<u>**49th ISCWSA Meeting – The Hague, Netherlands – March 8, 2019**</u>

Introduction

(Jonathan Lightfoot)

- Welcome statement, special thanks to the sponsors for the event, MagVAR and Gyrodata
- Safety instructions provided by staff from the World Forum
- The next meeting in Calgary will be Jonathan's last as Chairperson, he will be succeeded by Ross Lowdon – Program Chairperson

Schedule and Program Review

(Ross Lowdon)

- Overview of the agenda
- Again, thank you to the sponsors for their contributions
- There are some last-minute changes to the agenda, Jerry Codling will present on Error Modelling when Vertical (Low Angle SAG)

Keynote Presentation – Interactive Well Path Planning Integrated with Geoscience and Cultural Data

(Geoffrey Dorn)

- Currently works for CGG GeoSoftware
- Experience includes ARCO, Univ of Colorado, TerraSpark, GeoSciences, and now CGG
- He holds a PhD in Engineering of Geoscience from UC Berkeley
- Current work focuses on Seismic Interpretation, with 3D Visualization
- Cultural Data, and Well Path Planning were added into the G&G, and existing well database for a 3D Integration
- Software that includes all the available data, from well path planning and cultural data will help to mitigate HSE risks
    - The goals are to find, develop, and produce as efficiently and safely as possible
- Using spatially referenced data will aid in the planning of wells
    - Example given is research in New Mexico using Geophysics to support a 3D well path
- Permian Basin Examples
    - Shallow Drilling Hazards
        - Near Surface Karsts
            - This can lead to an environmental impact (image depicts a sunken rig)
    - Water Source or Water Problem
        - Understand the water table, find sources of drilling water
        - Dissolution/Collapse features
    - EM Responses
        - Can identify sub-surface hazards prior to drilling
        - Airborne data can identify potential karsts and features of concern

- o Planning in Mature Drilled areas
  - ▪ There is not a great deal of sub-surface data on the legacy existing wells
  - ▪ AC risk is a primary concern
- o Optimize Path and Completion Plans for Natural Fracture Swarms
  - ▪ Changing density of fractures interpreted by the seismic data is a useful tool to identify communication problems ahead of time
  - ▪ This can improve the completion strategy by evaluating the plan vs the combined data set
    - • Avoiding high fracture density, to appropriately drain different areas
- o Plan for Multiple Stack Reservoir Zones
  - ▪ This is common in the Permian
  - ▪ Modifying the software was a necessity to overcome this challenge
- • Barnett Shale Examples
  - o Optimized Path for Best Facies/Rock Properties
    - ▪ High Quartz and Brittleness are desirable
    - ▪ Clay rich rocks interfere with fracturing
    - ▪ Again, combining seismic and well logs into a 3D viz
  - o Well Path planned on Best Facies and Fractures
    - ▪ Identifying dominant fracture orientations
  - o Optimize for Best Zone in an interval
    - ▪ Minimize cost and maximize return
    - ▪ In this example there is a significant return on production vs completion effort and cost
    - ▪ Placing a well in the optimized zone requires less fracture pressure
- • Gulf of Mexico
  - o Planned Optimum Path to a Faulted Channel
    - ▪ Using 3D Viz allows the planning of wells to intersect the appropriate target, and avoiding faults
  - o Planned Path to a 3D Salt Trap
- • In Summary: Safety, Efficiency, Accuracy and Precision can be gained by using 3D Viz modelling with all integrated data to optimize cost and improve recovery.

(Questions)

- • Robert Wylie – Uncertainty in Well path, what is the potential growth scale in the software? (as it pertains to the uncertainty)
  - o Answer – Attempts are being made at the uncertainty levels, overall estimates of geological uncertainty are much poor today
  - o Inversion cubes are primarily used in the modelling and to understand uncertainty (10') of facies boundaries with really good well control. Structural, rather, is 10's of feet in uncertainty
- • Marc Willerth – When discussing the reactive well planning slide, was this a reaction to drilling dysfunction or of the downhole data, how did you get off plan?

- We knew we were off the original plan, this was to describe to get back on plan taking a look at the most efficient path to the target using all of the data combined, including the equipment available.
- Jonathan Lightfoot – What is the vision with incorporating error models and separation rules being published by this group, can they be incorporated in the future into the software?
  - Yes, that is the plan moving forward.

