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A Framework Delivers Multiparty Technologies Enhancing Drilling Operations Control

Matthew Isbell

Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

Agenda

SPE DISTINGUISHED LECTURER

- The idea – Reducing variation and human effort
- A problem and its value
- Project history
- A framework
- Examples
- Barriers
- The takeaway

Hypothesis

"Civilization advances by extending the number of important operations which we can perform without thinking of them."

– Whitehead 1910

How do you build lasting and effective collaboration?

Agenda

- The idea
- A problem and its value - Variation
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Decreasing Variation Improves Performance

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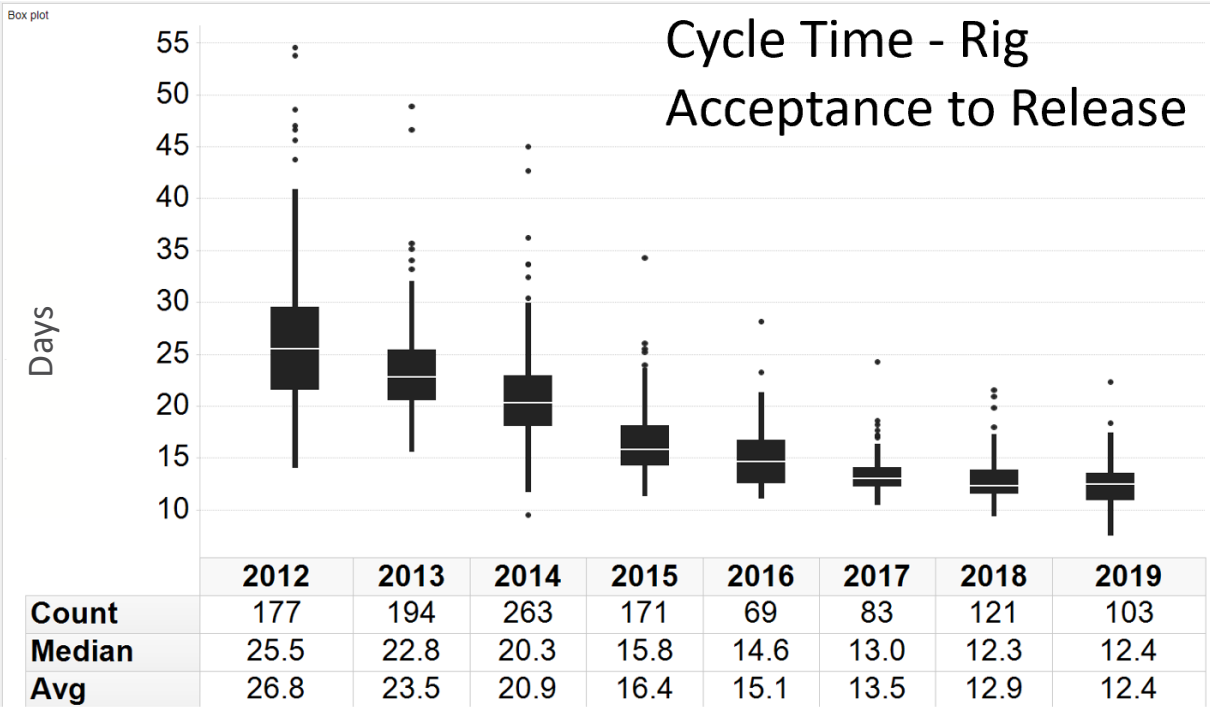
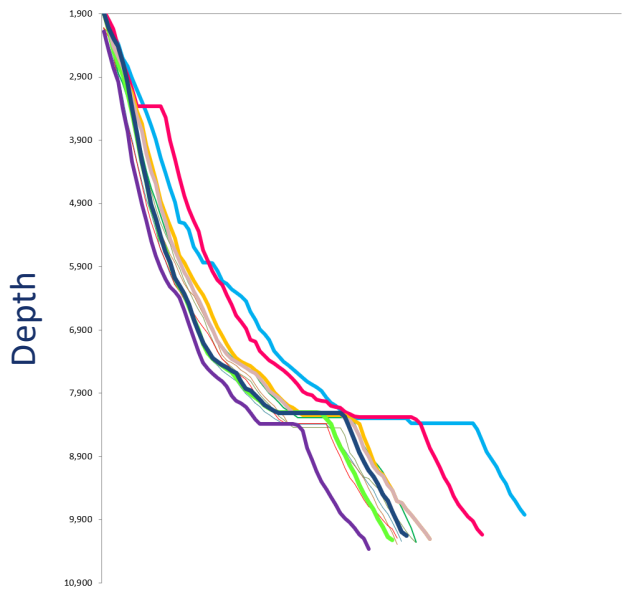
Why are we doing this? – Improve safety, quality, delivery, and cost



	2012	2013	2014	2015	2016	2017	2018	2019
Count	177	194	263	171	69	83	121	103
Median	25.5	22.8	20.3	15.8	14.6	13.0	12.3	12.4
Avg	26.8	23.5	20.9	16.4	15.1	13.5	12.9	12.4

Year

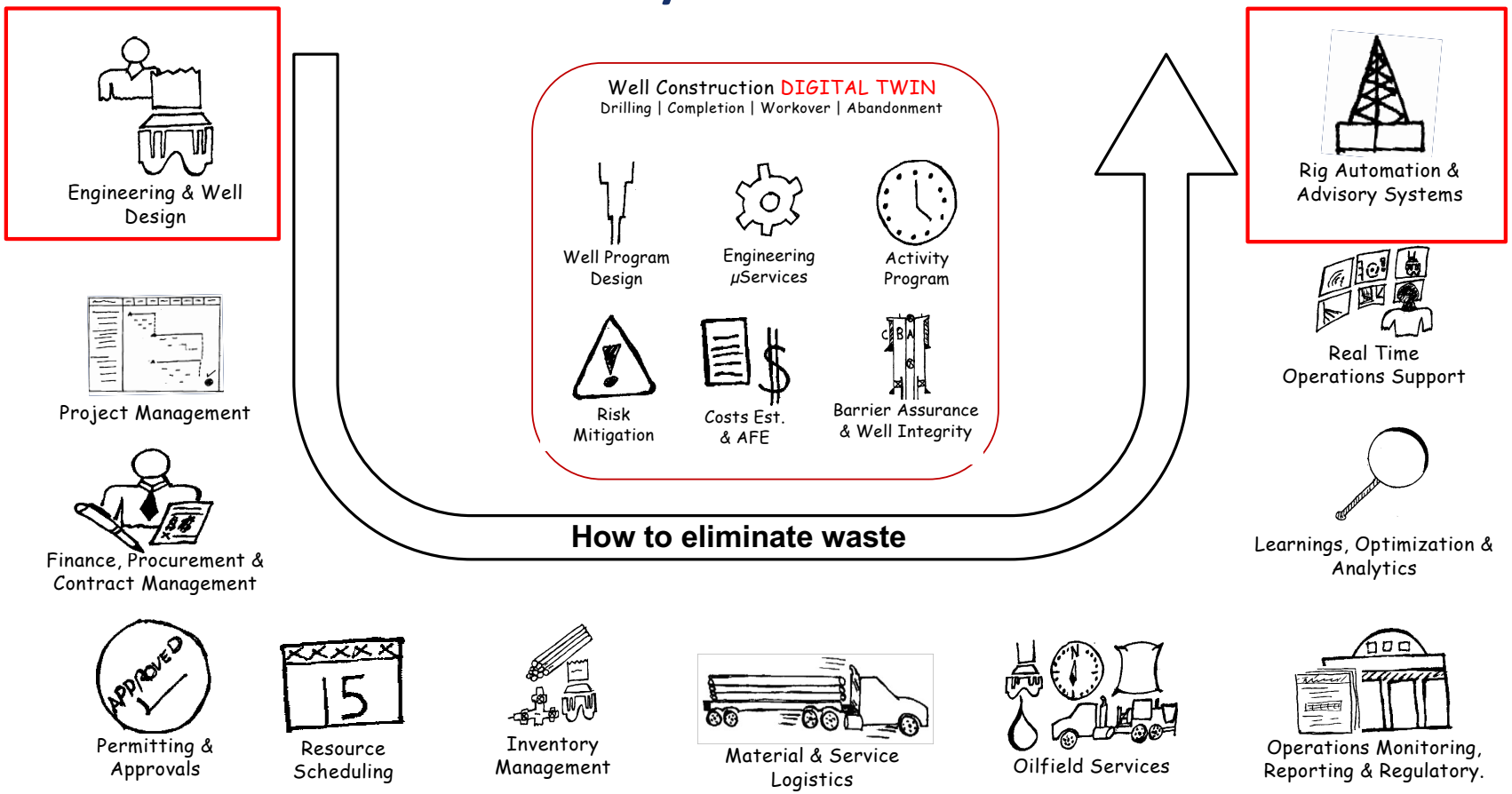
Variability example drilling a vertical interval for 12 Wells



