Slide 1

Drilling Optimization, Risk and Uncertainty Reduction, and Future Workforce Education Using Big Data Analysis

SPE Webinar – February 22, 2016

Dr. Eric van Oort
The University of Texas at Austin

TEXAS
The University of Texas at Austin

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Presentation Outline

- **RAPID Introduction**
- **How to Optimize?**
- **Data Analytics**
  - Does it pay off?
  - Data challenges
- **UT Student Data Analytics Project**
  - Analysis of a large field data-set
  - Development of data analysis techniques
  - Development of storyboards
- **Conclusions**

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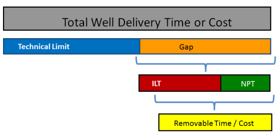
What is RAPID? Goals & Objectives

RAPID is an **interdisciplinary group of researchers and students** from multiple engineering disciplines (petroleum, mechanical, and aerospace) with these objectives and goals:

- deliver automation solutions for any and every aspect of well construction (drilling, cementing, completion / stimulation, production?)
- reducing drilling/completion time and cost by > 50%
- reducing the number of individuals at the rig site by > 50%.



- Onshore: NPT <10%, ILT ~30%
- Offshore: NPT 20-40%, ILT ~30%

RAPID RIG AUTOMATION
Performance Improvement in Drilling

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RAPID Steering Group

Dr. Mitch Pryor

Dr. Pradeep Ashok

Dr. Dongmei "Maggie" Chen


Additional Members

Dr. John Foster

Dr. Eric van Oort

Dr. Behcet Acikmese


RAPID RIG AUTOMATION Performance Improvement in Drilling

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RAPID Focus Areas

RAPID R&D Focus Areas

- Automation control systems
- Modeling, simulation, and empirical validation in downhole environments
- (Real-Time) Monitoring, data analytics, and "Big Data" issues
- Intelligent mechanization, automation, and equipment re-design

Undergraduate Programs

- First, maintain a "minimum effort" in all identified focus areas and viable undergraduate programs.
- Funds beyond baseline efforts (including baseline projects in all focus areas) will largely be guided by feedback from RAPID members
- Program Director will prioritize efforts to deliver a balance of short-term benefits and longer terms research efforts.

RAPID RIG AUTOMATION Performance Improvement in Drilling

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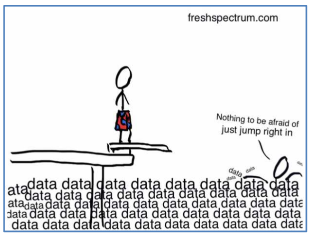
How to Optimize?

1. Automation
   – See previous webinar "Drilling Automation Research at The University of Texas at Austin"
2. Workforce Education
3. Data Analytics



Getting engineers ready for a data centric world

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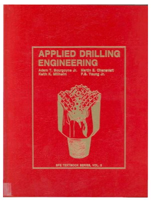
Drilling Education – The Old Way



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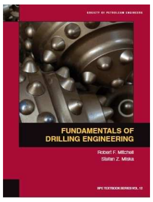

Applied Drilling Engineering – Bourgoyne et al.
1986

Fundamentals of Drilling Engineering – Mitchell and Miska
2011

Traditionally Teaching drilling has been about
Drill bits, directional drilling, drilling fluids, solids control, cementing, casing, well bore stability, well control, measurement-while-drilling techniques, stuck pipe, lost circulation, well bore hydraulics, etc.

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Drilling Education – The New Way

Advanced Simulators with Sophisticated Human Machine Interfaces

Data Analytics & Coding
- Machine Learning
- Statistical Learning
- Pattern Recognition
- Artificial Intelligence
- Crowd Sourcing
- Etc.

Traditional skills still needed, but this is the age of big data: post well analysis, real time data analysis provide great value & great opportunity for talent education

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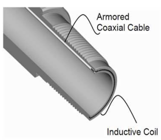
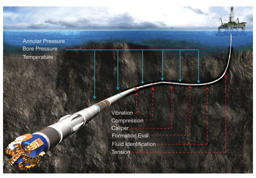
Data Analytics – Does it Pay Off?

