



Gulf Coast Section

# DRILLING STUDY GROUP

## Drilling Automation Will Its Rising Tide Sink Your Ship or Lift It Higher Than Ever?

SPE has had a technical section on Drilling Automation since 2012. At the 2021 SPE/IADC Drilling Conference in March, there were 40+ papers that had some level of drilling automation aspects in them. So, let's get out our crystal ball and see where things are headed and where they might end up. Who is doing what and why? What are the key enablers? Key drivers? What are the potential or existing blockers? Which companies and professions will be hurt? Which will be helped? Explore the wild and wooly topic of drilling automation



**Curtis Cheatham**

Sr. Drilling Engineering Advisor  
CORVA

WEBINAR: Drilling Study Group (<https://www.spegcs.org/events/6115/>)  
September 9<sup>th</sup>, 2021 / 11:30 am to 1:00 pm US CST

# Agenda

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- Welcome
- Introduction
- Presentation on **“Drilling Automation: Will Its Rising Tide Sink Your Ship or Lift It Higher Than Ever?”** by Curtis Cheatham
- Q&A
- Programs Highlight & Announcements
- Wrap Up & Virtual Group Photo

# Welcome

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# Drilling Study Group Team



- Tyler Reynolds
- Jose Contreras
- Gelila Kassaye
- Waqas Munir
- Ruchir Srivastav
- Oscar Sanchez
- Graham Mensa-Wilmot
- James Barry
- Ernie Prochaska
- Jesus Capo
- Christopher Clebowski

A vertical column of five team member cards on a dark blue background. Each card features a circular portrait on the left and text on the right. The members are: Jesus Capo (Chair), Tyler Reynolds (Programs Chair), Jose Contreras (Treasurer), Gelila Kassaye (Arrangement Chair), and Waqas Munir (Registration Chair).

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A vertical column of five team member cards on a dark blue background. Each card features a circular portrait on the left and text on the right. The members are: Ruchir Srivastav (Special Events Chair), Oscar Sanchez (Publicity Chair), Graham Mensa-Wilmot (DSG Sr Advisor Board), James A. Barry (DSG Sr Advisor Board), and Ernie Prochaska (DSG Sr Advisor Board).

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# Introduction

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- He holds B.S. and Master's degrees in **Mechanical Engineering** from Rice University in Houston, Texas

# Agenda

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- What is Drilling Automation and why do it?
- Where is the industry today?
- Who's doing what?
- What are:
  - Blockers?
  - Catalysts?
  - Solutions?
  - Characteristics of companies that will rise with the tide?
- What about us engineers – will we sink or swim?

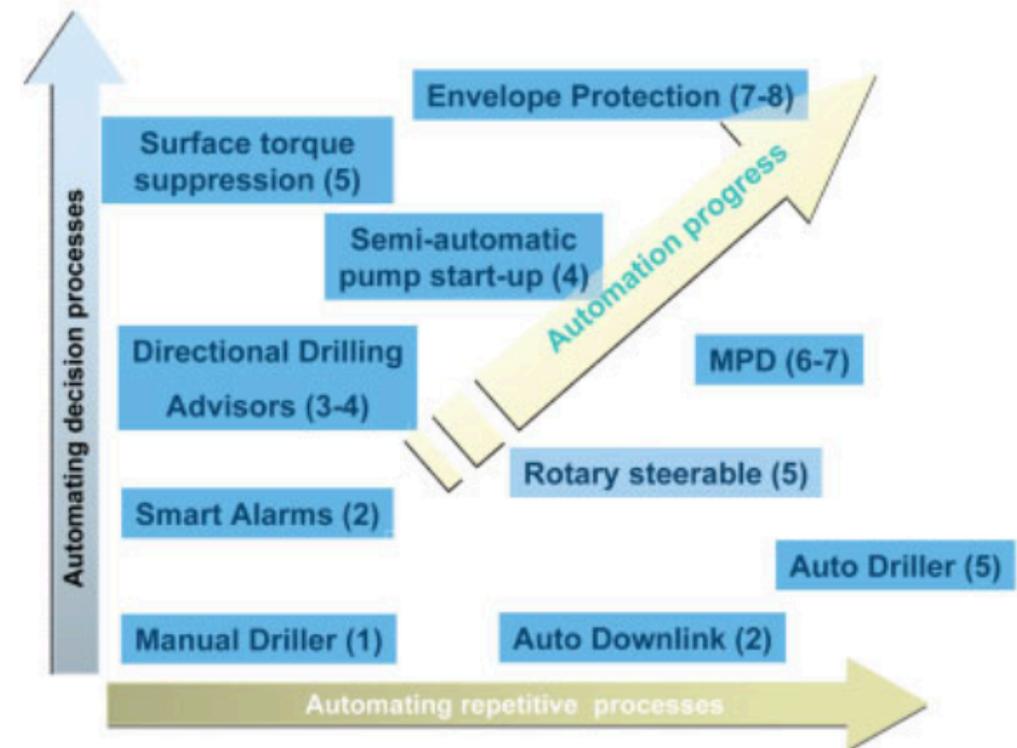
# What is Drilling Automation?

- In the Past
  - Replace human physical labor
  - Manufacturing a first winner
- Today
  - Wide range of processes and less structured environments, including drilling
  - Includes mental human aspects
- Classic definition from Sheridan (2002)
  - Mechanization + integration of sensing environmental variables
  - Data processing and decision making by computers
  - Mechanical actions or communication action (processed data to humans)
  - Open-loop operation or closed-loop control



# Why Do Drilling Automation?

- Why automate drilling?
  - Safety
  - Consistency
  - Speed – faster process
  - Quality – better result
  - Bottom line driven
- “Automation should be applied only to functions that:
  - System performs better or more reliably than people
  - Lighten workload allowing available resources to focus on managing those decisions that cannot be entrusted to machines”
- Disadvantages and pitfalls
  - “Evaluate need to automate to ensure it is not implemented simply because it is technically feasible”



**Fig. 1—Application map of Sheridan (2002) degrees of automation against present industry applications (MPD = managed-pressure drilling).**