Time

SPE Panel Presentation: Drilling Operation Automation as Process Control to Reduce Variation, 2019

Well Delivery Value Stream



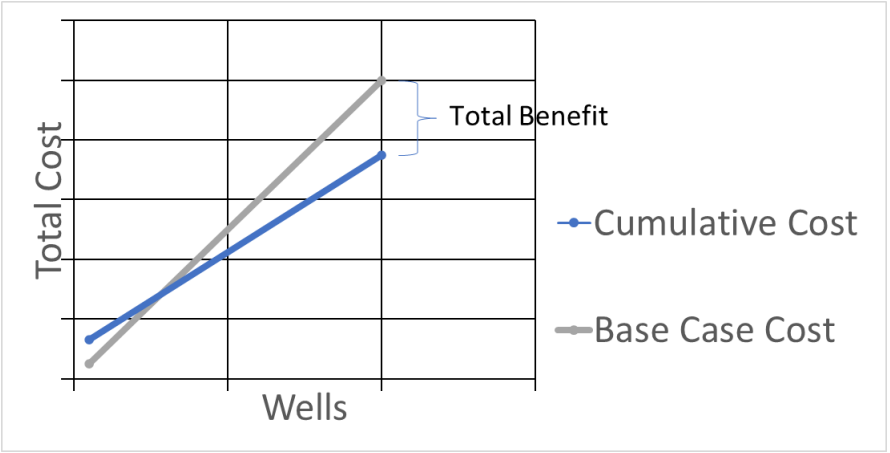
Where's the Value?

- Improving drilling operations processes:
  - Better system control -> Reduces variation
  - Better system design -> Improves the system functionality

- Value Impact
  - System improvements build and contribute to key performance indicators.

Economics

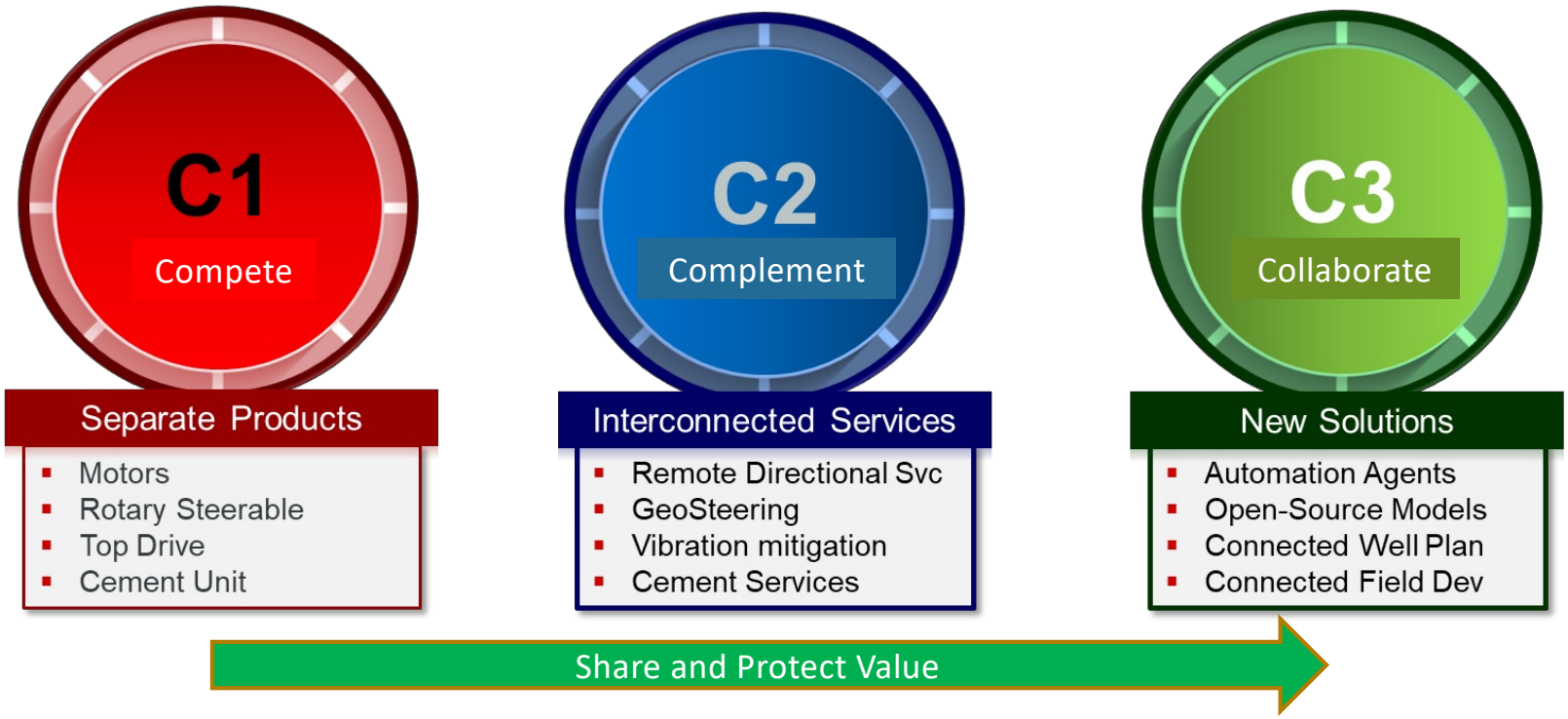
- Business considerations:
  - Investment: Cost of Capital
  - Operations: Total Cost of Ownership
  - Benefits: Return on Investment



Each Stakeholder may have different costs and benefits.

- Stakeholder perspectives:
  - Value is difficult to quantify and share among multiple parties.
- Path forward:
  - Invest in the infrastructure.
  - Innovate technology and business cases.

The 3 C's and Well Construction



Outcome based contracts incentivize collaboration.

Why do we want process automation?

- To improve safety, quality, delivery, and cost by reducing variation!

Strategy

- Support wellsite activities with process automation.
- Use machines to support people's work.
- Use a simple taxonomy to describe the strategy.

