

SPE Gulf Coast Section Annual Drilling Symposium

13 April 2017
Spring, Tx



Drilling Automation in Industry and Academia

Fred Florence
Rig Operations, LLC

SPE WORKSHOP

2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia



1

Today's Presentation



- Introduction to Drilling Automation
- Industry Efforts
 - DSATS
 - Members
- Academic Efforts
- Drillbotics™

SPE WORKSHOP

2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia



2

Introduction to Drilling Automation



An automated rig will have only two employees, a man and a dog.

The man will be there to feed the dog.

The dog will be there to bite the next person who tells this very old joke.

Introduction to Drilling Automation

- The automated rig should not replace the driller, but it should assist the driller with routine tasks and alert the driller of key conditions.
- An automation system must include the driller (human-in-the-loop)

Introduction to Drilling Automation

Most of today's "automation" is mechanization, or having machines do the heavy lifting



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

5

Introduction to Drilling Automation

Most autodriller's just lift the brake handle for the driller.

Some can position to stop the blocks in the right place for other operations like making connections or tripping.

What if they changed parameters based on models and measurements?



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

6

Drilling Systems Automation Technical Section (DSATS)

Formed in 2008 to help implement drilling automation

Plug and Play hardware and software interfaces

OPC/UA interface with DSATS naming convention

Best Practices

Business models

DSATS Members' Activity

Schlumberger's "Rig of the Future"

National Oilwell Varco's "NOVA"

Operator's Group on Data Quality

Various operators, contractors, service companies individual efforts

Academic Efforts

Mining University of Leoben mini-rig

UT's Rig Automation & Performance Improvement in Drilling (RAPID),

Tulsa's Drilling Research Program and others

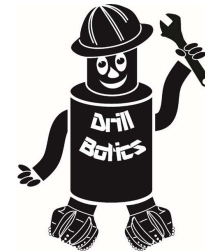
Joint Industry and Academia – What to Do?

“The big crew change” and it's gray-beards

The waning interest in STEM participation

The public view that the oil industry lacks the latest in technology

History of Drillbotics



- SPE Forum in Paris 2010 – Gerhard Thonhauser & FF
- Planning meeting (webinar) June 2011 re feasibility
- Dormant for 2012-2013 with minor events in background until driven by D.Justiniano and K.McKenna; draft guidelines
- Met with universities May 2014 re operational concerns
- First posted on DSATS site October 2014 and letters sent to schools

History of Drillbotics

- They build a rig – we make it challenging
 - Design and build a 2m high drilling rig
 - Use our bit and some flimsy aluminum drillpipe
 - Judges observe you drilling an unknown rock
 - There are only two buttons: start and stop
- Winners present a SPE paper using a travel grant provided by DSATS

$$P_{bcr} = \frac{\pi^2 * E * I}{(K * L)^2} = \frac{\pi^2 * 10000000 * 0.000546}{(1 * 36)^2} = 41.6 \text{ lbf} \quad (185.1 \text{ N or } 18.9 \text{ kg})$$

$$\tau = \frac{T * r_o}{J} = \frac{65.5 * 0.1875}{0.0010919} = 11247.6 \text{ psi} \quad (775.5 \text{ bar or } 77.55 \text{ Mpa})$$

$$T_{max} = \frac{\pi}{16} * \sigma_{max} * \frac{(d_o^4 - d_i^4)}{d_p} = \frac{\pi}{16} * 13779 * \frac{(0.375^4 - 0.305^4)}{0.375}$$

$$P_{burst} = \frac{2 * Y_p * t}{d_p * S_f} = \frac{2 * 13779 * 0.035}{0.375 * 1.5} = 1714.7 \text{ psi} \quad (118.2 \text{ bar})$$