Sub-Committee Activity Report: Collision Avoidance

(Steve Sawaryn)

- Nearing the end of about 10 years of work, the 2 SPE papers (184730-PA / 187073) have been published and are available on One-Petro for download
- The question is what do we work on next?
- In Dallas 5 main areas were decided on to be the next key focus for the group
  - Error Models / Collision Avoidance Relationship
    - Begin focus on sharing this knowledge with the Customer Base
  - Development of a Collision Avoidance Management Presentation Pack
    - 12 slides and a Video for Decision to Adopt
  - Development of a common Collision Avoidance report and Electronic Exchange
    - Group will break out in Calgary to work on the details of this
  - Adoption of the Global Error Model terms
  - Establish and document a revision control process and administration (including CA bibliography)
    - Revision control, very few big companies can change or take in new ideas continuously.
    - ISO Standard naming and methods should be investigated
    - Strategic Review of the document structure is needed

(Questions)

- Marc Willerth – Of the 2 papers in peer review, were there many changes after as opposed to how they were submitted before?
  - Answer – The changes were mostly just clarity and interpretation, one of the tables was reversed in the order of the entries, but the message remained the same overall
- Phil Harbidge – from the software providers, are there any updates on implementing the rules and process of the papers
  - Not a question that we asked, we are waiting now for the promotional material to come out, but we will ask it during the next meeting at the ATCE in Calgary

Sub-Committee Activity Report: Error Model Maintenance

(Andy McGregor)

- It has been 4 years since the last release of the error model
- Big thanks to Jerry Codling on updates to the XCL terms
- Jerry has produced a document, validation has been performed.

- o There are some details to double check over the next month so that we can move forward with the release
- Revision of the misalignment terms should be evidence based
  - o Jerry will present on this later today
  - o Pathcontrol has done work on this as well
    - ▪ We will review Pathcontrol's solution and Jerry's solution to roll up into the next revision
- Evaluating the ISCWSA Wells shows that as survey spacing is increased changes in the bottom hole positioning can be significant
- DECG can now be split into 6 new terms, implemented in one software
  - o Needs to be validated and final tested
- All of the work should wrap up by the end of Q2 (Target is to get it done before the next meeting)
- There are quite a few changes to how we document and release notes to the industry
  - o There is quite a bit of work that is required to roll out a new release
- WITSML 2.1, for error models is out for review (by September)
- BGS is now providing location-based uncertainty look up tables
  - o Software developers to look at the implications on how databasing of this information is exchanged
- Shell has standardized the ISCWSA error models that they use across their entire organization, this is something that we need to do as a community

(Questions)

- None at this time

Fundamentals of Magnetic Sensor Calibration with respect to MEMS-based and Traditional Fluxgate MWD Sensor Systems

(Chad Hanak)

- Physical Theory of Operation to be discussed
- MEMS – Lorentz Force example is shown as a type of the MEMS sensor that is used downhole
  - o Displacement is measured by either Relative Capacitance, LED, or Shift in Resonant Frequency
  - o Measuring relative capacitance, we can deduce the Magnetic Field Vector Component
- Fluxgate – In terms of the physics involved, this is actually a more complicated sensor than the MEMS example just given
  - o Saturation point is important, because we are trying to measure the net change in flux
  - o If an external magnetic field is introduced across the coil, the sense winding picks this up, see Faraday's Law
  - o One of the benefits of this sensor type is that it can be a dual axis sensor, whereas the MEMS is on one plane or axis (depending on how it is mounted to the chassis)
- Pre-Calibration Accuracy Expectations
  - o Bias – MEMS can be large, Fluxgate will be small (Manufacturing and DC Signaling)

- o MEMS may have more misalignment potential, mounting precision with smaller sensors create larger angular mounting misalignments
- Calibration Process Description
  - o Robert Estes has the patent on Total Field Calibration
- Sample Calibration Results
  - o MEMS from room temperature elevated by 100 deg C shows that bias in nT/deg C can be extremely large as opposed to Fluxgate
  - o Temperature Control when calibrating these tools is going to be the main concern here, large uncertainties can be included in the calibration if the control of the temperature sensitivity is poor.
- Where ISCWSA Can add value
  - o Operator Drives the MWD Company to Drive the Manufacturer, this all assumes that we are conforming to the OWSG Error Model Terms (In Spec)
  - o Sensor Misalignments, such as Twist, Bend, and Non-Orthogonality need to have specific terms for the models

(Questions)

