Case Studies
Dull Grading System Upgrade

9th February 2022

Outline

Objectives

- This workgroup will focus on creating **Case Studies** for the most **common modes of dysfunctions encountered** while highlighting their corresponding **post-run forensic evidence**.

- These will be **used for training**, as well as to ensure that the codes developed by the other workgroups are adequate for forensics and/or continuous improvement investigations.

Outcome

- Create **Forensics Evaluation Workflow(s)** and **Continuous Improvement Best Practice(s)**.

- Document to be published within **IADC as guidelines** and SPE as **technical papers**.

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The IADC Project Scope

Drilling Dysfunction

(How things work)

Surveillance

(What can be measured)

Bit Damage

(How things work)

BHA Damage

(How things work)

Diagnostic

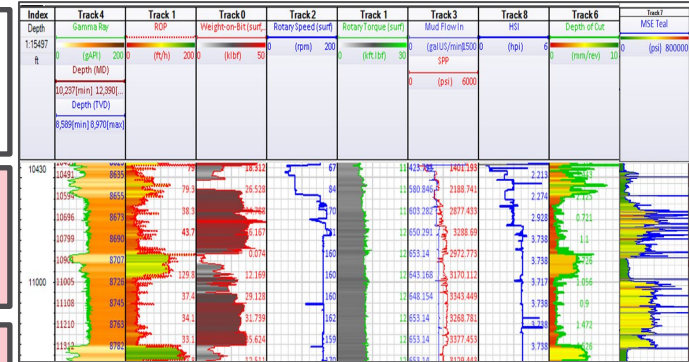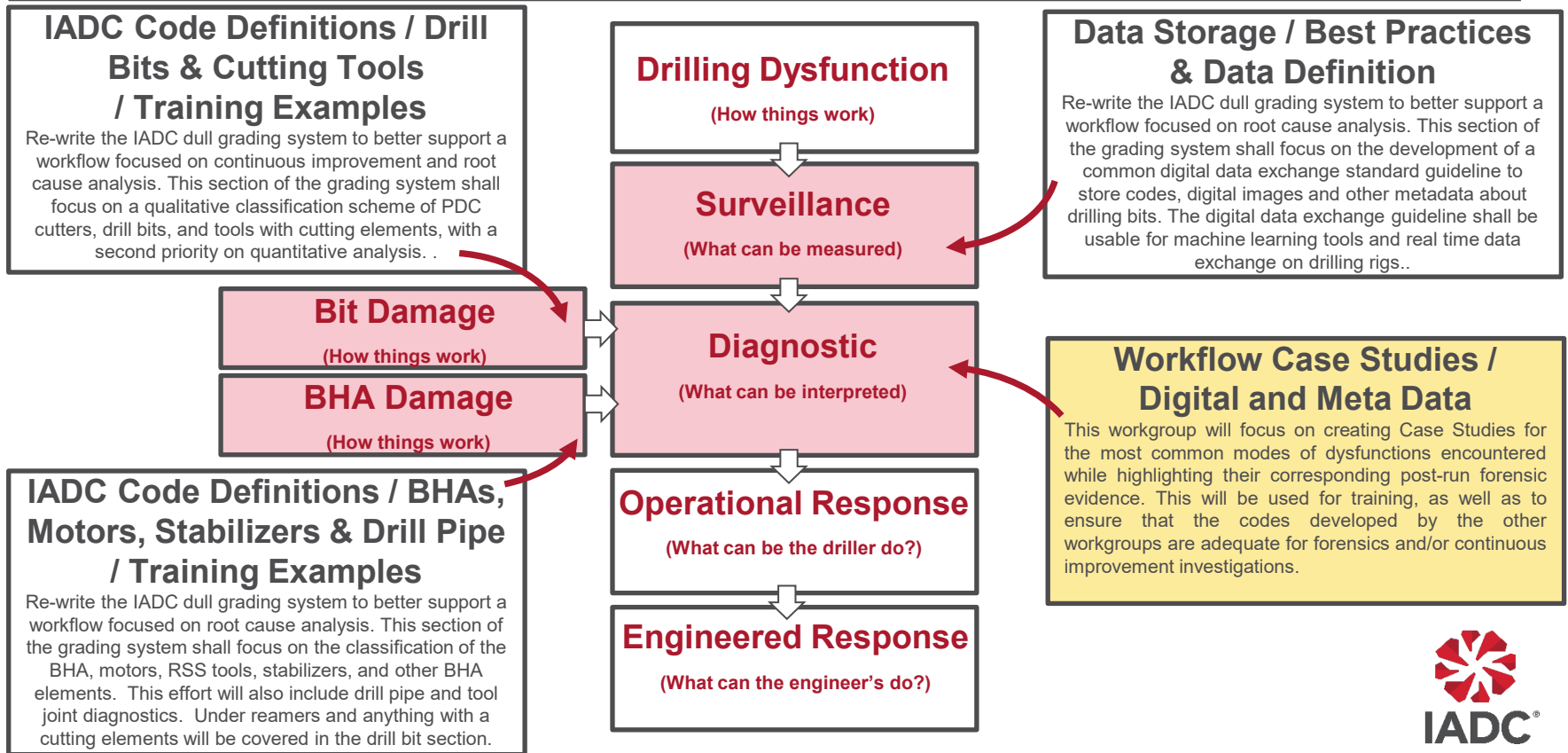(What can be interpreted)