OUTSIDE DIAMETER INCHES	WALL THICKNESS INCHES	ID INCHES
3/84 (24.7)	0.14	0.19
1/2 (12.7)	0.14	0.15
5/8 (1.61)	0.14	0.20
3/4 (0.76)	0.14	0.22
7/8 (0.91)	0.14	0.23
1 (0.91)	0.14	0.23
1 1/8 (1.31)	0.14	0.23
1 1/4 (1.31)	0.14	0.23
1 3/8 (1.31)	0.14	0.23
1 1/2 (1.51)	0.14	0.23
1 5/8 (1.51)	0.14	0.23
1 3/4 (1.51)	0.14	0.23
1 7/8 (1.51)	0.14	0.23
2 (1.51)	0.14	0.23
2 1/8 (1.51)	0.14	0.23
2 1/4 (1.51)	0.14	0.23
2 3/8 (1.51)	0.14	0.23
2 1/2 (1.51)	0.14	0.23
2 5/8 (1.51)	0.14	0.23
2 3/4 (1.51)	0.14	0.23
2 7/8 (1.51)	0.14	0.23
3 (1.51)	0.14	0.23
3 1/8 (1.51)	0.14	0.23
3 1/4 (1.51)	0.14	0.23
3 3/8 (1.51)	0.14	0.23
3 1/2 (1.51)	0.14	0.23
3 5/8 (1.51)	0.14	0.23
3 3/4 (1.51)	0.14	0.23
3 7/8 (1.51)	0.14	0.23
4 (1.51)	0.14	0.23
4 1/8 (1.51)	0.14	0.23
4 1/4 (1.51)	0.14	0.23
4 3/8 (1.51)	0.14	0.23
4 1/2 (1.51)	0.14	0.23
4 5/8 (1.51)	0.14	0.23
4 3/4 (1.51)	0.14	0.23
4 7/8 (1.51)	0.14	0.23
5 (1.51)	0.14	0.23
5 1/8 (1.51)	0.14	0.23
5 1/4 (1.51)	0.14	0.23
5 3/8 (1.51)	0.14	0.23
5 1/2 (1.51)	0.14	0.23
5 5/8 (1.51)	0.14	0.23
5 3/4 (1.51)	0.14	0.23
5 7/8 (1.51)	0.14	0.23
6 (1.51)	0.14	0.23
6 1/8 (1.51)	0.14	0.23
6 1/4 (1.51)	0.14	0.23
6 3/8 (1.51)	0.14	0.23
6 1/2 (1.51)	0.14	0.23
6 5/8 (1.51)	0.14	0.23
6 3/4 (1.51)	0.14	0.23
6 7/8 (1.51)	0.14	0.23
7 (1.51)	0.14	0.23
7 1/8 (1.51)	0.14	0.23
7 1/4 (1.51)	0.14	0.23
7 3/8 (1.51)	0.14	0.23
7 1/2 (1.51)	0.14	0.23
7 5/8 (1.51)	0.14	0.23
7 3/4 (1.51)	0.14	0.23
7 7/8 (1.51)	0.14	0.23
8 (1.51)	0.14	0.23
8 1/8 (1.51)	0.14	0.23
8 1/4 (1.51)	0.14	0.23
8 3/8 (1.51)	0.14	0.23
8 1/2 (1.51)	0.14	0.23
8 5/8 (1.51)	0.14	0.23
8 3/4 (1.51)	0.14	0.23
8 7/8 (1.51)	0.14	0.23
9 (1.51)	0.14	0.23
9 1/8 (1.51)	0.14	0.23
9 1/4 (1.51)	0.14	0.23
9 3/8 (1.51)	0.14	0.23
9 1/2 (1.51)	0.14	0.23
9 5/8 (1.51)	0.14	0.23
9 3/4 (1.51)	0.14	0.23
9 7/8 (1.51)	0.14	0.23
10 (1.51)	0.14	0.23

