SPE DISTINGUISHED LECTURER

Primary funding is provided by

The SPE Foundation through member donations and a contribution from Offshore Europe

The Society is grateful to those companies that allow their professionals to serve as lecturers

Additional support provided by AIME

SPE International

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

SPE DISTINGUISHED LECTURER

Lessons Learned, How NOT to Do Drilling Automation

Dr. William L. Koederitz, SPE, PE
GK Plus Innovations, LLC

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

Outline

- What is drilling automation?
  - Examples
  - Pros and Cons
  - How to decide?
- How NOT to do drilling automation
  - A positive side will be shown!
- Conclusions

Drilling Automation

- The technique of controlling a drilling process by highly automatic means, reducing human intervention to a minimum
- Mechanization is the replacement of human power with mechanical power

Levels of Automation

Level	Automation Description
6	System decides everything, acts autonomously, ignores the human
5	System executes automatically, then informs the human
4	System allows the human a restricted time to veto before automatic execution
3	System executes the suggestion if the human approves
2	System suggests one way to do the task
1	System suggests alternative ways to do the task
0	System offers no assistance, human must do it all

IEEE Transactions on Systems, Man, and Cybernetics- Part A: Systems and Humans, Vol. 30, No. 3, May 2000. Modified by A. DiFiore and W. Koederitz

Why Automate?

- Safety
  - Remove people from harm's way
  - Free up rig crew for monitoring
- Efficiency
  - Tasks that are repetitive and require continuous monitoring can be done more consistently with automation.
  - Free up rig crew for other tasks

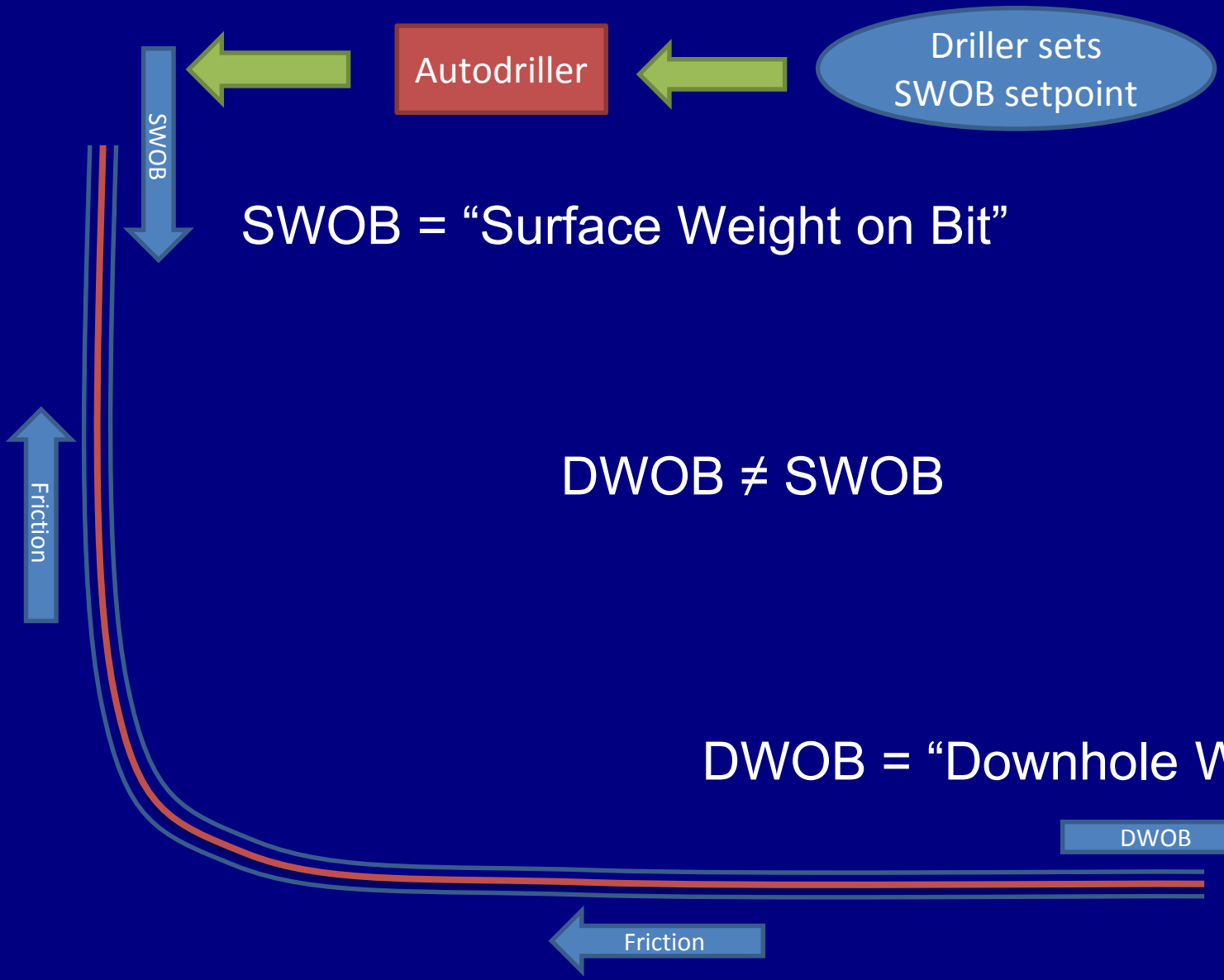
Why Automate?

