

- Tool Face Efficiency, Virtual Surveys, and Positional Uncertainty - an introductory discussion
- Robert Wylie

Speaker Information

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- Robert Wylie
- President
- April 11th, 2018
- xnDrilling, Inc.

Robert Wylie



- xnDrilling, Inc.
- Education
 - Glasgow Uni – B.Sc.(Hons. In Nat. Phil)
 - Strathclyde Business School, MS International Marketing
 - College of Piping – vibrations and fluids management
- 40 years in oil business
 - Formation Evaluation, MWD, Ops., Eng., Mfg., Marketing, Product Management,...
 - Currently living in Houston, Texas
- “Specialized” in
 - Instrumentation
 - Directional Sensors
 - Drilling
 - Automation

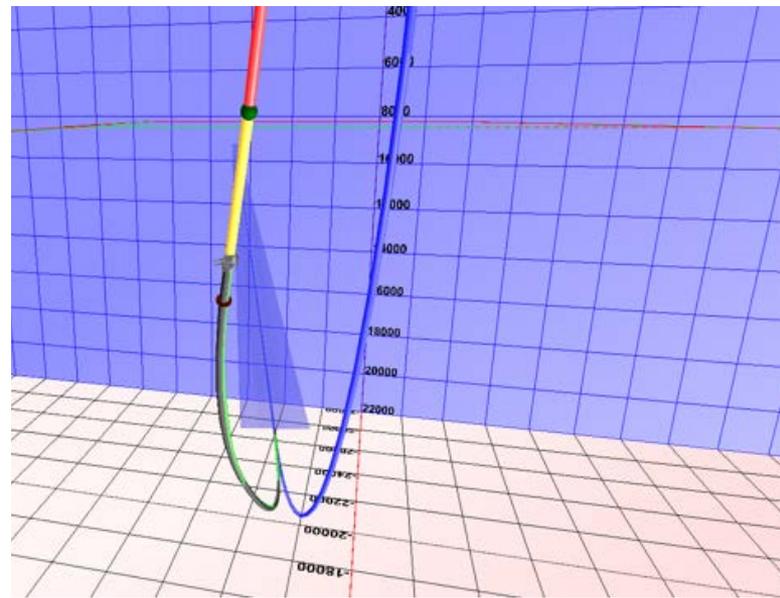
xnDrilling, Inc.

Drilling automation applications

- Making Real Time decisions from Real Time drilling data

Current focus

- Directional Drilling Advisement and Automation



xⁿDrilling

Topics

TF Efficiency, Virtual
Surveys, and Uncertainty.
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Tool Face Efficiency

Definition?

Virtual Surveys

Definition?

Positional Uncertainty for TVD corrections

Where do we go?