Operational Response

(What can be the driller do?)

Engineered Response

(What can the engineer's do?)

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The Interaction with other groups

IADC Code Definitions / Drill Bits & Cutting Tools / Training Examples

Re-write the IADC dull grading system to better support a workflow focused on continuous improvement and root cause analysis. This section of the grading system shall focus on a qualitative classification scheme of PDC cutters, drill bits, and tools with cutting elements, with a second priority on quantitative analysis. .

Drilling Dysfunction

(How things work)

Data Storage / Best Practices & Data Definition

Re-write the IADC dull grading system to better support a workflow focused on root cause analysis. This section of the grading system shall focus on the development of a common digital data exchange standard guideline to store codes, digital images and other metadata about drilling bits. The digital data exchange guideline shall be usable for machine learning tools and real time data exchange on drilling rigs..

Surveillance

(What can be measured)

Bit Damage

(How things work)

BHA Damage

(How things work)

Diagnostic

(What can be interpreted)

Workflow Case Studies / Digital and Meta Data

This workgroup will focus on creating Case Studies for the most common modes of dysfunctions encountered while highlighting their corresponding post-run forensic evidence. This will be used for training, as well as to ensure that the codes developed by the other workgroups are adequate for forensics and/or continuous improvement investigations.

IADC Code Definitions / BHAs, Motors, Stabilizers & Drill Pipe / Training Examples

Re-write the IADC dull grading system to better support a workflow focused on root cause analysis. This section of the grading system shall focus on the classification of the BHA, motors, RSS tools, stabilizers, and other BHA elements. This effort will also include drill pipe and tool joint diagnostics. Under reamers and anything with a cutting elements will be covered in the drill bit section.

Operational Response

(What can be the driller do?)

Engineered Response

(What can the engineer's do?)

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Bit & BHA Damage Poll

Ranking	Bit Damage Causes
1	Hard formation transitions. Interfacial severity. (with/without bedding angle)
2	Bit Whirl Damage (Forward or Reverse)
3	Structural Limit overload (Excessive WOB)
4	Torsional damage (Stick-slip)
5	Thermal Spalling
6	Axial Damage (Bit Bounce)
7	Damage During Drill out or whirl in casing
8	Smooth Wear
9	Junk Damage
10	Substrate Erosion or Corrosion
11	Bit Balling (ribbon flow problems and erosion)
12	High Frequency Torsional Oscillations (HFTO)
Other	Damages due to uneven loading between bit and hole opener/ reamer and vice versa
	Reaming following previous underage bit
	Motor stalling
	Bit stalling
	Loss of tool face control
	Reaming in hole
	Bit side loading in bent motor operations