- Enhance Crew Capability
  - Shortage of experienced individuals at the rig
- Improved Performance
  - Do things that people can't do (non-stop)
- Reduce number of people at rig
  - ???
  - May move some off of rig

Automation Example

Controlling Downhole Weight on Bit

Conventional SWOB Control



Why DWOB Control is Better

- Constant DWOB provides better results
  - Higher Rate of Penetration
  - Better directional control

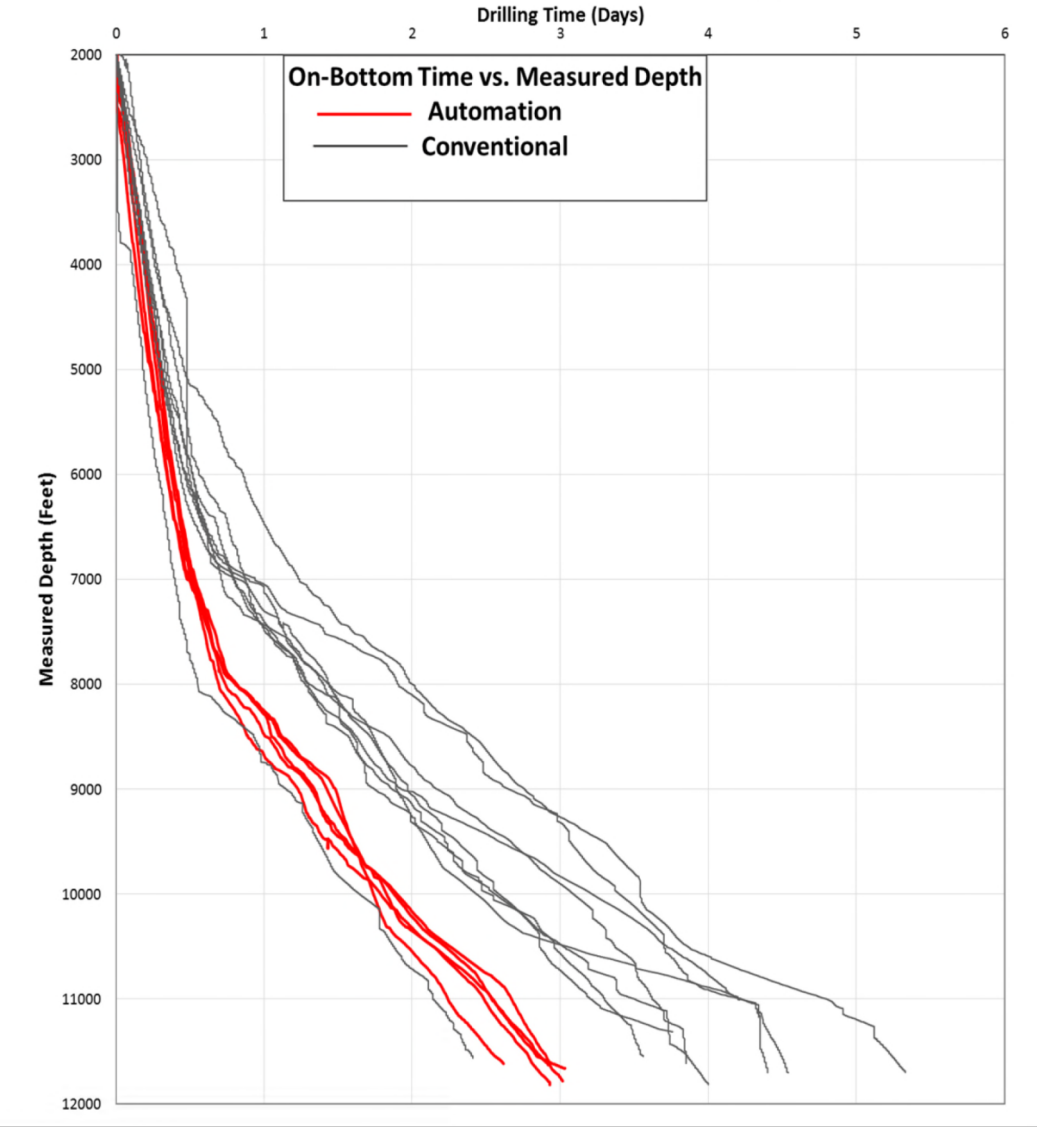
Manual DWOB Control

- Control process by driller
  - Read slow-speed DWOB
  - Compare to desired DWOB
  - Adjust SWOB setpoint in autodriller
- Holds DWOB “close” to desired
- Requires constant monitoring, adjusting
- If downhole conditions change, must react rapidly

Automated DWOB Control

- Driller sets desired DWOB, SWOB range
- Automated optimization process
  - Analyze high-speed surface and downhole drilling data
  - Computes change in SWOB
  - New SWOB sent direct to rig
- Driller now only has to monitor
- Holds DWOB very close to desired
- Reacts quickly to changes downhole