Agenda

- The idea
- A problem and its value
- Project history – The journey map
- A framework
- Examples
- Barriers
- The takeaway

Journey Map

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2015	2016	2017	2018	2019
Automation Work Commences - Wired Pipe and Downhole WOB Control	Geo-Steering and Real-Time Directional Center	Automated Directional Drilling Instructions Drilling Data Analytics	Automated Sliding Tubular Running Operations	Managed Pressure Drilling Drilling Operation Automation

2020	2021	2022	2023	2024
Drilling Mechanics Linked to Automation Practices	Drilling Mechanics Studies High Frequency Data Use	Drilling Limiter Redesign Process Business Practices	Outline Automation Process Design Using Drilling Mechanics	Wellbore Quality Study Interoperability

Journey Map

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2015	2016	2017	2018	2019
	SPE 178870		SPE 184739 SPE 189605 SPE 189626 SPE 189691	SPE 194117

2020	2021	2022	2023	2024
SPE 195818 SPE 199571 SPE 204099 SPE 201684	SPE 204050 SPE 206026	SPE 208776 SPE 210249 SPE 208710	SPE 212520	SPE 217659 SPE 217748

Agenda

- The idea
- The problem and its value
- Project history
- A framework – The guide for those doing the work
- Examples
- Barriers
- The takeaway

Future – Well Delivery as a Process

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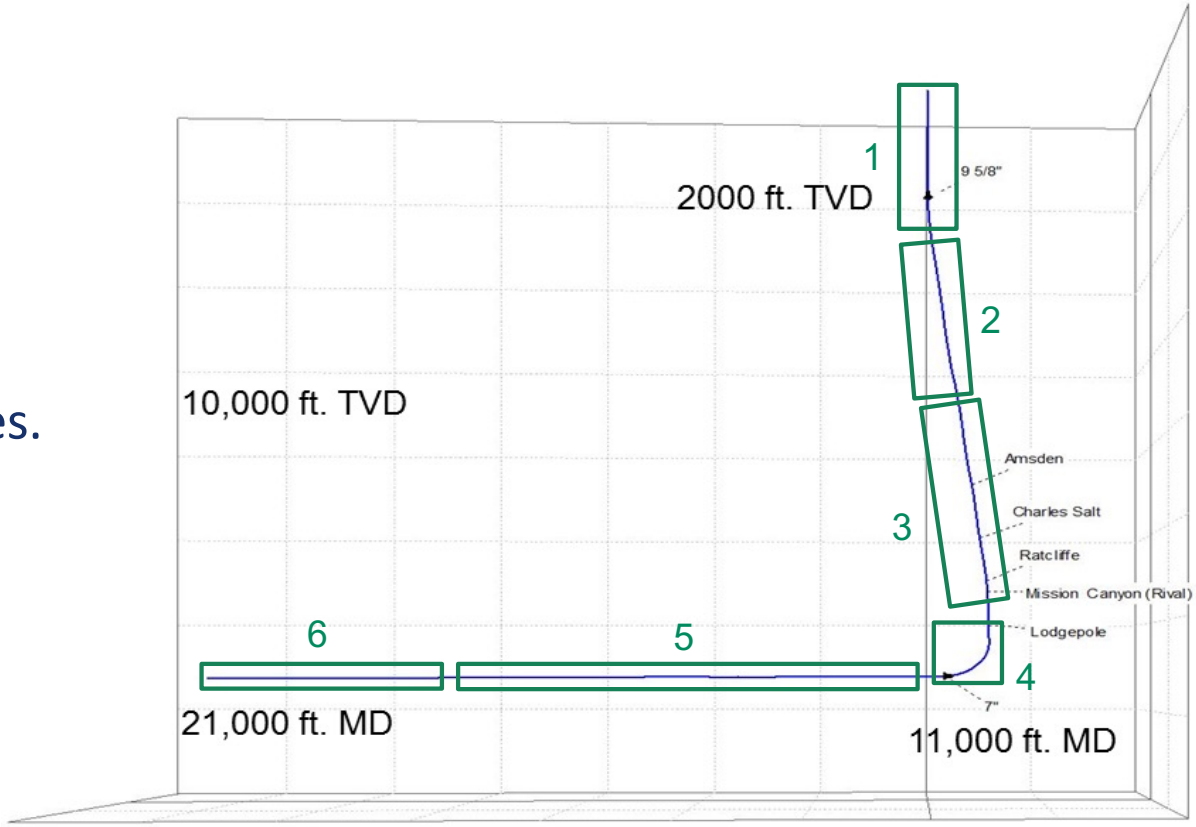
Processes For Each Zone

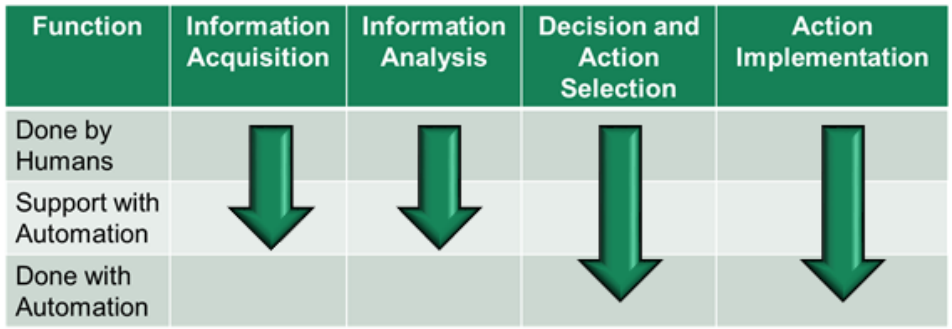
- Plan
  - Standardize operating procedures.
- Execute
  - Use automated procedures.
- Review
  - Evaluate processes.
- Optimize
  - Adjust procedure.



Process and Control Systems

Vision and Strategy:

- Use machines to support people's work.
- Support wellsite activities with process automation.
- Follow this basic taxonomy with humans and automation:

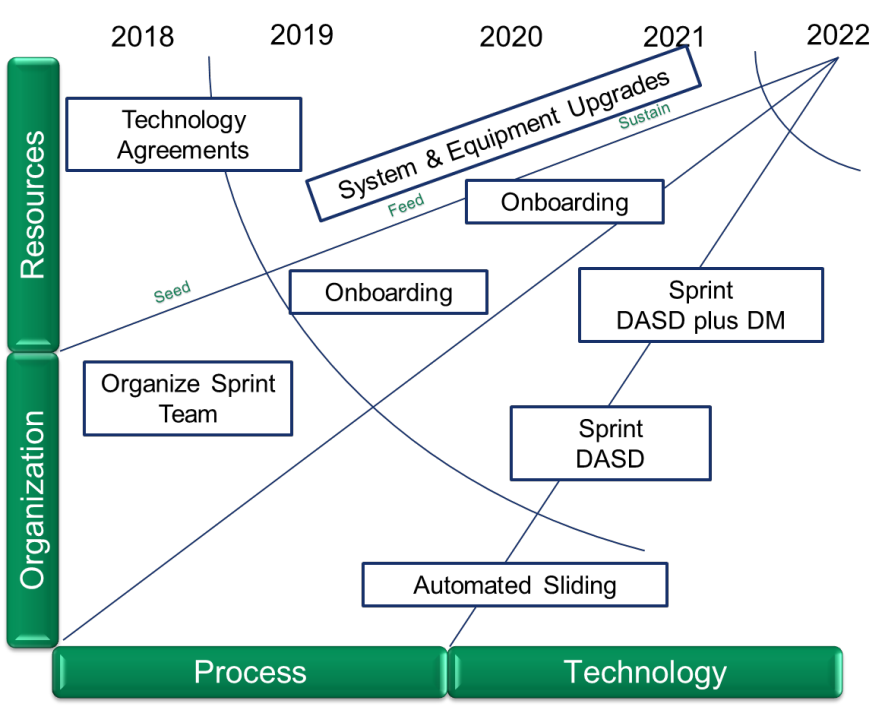


Levels of Automation Taxonomy

https://dsabok.org/hsi/

Journey Map

- Core Principles:
  - People use process and technology to do their job.
  - Workers address work product and process improvement.
  - Project team provides technology to do work.