- Angus Jamieson – Hysteresis, MEMS over time with pumps on and pumps off, do we have a potential heating up and cooling down effect problem
  - o Answer – There are MFG's in this room that might be able to answer, I could see that as an issue but unable to comment
- Andy McGregor – When the model was initially created, it was done so with the understanding that it (MWD Sensors) was all under one roof (essentially), The MWD company would build, test, calibrate, and run the tool
  - o We have values that we have to assume as 1-sigma values, both downhole and from surface roll tests
- Robert Wylie – Initial values back in the 90's were looked at over numbers of runs in a look back against the calibration. The reason that this (Committee) was started was the spec that was being quoted were questionable from the providers. The concern in the industry in the tool frame reference, twist and bend is subsequent to the calibration and could be external, such as the housing. Operationally, this can impact performance of the bounds of the tool from a opertions perspective. Bias, and Scale can also be driven largely by the electronics in the system itself (the drivers for fluxgate).
- Marc Willerth – One reason that Non-Orthogonality is not considered, for any Survey Station it can be decomposed into bias and scale and represents a bounded error. A more conservative estimate is as a bias for this
  - o For a single survey station, this may be true, but as it propagates along a well path the consideration of the error term should be made

Treasurer's Report

(Robert Wylie)

- Estimated Revenues for this meeting were around $9,400
- Registration, Catering and fees will come in around $8700 for a net income of $700

- Bank Balance as of the 31st of August 2018 2was $115,204, the 48th meeting generated a $260 net loss
- Bank Balance prior to the meeting this year sits around $114,915

(Upcoming Forecasted Expenses)

- Phil Harbidge – API RP78 is looking to spend about $10K for technical writing of the finalized documents
- Carol Mann – Education is looking to create videos and recordings of webinars and web content
- Jonathan Lightfoot – partnering with DSATS for sponsorships (Drillbotics)

(Questions)

- Pete Clark – Several expenses have been discussed, do we have a mechanism for determining how and where we spend
  - We have a purchasing policy in place to handle this, with checks and balances (such as a majority officer vote, and communication with the subcommittees)

Chairperson Quick Update – Drilling Advisory Board

(Jonathan Lightfoot)

- Voting on the Constitution will be postponed until the Calgary Meeting based on some recent feedback received by members of the body
- DUPTS, DSATS, and WPTS (ISCWSA) will begin to liaison together to prevent duplication of efforts in certain areas:
  - Anything that is borehole trajectory related, ISCWSA will have a chance to provide input

Combined Gyroscopic and Magnetic Surveys Provide Improved Magnetic Survey Data and Enhanced Survey Quality Control

(Adrian Ledroz)

- Solid State is now performing at a level consistent with the spinning mass gyros
- Description of new solid-state gyroscopic survey tools
  - Vibratory gyroscope operating in a high frequency, during a rotation the Coriolis effect imposes a change in the frequency
  - Examples are Wine Glass, Tuning Fork, Beam, or Hemispherical gyros
  - Solid State as opposed to Spinning Mass has many benefits, power, time and decreased complexity for example. This creates a lower position uncertainty in the tool (random noise is still present) by removing the systematic errors that are present in the spinning mass gyros
  - Significant reduction in the size of the tools as compared to before
- The combination of gyroscopic and magnetic survey data
  - In particular we are looking into the Declination Error, this is something that needs an independent measurement to verify.
  - MWD Accel and Mag Measurement to produce a Survey, A Gyro Survey, Take the Azimuth, the differences can be used to improve the understanding

- o   A Kalman Filter, or statistical estimation process is implemented in real time
- Case Studies
  - o   (1) Taking data from a Job in US Land where Gyro and MWD were both run to well TD in a Horizontal Well (South Facing)
  - o   (2) Pad Drilling Example
    - ▪ Declination Error was discovered to be around 0.5 degrees.
- Magnetic Models, there is no standard. Commercial incentives are present
- Downhole, statistical estimation of MWD and Gyro will be the only way to improve over some of the limitations from conventional methods
- Operating Practice considerations
  - o   Simplification of the BHA's will be possible (GWD)
  - o   MWD can then be used without the need for IFR
- Re-assessment of well placement methods
- Advanced error model QC with two independent measurements will identify declination error

(Questions)

- Chad Hanak – going back to case study 2 is something that we also see a lot of, if your declination is out, then BT and Dip is out as well (from AMI in MSA) especially going East West. This is problematic if there is no way to handle this in the solution (accuracy issue)
- Sareddy Escobar - Is this a GWD, and can it be used in Sub Sea Operation,
  - o   GWD is still in development for H2 this year
- Angus Jamieson – What we are really looking for is the final uncertainty in the final position, we want to be able to combine the MWD with the Gyro from the 2 independent surveys as oppose to one winning over the other
  - o   The Gyro and MWD with all the corrections will be close to each other, overall creates a 20-30% reduction, we are working on a simplified output and a paper as well (May presentation)
- Robert Wylie – Are you developing a new error model, and how will you verify that?
  - o   We have been working on this for many years and considering what Chad has mentioned, we are looking at the uncertainty in the two tools and the differences between them. You need to know for the next well that you are meeting the QC and the uncertainty you are claiming
- Andy McGregor – Are we at a level where they can be run inertially on the way out of the hole?
  - o   Our plan is to run this in continuous mode
- Marc Willerth – you have a couple of case studies against MSA and IFR, have you compared them to other high-end Gyros?
  - o   Yes, spinning mass and earth rate, and we are matching at or better with those also.