Bit Damage Causes

Ranking	BHA Damage Causes
1	Measurement While Drilling (MWD)/ Logging While Drilling (LWD) internal Failure (Whirl related)
2	Motor Chunking (Whirl related)
3	BHA/DP Fatigue (Whirl related)
4	(HFTO) Damage
5	Wear on motor stabilizer (and loss of steering)
6	Damage during drill out
7	Abrasive wear
8	BHA/DP/Connection Technical Failure
9	Undergauge bit
10	Heat checking/Thermal Damage
11	Junk Damage
12	Motor, MWD, or RSS failure
Other	Inability to Steer
	BHA damage due to surface control system dysfunction (eg WOB Oscillation)
	Stabilizer Hanging
	Cyclic Fatigue (Washouts)
	Broken shaft in RSS
	Torque limiter induced stick-slip
	Excess Shocks and vibration when rotating off bottom

BHA Damage Causes

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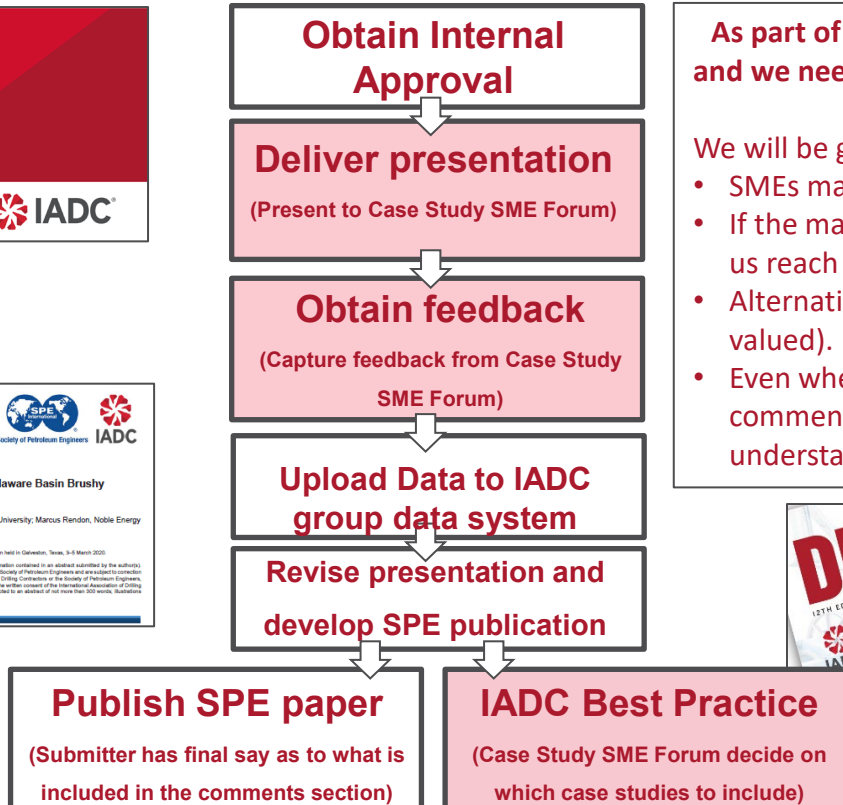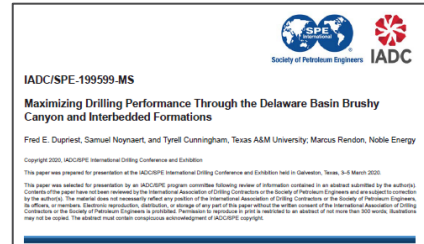
What does a good case study consist of?