Performance Comparison

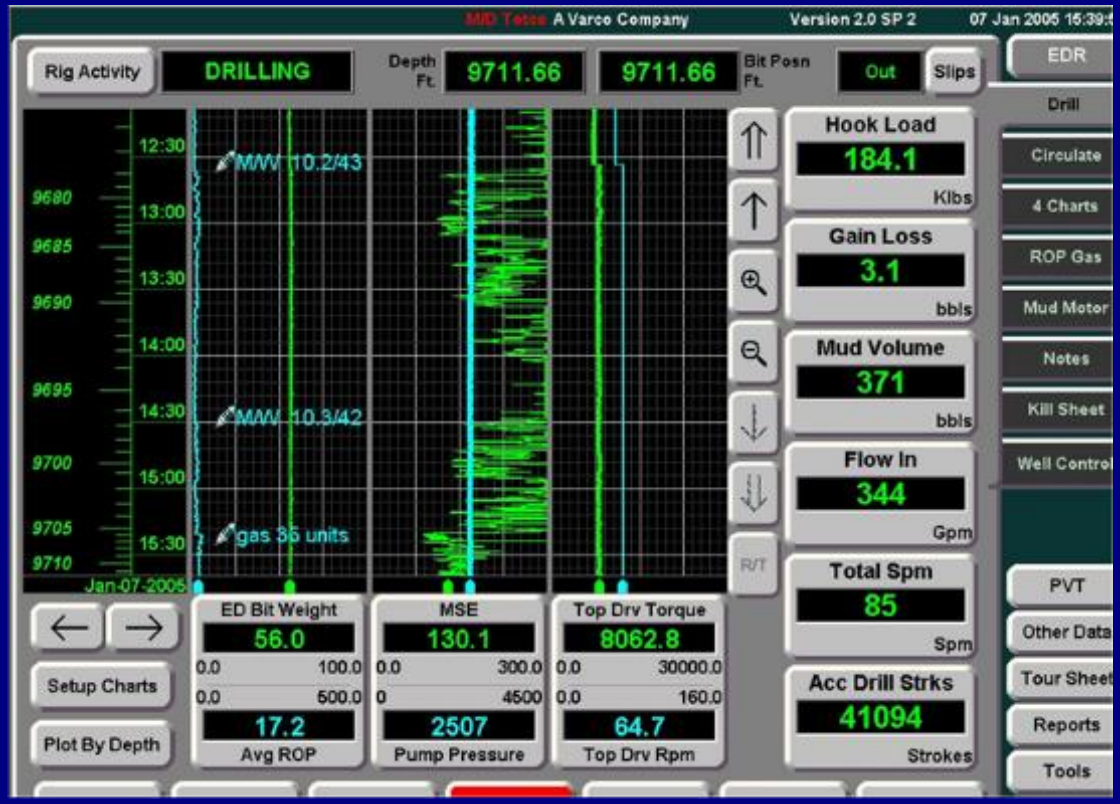


Automation Example

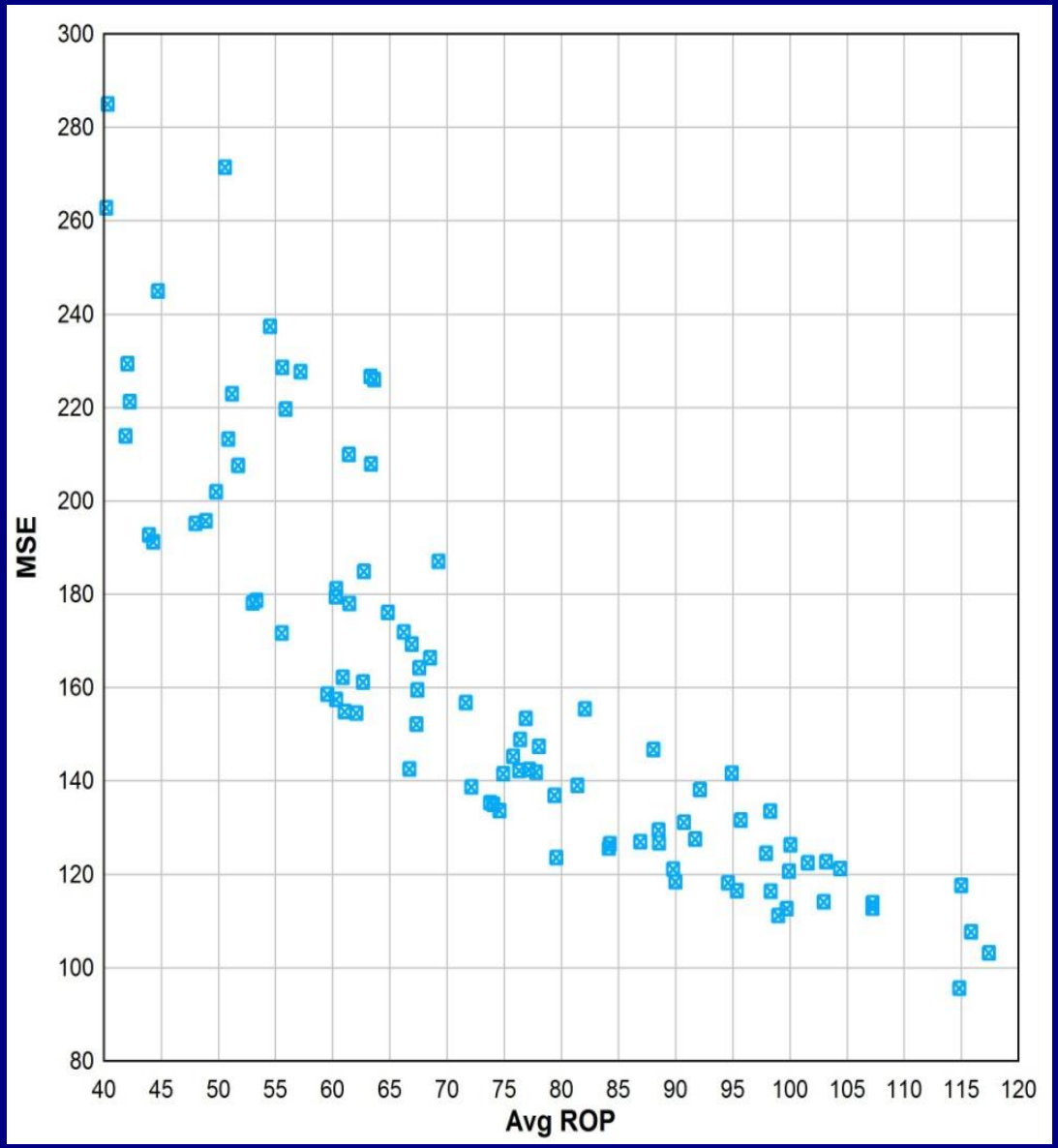
Optimizing Drilling Performance

Example – MSE Optimization

- MSE = “Mechanical Specific Energy”
- MSE = energy in / volume of rock drilled
- Lower MSE ➔ more efficient drilling



MSE vs ROP


MSE
300
280
260
240
220
200
180
160
140
120
100
80
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Avg ROP