Webmaster's Report

(Phil Harbidge)

- We have 2 websites, there is a project to upgrade our website, extensive rebuild and optimization. Pricing has come through this morning

- Looking to revamp the whole site and include new pages for the SC's, with searchable content, and dynamic content
- Secure (HTTPS) is something we need to add to the Scope as opposed to unsecure (HTTP), some employers and universities don't allow unsecure connections
- The SPE website, will hopefully be updated as well as we mirror our ISCWSA site onto this one.
- We are trying to get the official emails to go through the SPE for email communication
    - We have to go through the SPE Informz for large (over 100) email blasts
- We have updated the links to the eBooks that were mislabeled on the sites
- Membership on the ISCWSA website about 5K clicks on the year
- We are growing steadily year on year, we need to bring in some of the younger registered members to participate in the working sub committees and general meetings
- We are looking to spend some money on the processing of and publishing content from the sub committees. We need templates standardized about content for publishing
- Either we need volunteers and or the SC Chairs will have to do this

(Questions)

- Carol Mann – can the SC be on email? Can we update the LinkedIn from the SC's
    - Answer – yes, just no large blast
- Darren Aklestad – do we have a requirements document that we can review for the website updates
    - Yes we do, but please follow up promptly so we don't delay the process any longer than needed (3 years in the works) and we only have a couple of weeks before the decision needs to be made

Eliminating Rig Time from MWD Surveying

(Ross Lowdon)

- The Surveying Conundrum
    - With the increased complexity of drilling wells today, we have to survey the wells (properly)
    - The surveys are there for the lifetime of that well, the reality is that we don't know where half of the wells in the world are when they are due to be plugged and abandoned (soon)
    - This is a time-consuming process, surveying, planning, pump cycling
    - Additional pump cycling Surveys can create Directional Drilling issues with Borehole stability
- MWD Current and Future
    - Taking surveys when you are stationary is a big time penalty
    - Continuous 6-axis is now available in real time, these are not definitive surveys
    - Improved directional control
- Drilling Mode Surveys
    - Three main problems: Phase compensation, Shock and Vibration, Eddy Currents
    - Eddy currents are related to the thickness of the color and the rotation speed and conductivity of the collar of the MWD tool. No one measures this

- o Small changes in the ID and OD create large changes in the eddy currents and losses
- Design
    - o Hardware
        - ▪ Magnetometers are somewhat limited in their response, you can overclock them, but you have to compensate for this
- Field Test Results
    - o The Azimuth plotted drove us to fix the algorithmic issues
    - o Improvements in the algorithm resulted in dramatic improvements in the field trial results for Dynamic Measured Surveys (DMS)
- Testing the theory
    - o Could we get to the point of delivering a consistent azimuth? The inclination was not really ever an issue.
- Error Modeling
    - o Because you are continually rotating, the cross axis combined errors are somewhat unique compared to static surveys
    - o The modification where a combination of the cross axes, and a creation of new terms
        - ▪ Phase Shift Difference
        - ▪ Attenuation
        - ▪ Acceleration Noise
        - ▪ Eddy Currents
        - ▪ Centripetal Acceleration
        - ▪ Depth Shift Compensation
    - o The goal of the error model was to start with the same size EOU as the existing static survey models that we use today (hopefully improve from there)
- Further work and conclusion
    - o Zero MWD Rig Time is the big prize, DMS Surveys look really promising
    - o Thank you to Chad Hanak and the other co-authors for their work on this topic

(Questions)

- Stefaun Maus – can you say more about the attenuation errors? Is it because of the averaging?
    - o Answer – yes, due to the low pass filter response
- Adrian Ledroz – back to slide to 7 the last column was the total field, why is this growing with the speed?
    - o Due to the bandwidth on the magnetometers, we will need to move to higher bandwidth in order to improve this
- Angus Jamieson – combining the cross axes, are you smoothing this effect with respect to the azimuth?
- Andy McGregor – is this now something that the error model SC can help take on to the existing framework
    - o This is something that we would like to do, testing and validation are still needed
- Gary Skinner – what are you doing in regards to QC to the DMS data?
    - o We are building a dynamic FAC because of the combined XY terms (effectively becomes a 4 axis survey since the cross axes are now combined)

From an art to science: Factory Drilling Plug and Abandonment Wells at Twice the Speed and for Half the Cost