Tool Face Definition

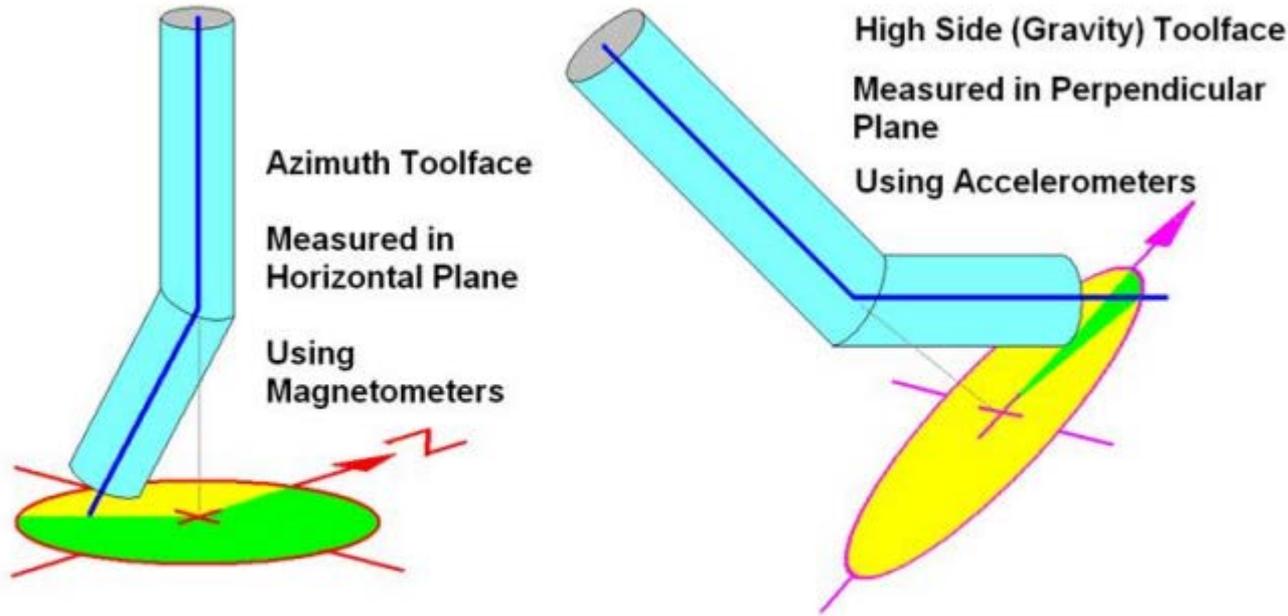


Figure 34: Graphical representation of two types of toolface.

Indicates the direction in which a drilling motor (or rotary steerable) is pointing the bit, in order to steer the well.

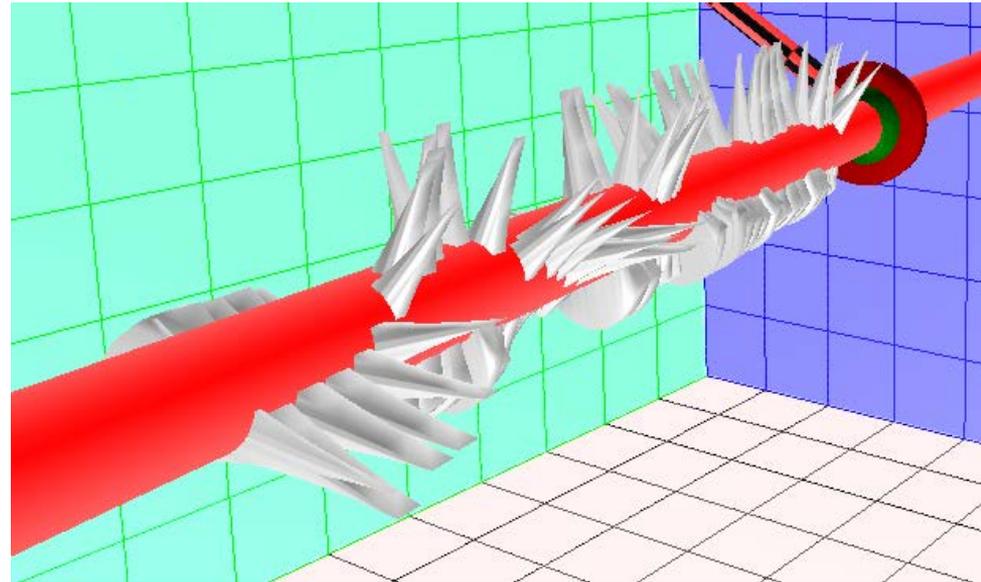
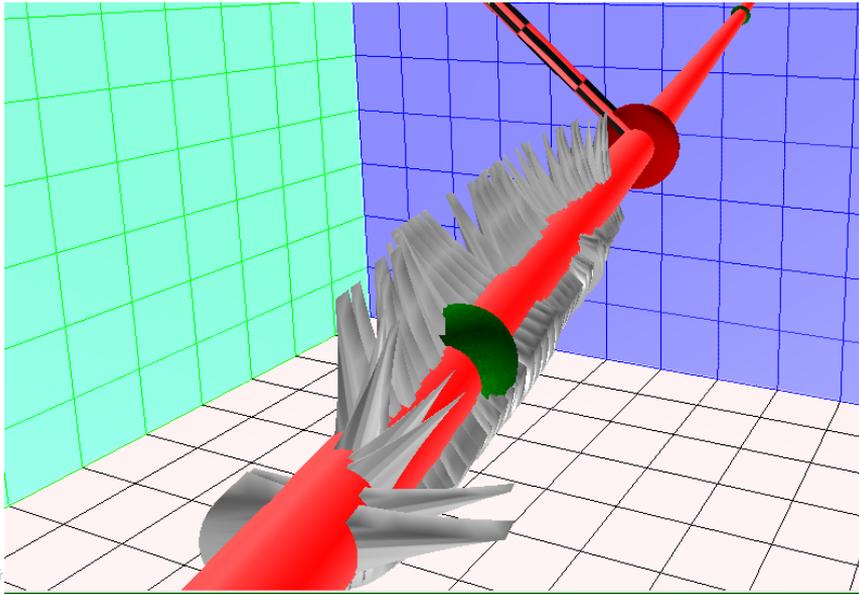
Magnetic Tool Face.
Gravity Tool Face.