Vs

"Add this and it will improve your ROP by 30%"

Case Study Maturation

IADC Case Study
TITLE: BHA HFTO Failure

Author / Company
Date

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IADC/SPE-199599-MS

Maximizing Drilling Performance Through the Delaware Basin Brushy Canyon and Interbedded Formations

Fred E. Duprest, Samuel Noynaert, and Tyrell Cunningham, Texas A&M University; Marcus Rendon, Noble Energy

Obtain Internal Approval

↓

Deliver presentation

(Present to Case Study SME Forum)

↓

Obtain feedback

(Capture feedback from Case Study SME Forum)

↓

Upload Data to IADC group data system

Revise presentation and develop SPE publication

↓

Publish SPE paper

(Submitter has final say as to what is included in the comments section)

IADC Best Practice

(Case Study SME Forum decide on which case studies to include)

As part of the Case Study SME Forum your opinion is valued, and we need your support to reach a direction for our industry.

We will be going into new ground in a few areas;
- SMEs may not always agree – that's ok.
- If the majority of SME's reach a consensus, then this will help us reach an aligned view for what is deemed Best Practice.
- Alternative views can always be published separately (and are valued).
- Even when we don't reach consensus, we suggest including comments to this affect as it suggest we don't fully understand the issue yet.

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2021 Case Studies Group Delivery

Date	Presenter	Company	Title
7-Apr-21	Ysabel Witt-Doerring	University of Texas	PDC Wear and Ring Out
21-Apr-21	Ty Cunningham	ExxonMobil UIS	Drill String Washout
5-May-21	Fred Dupriest	Texas A&M	Use of Baseline MSE in Bit Forensics
19-May-21	Cade Jackson	Performance Drilling Consultants	8 1/2" Bit Failure: Midland Basin
			Borehole Stability during tripping
2-Jun-21	Willie Watson	Shell	Case Study Group critical data and damage cause review
	Paul Pastusek	ExxonMobil UIS	Core out due to plugged Nozzles
16-Jun-21	Preston Wolfram	Smith Bits	Texas Panhandle 8.75" Shoetrack Drill Out Damage
30-Jun-21	Eric McClain	Occidental	Whirl > Ring Out > Inward Loading > Broken Blades
14-Jul-21	Raafat Abbas	Chevron	Ring out during drilling Interbedded formations
25-Aug-21	Raafat Abbas	Chevron	Cored during a connection
8-Sep-21	Fred Dupriest	Texas A&M	Cutter sliding distance & Low WOB Forensics
22-Sep-21	Graham Mensa-Wilmot	XCDrill	Heat Checking (Definition, Forensics, Field Cases, and Remediation)
6-Oct-21	Ysabel Witt-Doerring	Halliburton	Gauge Trimmer Damage
20-Oct-21	Ty Cunningham	ExxonMobil UIS	Mud Motor Back-Offs: Real-Time Identification & Operational Response
3-Nov-21	Andrey Rebrikov & Nikita Koshelev	Halliburton DBS	The use of a sensor modules system for measuring drilling parameters in a bit
17-Nov-21	Junichi Sugiura	Sanvean Technology	Motor backdrive and stick- slip dynamics
1-Dec-21	Jian Chu	University of Texas	Bit Damage Analysis via Image Processing

IADC/ SPE Galveston 2022
May 2021 Abstract submitted
Aug 2021 Accepted
Nov 2021 Paper submitted
Feb 2022 Presentation submitted
Mar 2022 Paper presented

Key Presentations dates:

18 Case Studies Reviewed in 2021

Aug 2021 Industry update

SPE 208707 - Bit and BHA forensics using rig-based photographic documentation practices

SPE 208712 - Data Collection and Workflow Required to Conduct Bit Forensics and Create Effective Changes in Practices or Design

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(SME Poll)
What is limiting you use your special forensic skills?