(Clinton Moss)

- Review of Ranging Techniques
    - PMR – monitored through continuous BT
    - AMR – Patent 9938773
    - Wireline Active
- Project Details
    - US Case Study, regulatory prefers that the wells are milled and re-entered
- Technical Challenges
    - Casing Damage creates a problem for AMR, since current is collected and flows on the casing, if the target well is broken current doesn't collect well for signal
    - Plurality of wells creates a plurality of signals, this creates complications
    - Verticality of a target is a tremendous challenge
    - Shallow intercept depths with a high precision for re-entry are required
- The Engineered Approach – Methodology
    - ISCWSA is the focus for starting the operations groups involved in solving these challenges for P&A

(AnaS Sikal)

- P&A Well Phases
    - Systematic interception of the target is the desired outcome, partnering companies with technology
    - The right tools also require the right team, the quality of people/specialists need to be adequate
    - Remote Support Center for liaison with the Operators ensure consistent communication and data transfer
    - Process needs to be established and followed, the trip times are extremely quick and can post challenges for the operations.
    - For an existing older well where there are poor or no surveys, additional steps may be needed to develop the optimal plan and ranging strategy
- Ranging Process Flow
    - Wireline tools collect the data for performing ranging and analysis
    - A method needs to be created to write the decision for moving forward, being too close to the target (premature) or too far (missing target) are crucial

(Clinton Moss)

- Combination of Techniques
    - Casing breaks with gaps create issues for active, but open possibilities for passive
    - Ranging Tools with Gyroscopes can mathematically relate an azimuth to target
- Challenges of Referencing the Target in Vertical Hole
    - Parasite wells, or adjacent wells that give off additional signal from the ranging process can be modelled for approach

- - - Spacing the electrode can lessen the signal impact from the parasite
    - Attack the target at the TVD of a parasite well where a break in the casing is evident
- Ranging Tool Response
- A selection of Ranging Data
- Milling and Re-entry
- Results
    - In 50 wells drilled in that area, a 12-day program for each on average came down to 6 days (Well Intercept Book is the founding document)

(Questions)

- Harry Wilson – what was the average well distance in the congested areas?
    - Answer – 100 to 120 feet
- Benny Poedjono – who provided the milling equipment?
    - Weatherford – Concave mills (they tend to center up), also on this project we did not set a kill string
- Pete Clark – Was this run on a bent motor, and any problems running through the well head?
    - Yes, when we went through open hole it was a 2.38 as opposed to a 1.5 fixed with a kill string, and no issues running in

Sub-Committee Activity Report: Survey QA/QC

(Phil Harbidge)

- Recently formed this committee in Dallas (last meeting)
- Updated the mission statement
- Will deliver 3 documents reduced in size for the API RP78, an eBook will come from this
- 22 people in the first meeting in Dallas, smaller size this meeting and we were able to finish one of the documents (reduced draft)
- Will have 2 online calls before the Calgary Meetings
- Chad Hanak and Ryan Kirby leading for the MWD QA/QC document
- Mahmoud El Gizawy is leading the Depth QC document
- Documents were reformatted as prescriptive, instructional documents, we will have this over to the API for Technical formatting
- The rest of the data will form an ISCWSA eBook from the trimming of these documents to provide as a reference and background information for the standards that come from this
- There is some overlap with other technical sections, and communication between them will be needed.

(Questions)

- None at this time

Estimating Errors for High Definition geomagnetic models

(Ciaran Beggan)

- Over 10 years in Geomagnetism

- Holds a PhD from the University of Edinburgh
- Specializes in Main Field Modelling, Forecasting, Crustal Field
- World Magnetic Model was updated recently (about halfway through the expected time frame of the model)
- Industry request to capture more of the crustal anomalies and higher resolution data as it pertains to the magnetic field
- The goal is to reduce the uncertainty, but how do you quantify this as you add more sources?
- 133-degree models 300km wavelength (satellite data)
    - Adding in marine and aeromagnetic improves to theoretically 7200 or about ~4km' wavelengths
    - 28-50km wavelengths, or 800-1440 degrees is realistic
- Magnetic Fields (X,Y,Z) are linear, errors and difference from Dip, Inclination, Field (DIF) are non-linear
    - Errors are not Gaussian
    - They are typically represented better by the Laplacian distribution
- There are over 85,000 ground vector shots over the last ~120 years
    - Global averages X, Y, Z, are 90, 91, 185 (1440 deg), but this includes Volcanos and poorer surveyed areas
    - Compared IFR data with ground shots from the satellite era, with this a derived reduction scale factor can be made for the hydrocarbon bearing areas
        - X, Y, Z, are 0.66, 0.75, 0.85 respectively
- World Digital Magnetic Anomaly Map version 2 (WDMAM2)
    - Based on Airborne and Marine surveys, this was used as a platform for introducing the reducing scale factors
- External Field, auroral electrojets, equatorial electrojet and geomagnetic storms
    - Quasi-Dipole coordinate system
- Comparing the model and prediction year over year (confined to the satellite era) the change in scale in uncertainty is quite small
- Combining uncertainty
    - Provide a useful scalable 1 sigma uncertainty for latitude and longitude grid coordinate systems
- Converting to DIF
- Global Declination from ISCWSA Error Model DECG, best fit (0.07 deg)
- Be aware that some areas do have much larger uncertainties