# Key Takeaways from This Talk

1. Drilling Automation takes many forms
  - It is not simply rig automation where you push a button
2. Various forms of Drilling Automation are in different levels of maturity
  - Some forms have been commercial for decades
  - Most aspects of drilling are benefitting from some type of automation
  - Our industry is reaching a tipping point
3. Humans will be in the loop for some forms for many years



# Where is the Industry Today?

- 2021 SPE/IADC Drilling Conference
  - Drilling Automation dominated the conference
  - 40 of 101 total papers
- Industry groups actively pursuing Drilling Automation
  - SPE Drilling Systems Automation (DSATS)
    - Drilling and Wells Interoperability Standards Subcommittee
  - IADC Advanced Rig Technology (ART)
    - Sensor Stewardship Committee
      - Recommended practices for minimum calibration + maintenance for rig sensors



# Automated Drilling has Many Forms

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- Automated Directional Drilling
- ROP optimization / Automated Drilling Advisory Systems
- Hole cleaning monitoring
- Automated Torque & Drag monitoring
- Automated Surface Pressure Anomalies
- Automated Alerts
- Automated Geosteering
- Rig automation
- Automated Mud Property Measurement

# Levels of Drilling Automation



- Several versions
  - Sheridan, Thorogood et al. MacPherson et al.
  - Drilling Systems Automation Roadmap 2019 shown here
- Shades of gray
- Winning strategies for each level
- Advisory system will win sometimes
- Control systems are a different animal with different requirements

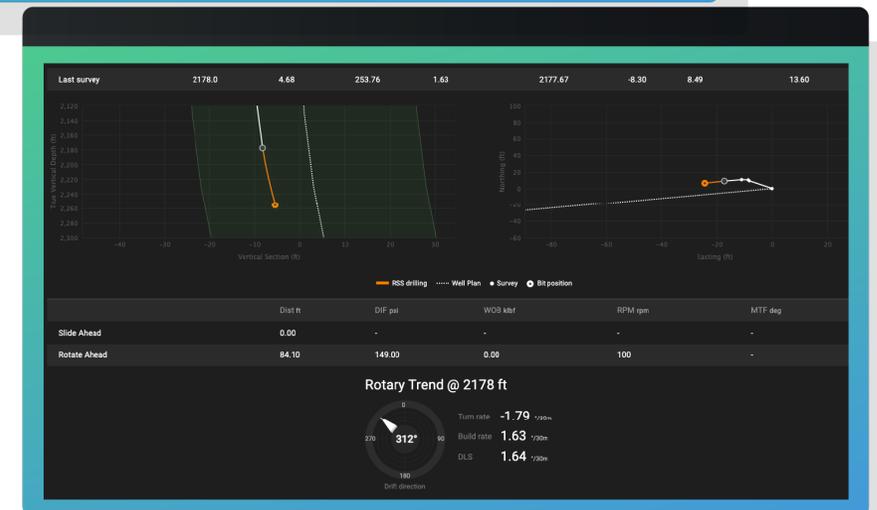
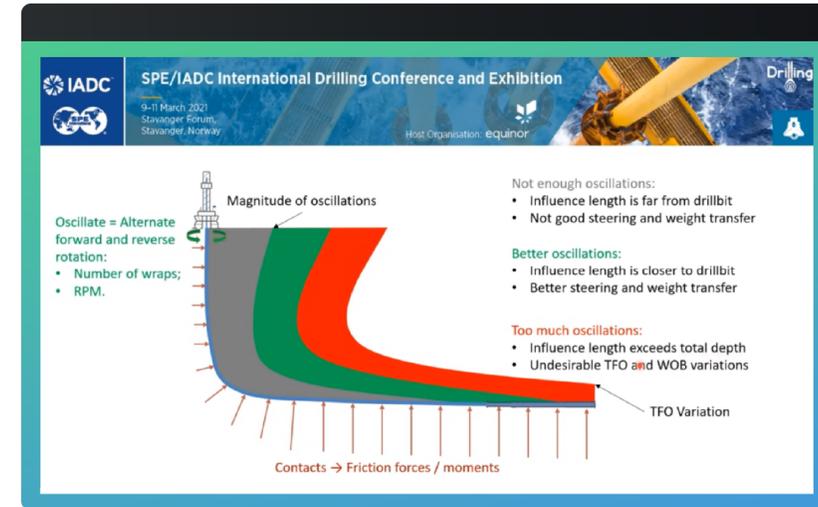
	A	B	C	D
LEVEL	INFORMATION ACQUISITION	INFORMATION ANALYSIS	DECISION AND ACTION SELECTION	ACTION IMPLEMENTATION
0	Manual	Memory Analysis	Human Decision	Manual Action and Control
1	Artifact-Supported	Artefact-Supported	Artefact-Supported	Artefact-Supported
2	Low Level Automation	Low-Level Automation	Automated Decision Support	Step-by-step Action Support
3	Medium-Level Automation	Medium-Level Automation	<b>Advising</b>	<b>Automating</b>
4	High-Level Automation	High-Level Automation	Low-Level Automatic Decision Making	High-Level Support Action Execution
5	Full Automation	Full Automation	High-Level Automatic Decision Making	Low-Level Action sequence Automation
6			Full Automatic Decision Making	Medium-Level Action sequence Automation
7				High-Level Action Sequence Automation
8				Full Automation

**Table 2b: LOAT Tabulation – Monitoring, Advising, Automating Transition**

# Automated Directional Drilling

## 2021 SPE/IADC Drilling Conference

- **Automated Directional Drilling with Deep Reinforcement Learning in a Simulated Environment – SLB (SPE 204105)**
- **Improving Surface Oscillation Tools Performance Using Time-domain Dynamics and Torque and Drag Models – Helmerich & Payne (SPE 204071)**
- **Combining Live Drilling Data Stream With Cloud Data Analytics Pipeline to Perform Real-time Automated Projections to the Bit – Corva + Colorado School of Mines (SPE 204065)**