Illustration shamelessly
"borrowed" from our eBook

Holding Tool Face

It can be challenging to maintain the desired Tool Face, particularly with long laterals.

Drillers are often gauged on their ability to set and hold the desired Tool Face

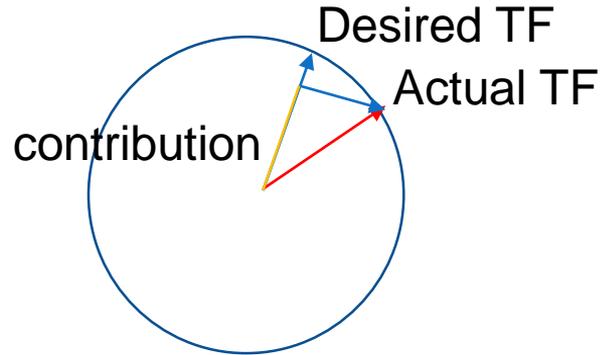


Tool Face Efficiency

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Tool Face Efficiency

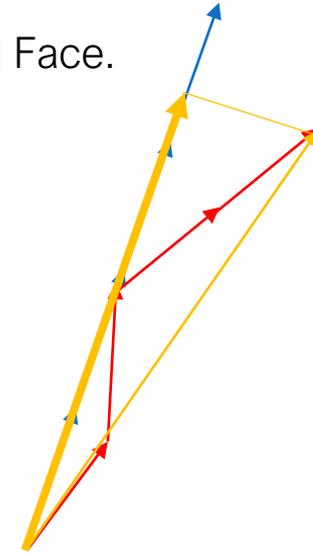
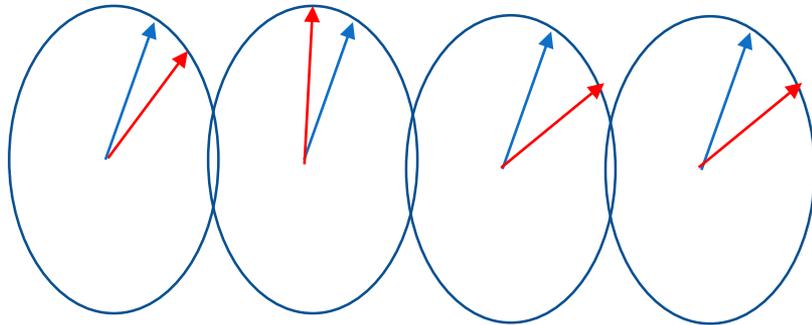
The percentage of a slide pointing in the direction of the specified Tool Face.