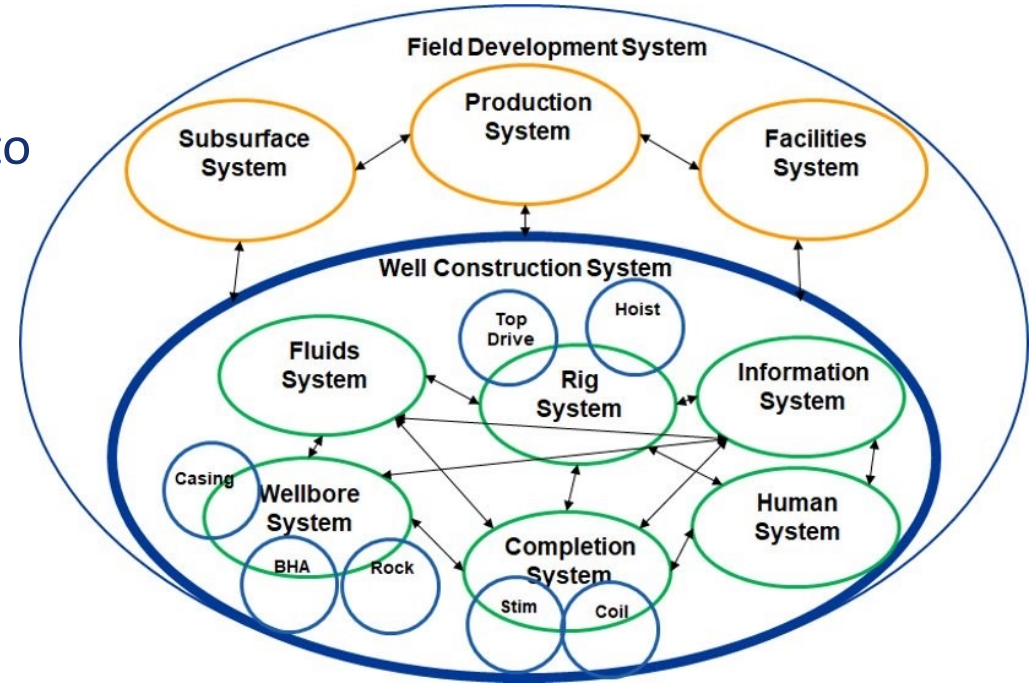


SQDCP = safety, quality, delivery, cost, people

DASD = Drill a Stand Down DM = Drilling Mechanics

Breaking Down the Problem…

- Question:
  - How do you transform a complex system of systems into a unified hierarchy of actionable tasks?
- Complication:
  - Multiple parties and systems
- Hypothesis:
  - A digital system integrates activities and coordinates actions to produce outcomes.



Reference: Drilling Systems Automation Roadmap 2019-2025

The Framework

Collaborative Elements

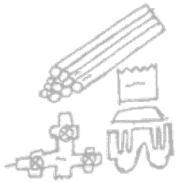
- Vision/Strategy/Value
- Journey Map
- Levels of Automation Taxonomy
- Systems of Interest

- Architecture: How a project's technology and tools work.

- Refine, refine, refine,…

Perspectives

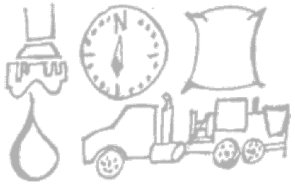
- Stakeholders have different well construction perspectives.
  - So, architecture, value streams, and workflows… must be explored and correlated…