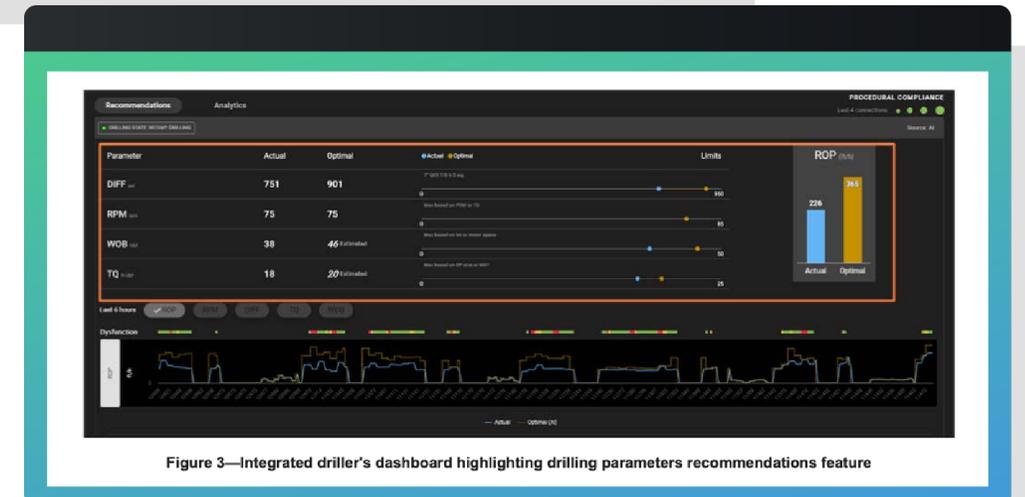
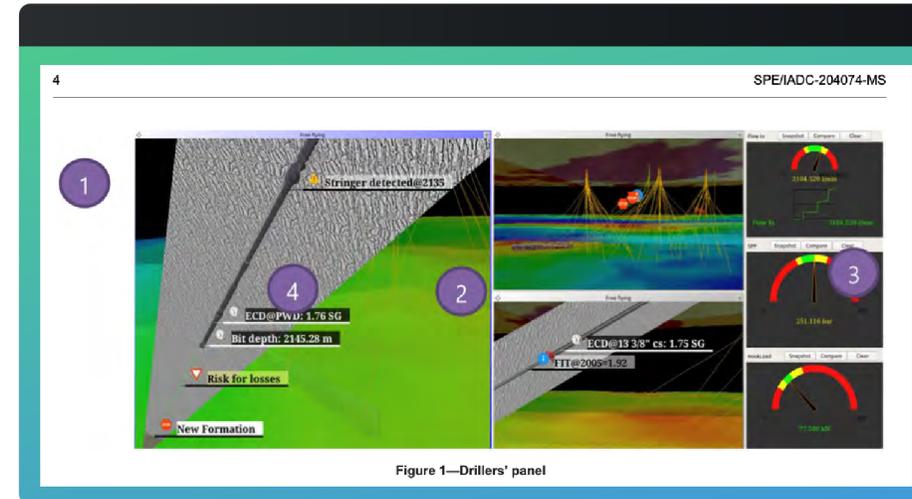


# Automated Drilling Advisory Systems

## 2021 SPE/IADC Drilling Conference

### Optimal Parameters Ahead

- **Drilling Advisory for Automatic Drilling Control – eDrilling & Equinor (SPE 204074)**
- **From Science to Practice: Improving ROP Using a Cloud-Based Machine-Learning Solution in Real-time Drilling Operations – Corva (SPE 204043)**



# Automated Hole Cleaning Assessment



## 2021 SPE/IADC Drilling Conference

- **A Probabilistic Belief System to Track the Cleanliness of a Hole in Real-time –** Intellicess Inc, Apache Corp, Montana Tech (SPE 204125)
- Bayesian network to infer probability
- Method deployed in drilling advisory system
- Most relevant features
  - “circulation rates during drilling
  - Tight spots when moving the drillstring
  - Bit hydraulics
  - Prolonged periods of inactivity”