Data (40%)   **Time (30%)**

Training (25%)   **Nothing (5%)**

Analytics

Engineering ↔ **Operations**

Time	drilling team inertia	bit photos
Access to data	Nothing	time
Limited access to data	incomplete/poor data quality	Limited time
Lack of a comprehensive IADC code to describe what I see	Time	time specifically for data mining
locating data	Poor data quality	drill bit specs
Misalignment on the theory with stakeholders	time	Drill teams training in the physics of how things work
data flow	Acceptance and understanding of new technology	

Dealing with Data

❑ Define the critical and nice to have data required for each case study and group/label according to workgroup consensus.
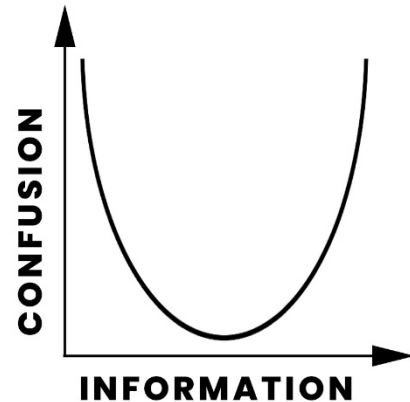
Data Collection to Support Forensics

Potential Data Sources

All EDR (surface) data (1 sample/sec+)
Bit & BHA photos (pre and post run)
Meta Data / Notes
Well Information / Rig Information
Drill Pipe Size
Well Trajectory/ TVD
Formation Tops
UCS/Formation strength data (this well or offset data)
BHA spec sheet including DP
Detailed Mud motor specs/ RSS
     Manufacturer, model, serial number, etc.
     Speed, bend angle, max diff etc…
Daily Drilling Reports
IADC Codes and reason pulled
Downhole data (continuous/memory/burst data at bit, motor, or BHA)
Rig Information – Control Systems etc.

Case Studies Review

What information did you **have?**

What information did you **need?**

What information would you have **liked to have?**

Data Types to Support Forensics
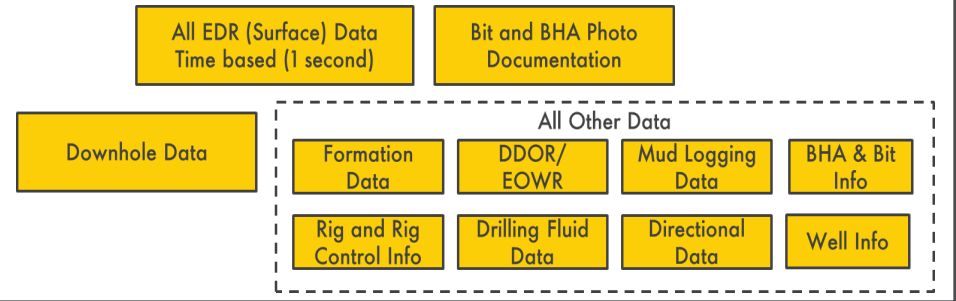
- All EDR (Surface) Data Time based (1 second)
- Bit and BHA Photo Documentation
- Downhole Data

All Other Data
- Formation Data
- DDOR/ EOWR
- Mud Logging Data
- BHA & Bit Info
- Rig and Rig Control Info
- Drilling Fluid Data
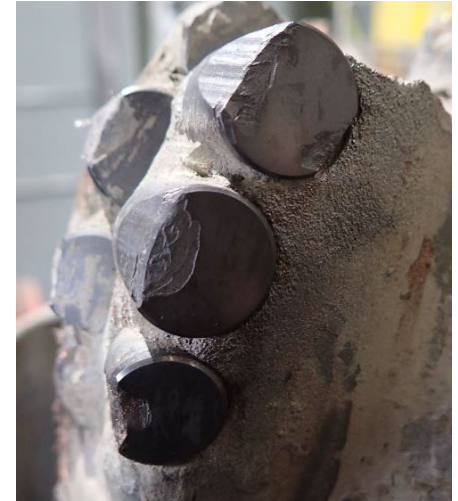- Directional Data
- Well Info

SPE 208712 - Data Collection and Workflow Required to Conduct Bit Forensics and Create Effective Changes in Practices or Design