(Questions)

- Adrian Ledroz – back to slide 3 or 4 the uncertainties between observatories, how are these numbers derived?
    - Answer – ground shots but does include observatories. This is the comparison between the models in DIF, these have the main field removed and diurnally corrected. The short-wave length in the crust would be missing here.
- (Unable to hear name) – Elaborate a little bit on the moving of the north pole WMM issue

- o WMM is issued every 5 years, made a prediction about the rate of change. On very high latitudes above 55 deg North, the error exceeded the limitation of the spec for application (military), South of the 55 deg mark, the change was insignificant
- Pete Clark – some of the countries appeared to be excluded, does this have an impact or a negligible effect?
    - o Public Data is donated by volunteer organizations in this study as well, some countries said yes and some said no (could be geo-political reasons)
- Manoj Nair – you selected a few regions for determining the crustal error, are you planning to release what locations you used to determine the error?
    - o Yes
- Manoj Nair – for the disturbance field, do you also use the same methodology?
    - o Yes
- Stefaun Maus – if you look at the degree of the model 800 to 1600, coefficients go in a square, this creates more information in the model but at the same time you do not see a significant reduction in the error
    - o We suspect that data from pre-1980 or where we don't have a homogenous data set around the world, we have focused areas (clustered areas) we don't get a nice spread that would show a nicer reduction

Sub-Committee Activity Report: Operator Wellbore Survey Group (OWSG) & Update on API RP78

(Pete Clark)

- it became apparent that we need to reinvigorate the use of the OWSG models
- Last meeting in Dallas, minutes have not been distributed yet but will.
- Boundary lines between common vendors and use (such as No-Go Lines) still need work
- Since the RP78 became an initiative, we have been making progress we have a unified document and filled in some gaps. Operations section and hand off of operations cycle have been largely completed. Current document is over 200 pages.
- Approximately 1 man month of work ahead of us
    - o We need to take the document as it stands and convert this to a technical document so that it can be passed onto a technical writer for finalization.
    - o Thanks to ISCWSA for providing the material for this document, to get to a recommend practice
    - o Thanks to the QA/QC Sub Committee on delivering the first Gyro QC document

(Questions)

- Harald Bolt – to what extent and what we have finished with RP78, are we doing double the work?
    - o Answer – we have largely taken what has already been written and trimming it down to something appropriate for a standard, a wide readership for, we are in the early technical stages
- Phil Harbidge – the remaining content will be formed into an eBook for QA/QC, so this learning is not lost

- Harry Wilson – The error models, (OWSG) is struggling to maintain them, should the error model committee take them under the Technical Section in order to maintain them, if you release an error model without the associated QA/QC is it complete? The method to QC different kinds of surveys, the users probably don't know how to use them.
  - We need to make them available and public, we know that QA/QC is needed. What we don't want to lose sight of is that the OWSG set of models have provided some standardization.
- Robert Wylie – perhaps this is something the committees could take on together

Uncertainty in Depth: Reduced

(Harald Bolt)

- We never have a depth problem until the problem occurs
  - This results in financial loss and ultimate recovery
- If you look at a geological event, or seismic measurement
- Measurement accuracy components
  - Without requirements you can't have accuracy
  - Methodology (Drill Pipe, Wireline)
  - Calibration system used is quite important
  - Correction model and calculation, what is the model and application?
  - Uncertainty model and calculation will also have an effect
- True Along Hole Depth is the desired outcome
- Uncertainty relationship consists of calibration, correction, and model terms
- Calibration Accuracy
  - Shelf life, when did the calibration occur and when does it become invalid?
- Calibration Parameter
  - Two main components of correction, thermal expansion and elastic stretch contribute the most.
- Correction Model
  - Single Point, Straight Line, Way-Point
  - The bit doesn't move when the well is TD, the only thing that moves is the perception of where the well is.
  - With the Way-Point model we split the well up into section to get unique corrections and uncertainty
- Example given in North Sea
  - Temperature and Tension curves plotted against Bit Position
  - Differences in comparing the correction size in models shows to be impactful as the hole depth increases after deviation in the wellbore from vertical.
  - Uncertainty in the different models shows significant differences
- The decisions we make affect the results, manage the expectation