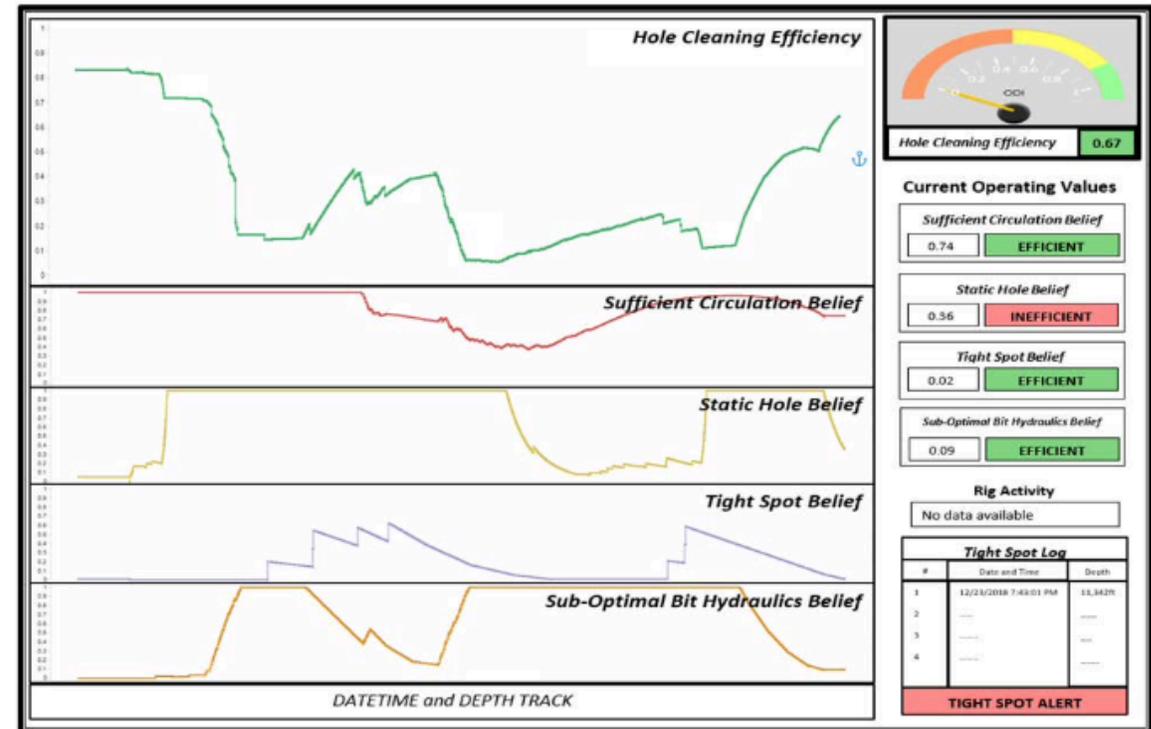
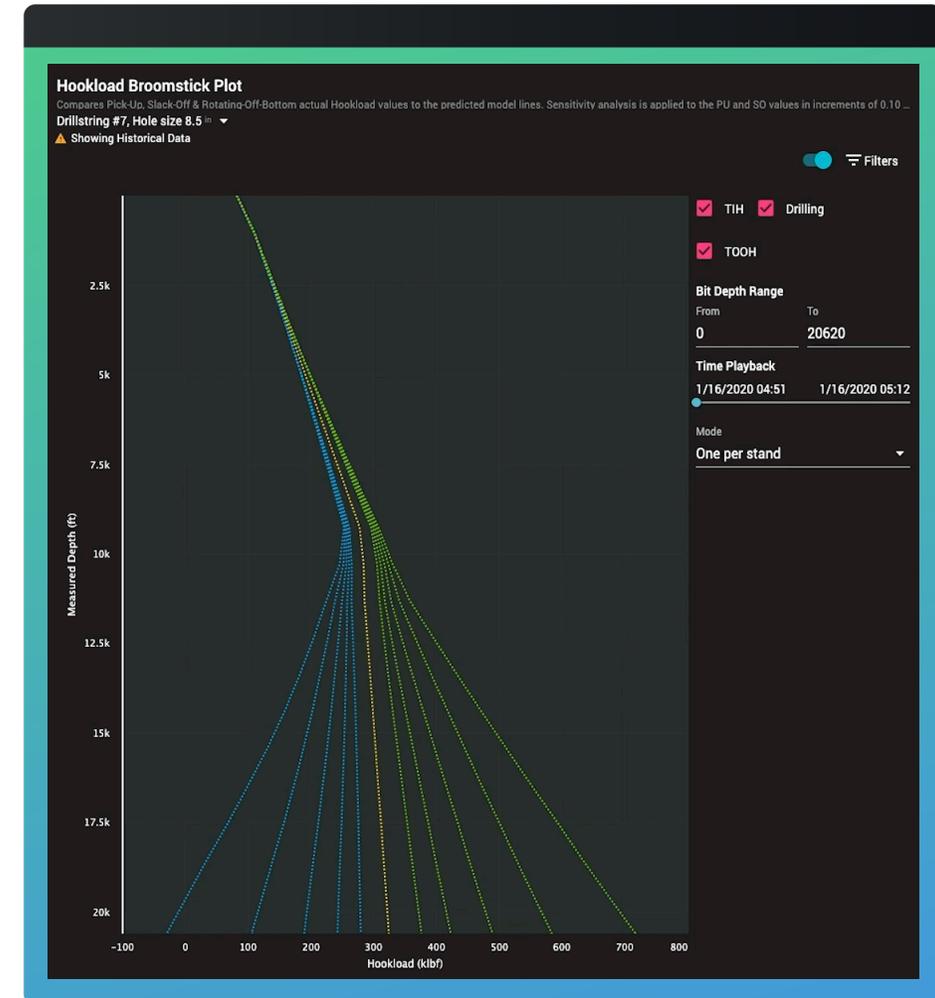


Figure 7—Example of Hole Cleaning Efficiency Display Seen by Operator

# Automated Torque & Drag

## Corva

- Automated rig activity detection
- Automated data point selection for appropriate rig activity
- Automated broomstick generation while drilling and tripping
- Automated alerts
  - Excessive overpull
  - Max WOB or Hookload
  - Non-compliance to operator's PRS friction test



# Automated Surface Pressure Anomalies



## 2021 SPE/IADC Drilling Conference

- **Detecting Pressure Anomalies While Drilling Using a Machine Learning Hybrid Approach – SLB (SPE 204035)**
- Machine Learning hybrid
  - ML enables automated learning
  - Physical models work to compensate gaps in training data
- Field examples for drillstring washout detection