History of Drillbotics - Pipe



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

History of Drillbotics - Bit



1.125" micro-bit



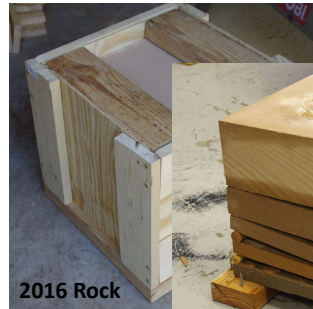
Students bought test bits



Students made their own bits

2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

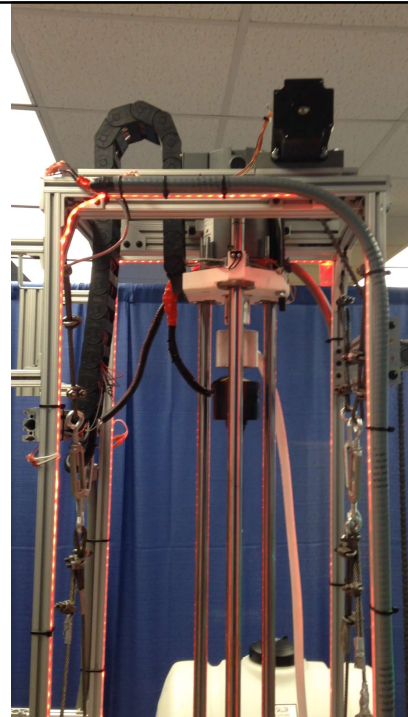
History of Drillbotics - Rock



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

15

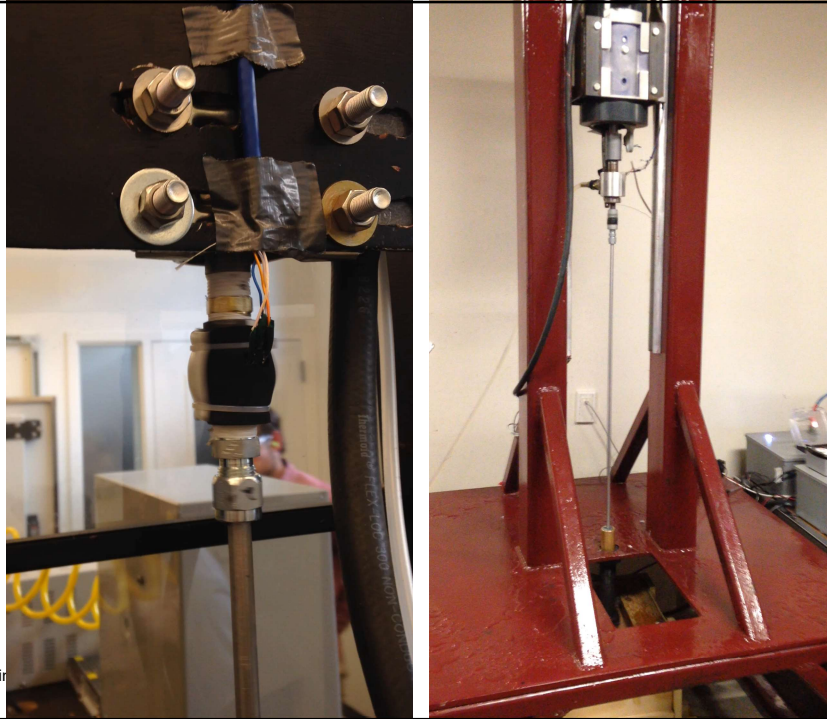
History of Drillbotics – How Does it Work?



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

16

History of Drillbotics – How Does it Work?

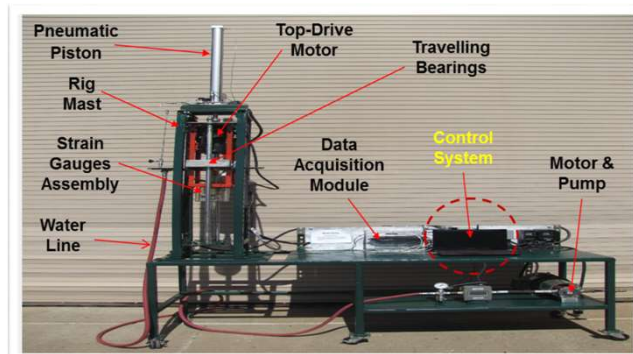


2017 GCS Drilling Symposium: Drilling Automation in

17

History of Drillbotics - 2015

- Four schools entered design reports in the fall of 2014
 - Texas A&M
 - University of Agder
 - University of Oklahoma
 - University of Texas at Austin
- Winning team from OU