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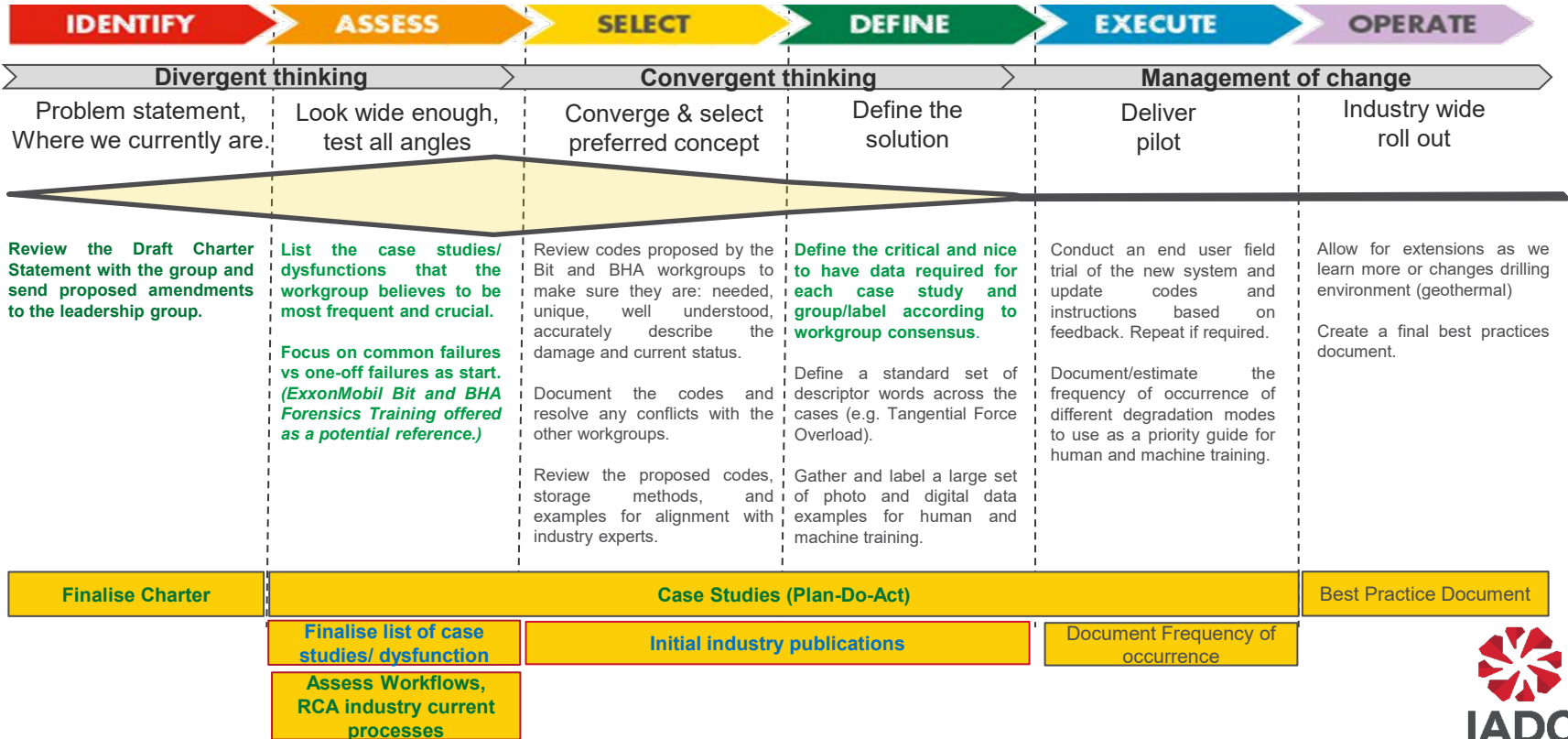# Drill Bit Images
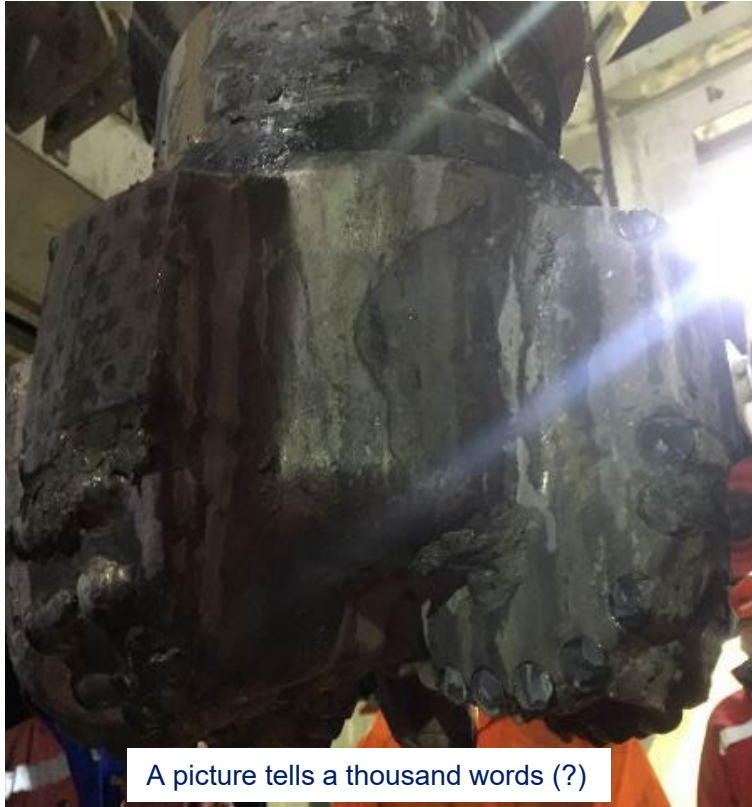
A picture tells a thousand words (?)