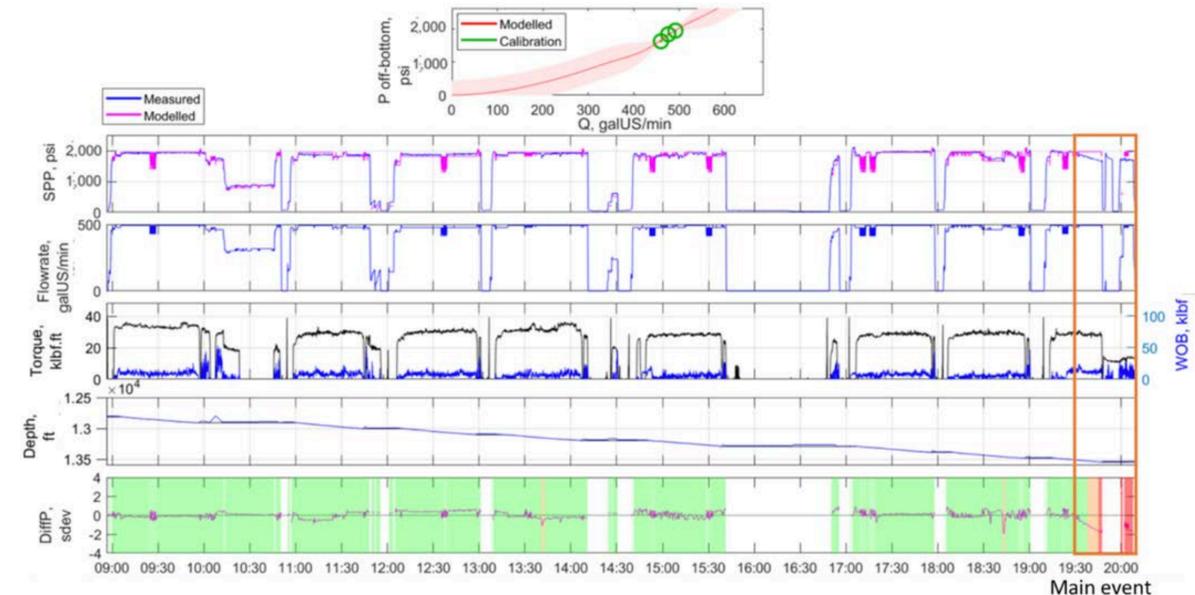
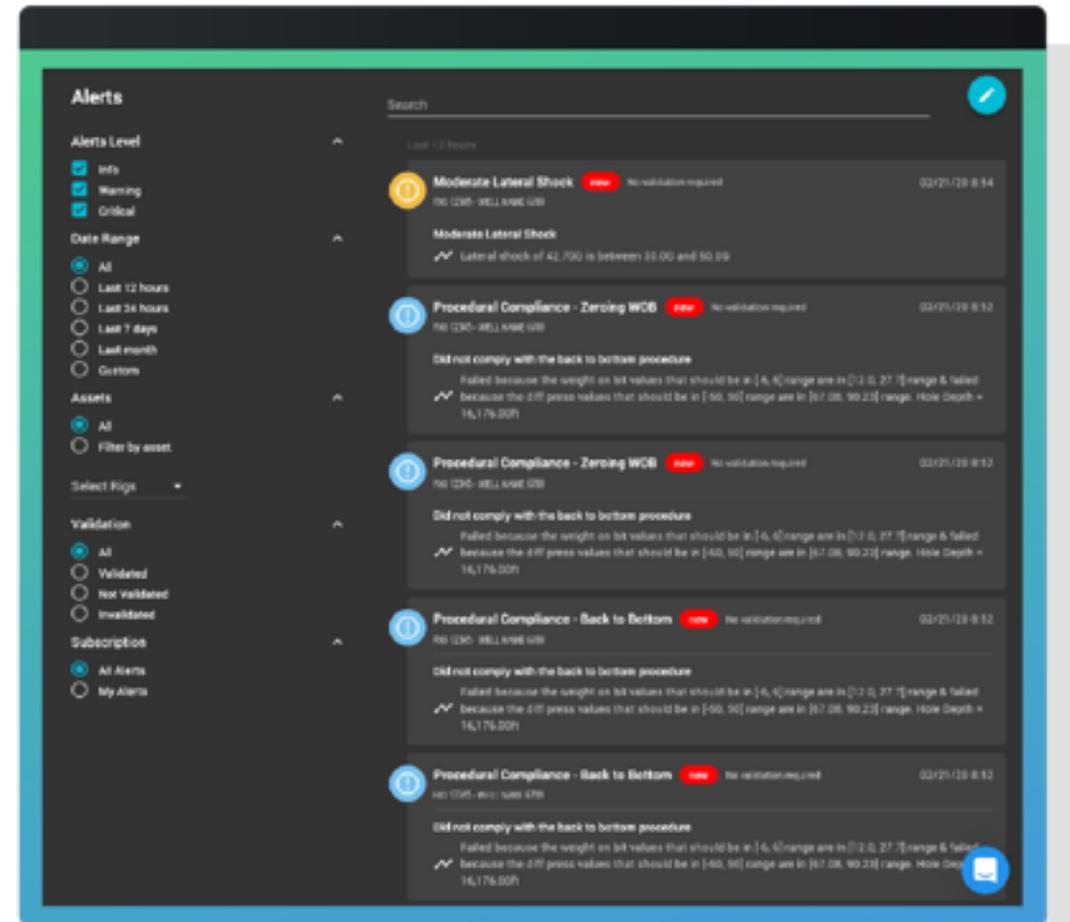


Figure 3—Off-shore pressure loss detection example

# Automated Alerts

## Corva

- Consume big drilling data
- Apply user-defined rules or use existing alerts
- Applications
  - Drilling efficiency
  - NPT detection
  - Divergence from plan
- Management by exception
- Consistent and efficient compared to manual data monitoring
- Scalable to large number of rigs



# Automated Geosteering

## 2021 SPE/IADC Drilling Conference

- **An Introduction of Drilling Data Space –** Equinor (SPE 204051)
- **Integrated Real-time Simulation In An Earth Model - Automating Drilling and Driving Efficiency –** Baker Hughes (SPE 204069)
- **Systematic Decisions Under Uncertainty: An Experiment Towards Better Geosteering Operations –** NORCE, U Stavanger, Bendiksen Konsult (SPE 204133)
- **Improved Typelog Alignment for Automated Geosteering Using Multi-stage Penalized Optimization –** Helmerich & Payne (SPE 204053)
- **Geosteering Using an Automated Computational Framework –** University of Texas at Austin (SPE 204122)

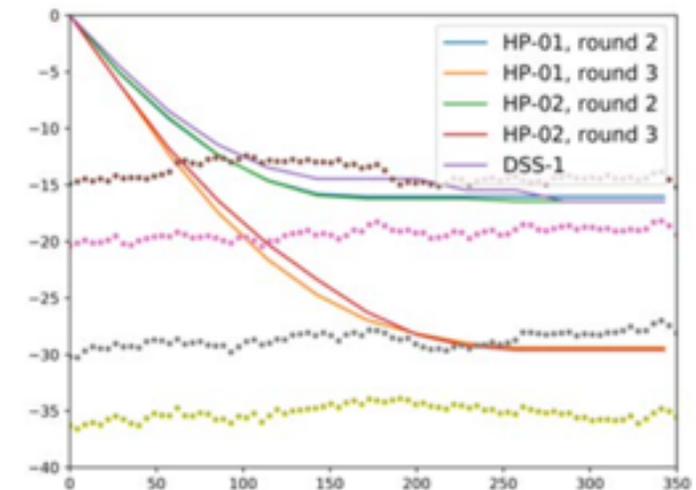


Figure 2—Combined results of rounds 2 and 3. Both rounds had identical earth models (unknownst to participants) with the optimum layer being the top layer. The boundaries are displayed as dots. By design DSS-1 produces identical decisions for identical rounds.

