVER
- STORAGE
- WORKSTATION
- AUDIO/VIDEO
- SYSTEM MANAGEMENT
- RIG INTERFACE

ARCHITECTURE FUNCTIONALITY:
- Intrusion Protection Firewalls
- System Management
- Switch
- Blade Server
- Blade Server
- Blade Server
- Network Attached Storage
- Storage Area Network
- Video Display
- Codec
- Video Switch
- Wireless Router
- Timing Server
- Printer
- Workstation
- Audio Interface Unit
- Audio Headset

EXTERNAL INTERFACES:
- Rig Communications Link
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THIRD PARTY REAL TIME MONITORING PROVIDERS

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Tool Examples

ROP Drilling/Sliding
Filter: Bakken, North of the River, Day Crew

Single Case Analysis (SCA)
SE-GOM-1213

Formation Parameters
- Young's Modulus E:
  - Calculated: 33.75 GPa
  - Measured: 36 GPa
- Poisson's Ratio μ:
  - Calculated: 0.4
  - Measured: within ±0.5
- UCS (Kp):
  - Calculated: 33 MPa
  - Measured: within ±10 MPa
- Friction Coefficient (µ):
  - Calculated: 0.3
  - Measured: within ±0.1
- Tensile Strength (Ts):
  - Calculated: 2.8 MPa
  - Measured: within ±0.5 MPa

Planned Wellbore Parameters
- Wellbore Deviation:
  - Calculated: 107 ft
  - Measured: 103 ft
- Wellbore Obliquity:
  - Calculated: 8°
  - Measured: within ±5°
- Applied Mud Weight:
  - Calculated: 13.75 lb/gal
  - Measured: within ±1 lb/gal

Stress/Pressure Parameters
- Maximum Stress (S1):
  - Calculated: 6,000 psi
  - Measured: within ±500 psi
- Minimum Stress (S3):
  - Calculated: 2,000 psi
  - Measured: within ±200 psi
- pore Pressure:
  - Calculated: 2,000 psi
  - Measured: within ±200 psi
- Acuteness of Stress:
  - Calculated: 10°
  - Measured: within ±5°
- Stress Regime:
  - Calculated: normal faulting
  - Measured: normal faulting
- Dipstep Parameter:
  - Calculated: 4°⇒3°
  - Measured: within ±1°

Additional plots include: Borehole Plot, Open Hole Log, Omega Plot, and Hole Circumference Plot.