(Questions)

- Sareddy Escobar – If these are applied in real time, how does this affect geo-steering,

- o Answer – what are the requirements that you have for the accuracy for what you are trying to get? How accurate do you want it to be, based on that you decide on which technique or methodology that you need to use and implement. It takes investment, but it can be done.
- Harry Wilson – Does it affect geo-steering? Yes, it would improve or enhance the depth for the interpolation
- Kirtland McKenna – correcting ROP measurements in real time, from this aspect how do you correct for drag in the well and things like pipe stretch
  - o The correction comes from POOH with a simple sliding motion. The correction parameters required while drilling down are extremely complex. Drilling is dynamic and modelling this is difficult, the depth correlation moment is when coming out of the hole.
- Angus Jamieson – a lot of people look at the T&D model and say we know the Friction Factors, most of the Geologists are looking for accuracy on TVD, in the Top Hole low Inclination, if the FF's are wrong the Drag and Stretch is also wrong, so Friction doesn't have a big effect. In the Horizontal the Friction is great, but the impact on TVD is small.
- Benny Poedjono – What do you want for accuracy, that is the question. Define the need (Operators). If you land too high or too low, you lose the pay zone. Don't miss it if you have a better chance to hit the target. The question is how much are you willing to spend?
- Jonathan Lightfoot – we have a depth term in the models that we use, in order to drive value what improvement in the error model maintenance groups can we do
  - o Harry – we wrote a paper on this, Temperature and Tension effect in a broad global sense, if you assume a mean of 0. The bit is deeper, so this should be a biased term, but the word bias was misleading. Stretch is a scale factor, it is linear with depth.

Well Intercept Sub Committee Update

(Benny Poedjono)

- Update on the eBook, the latest release was published yesterday and is available on the website
- Milestones Reached
  - o 43rd started the eBook, by the 47th it was finished, 49th revisions made.
  - o Added Resistivity Ranging Techniques
  - o New Section of Magnetized Casing
  - o New Section of Energized Wire system
  - o New Section of Surface Access System
  - o Content added in several other sections
- Next steps are to pass onto education for distribution and sharing
- Dissolved SC for now
- Maintenance Team remains intact
  - o Benny Poedjono
  - o Pete Schiermeier
  - o Chad Hanak
  - o Roger Goobie

Low Angle Survey Errors

(Jerry Codling)

- Revision 4 of the ISCWSA error models resulted in some cases of extremely large EOU's
- Land Drilling has low angle well crossing potentials where this is concerning, this forces well separations that are unreasonable
- Proposed revisions of the error model (Rev 5)
    - Increased Random Error values on XYM3 and 4
    - There will be a course length dependent set of terms
- Within a month (and with some work) we are optimistic to release the next revision
- What happens between two survey stations is not well represented by the Minimum Curvature Method (MCM)
- Formulation on tortuosity in a "straight" section of the wellbore
- SPE-187073 as a reference
    - XCL and Random errors
    - Misalignment error, and deflection
- Low angle drift is something that may not be properly accounted for in the Error Model
- In recent studies there were 75% of surveys in top-hole sections of inclination from MWD reading larger angle than that of Gyros
    - Why is this? Typical "Conventional" US Land BHA's run as slick as possible for optimal sliding performance
    - Proposed change is to look at the Deflection formula again
- With the release of the new error model, in areas where top hole section required more space before for Separation Factor, you may actually have more space now (if you look at them from the planning perspective)

(Questions)

- Stefaun Maus – if you have a small error by the sample of the magnetometers you can have large azimuth changes
    - You can have gross errors, but you all are the experts on magnetometers
- Angus Jamieson – thank you for the work that goes into this presentation, previously in the original Error Model with SAG, are there any changes to the SAG correction on the coefficient in the new model?
    - The bending above the last stabilizer is the key, vendors are using specific models as needed right now
- Marc Willerth – as a function of course length the crossover instead of being 1200' is more like 12 course lengths if something like DMS Surveys are in use (Basically the 12th survey)
    - This should justify that shorter survey course lengths could come about to reduce error in the random values, but yes the image was depicting 100' course lengths

Sub-committee Activity Report: Education

(Carol Mann)