# Rig Automation Systems

- Many systems in use and/or in development
  - NOV NOVOS
  - SLB
  - Nabors
  - H&P
  - Etc etc.

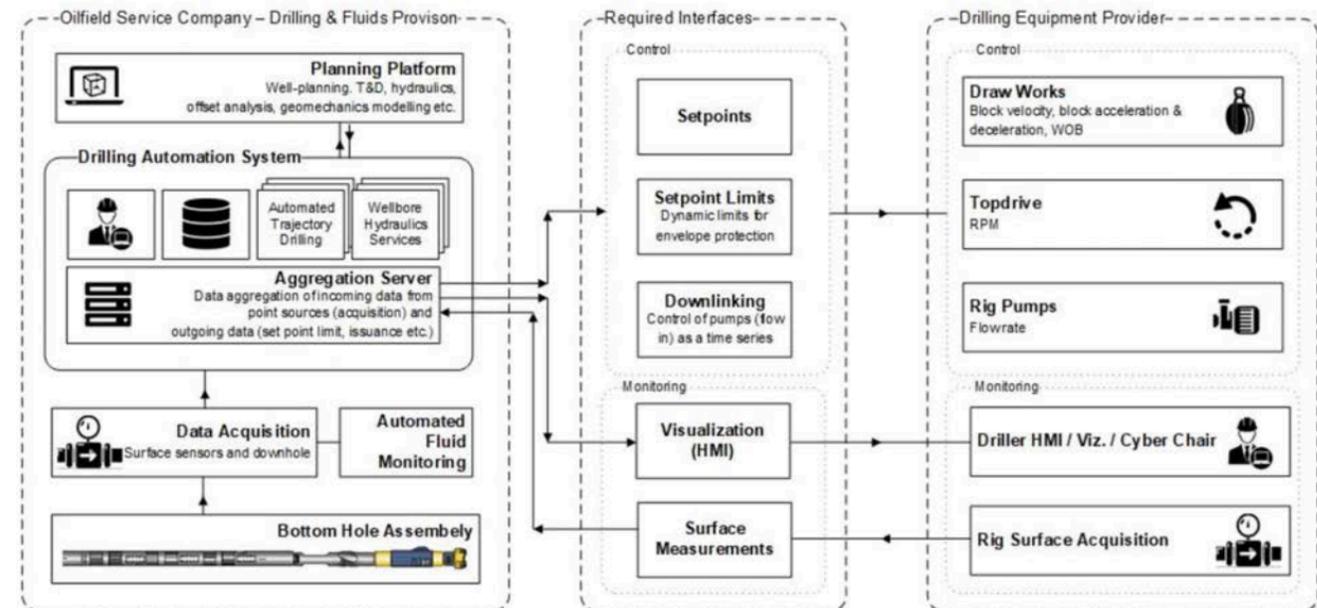


Figure 12—High-level topology of a drilling automation system with required system interfaces.

# Automated Mud Property Measurement

## 2021 SPE/IADC Drilling Conference

- **Automatic Drilling Fluids Monitoring –**  
Equinor + Baker Hughes (SPE 204041)
- Density and full rheology profile for mud going in and coming out
  - Figure lower right
- Applications
  - ECD, swab + surge, hole cleaning
- Benefit of continuous mud weight vs manual measurements
  - Figure upper left shows close model agreement with automated / continuous mud weight