- Data may be hard / expensive to collect
  - E.g. downhole HF data
- Data-standards are often lacking
- Data collection / curation may be very labor-intensive
- Dedicated company resources for analysis may not be available
- Turn-around time may be too long for meaningful optimization
- Specific data challenges may be significant (see later)



Source: Reeves et al. (2005)

Amplification Joint



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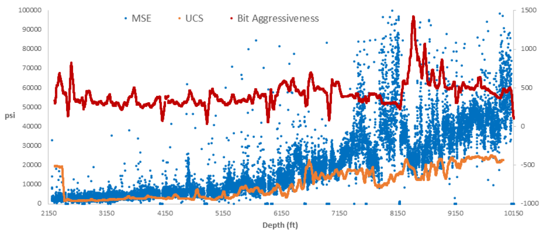
Is There Value in the Data? - 1



Drilling limiter chart for a horizontal shale well, derived from surface data

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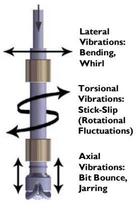
Is There Value in the Data? - 2

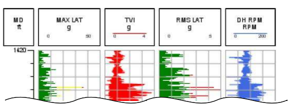
Vibrations



Sensors

- Downhole sensors measure movements, pressures, temperatures and bending forces
- Standalone subs with single sensors or suite of sensors in one tool
- Continuous and burst data

Data Logs



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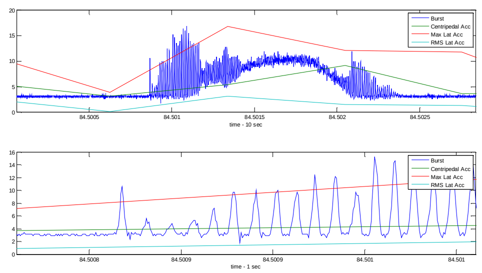
Is There Value in the Data? - 3



Coupling of whirl and stick-slip vibrations, derived from downhole HF burst data

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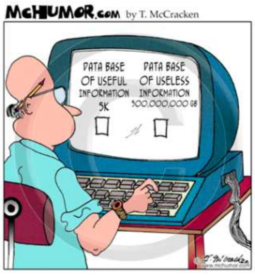
Data Challenges

- Big Data – or Messy Data?
- Data Quality & Uncertainty
- Data Frequency & Sampling Rate
- Data Standards
- Data Mnemonics & Metadata
- Data Collection & Curation
- Data Interpretation
- Data Security (Cyber Security)
- Data Transmission
- Data Storage
- Etc.



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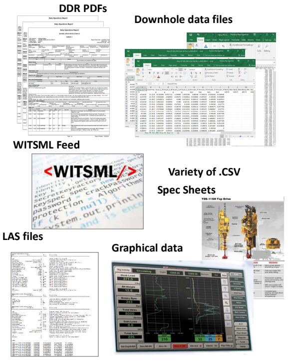
Big or Messy Data?



- Drilling and completion data presents more of a "messy" than a "big" data-problem, due to the range of structured and unstructured data, static vs. dynamic information, etc.
- Since optimization, risk and uncertainty reduction often require information from various sources, this can be a daunting task!

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Sensor Data Quality

- Sensor technology used out in field operations is often decades old, i.e. most sensors on modern drilling rigs data back to the 1950's and 60's.
- Generally, data are of poor quality, as indicated by a recent comprehensive study by Chesapeake
- Data collected by oil and gas companies are seldom used, with a prime reasons being lack of qualified manpower to prepare the data and carry out its analysis and awkward storage / data security requirements.
- Transmitting and storing useless but massive data is a high tax on the industry already strapped for cash and prevent efficient use of information nuggets hidden in noise.
- Data-analysis and machine-learning algorithms are not being used to their full potential or are immature for oil and gas applications.
- Even when data and analysis are available, the data are hardly ever used effectively for safety, performance improvement and unit cost reduction purposes etc.
- Expensive superfluous or missing data are in fact a burden and cost rather than a benefit to the industry and lower its operational efficiency in time of hardship and belt-tightening

Sensor	Rig A	Rig B	Rig C	Rig D	Rig E	Rig F
Rotary Torque	17%	17%	22%	24%	21%	18%
Makeup Torque	23%	11%	12%	17%	60%	13%
Rotary RPM	1%	1%	1%	1%	2%	1%
Pump Rate	1%	32%	1%	1%	40%	1%
Block Position	6"	<0.5"	<0.5"	6 ft	<0.5"	<0.5"
Hook Load	11%	N/A	18%	N/A	12%	N/A
Pit Volumes	15%	12%	18%	16%	15%	22%
Pump Pressure	5%	4%	4%	4%	3%	5%

Average error rates for rig sensors on land rigs operated in the continental US by Chesapeake (after Zenero et al., 2016). Error rates in red font are considered unacceptably high, particularly when considering the crucial role that many of these sensors play in avoiding catastrophic well incidents, e.g. associated with uncontrolled formation influxes / kicks.