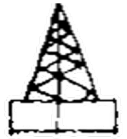
SUPPLIER ACTIVITY PROGRAM

WELLSITE SUPERVISOR ACTIVITY PROGRAM

FINANCE ACTIVITY PROGRAM

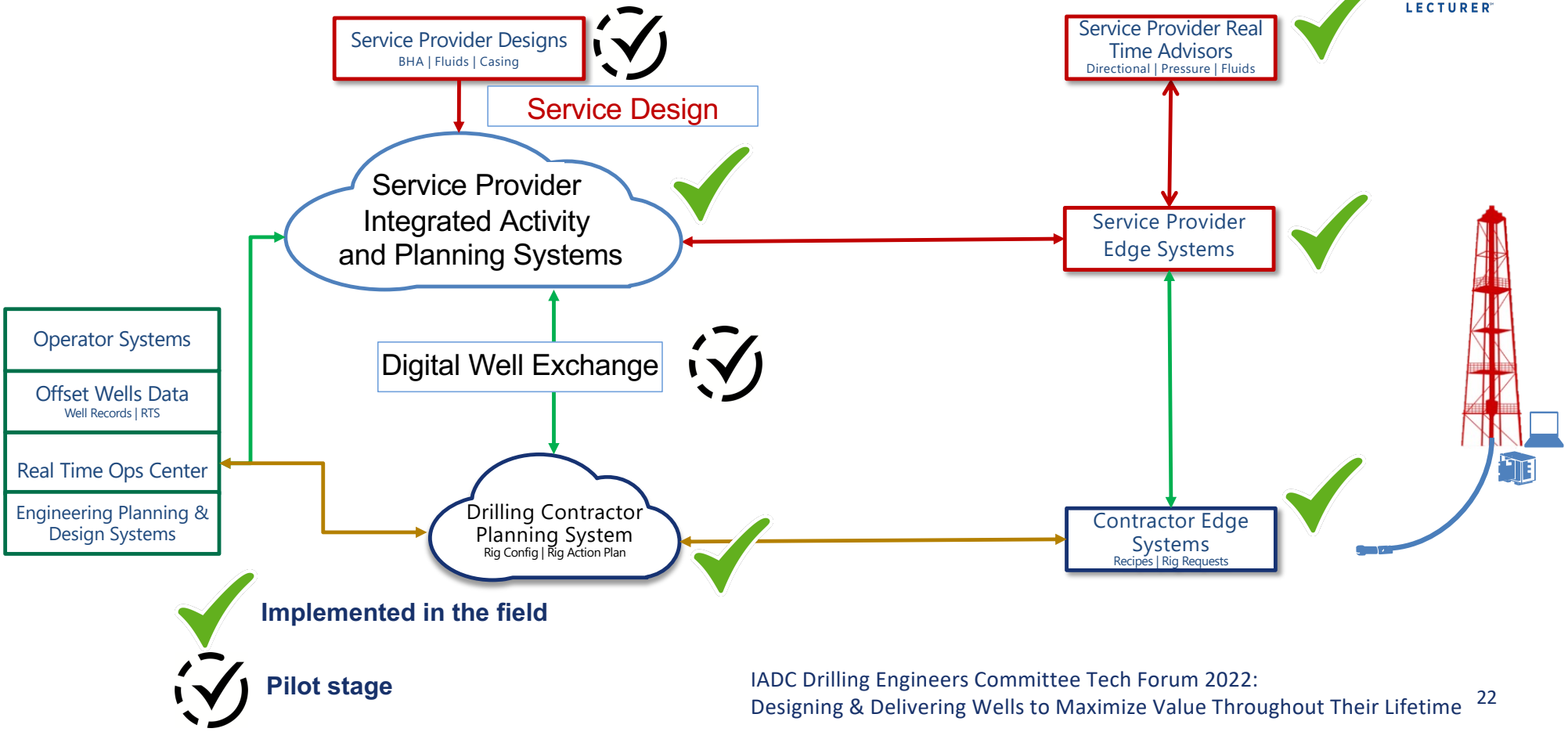


SERVICE PROVIDER ACTIVITY PROGRAM

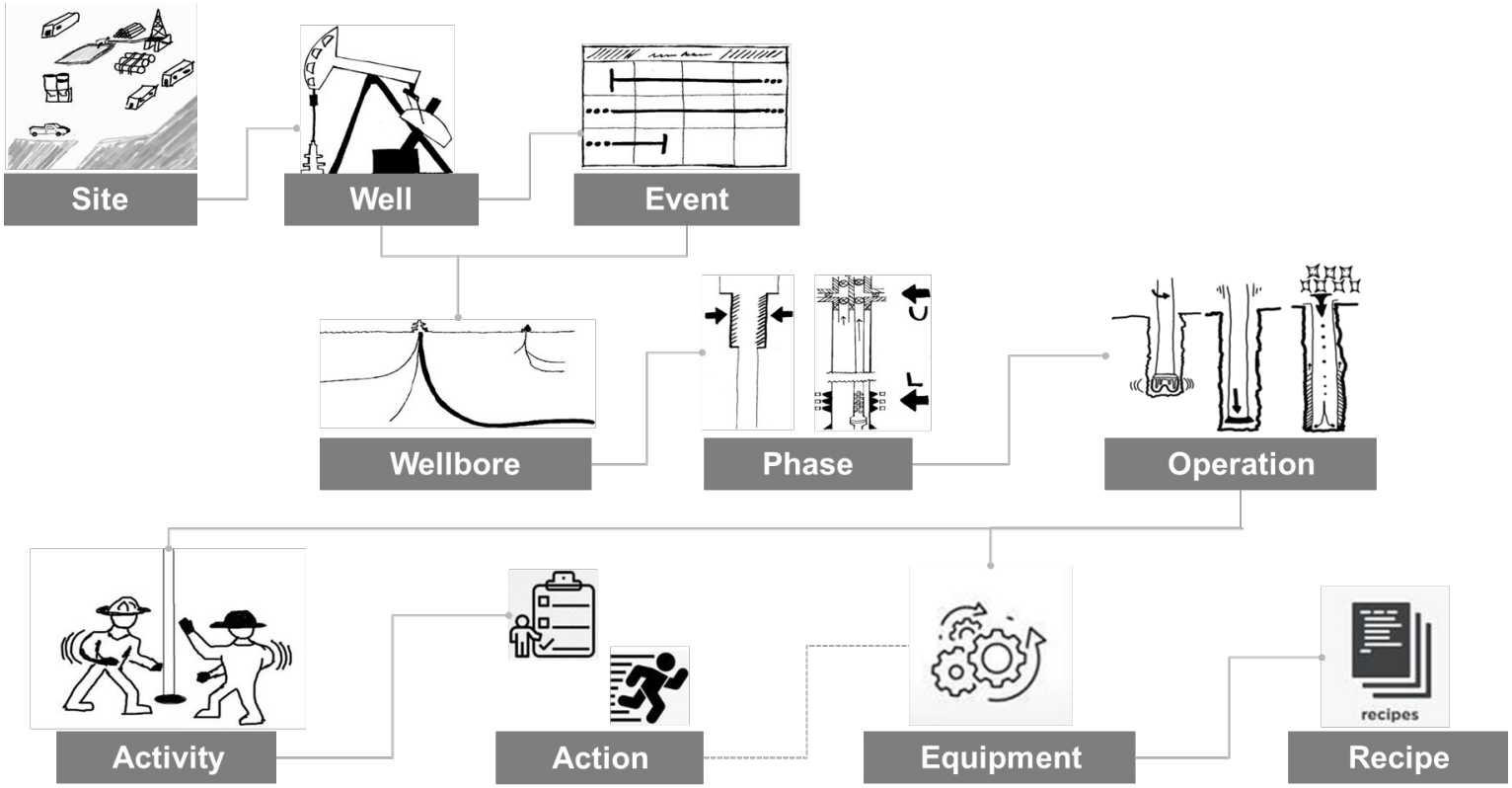


DRILLERS' ACTIVITY PROGRAM

General Architecture - Today



Overview
Activity Taxonomy and Semantics



Agenda

- The idea
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- A framework
- Examples – What happened?
- Barriers
- The takeaway

By Project

- Remote Directional Drilling
- Multiparty Planning
- Drill a Stand Down
- Slide Drilling
- Drilling Mechanics and Wellbore Quality

Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
Done by Humans	↓	↓	↓	↓
Support with Automation			↓	↓
Done with Automation				

Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
Done by Humans	↓	↓	↓	↓
Support with Automation				↓
Done with Automation				

Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
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Support with Automation			↓	↓
Done with Automation				

Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
Done by Humans	↓	↓	↓	↓
Support with Automation				
Done with Automation				

Remote Directional Drilling

- Manual

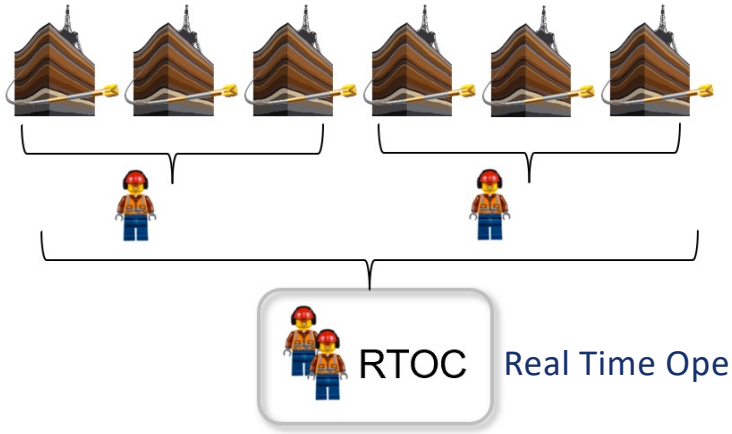
Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
Done by Humans	●	●	●	●
Support with Automation				
Done with Automation				

6 rigs - 12 DD's learning one well at a time

DD - Directional Driller

- Software Supported

Function	Information Acquisition	Information Analysis	Decision and Action Selection	Action Implementation
Done by Humans	↓	↓	↓	↓
Support with Automation				
Done with Automation				