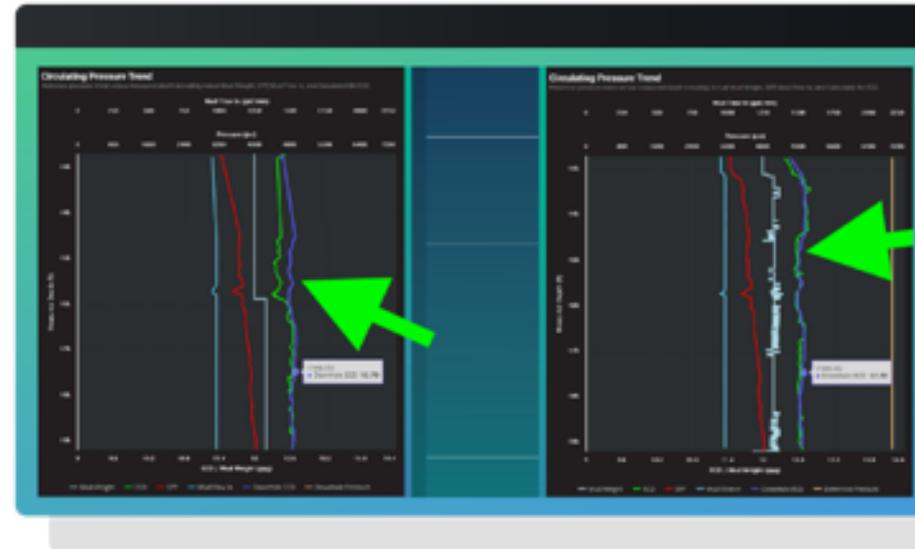


Figure 2—APM unit installed on an offshore platform in Norwegian sector

# What are the Blockers?

- Throw away the old way of thinking



# What are the Blockers?

- Throw away the old way of thinking
- Embrace the new reality



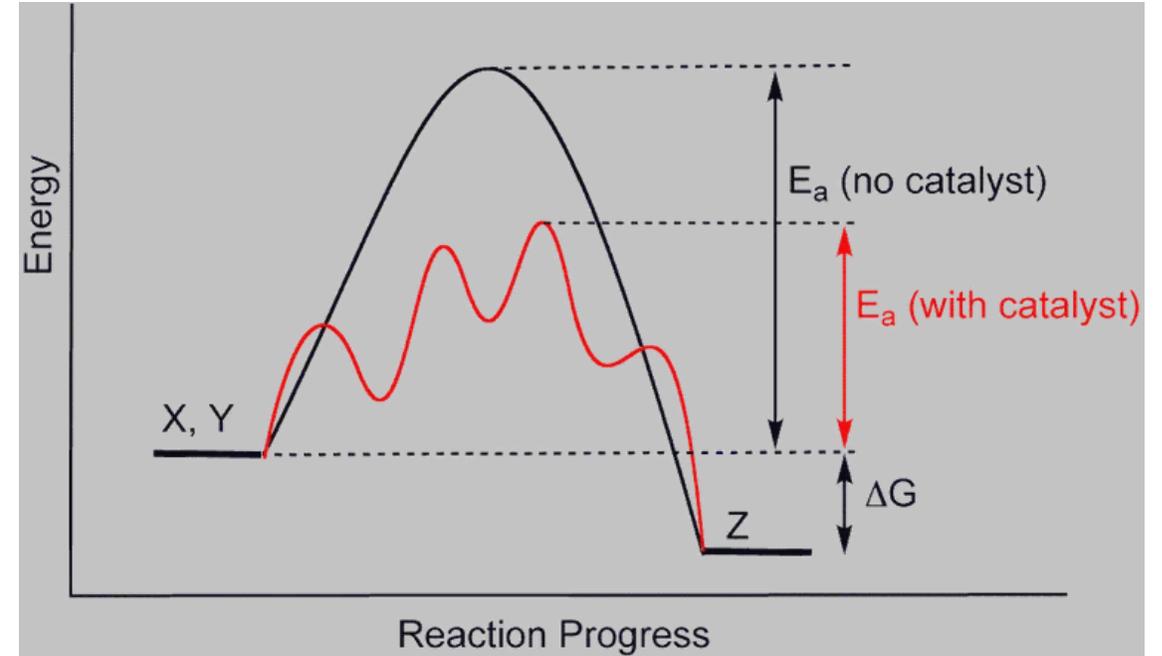
# Blockers

- Mistrust
- Resistance from individual
- Silos – organizations and industry
- Impact of automation on other systems and vice versa
- Data lakes aren't well connected
- Overpromised benefits



# Catalysts

- Operator shift from growth to profitability
- Leadership mindset
- Need best driller to scale to all rigs in the fleet
  - Automation doesn't take breaks or vacations
- Partnerships, industry cooperation, sharing
- Change management and communications are essential
- Digital technology
  - Data science, machine learning
  - Cloud enabling data availability anywhere anytime with mobile
    - Fits today's engineers' needs/wants





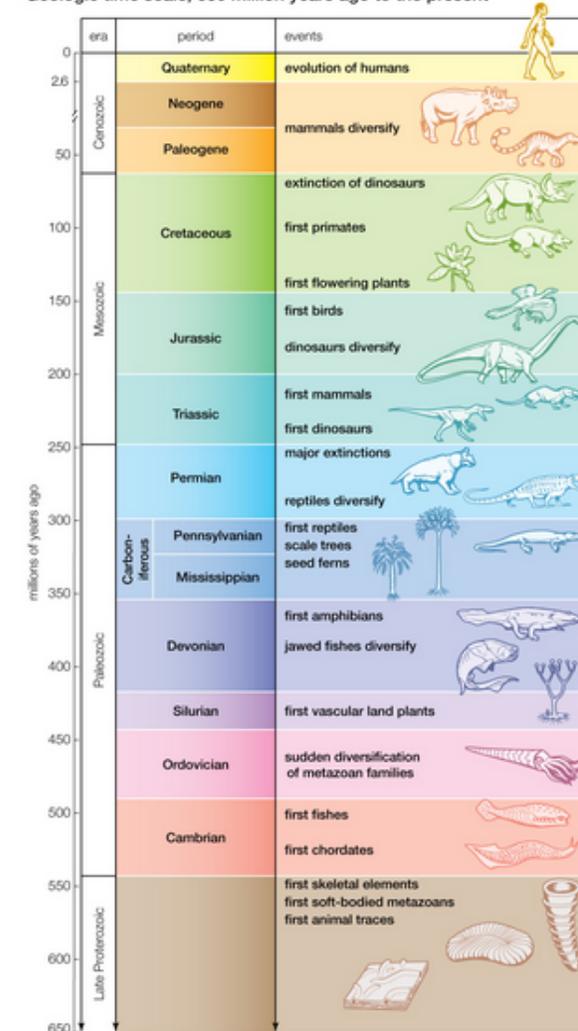
# Evolution not Revolution



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- People
  - Changing mindsets and attitudes drive adoption
  - The world is changing fast: bet on the future
- Process
  - Fit into existing workflows at first to produce consistency
  - Then Change the workflow to suit the new processes + technology
- Technology
  - Hardware
  - Software
  - Integrated systems

Geologic time scale, 650 million years ago to the present



# Industry – Break Down the Silos

- Join forces
- Partnerships
  - Operators, Oilfield Service Cos, Rig Contractors, academia, entrepreneurs, Software as a Service (SaaS)
- Data collection, storage, management changing from old paths
- Cloud is growing like crazy
- Edge has the edge for sub-second control systems
- Future – Distributed Cloud?
  - But my crystal ball gets a bit cloudy



# Companies – Who Will Win?

- Most successful to adapt to:
  - Changing business environment
  - New technology
  - Changing customer needs
- MBA nugget – don't be the last company making buggy whips!
- Integrate
  - No one can do it all
  - Requires partnerships to build industry standards
    - MSE led by Fred Dupriest (Texas A&M)
    - Dull Bit Grading led by Paul Pastusek (ExxonMobil)



# Engineers – Who Will Thrive? Survive?



NORM  
JUNG

"WE DON'T NEED WAITERS SINCE WE COMPUTER-  
IZED OUR ORDERING PROCESS. HOWEVER, I  
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# Engineers – Who Will Thrive? Survive?