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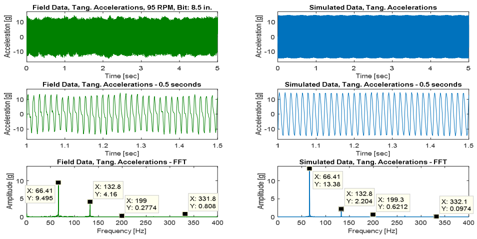
Data Uncertainty: Are We Sure of What We Are Measuring?



SPE 170955

Pure and Coupled Drill String Vibration Pattern Recognition in High Frequency Downhole Data

Theresa Baumgartner and Eric van Oort, SPE, The University of Texas at Austin

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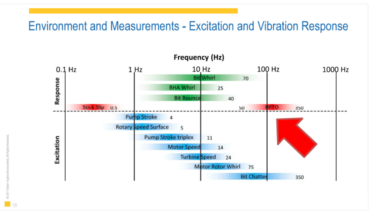
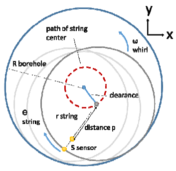
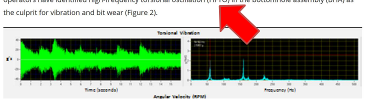
Are HFTO's Real?

Environment and Measurements - Excitation and Vibration Response





Placing advanced vibration sensors downhole is critical in preventing bit wear and tool damage. By incorporating technologies such as the [redacted] operators have identified high-frequency torsional oscillation (HFTO) in the bottomhole assembly (BHA) as the culprit for vibration and bit wear (Figure 2).



High-Frequency Torsional Oscillations (HFTO) can be satisfactorily explained as a sensor artifact due to off-center rotation of accelerometers during whirl

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Data Measurement Frequency

Type	Sub-Category	Comments	Observed Typical Frequency/Periods	Data Sampling and Processing Rate
Lateral Vibrations				
	Backward Whirl	Additional dynamic component, high amplitudes, negative radial accelerations	Up to 120 Hz +	250 Hz +
	Forward Synchronous Whirl	Identified from bit wear, whirl speed equals rotational speed, low frequencies	< 3 Hz	10 Hz
	Off Center Rotation	Only movement of the sensor without dynamical forces, very high frequency spectra of overtones (500 Hz+)	First mode up to 70 Hz + overtones	250 Hz +
	Chaotic Whirl	Described in literature, not (yet) identified in data		
Torsional Vibrations				
	Harmonic Stick Slip	Period depends on length of drill string, negative rotation can occur	<0.1 – 2 Hz	5 Hz
	Torsional Fluctuations	Frequencies related to RPM, Different sources, e.g. stabilizers, doglegs, buckling,	0.5 Hz – 10 Hz	20 Hz
	Lithology changes	Correlation with tangential acceleration, depth based	< 1 Hz	< 2 Hz
Axial Vibrations				
	Bit Bounce	Harmonic axial fluctuation of high amplitude	5-20 of Hz	50 Hz
	Vibrational Dynamics	Effects of lateral and torsional vibrations on axial vibration measurements	Up to 120 Hz	250 Hz +
	RPM Fluctuations	Stress and strain changes for each rotation, especially in curve section	0.5 Hz – 10 Hz	30 Hz
Downhole Weight on Bit				
	Weight transfer	Low frequencies	< 1 Hz	< 2 Hz
	Dynamics (Vibrations)	Whirl and stick slip frequencies	Up to 120 Hz	250 Hz +
	Bit Bounce	Harmonic fluctuation, medium frequency	5-20 of Hz	50 Hz
Downhole Torque				
	Torque Transfer	Due to friction, buckling	0.5 Hz – 10 Hz	20 Hz
	Torque Fluctuations	RPM related	0.5 Hz – 10 Hz	20 Hz
	Dynamics (Vibrations)	Whirl and stick slip frequencies	Up to 120 Hz	250 Hz +
Pressure				
	Kick detection	Pressure increase due to influx	< 1 Hz*	
	ECD monitoring	Cuttings transport, surge and swap	< 1 Hz*	
	Changes in DH pressure regime	Depending on DH pressures, ECD, pump rates, etc.	< 1 Hz*	
	Dynamics (Vibrations)	Pressure fluctuations based on pipe movements	Up to 120 Hz	
Temperature				
	Temperatures	Low frequencies	< 1 Hz	

... frequencies that reveal valuable information

.... currently reported in literature, high frequency pressure data may reveal higher frequency phenomena*

Table 1: Summary of downhole dynamics observed in high frequency downhole data

SPE-174986-MS

Maximizing Drilling Sensor Value through Optimized Frequency Selection and Data Processing