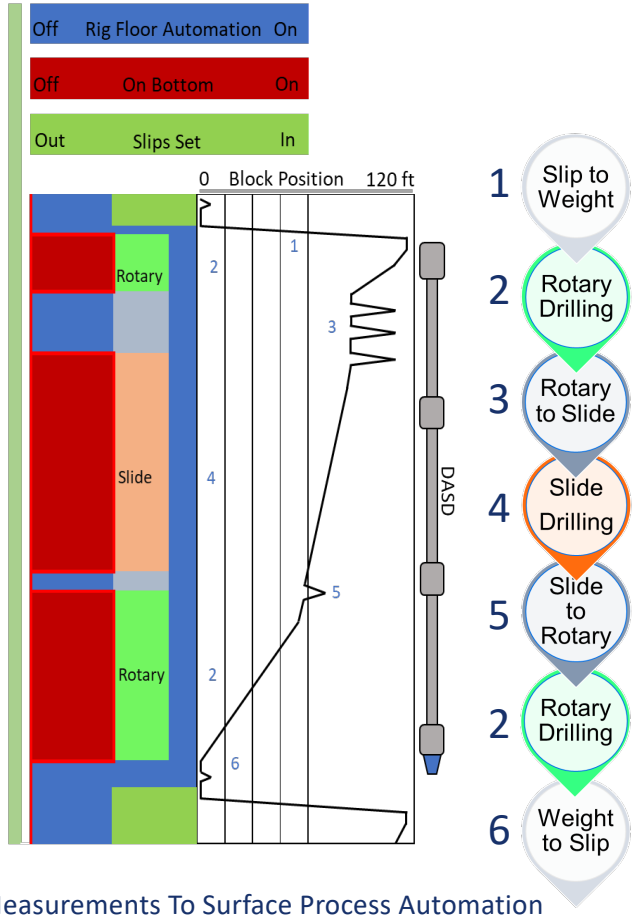


Real Time Operating Center

2 DD's learning six wells at a time

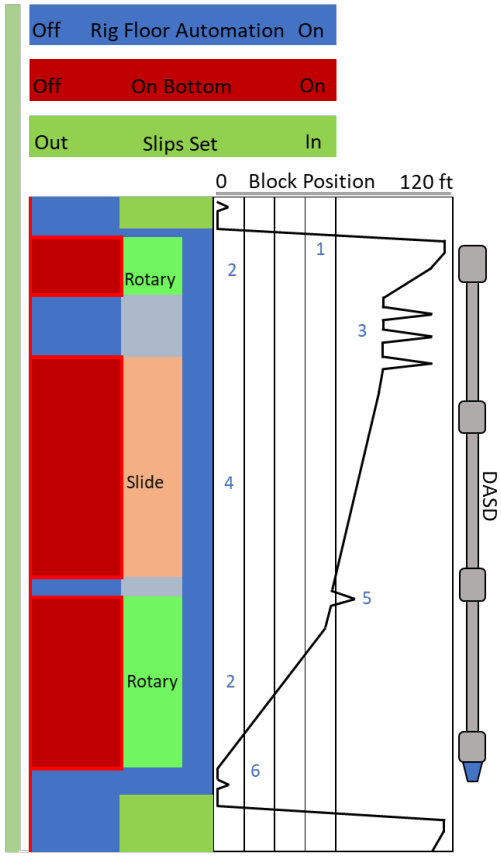
Drilling Operations Process Automation

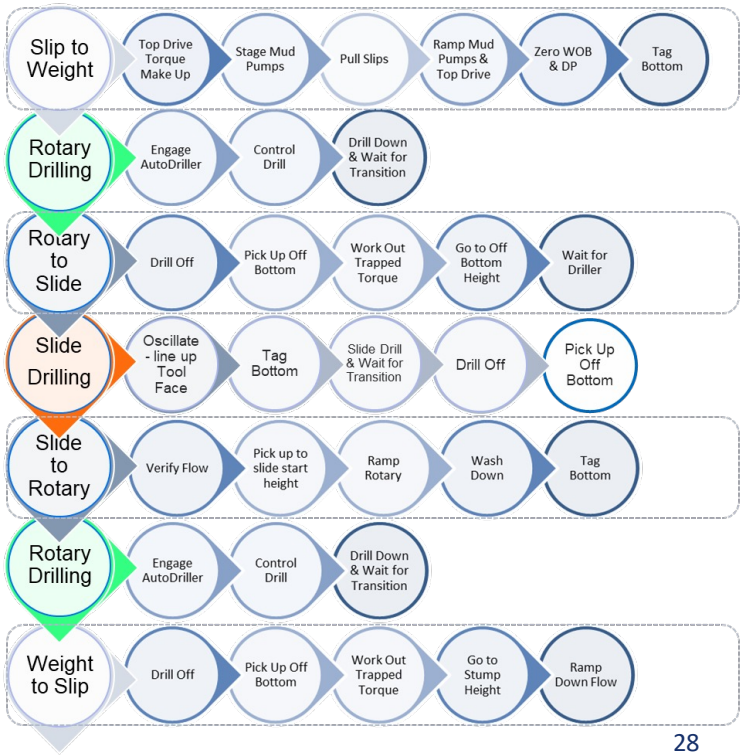
- Drilling intervals are a repetitive cycle of Drilling a Stand (90’ of drill pipe) Down (DASD).
- Each stand repeats basic processes with adjustments to specific conditions.
- Manual or automated.



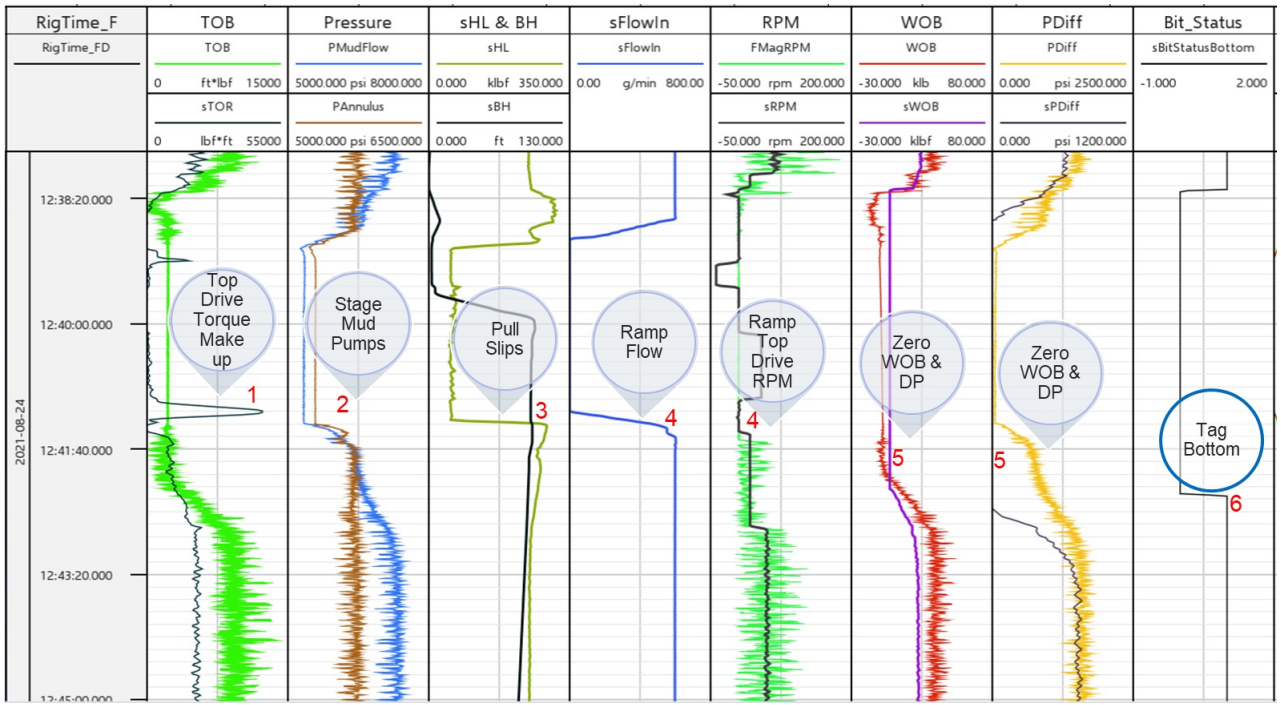
Drill a Stand Down - Process Roadmap

- Each process step contains many sub-steps.