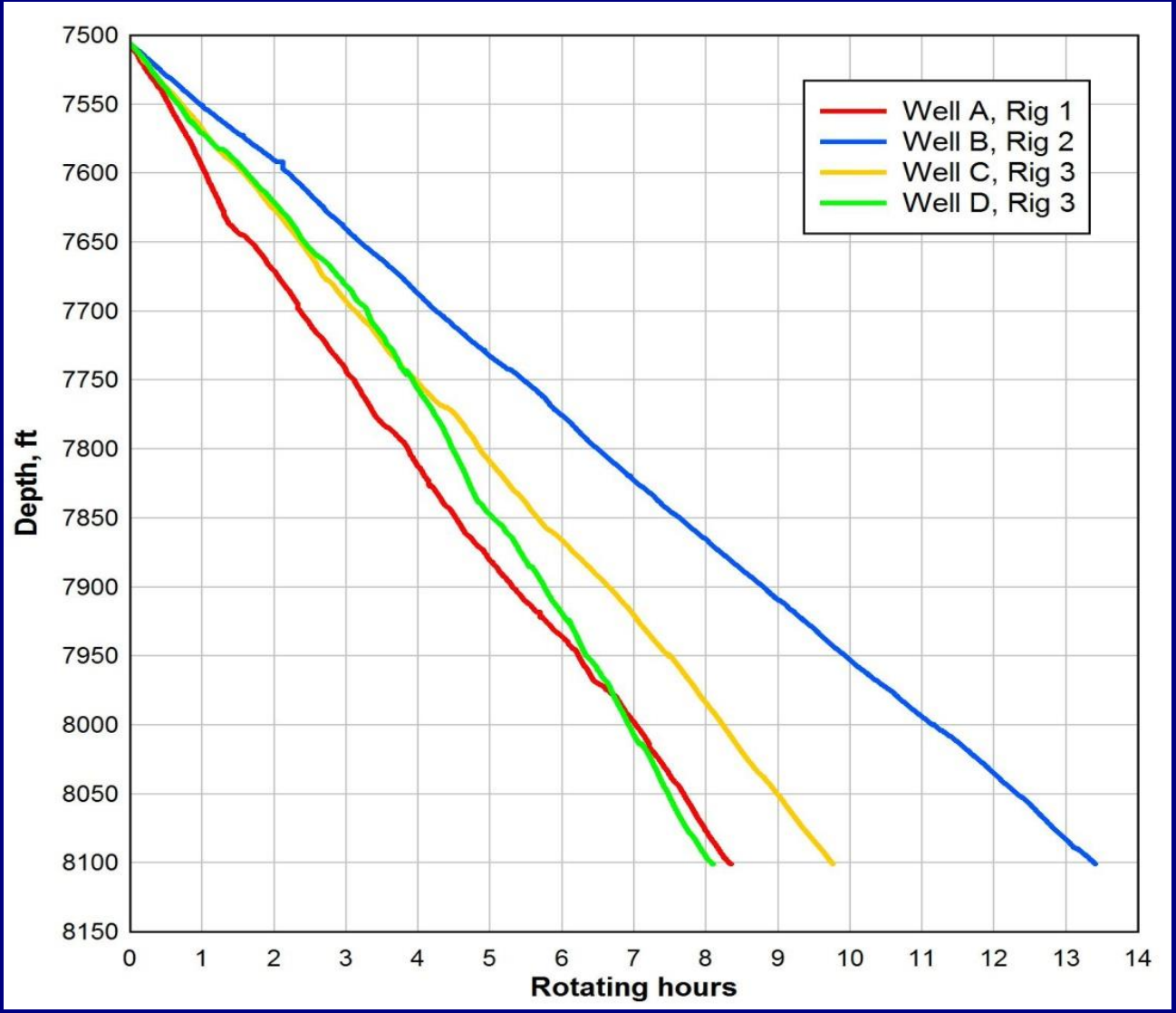
Manual MSE Optimization

- Optimization process by driller
  - Change Bit Weight and/or RPM
  - MSE response dictates next change
- Performance improvement
  - More as driller gains experience
- Requires constant monitoring, adjusting

Automated MSE Optimization

- Driller sets bounds on Bit Weight, RPM
- Automated optimization process
  - Analyze recent drilling & MSE data
  - Search technique selects Bit Weight, RPM
  - New Bit Weight, RPM sent direct to rig
- Driller now only has to monitor
- Performance improved in most cases
  - Can’t compete with dedicated expert driller

Performance Comparison



Risks of Automation

- Complacency
- Loss of ownership
- Dependent on data & control quality
- Maximum performance limited by “smartness” of automation logic
  - In the specific situation
- Automation can not innovate
  - Only motivated people can do that

When & What to Automate

- Selection Methods
  - Look for good automation applications
  - Look for performance improvement opportunities
    - Define automated and non-automated options
- Decide based on your criteria
  - Safety
  - Return on Investment

How Not to …

- Format
  - *A statement about drilling automation*
  - Why the statement is wrong
  - Solutions

How Not to …

“Driller is no longer needed. ”

- Driller is the core of rig activity
- If he is left out, automation will not work
  - Even if no action is required on his part
- Solution
  - Design system with driller at center and in control
  - Treat driller as most-critical automation enabler

How Not to …

"That rig's data was good enough for drilling, so it'll be fine for automation."

- Typical rig data is never good enough
  - Often already insufficient (if you really look)
- Reliable, high-quality data is a must-have
- Solution
  - Investigate rig data quality, upgrade as needed
  - Continuous monitoring of data quality

How Not to …

"That rig's controls were good enough for drilling, so they'll be fine for automation."

- Reliable, sufficiently precise control of rig equipment is a must-have