Theresa Baumgartner, SPE, and Eric van Oort, SPE, The University of Texas at Austin

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Data Standards

```
~Sensor Information Block
#TAG                  Data                       Unit     Description
#--------- ---------------------------------- -----     ------------------------------------------------------------

 ~S1                                       1:          Sensor number (S1,S2,S3,Ö)
 SensorName                   Accelerometer:          Commonly used sensor description or name
 SensorType         Tangential accelerometer:          Technical sensor name
 SensorCategory                Acceleration:          Acceleration, Velocity, Displacement, Force,...
 relAxialPosition                        3.5: ft       Distance from lower end of device
 relLateralPosition                     4.12: in       Distance from device axial center
 SamplingRate                            800: 1/sec    Sensor sampling rate
 LastCalibrationDate        10:11:2015 20:15:          Date and time of last sensor calibration
 LastCalibrationType                 offsite:          Offsite,onsite manual,onsite semi-automatic,onsite automatic
 MinValueRange                          -100: g        Lower limit of sensor measurement
 MaxValueRange                          +100: g        Upper limit of sensor measurement
 Accuracy                              0.005: +/-%FS   Estimated field accuracy
 Precision                             0.005: g        Repeatability of measurement
 DigitalResolution                     0.005: g        Measurement increments
 Filter                                    y: (y/n)    Signal goes through filtering process
 High Cut-Off Amplitude                  -72: dB       Filter description details
 High Cut-Off Frequency                   45: 1/sec    Filter description details
 High Roll-Off Amplitude                  -3: dB       Filter description details
 High Roll-Off Frequency                  35: 1/sec    Filter description details
 Low Cut-Off Amplitude                     0: dB       Filter description details
 Low Cut-Off Frequency                     0: 1/sec    Filter description details
 Low Roll-Off Amplitude                    0: dB       Filter description details
 Low Roll-Off Frequency                    0: 1/sec    Filter description details

 ~S2                                       2:          Sensor number (S1,S2,S3,Ö)
 SensorName                     downhole WOB:          Commonly used sensor description or name
 ...                                     ...:          ...

~Measurement Information Block
#TAG                  Column Nr.                 Unit     Description
#--------- ---------------------------------- -----     ------------------------------------------------------------

 Time                                      1:          Time and date in standard format
 Elapsed Time                              2: s        Zero value = start of bit run
 Acceleration                              3: g        Radial acceleration
 RPM                                       4: RPM      Calculated value from radial acceleration
 RMS                                       5: g        Desrciption of calculation - average

~Measurement Information Block
#TAG                  Column Nr.                 Unit     Description
#--------- ---------------------------------- -----     ------------------------------------------------------------

 ~C1                                       1:          Channel number (C1, C2, C3,Ö)
 Sensors                                 1,4:          Sensor or sensors used for this measurement
 OutputRate                              0.4: 1/sec    Channel data rate
 MeasurementCharacter                      n: (y/n)    None, average, standard deviation, minimum, maximum, RMS, etc.
 MovingAverage                             y: (y/n)    Average calculated in moving window vs. fixed WINDOW
 WindowLength                             10: sec      Window length of statistics
 DerivedValue                              y: (y/n)    Output other than direct measurement or statistics
 DerivationDetails                     S1+S2:          Description of derivation
                                           n: (y/n)    Continuous data stream over the entire run vs sequences
                                           5: sec      Window length of one high frequency sequence
                                          20: min      Time distance between two windows
                                          no: (y/n)    Start of data collection after triggering measurement value
                                           y: (y/n)    Post retrieval data correction
                                      Manual:          Description of algorithm or procedure for data correction
                                           y: (y/n)    Classification of measurement into severities or types
                              mild vibs(0/5):          Name of classification type and upper and lower limits
                            vere vibs(5/inf):          Name of classification type and upper and lower limits
                                                       Irregular measurement observations

                                           2:          Channel number (C1, C2, C3,Ö)
                                           2:          Sensor or sensors used for this measurement
                                         ...:          ...

                                 0.000000     5.592454246     96.42046189     77.13636951
                                 0.001250     4.838110207     109.4702876     87.57623009
                                 0.002500     8.873063461     94.54559966     75.63647973
 2015-11-15T03:31:57.8897500     0.003750     8.264953178     104.9712956     83.97703648
 2015-11-15T03:31:57.8910000     0.005000     4.860732869     98.58256063     78.86604850
```

IADC/SPE-178900-MS

Efficiently Transferring and Sharing Drilling Data from Downhole Sensors
Theresa Baumgartner, Yang Zhou, and Eric van Oort, The University of Texas at Austin

This paper was prepared for presentation at the IADC/SPE Drilling Conference and Exhibition held in Fort Worth, Texas, USA, 1–3 March 2016.