Cutting Structure				Bearing	Gauge	Remarks	
Inner Rows – Avg Cutter Wear	Outer Rows – Avg Cutter Wear	Primary Dull Characteristic	Location of Primary Dull Characteristic	Bearing & Seals	Undersize 16ths inch	Other Dull Characteristic	Reason Pulled

SPE 208707 - Bit and BHA forensics using rig-based photographic documentation practices

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Project Maturation

Jan '21	April '21	Aug '21	End Q1 22?	End Q2 22?	End Q3 22?

IDENTIFY	ASSESS	SELECT	DEFINE	EXECUTE	OPERATE

Divergent thinking		Convergent thinking		Management of change	
Problem statement, Where we currently are.	Look wide enough, test all angles	Converge & select preferred concept	Define the solution	Deliver pilot	Industry wide roll out

Tasks

Review the Draft Charter Statement with the group and send proposed amendments to the leadership group.	**List the case studies/ dysfunctions that the workgroup believes to be most frequent and crucial.** **Focus on common failures vs one-off failures as start. (ExxonMobil Bit and BHA Forensics Training offered as a potential reference.)**	Review codes proposed by the Bit and BHA workgroups to make sure they are: needed, unique, well understood, accurately describe the damage and current status. Document the codes and resolve any conflicts with the other workgroups. Review the proposed codes, storage methods, and examples for alignment with industry experts.	**Define the critical and nice to have data required for each case study and group/label according to workgroup consensus.** Define a standard set of descriptor words across the cases (e.g. Tangential Force Overload). Gather and label a large set of photo and digital data examples for human and machine training.	Conduct an end user field trial of the new system and update codes and instructions based on feedback. Repeat if required. Document/estimate the frequency of occurrence of different degradation modes to use as a priority guide for human and machine training.	Allow for extensions as we learn more or changes drilling environment (geothermal) Create a final best practices document.