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# Drilling Engineers – How to Thrive



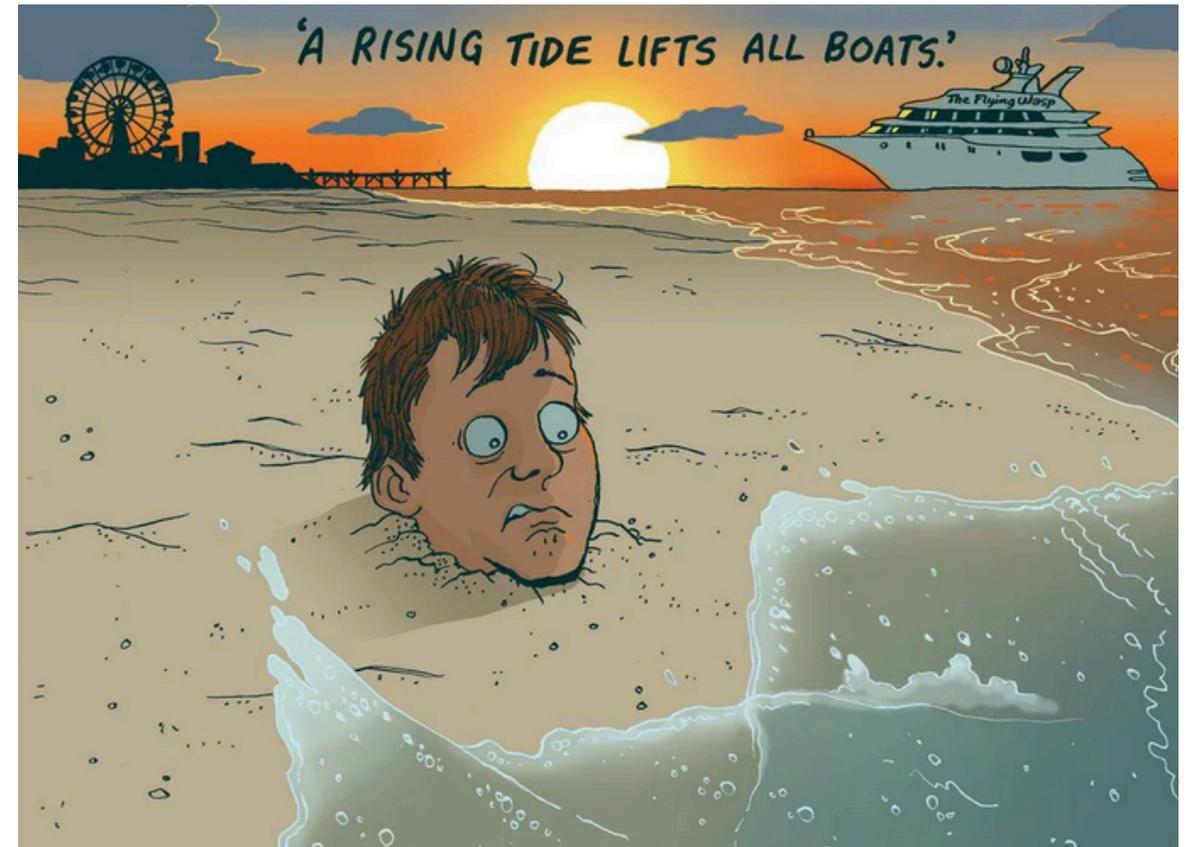
## Burning Questions

- Will automation cause me to lose my job?
  - Depends
- Will automation change my job?
  - Most assuredly
- How do I thrive in an increasing drilling automation world?
  - Embrace change
  - Love new technology but verify
  - Remember the drivers for automation

## Four Pillars of Solutions for Us

- Data science
  - Sure, it's overhyped today
  - But it's here to stay + will grow in importance
  - Don't be the last one who knows only Excel!
  - "Coding is the new English"
- Domain expertise in petroleum engineering will remain of prime importance
- Teammates isn't just a buzzword
  - The best teams usually beat the all-stars in any competition
- Sharpen your own critical thinking skills
  - Challenge yourself
  - Continuing education, join things, network

“It is not in the stars to hold our destinies, but in ourselves”  
William Shakespeare



# Q&A

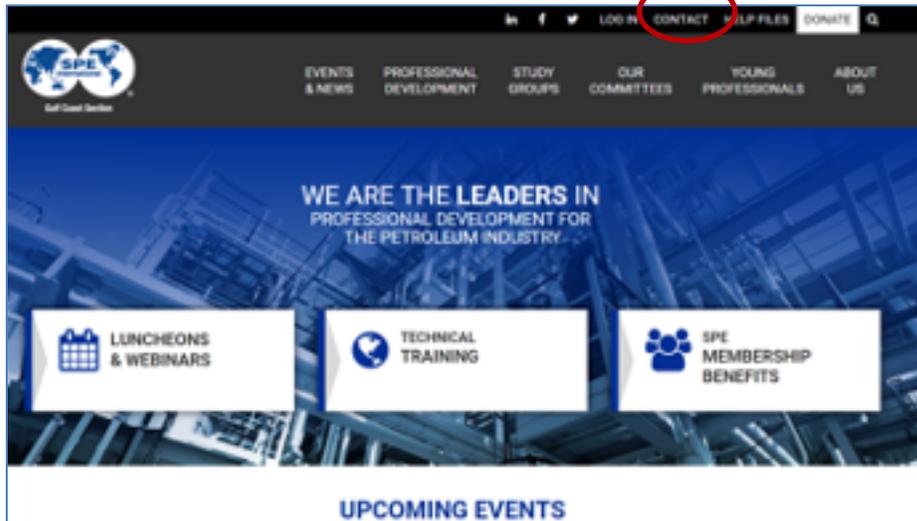
## Example... Create ours

Please complete the post event survey at the link below

<https://forms.gle/PRmvEjRba78LsHDPa>

# Stay Connected with SPE Drilling Study Group

1. LOG IN to your account (spe.org AND spegcs.org)
2. Update email preferences under “Events & News”
3. Enter your email address to update your selection



## Events

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- GCS - Drilling Study Group
- GCS - Digital Transformation Study Group
- GCS - Education
- GCS - EnergyDot
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Alternatively, Direct Link: <https://spe-gulfcoast.informz.net/spe-gulfcoast/default.asp?fid=3590>