Tool Face Efficiency

Tool Face Efficiency

The percentage of a slide pointing in the direction of the specified Tool Face.

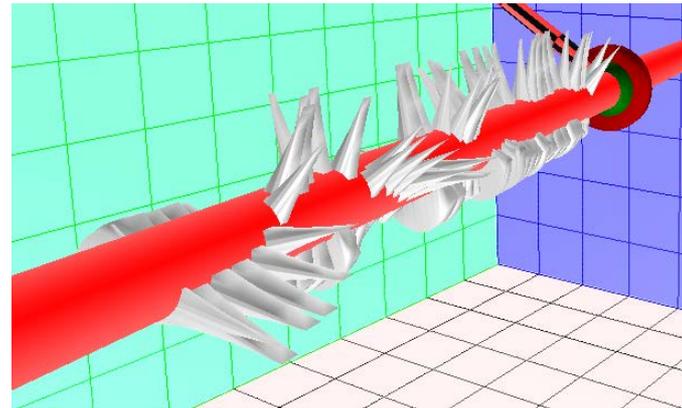
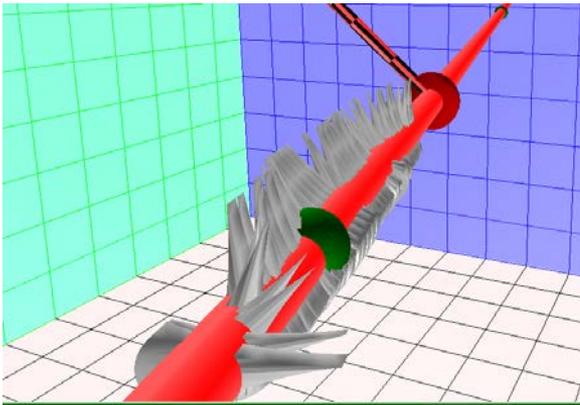


Tool Face Efficiency

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Tool Face Efficiency

A: the percentage of a slide pointing in the direction of the specified Tool Face

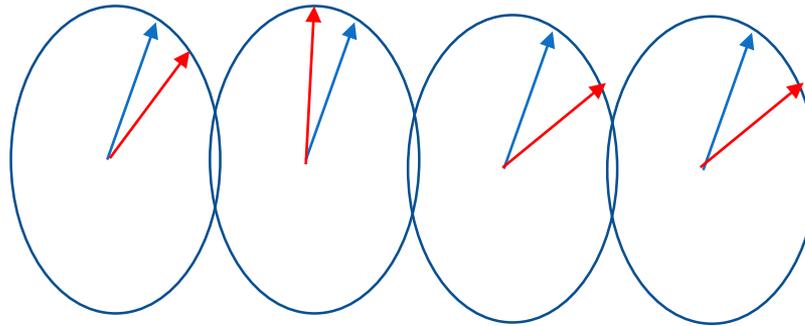


Build Efficiency

Build Efficiency

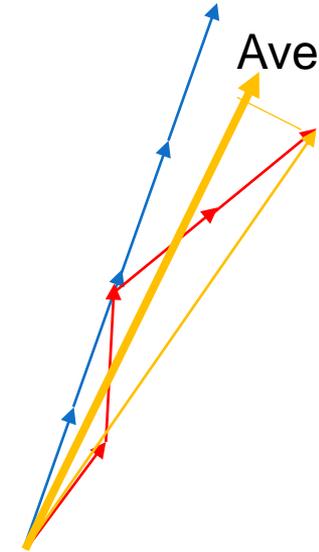
The percentage of a slide pointing in the direction of the **average** Tool Face of a slide

Relates to Dog Leg Severity



Desired TF

Average TF



Virtual Measurement

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A parameter that is not measured directly but is calculated from related measurements,