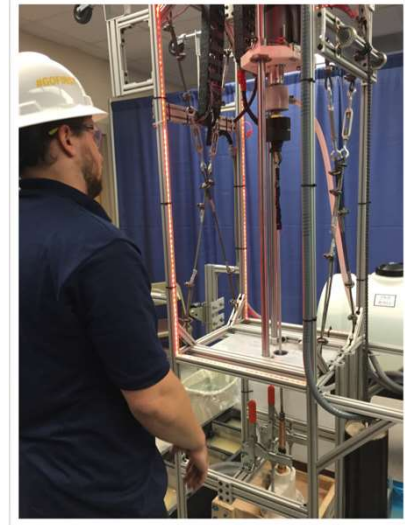


2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

18

History of Drillbotics - 2016

- Ten schools entered design reports in the fall of 2015
 - Texas A&M
 - University of Agder
 - Colorado School of Mines
 - University of Houston
 - University of Louisiana Lafayette
 - University of North Dakota
 - University of Oklahoma
 - University of Stavanger
 - University of Texas at Austin
 - West Virginia University
- Winning team from WVU



2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

19

2017 Entrants and Finalists

- Ten schools entered design reports in the fall of 2016
 - **Texas A&M**
 - **Clausthal University of Technology**
 - **Colorado School of Mines**
 - Missouri S&T
 - **NTNU**
 - **University of Oklahoma**
 - **University of Stavanger**
 - **University of Texas at Austin**
 - University of Calgary
 - Pandit Deendayal Petroleum University*
 - University of North Dakota (withdrew)
- Seven were selected as finalists

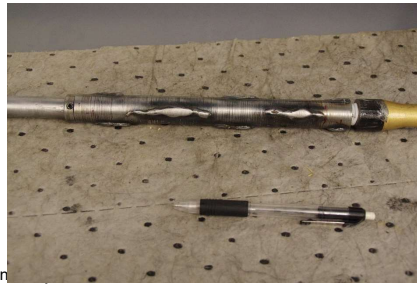
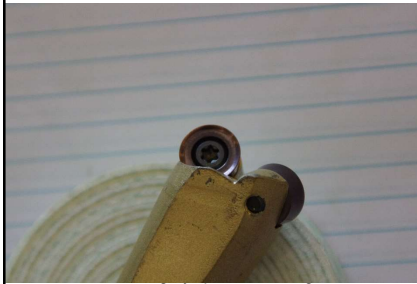
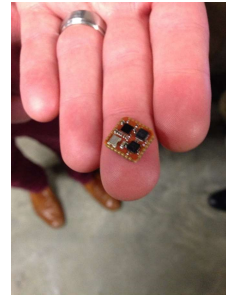
2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

20

Unique Designs

Pipe and BHA

- Special stabilizers & DH tools
- Vibration sensors
- Telemetry, wired and wireless



21

Unique Designs

Modeling and Algorithms

- MSE
- Whirl
- Optimization

- Those who tried to do this with only a PC and a DAQ found the comms too slow
- Better solutions from those with appropriate speed/response
- Most only look at ROP optimization, which is not enough

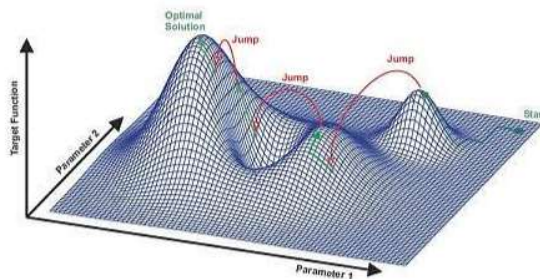


Figure 8 Simulated annealing example

22



Drillbotics 2018

Some schools plan to return in 2018
Several new schools planning to field teams

- Denmark
- UK
- USA
- Others?

We always need enthusiastic judges.

We need sponsors.
More sponsors allow more teams to participate.

2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia

23



www.Drillbotics.com
[Email: 2017@Drillbotics.com](mailto:2017@Drillbotics.com)

- Thanks to the DSATS board of directors who authorize and fund this project.
- Thanks to the judges who give their time, money and mentoring.
- Thanks to the universities who fund the student teams and help them design and build the rigs.
- Mostly, thanks to the students who spend countless hours to create new ways to improve drilling automation.

And please don't forget our sponsors!



SPE WORKSHOP
2017 GCS Drilling Symposium: Drilling Automation in Industry and Academia



Society of Petroleum Engineers

24