- Typical rig control is often not precise enough or is not readily accessible
- Solution
  - Evaluate rig control capability, resolve issues
  - Continuous monitoring of control quality

How Not to …

"Since it's automated, driller only needs to turn it on, not understand how it works."

- This reduces effective use (loss of value)
  - Worst case, destroys rigsite acceptance
- Optimum use by rig ➔ maximum value
- Solution
  - Design so driller is well informed of how it works
  - Enhance comfort level (simulator exercises a +)

How Not to …

"Their only choice is on or off."

"Let's let them adjust everything."

- There is an optimum level of interaction for each driller and situation
- But too many levels are confusing
- Solution
  - Analyze drillers, identify group(s)
  - Design for some variation in drillers
    - Basic vs advanced

How Not to …

"Let's make the system do everything (we think) they need. They'll sort it out."

- The driller is over-loaded by this, resulting in misuse or non-use
- Solution
  - Design the system as a suite of tools
    - Driller picks the right tool for the right job
  - Key decision criteria are simplicity, modularity, benefit/cost ratio

How Not to …

"The system will handle all possible conditions, without any ongoing adjustments."

- Unlikely system can handle all possibilities
- Changes in rig, sensors, drilling, …
- Solution
  - Design with adaptive control to minimize rig-site adjustments
  - Implement automated diagnostics for quicker problem recognition

Conclusions

- Automation is a tool to improve performance
  - Pros and cons, per application
- Critical success factors
  - Deciding if and what to automate
  - Design and implementation
    - People issues often > technical issues
    - Do not leave the driller out!

SPE DISTINGUISHED LECTURER

Your Feedback is Important

Enter your section in the DL Evaluation Contest by completing the evaluation form for this presentation
Visit SPE.org/dl

SPE International

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