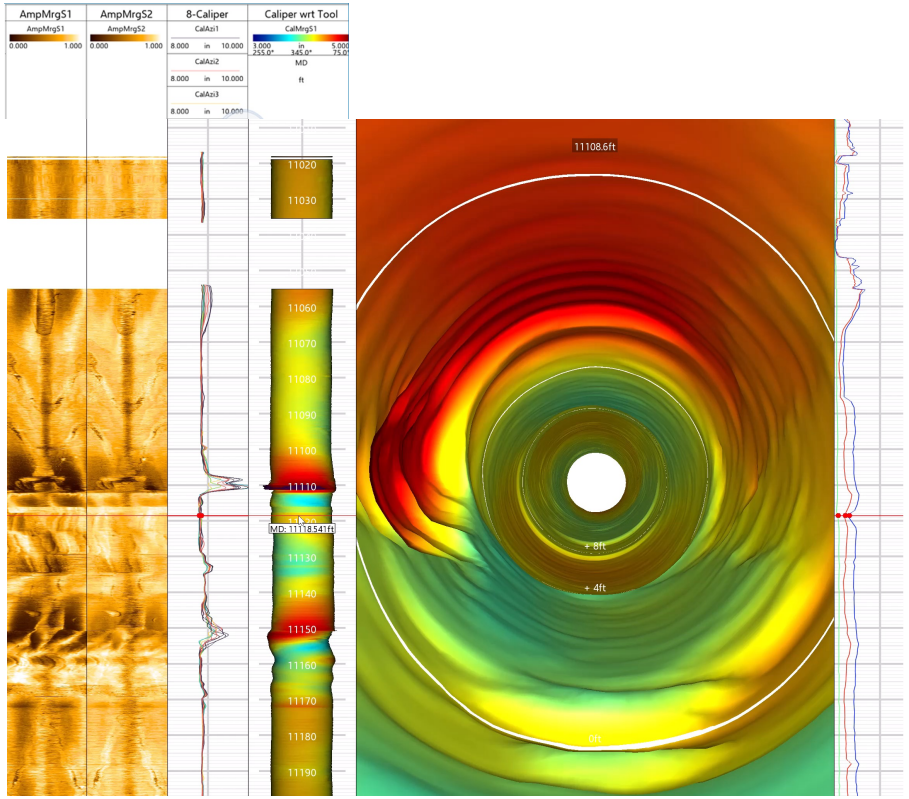
Slip to Weight – Transition From Off to On Bottom



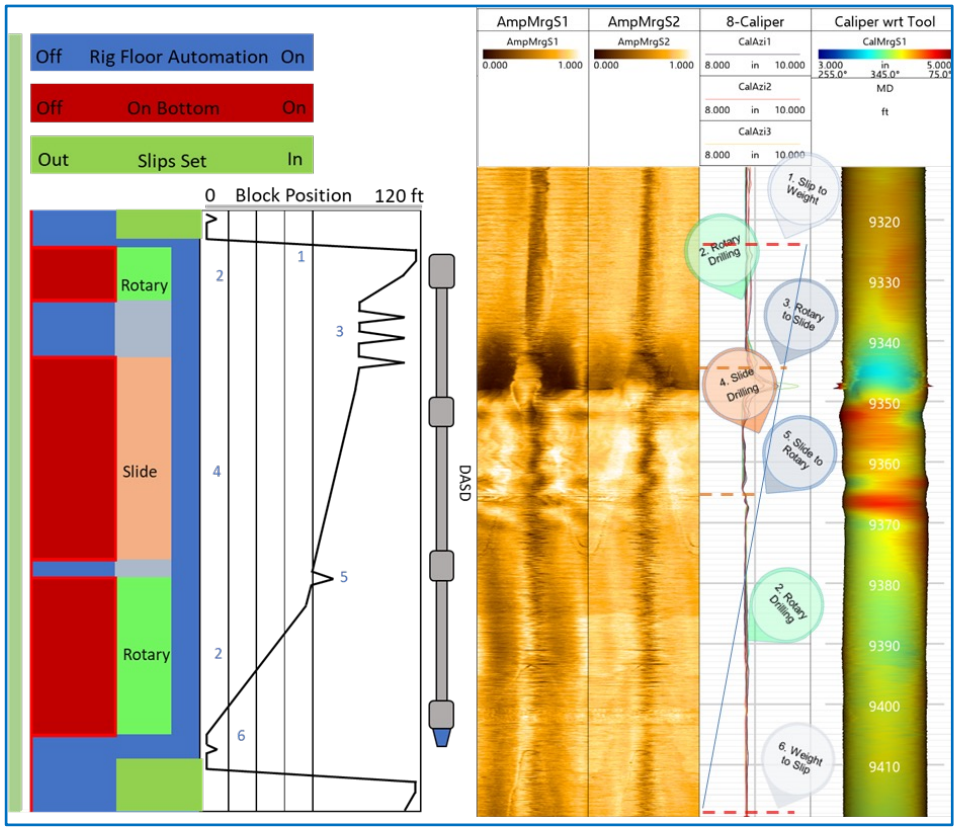
Example to show sub-steps.

Extension to Wellbore Quality

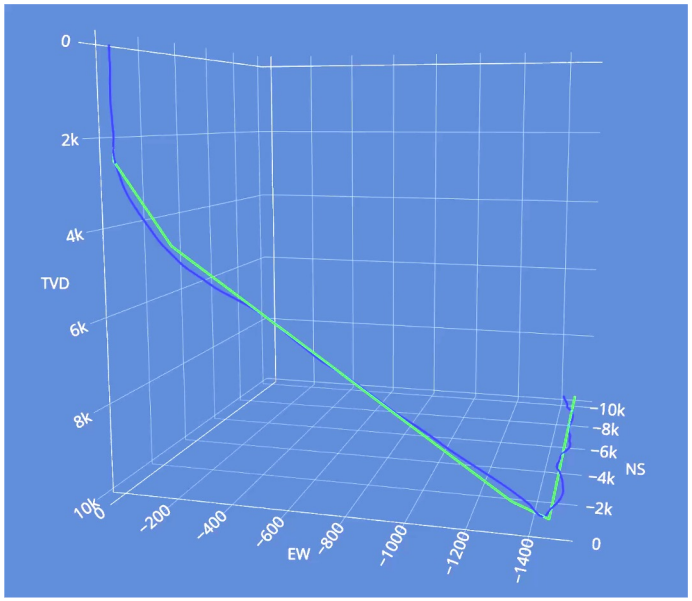
- Desired Outcome:
  - Deliver a fit-for-purpose well meeting stakeholder requirements.
- Are current wellbore quality metrics adequate?



Extension to Wellbore Quality



- The wellbore is the cumulative result of drilling each stand.