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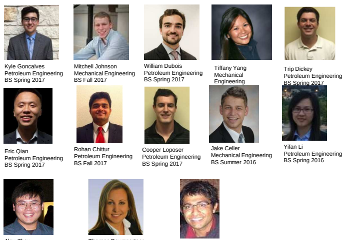
UT Student Data Analytics Project



Kyle Goncalves
Petroleum Engineering
BS Spring 2017

Mitchell Johnson
Mechanical Engineering
BS Fall 2017

William Dubois
Petroleum Engineering
BS Spring 2017

Tiffany Yang
Mechanical
Engineering

Trip Dickey
Petroleum Engineering
BS Spring 2017

Eric Qian
Petroleum Engineering
BS Spring 2017

Rohan Chittur
Petroleum Engineering
BS Fall 2017

Cooper Loposer
Petroleum Engineering
BS Spring 2017

Jake Celler
Mechanical Engineering
BS Summer 2016

Yifan Li
Petroleum Engineering
BS Spring 2016

Alex Zhou
ILT / Tortuosity / Drag
Modeling
PhD. Fall 2017

Theresa Baumgartner
High Frequency Data Analysis
PhD. Fall 2016

Gurtej Singh Saini
Petroleum Engineering
PhD. Fall 2019

PhD students share knowledge with undergraduates to solve state of the art data analytics problems

Developing future talent

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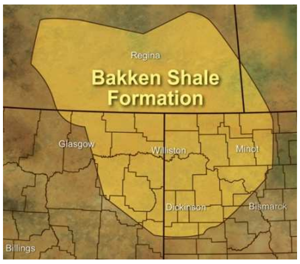
Data Sources

16 wells drilled in the Bakken formation in summer 2015

- Downhole, surface and directional data
- Over 100 GB of sensor data
- Over 20 million rows of data
- 588 listed channels per well
- 6+ GB CSV files
- Daily Morning Reports (DMRs)
- Well plans
- Well surveys
- Formation tops



The Work Environment

- Real-time collaboration center for teaching & R&D
- Ability to follow multiple concurrent drilling / completion operations
- Study complex data pattern analysis for NPT/ILT mitigation in real-time and on historical wells

UT has its own real-time center for drilling & completions data-gathering & processing, carrying out R&D and training students

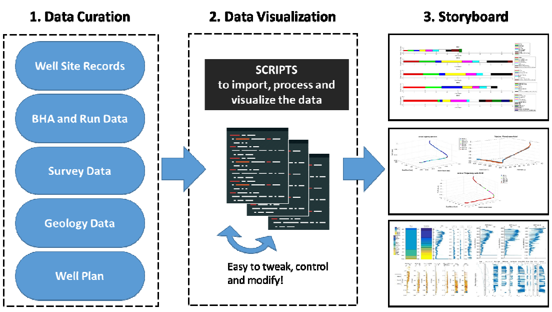
Motivation and Objectives

Maximize Value from Data
- Analyze large time-based drilling data
- Differentiate BHA and directional drilling performance
- Find cost saving opportunities
- Build automated data analysis and visualization tools

Educate Students
- Familiarize students with drilling processes and jargon
- Develop data analytics skillset
- Build workforce for tomorrow

Establish RAPID Data Analysis Toolkit
- Identify, streamline, and document work flows
- Standardize software tools
- Increase efficiency of future analysis

The Big Picture



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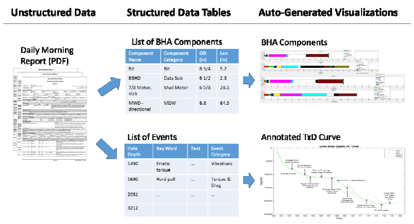
Data Curation and Visualization

- Analyzed essential information from Daily Morning Reports (DMRs)
- Extracted information from well plan, well surveys, formation data, DMRs, well site sensor data
- Detailed behavior of the well analyzed in general
- Served as a major step in onboarding of students



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15 Different Visuals Generated