Weight On Bit is a Virtual Measurement that we have used for decades – typically

$$\text{Surface WOB} = \text{Hook Load (bit off bottom)} - \text{Hook Load (bit on bottom)}$$

A survey giving Inclination and Azimuth that is not measured directly by inclinometers and magnetometers or gyroscopes, but is calculated from related measurements,

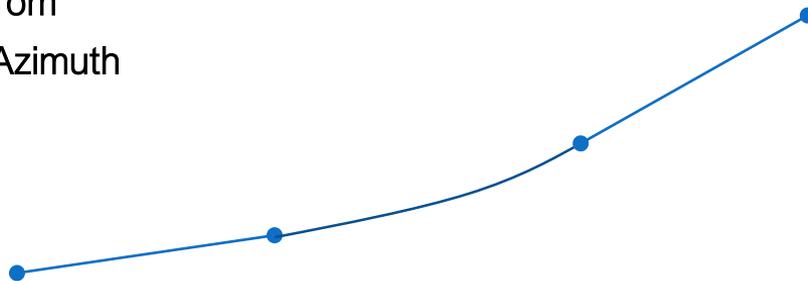
A Virtual Survey can be calculated from

starting Inclination and Azimuth

“Delta” depth drilled

Tool Face

Bend



I.e. calculate the incremental change in Inclination or Azimuth from the length drilled, bend, and direction of bend, and add that to the starting inclination and azimuth.

The Bend can be from a bending moment, Motor Yield of motor, or Rotary Steerable.

The direction is typically from Tool Face

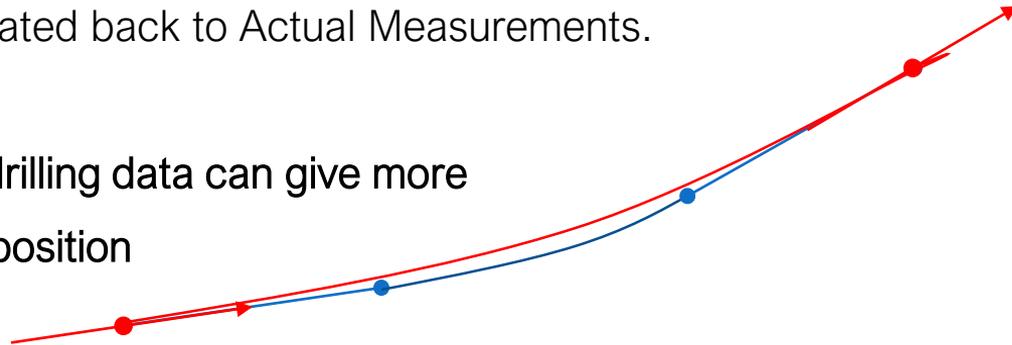
Virtual Survey Calibration

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Every Survey tool needs calibration / verification.

Virtual Surveys are related back to Actual Measurements.

But Virtual Surveys from actual drilling data can give more
precise information of well bore position
in between
directly measured (“approved”) surveys.



Virtual Surveys are used by Directional Drilling Automation software for a better knowledge
of the wellbore position in between surveys.

Virtual Surveys and TVD corrections

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Virtual Surveys can be used to
enhance survey frequency,
hence improve knowledge of borehole shape
and correct TVD estimations (or calculations if you prefer)

So what are the uncertainties, and how much can we gain?

TVD Corrections – how to quantify?

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Depth uncertainty

ROP and delta depth increments usually measured at surface
averages out some during a slide

Tool Face uncertainty

Tool Face / Build Efficiency definitions can help

Bend uncertainty

Motor Yield can be variable, but uncertainties can be decreased with reference to the measured survey points

Positional Uncertainty for TVD corrections

Where do we go from here?

Conclusion

- Automation of Directional Drilling is bringing new information to the table
- Hole position can be improved by deeper analysis of the measurements that we are making (P.S. we need to ensure good practices)
- The uncertainty models need developed and established for wide and consistent use.