Deliverable

Finalise Charter	Case Studies (Plan-Do-Act)				Best Practice Document
	Finalise list of case studies/ dysfunction	Initial industry publications		Document Frequency of occurrence	
	Assess Workflows, RCA industry current processes				

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2022

Date	Presenter	Company
2-Feb-22	Paul Pastusek	Exxon
16-Feb-22		
2-Mar-22	Fred Dupriest	Texas A&M
16-Mar-22	Raafat Abbas	Chevron
30-Mar-22		
13-Apr-22		
27-Apr-22		
11-May-22		
25-May-22		
8-Jun-22		
22-Jun-22		
6-Jul-22		
20-Jul-22		
3-Aug-22	Raafat Abbas	Chevron
17-Aug-22		
31-Aug-22		
14-Sep-22		
28-Sep-22		
12-Oct-22		

If you have a case study of interest please get in touch and secure a slot

9 Feb – IADD/ IADC Presentation (Zoom)
8-10 Mar – SPE/ IADC Conference (Galveston)
3-5 Oct - SPE ATCE Conference (Houston)

IADC/ IADD Presentation
Feb 2022 Presentation submitted
Mar 2022 Paper presented

ATCE Presentation
Jan 2022 Abstract submitted
April 2022 Acceptance/ Rejection
June 2022 Paper submitted
August 2022 Presentation submitted
October 2022 Paper presented

SPE XXXXXX – IADC Code Upgrade: Interpretation Of Surface And Downhole Data To Support Drilling Forensics

IADC Publication: Drilling Forensics (?)

The Case Studies > Drilling Forensics group:
Is there an opportunity to make this evergreen?

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Drilling Forensics – where to start?

If you are interested to find out more about drilling forensics (1) Drilling Forensics Session Link below.

ExxonMobil's Paul Pastusek to lead drill bit forensics virtual session on 12 April

[Drill Bit Forensics Session Now Available for Viewing - IADC.org](#)
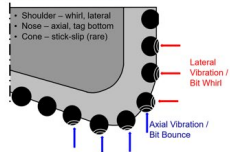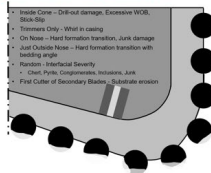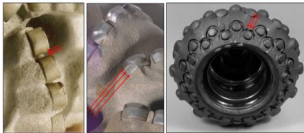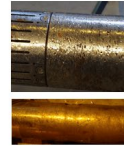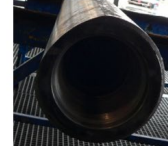
(2) Tune into the IADC conference on March the 10th and access the publications when available.
(3) Get in touch direct with the IADC team. bitsdullcode@iadc.org

Attendees

WW	Willie Watson (Me)
IADC	IADC Corp Services (Host)
	Paul Pastusek
	Stephanie Carling (Co-host)
DD	Dustin Daechsel
DS	David Shackleton
DL	Dustin Lyles
IADC	Linda Hsieh
PN	Paul Neil
RV	Robert van Kuilenburg
	Tom Roberts

AS	Ahmed Suleiman
AB	Alex Benson
AA	Ali Amani
AT	Andr� Time
AB	Andres Belloso
AG	Aydar Galimkhanov
AG	Aydar Galimkhanov
BE	Braden Engel
BL	Brandon Linford
CB	Camelia Baluta
CA	Carlos Alberto Zapata
CM	Christopher Marland

DC	David Conroy
EL	Eileen Louvier
ED	Enzo David Sanchez Villar
EO	Eric Oort
GC	gary chen
HI	Hani Ibrahim
HB	Hilda Bravo
JN	James Ng
JO	Jim Oberkircher
JF	John Fairbairn
JH	John Herman

KM	Karam Mekky
LS	Les Skinner
MP	Marco Perez
MB	Mario Bonvini
MB	Michael Bartrip
ND	Neerali Desai
NA	Nicholas Abolins
NM	Nicholas Mohammed
OO	Osas Ogunmwonyi
OS	Oscar Sanchez
PC	Prabhakaran Centala

RT	Rob Tipples
RE	Robert Estes
SK	Sahet Keshiyev
SE	Sean Emery
SS	Shahin Shajahan
SM	Stephane Menand
TC	Tartan Collier
TW	Todd Wensley
YH	yahya hashemian
YZ	Yunchuan Zhao
ZE	Zikora Ezedinma

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