	Plot Title	Description	
1	Sample BHA Visualization	Basic sketches of the BHA used during each run while the well	Overview of the BHA and Well Performance
2	Summary Drilling Performance for each well	Formation tops, BHA runs, vibrations (XY, SS, Z) and ROP	
3	Overview of the Directional Performance	Formation tops, BHA runs, slides versus the directional parameters	
4	Planned versus Actual Well Trajectory	3D trajectory of the well versus the planned path	Directional Performance of the well
5	Actual Well Trajectory versus DLS	3D trajectory of the well path colored for different values of DLS	
6	Actual Well Trajectory versus ROP	3D trajectory of the well path colored for different values of DLS	
7	Comparison of 2D Directional Channels	Comparison of planned with actual directional channels: Inclination, Azimuth , DLS, E/W, N/S, TVD	
8	Parameters on Surface	Surface parameters : RPM, Torque, WOB with ROP, Differential Pressure, DSE and MSE	Drilling Dynamics and Performance
9	Parameters at the Bit	Downhole "at the bit" parameters : RPM, Torque, WOB with ROP, Differential Pressure, DSE and MSE	
10	Comparison of ROP	Comparison of ROP of all the wells in a pad	
11	Comparison of Slides for Each Well	Comparison of slides of all the wells in a pad	
12, 13, 14	Comparison of Vibrations	Comparison of vibrations (XY, Z, SS) of all the wells in a pad	
15	Time Based Plots	Basic time based parameters : Hole depth, bit position, block height, SWOB, hook load, vibrations (XY, Z, SS), pump pressure	

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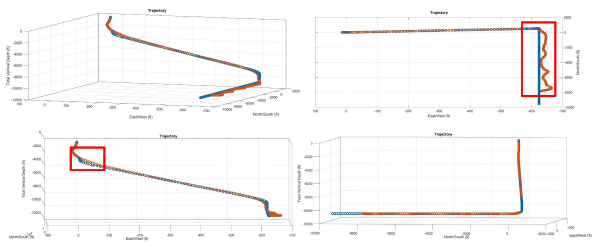
Example Visual 1 : Planned vs. Actual Well Trajectory



Relevance: Visual comparison of the actual versus the planned trajectory

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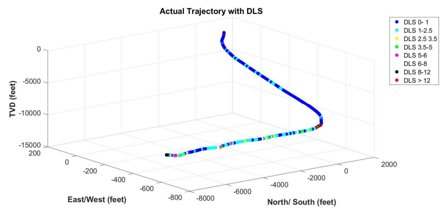
Example Visual 2 : Well Trajectory versus DLS



Relevance: Looking at the DLS and other drilling dynamics parameters (e.g. ROP) over the well trajectory

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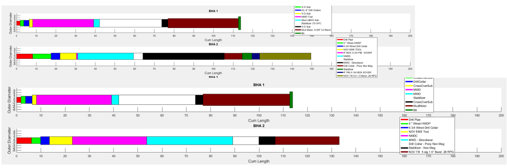
Example Visual 3 : BHA Comparisons



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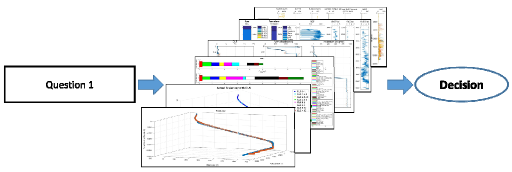
What is Storyboarding?

- Pre-selected visuals to answer commonly asked questions
- Organizing visuals in a sequence to tell a story
- The sequence is decided based on the application
- Around 4 to 10 visuals per question



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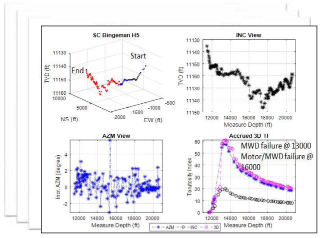
Automated Tortuosity Analysis



IADC/SPE- SPE-178869-MS

Improved Wellbore Quality Using a Novel Real-Time Tortuosity Index

- Automated tortuosity analysis
- High tortuosity wells linked with high equipment failure rate due to drillstring vibrations
- High tortuosity wells possible linked with:
  - Premature submersible pump failures
  - Casing running problems
  - Cementing & zonal isolation problems
  - Hydraulic fracturing & production inefficiencies

An interesting dilemma: "drilling fast" at all cost, or offsetting fast drilling with wellbore quality

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Summary on Tortuosity Analysis

