SPE Gulf Coast Section
Annual Drilling Symposium

13 April 2017
Spring, Tx

Drilling Automation in Industry and Academia

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Today's Presentation

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

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

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?

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

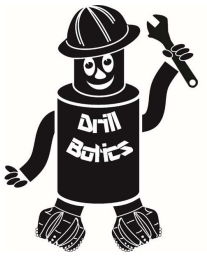
UT's Rig Automation & Performance Improvement in Drilling (RAPID),

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

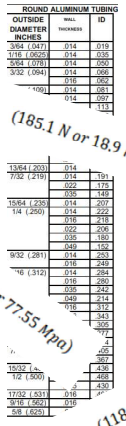
- They build a rig – we make it challenging
  - Design and build a 2m high drilling rig
  - Use our bit and some flimsy aluminum drillpipe
  - Judges observe you drilling an unknown rock
  - There are only two buttons: start and stop
- Winners present a SPE paper using a travel grant provided by DSATS

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

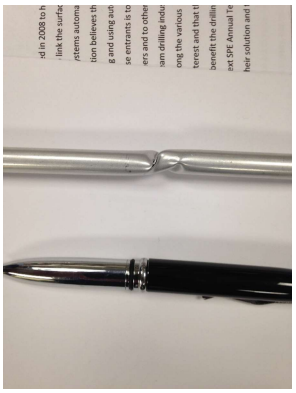
$$\tau = \frac{T * r_o}{J} = \frac{65.5 * 0.1875}{0.0010919} = 11247.6\ psi \quad (775.5\ bar\ or\ 77.55\ Mpa)$$

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

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



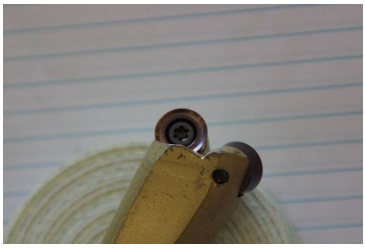
History of Drillbotics - Pipe



History of Drillbotics - Bit

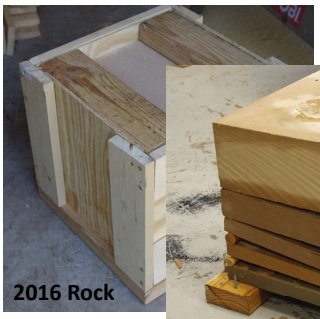
1.125” micro-bit

Students bought test bits

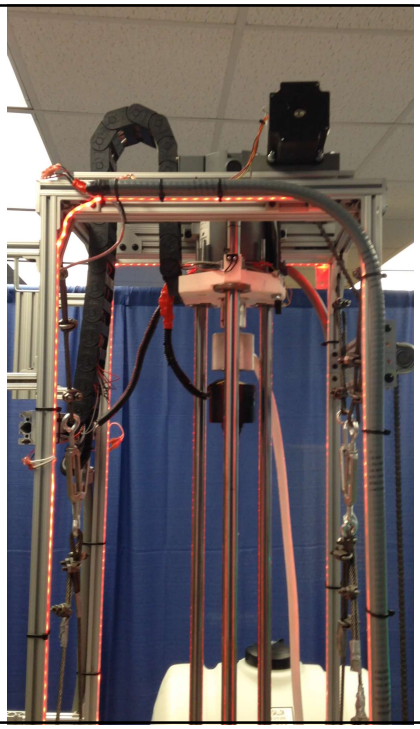


Students made their own bits

History of Drillbotics - Rock



History of Drillbotics – How Does it Work?



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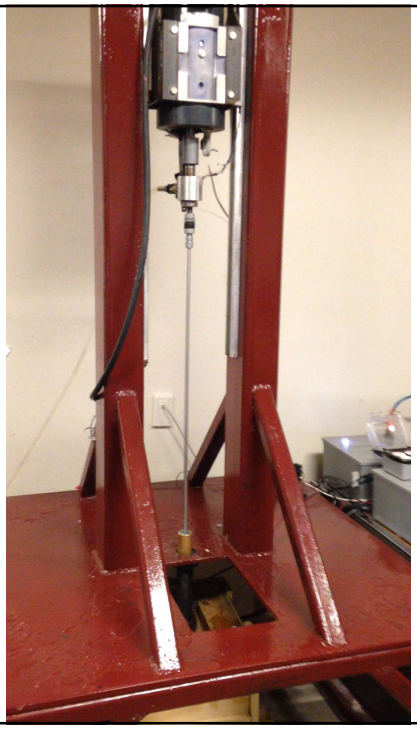
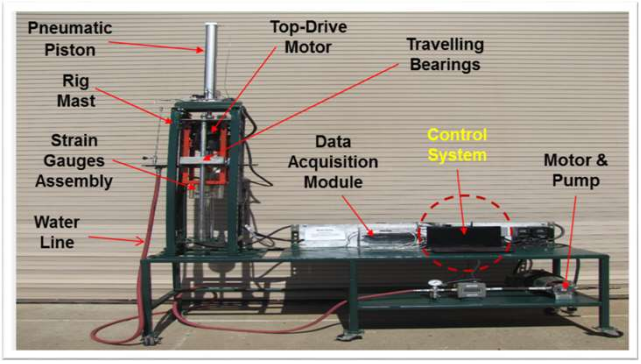


History of Drillbotics - 2015

- 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



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

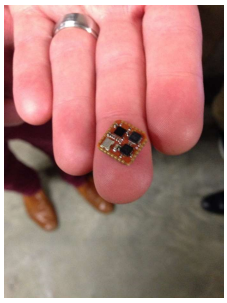
2017 Entrants and Finalists

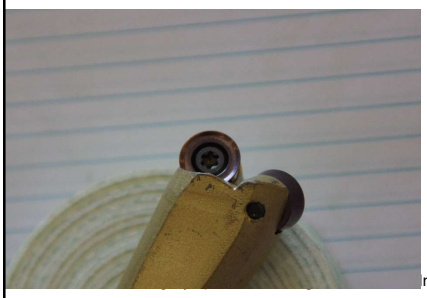
- Ten schools entered design reports in the fall of 2016
  - **Texas A&M**
  - **Clausthal University of Technology**
  - **Colorado School of Mines**
  - Missouri S&T
  - **NTNU**
  - **University of Oklahoma**
  - **University of Stavanger**
  - **University of Texas at Austin**
  - University of Calgary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

Unique Designs

Pipe and BHA

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





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Unique Designs

Modeling and Algorithms

- MSE
- Whirl
- Optimization

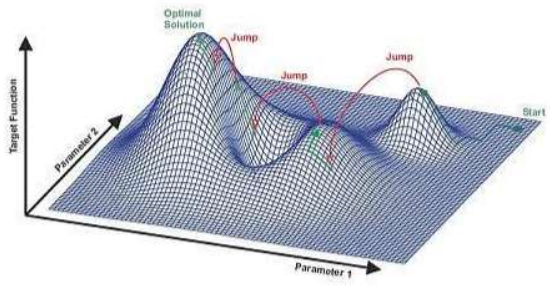

Figure 8 Simulated annealing example

- 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

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 ANNUAL DRILLING SYMPOSIUM

www.Drillbotics.com

Email: 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!

BAKER HUGHES, Schlumberger, OXY, evolution ENGINEERING, NOV, SIEMENS, Robotic DRILLING SYSTEMS, MathWorks, Quality Building Stone, Rig Operations, LLC