SPE 217659 A Novel Approach to Borehole Quality Measurement In Unconventional Drilling

Learnings

Downhole Behaviors

- Drilling System Vibration
  - Mud-Motor Stalls
  - Mud-Motor Back-Drive
  - Stick/Slip
  - Whirl
  - Bending
- Hole Spiraling
- Hole Ledging
- Hole Breakout
- Hole Rugosity

Wellbore Quality Impact

- More Slide Operations (More Artifacts)
- Wellbore Diameter Variability
- Wellbore Tortuosity
- Higher Drag and Potential Drift Issues
- Casing/Liner Centralization
- Cementing Quality
- Pass-Through Limitations
- Water/Gas Traps in Horizontal Wellbores
- Survey Accuracy

Agenda

- The idea
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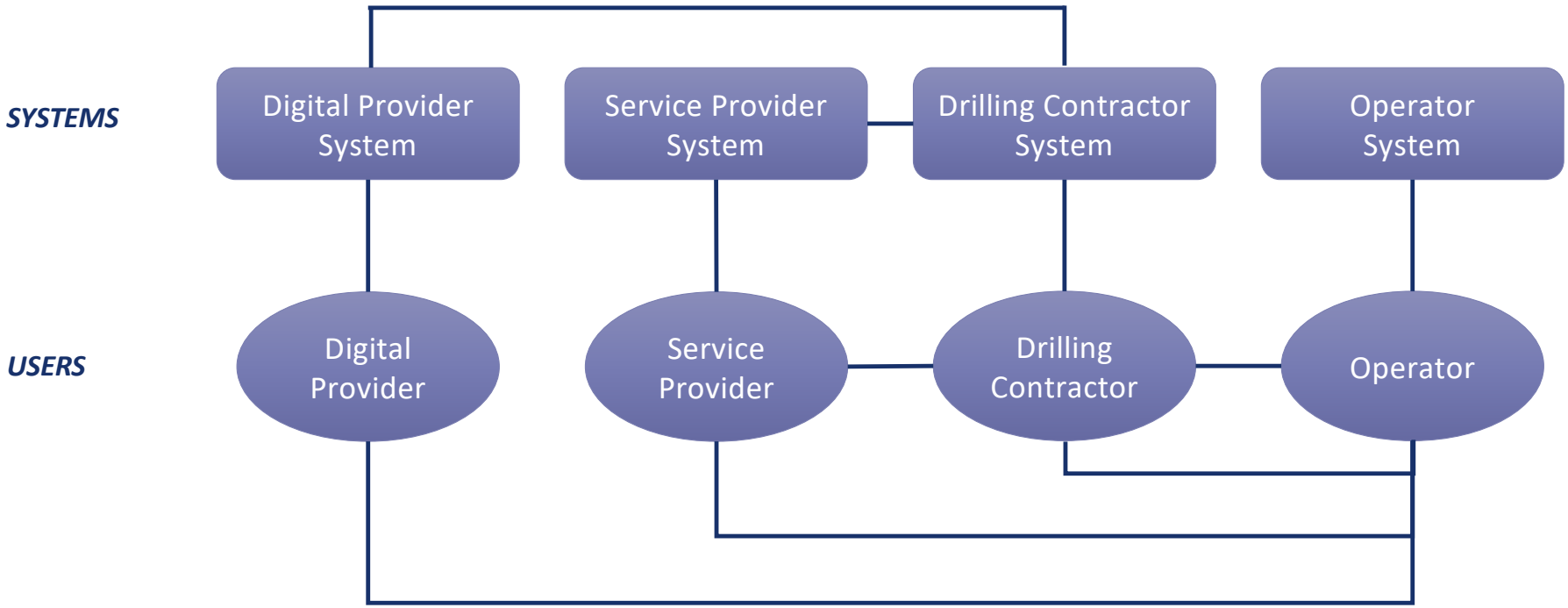
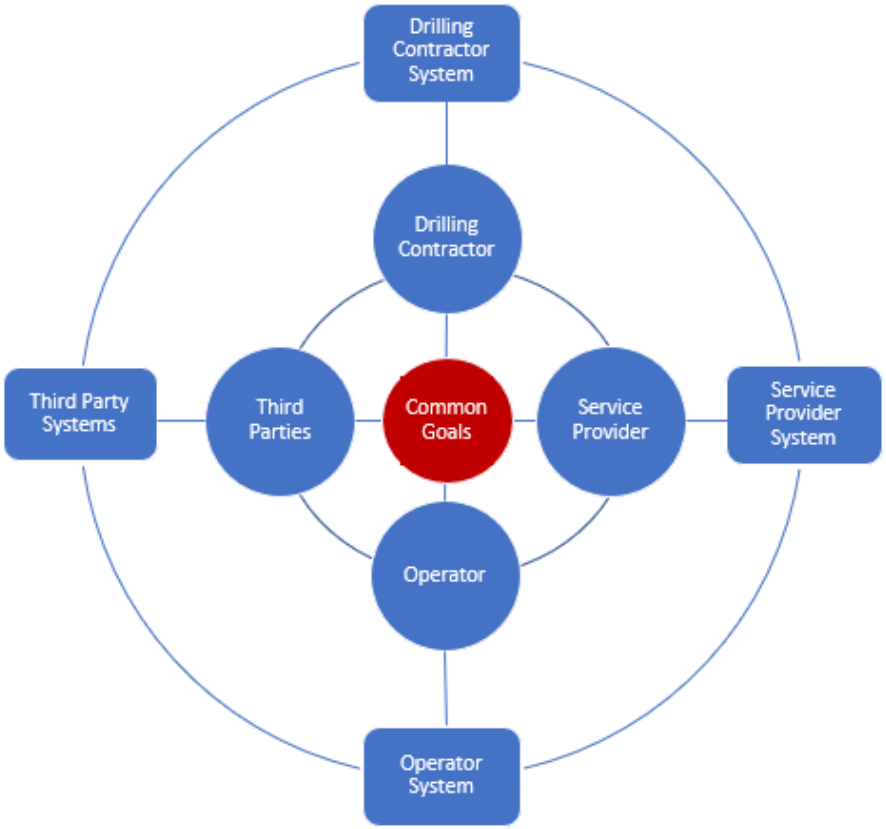
- Examples
- Barriers – What's holding us back?
- The takeaway

Current Relational Architecture



Desired Future Relational Architecture



How to put it all together?

Drilling and Wells Interoperability Standards (D-WIS)

- System Infrastructure / Network Design
- Drilling Systems Automation Technologies
- Separation of Concerns (risk)
- Permissions
- Transparency

Humans are still part of the automation framework.

Agenda

- The idea
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- Examples
- Barriers
- The takeaway – What's the right thing to do?

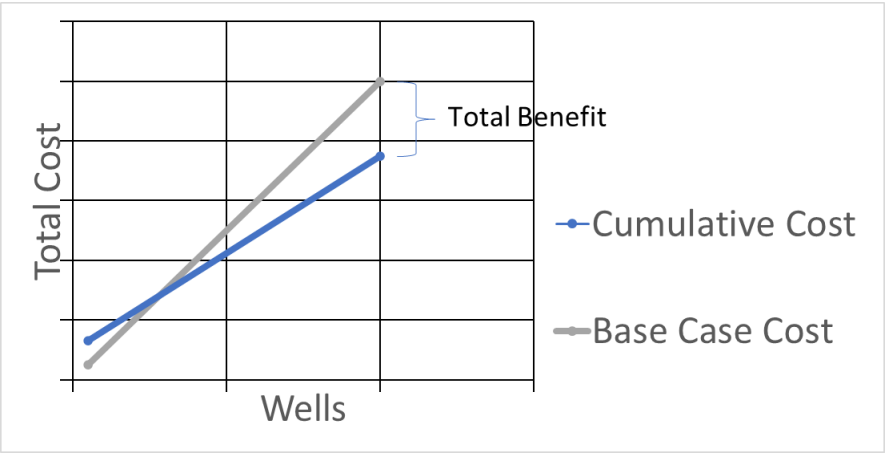
Why Address All This Complexity?

Doing the right thing more rightly…

Paraphrasing Peter Drucker (management consulting guru)

Closing Thought – Beyond Automation

- People, technology, and processes work together to realize benefits in the well lifecycle for everyone.



THANK YOU!

Acknowledgements:

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