Pad	Well	Peak 3D TI	End 3D TI	End Inc TI	End Azm TI	Section Length (ft)	# Inc Infl.	# Azm Infl.	Dysfunction 1	Dysfunction 2	Dysfunction 3	Dysfunction 4
Pad B		62	17.7	12.9	12.03	10274	32	21	MWD failure @ 13000	-	-	-
		98.3	31.2	11.4	29.08	9554	35	29	Motor failure @ 17000	-	-	-
		152.3	61.3	60.2	11.7	9482	35	19	MWD failure @ 12000	Motor failure @ 17000	MWD failure @ 18000	Shock sub failure @ 195000
		60.7	20.1	8.02	18.48	9194	36	32	MWD failure @ 13000	Motor/MWD failure @ 16000	-	-
Pad C		85.7	33.4	16.3	29.17	8546	29	13	Lockup @ 11929	-	-	-
		5.4	3.59	2.51	2.57	9256	28	19	-	-	-	-
Pad G		5.8	3.95	3.39	2.04	8886	27	9	-	-	-	-
		24.7	10	5.63	8.29	8810	29	15	Motor failure @ 19500	-	-	
		22.8	7.65	5.77	5.02	9301	32	19	Motor/bit failure @ 13000	Motor failure @ 17500	MWD failure @ 18500	-
		23.8	7.27	3.88	6.15	9264	33	23	Motor failure @ 21000	-	-	-
		26.3	11.4	7.09	8.88	8925	34	18	motor failure @ 17000	Liner stuck @ 20500	-	-
Pad K		8.22	8.22	6.06	5.56	7869	25	21	Sidetrack @ 19000 due to bad MWD	-	-	-
		6.4	5.59	3.87	4.04	2857	12	5	-	-	-	-
		4.74	4.74	3.62	3.06	9539	32	23	Sidetrack @ 20000, lowered target	-	-	-
		4.79	4.79	3.26	3.52	7706	26	21	-	-	-	-
		18.65	18.7	8.54	16.58	9606	39	30	Circulation issues @ 21000	-	-	-
		6.9	5.72	4.49	3.54	9894	30	22	Slow ROP @ 14000	Shock sub failure @ 19000	-	-

Occurrence of drilling dysfunctions have been linked with high detected tortuosity (Peak TI and End TI)

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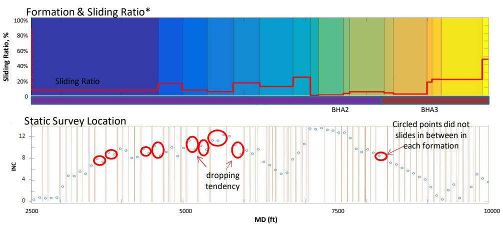
BHA Performance Visualization



*Sliding ratio: sliding drilling depth over overall depth per formation

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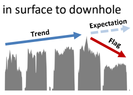
Downhole Data To Improve Surface Processes

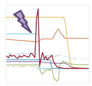
Monitoring *changes* in surface to downhole ***transfer functions***

- Surface Data: Primary Source
- Downhole Data: Shown if differs from expectations



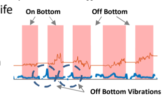
Understanding effects of ***surface actions*** on ***downhole forces***

- Negative or positive effects of surface processes, e.g. during ***connections***



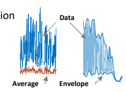
Recognizing the importance of ***off-bottom events*** on tool life

- Focusing on time based data



Investigating multiple **data aggregation** methods

- Not enough resolution to display high frequency data
- Averaging covers important events
- Envelopes



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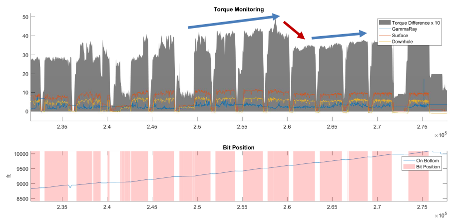
Torque Monitoring - Example



EXAMPLE

- Aggregation of data using envelopes
- Adding Gamma Ray, on off bottom indicators
- Investigation of trends and changes in delta TOB between downhole and surface

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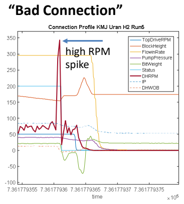
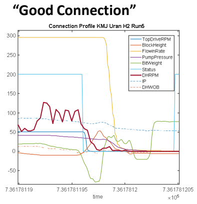
Connection Practices Impact Downhole Forces

"Bad Connection"



"Good Connection"



EXAMPLE

- Downhole data reveals bad practices of operations
- Using downhole data to understand implications of actions on surface
- E.g. time of pump shut in and picking off bottom
- Implementation of based practices
- Required: Good time alignment and recognition of latencies to establish cause and effect relationships

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Project Conclusions

- Developed a workflow to process and utilize large volumes of data
- Workflow:
  - Step 1: Define KPIs and visualizations
  - Step 2: Automate processes to handle simultaneous analysis of multiple wells
  - Step 3: Build storyboards for quick optimization decision-making

Observations:
- Data curation takes up to 80% of the time spent on analyzing data
- Multiple well pads with similar drilling conditions offer unique opportunity to analyze and optimize BHA performance
- Close collaboration with and frequent feedback from operator leads to better results

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The Value for the Operator

- Improved value extracted from data collected for an in-depth data study.
  - Many files would otherwise never have been further analyzed.
- Gained insights into data quality will improve data standards and service agreements between the data service provider and the operator in the future.
- Realized quick cost savings from operational, BHA and well design changes identified by observations in the data.
- Improved standardization and use of drilling data for visualizations.
- Tested new visualization concepts, such as the storyboards, to increase the efficiency of dealing with large amounts of data and different types of measurements.
- Utilized an inexpensive yet well qualified research workforce at an educational institute.
- Educated and supported the training of future drilling engineers, i.e., future workforce.

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The Value for the University

- Provided a competitive advantage for their students in landing a position in the industry.
- Showcased the beneficial applied use of research funding.
- Demonstrated its flexibility to adopt novel teaching strategies to a rapidly changing environment.
- Contributed in innovative ways to solve oild & new industry problems.
- Differentiated itself by quickly adapting to new industry needs and trends.

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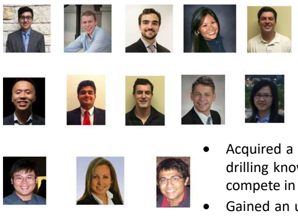
The Value for the Students



- Acquired a variety of important soft skills and real world drilling knowledge, improving their ability to successfully compete in the marketplace for future industry jobs.
- Gained an understanding of the benefits of data analysis and structured problem solving for moving towards more efficient drilling.
- Learned various tools and methods for analyzing large data sets containing information from multiple systems and representing complex engineering problems.
- Benefitted from the monetary compensation while at school.
- Made contacts with a possible future employer.

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Upcoming SPE Paper on Future Workforce Education

SPE-184739-MS

To be presented at the SPE/IADC Conference in Den Haag, NL, March 2017

Future Workforce Education through Big Data Analysis for Drilling Optimization

Y. Zhou, T. Baumgartner, G. Saini, P. Ashok, and E. van Oort, The University of Texas at Austin; M.R. Isbell, Hess Corporation; D.K. Trichel, formerly of Hess Corporation;

Paper with focus on educational aspects:

- Data in drilling will become ever more important in the future:
  - Big data analysis and combination of data from multiple sources
  - Larger number of sensors and increased communication (Internet of Things)

→Coding skills will become valuable asset of young drilling engineers (analysts)

Teaches drilling in ***a different way***:
- Start from operational (messy) perspective
- Learn theory together with practice

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- Yang Zhou, Pradeep Ashok, Theresa Baumgartner, and Eric van Oort, *Future Workforce Education through Big Data Analysis for Drilling Optimization*, Paper SPE 184739 presented at the SPE IADC Drilling Conference 14-16 March 2017 in The Hague, The Netherlands

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Acknowledgments

Sponsors

- RAPID Consortium Members:
  - ExxonMobil
  - Saudi Aramco
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  - Baker Hughes
  - NOV
  - ConocoPhillips
  - Apache

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- Tesse Smitherman

TEXAS
The University of Texas at Austin

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Why Decommissioning & Abandonment R&D?

Canada is expected to abandon a record number of oil and gas wells in the coming years, with 93,000 wells currently abandoned temporarily. (Source: Globe and Mail, November 21, 2016).

5 structures in the Gulf of Mexico and their associated wells are expected to be decommissioned between 2019-2023 (source: Oil and Gas Journal, May 5, 2014)

Decommissioning activities on the UK Continental Shelf will ramp up over the next 5 years. (Source: Wood MacKenzie, Oil and Gas Journal June 6, 2016)

Decommissioning activities in the North Sea are estimated to require an $80 billion investment between now and 2040. (Source: Wood Mackenzie, Oil and Gas Journal, May 2, 2016)

IHS: Decommissioning of aging offshore oil and gas facilities Increasing, annual spending rising to $13B by 2040

November 29, 2016

CODA Well Construction Decom, Abandon

co·da
/ˈkōdə/

noun MUSIC

the concluding passage of a piece or movement, typically forming an addition to the basic structure.

- the concluding section of a dance, especially of a pas de deux, or the finale of a ballet in which the dancers parade before the audience.
- a concluding event, remark, or section.
  "his new novel is a kind of **coda to** his previous books"

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CODA Focus Areas

UT Austin Well Abandonment Consortium

- Novel (Cementitious) Materials
- Novel Sensors and Measurement Techniques
- Advanced Modeling and Software
- New & Efficient Abandonment Techniques
- Undergraduate Programs

CODA Well Construction Decom, Abandon

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