- Started in Geology, then moved to Geophysics, passionate about raising awareness about our Committee
- Worked on the Mission Statement for the Constitution and the Website
- We are an advisory and awareness committee
- Steve Sawaryn has been our distinguished lecturer and completed his tour
- Harald Bolt and Ross Lowdon have been nominated for the next round
- Webinar Potential Candidates
    - Marc Willerth and Lisa Grant
    - Steve Sawaryn's DL Talk with the release of the recording (under peer review)
    - Steve Grindrod
- Student Outreach is a primary focus
    - Student Chapter and Organization Projects to coordinate attendance
- We want to Educate the Educators
- Drillbotics Competition is looking to broaden to a wider SPE event
    - They want to add in the Directional Drilling aspect of a Drilling a Directional Well
    - We will follow up with suggestions to their panel, but we want to participate with sponsorship and judging in both the EU and US.
- ½ Day Special Sessions, 2018 Automation of Well Placement which had great turn out (Standing room only)
    - 2019 Automation of Well Construction Process, Operators, Vendors, Service Companies and Drilling Contractors
- The Intro to Wellbore Positioning is being translated into Spanish
- Test Site at Loch Ness is now in place with 2 Well Bores active and available for testing

(Questions)

- None at this time

Distinguished Membership Award

(Matthew Rhodes to Introduce)

- Hugh Williamson announced as this year's recipient
- Congratulations to Hugh and his tremendous achievement (and retirement)

Secretary's Report

(Ryan Kirby)

- Again, the email distribution has changed per SPE's request. Please be responsive if you get correspondence requesting approval to receive emails from the ISCWSA. And sign up again if you have not, you will have to opt-in for email correspondence on the SPE Website
- Thank you again to the Sponsors MagVAR, and Gyrodata
- Reminder that there will be 4 positions open for nomination in Calgary

    o Program Chair, Membership Chair and two Directors at Large

Closing Statement

 (Jonathan Lightfoot)

- The 50th meeting will be in Calgary, Alberta, Canada in October (2nd and 3rd)
- The Constitution will be voted in during the next meeting
  - o Feedback from the group is appreciated and needed before that time

Attendee List:

Gary Skinner - Baker Hughes

Gunnar Tackmann - Baker Hughes

Henry Wilson - Baker Hughes

Michael Long - Baker Hughes

James Ang - Bench Tree

Matthew Rhodes - BP

Ciaran Beggan - British Geological Survey

Ellen Clarke - British Geological Survey

Susan Macmillan - British Geological Survey

Geoffrey Dorn - CGG GeoSoftware

Joseph Dominguez - CGG GeoSoftware

Pete Clark - Chevron ETC

Kirtland McKenna - Colorado School of Mines

Steven Sawaryn - Consultant

Steve Grindrod - Copsegrove Developments Ltd

Harald Bolt - Depth Solutions

Loïc Brillaud - DrillScan Europe

Stephane Menand - DrillScan US, Inc.

Andy Sentance - Dynamic Graphics, Inc.

Carol Mann - Dynamic Graphics, Inc.

Philip Scott - Dynamic Graphics, Inc.

Heather Vannoy - EOG Resources

Erik Nyrnes - Equinor ASA

David Erdos - Erdos Miller

Adrian Ledroz - Gyrodata

Alan Bernard - Gyrodata

Alan Emerson - Gyrodata

Albert Lindie - Gyrodata

Barry Smart - Gyrodata

Fraser Cowie - Gyrodata

John Weston - Gyrodata

Jon Bang - Gyrodata

Lee Morrison - Gyrodata

Andy McGregor - H&P Technologies

Angus Jamieson - H&P Technologies

Marc Willerth - H&P Technologies

Stefan Maus - H&P Technologies

Jerry Codling - Halliburton

Sareddy Escobar - Husky Energy

Shaun St Louis - IPM

Matthew Hilgenfeld - Native Navigation

Manoj Nair - NOAA/CIRES

Jonathan Lightfoot - Occidental Oil & Gas Corp.

Andreas Strømhaug - Oliasoft

Tore Halvorsen - Oliasoft

Anas Sikal - PathControl

Denis Reynaud - PathControl

Philip Harbidge - PathControl

Benny Poedjono - Schlumberger

Darren Aklestad - Schlumberger

Lu Jiang - Schlumberger

Mahmoud El Gizawy - Schlumberger

Ross Lowdon - Schlumberger

Sjoerd Brands - Schlumberger

Ben Hawkinson - Scientific Drilling

Mark Fraser - Scientific Drilling

Frank Satijn - Shell

Koen Noy - Shell

Marc Crombaghs - Shell

Sofoklis Melissovas - Shell

David Cramer - Sparrow Technology Inc.

Anne Holmes - Sperry Drilling

Pete Schiermeier - Sperry Drilling

Chad Hanak - Superior QC

Mark Thomas - Superior QC

Robert Dufield - Superior QC

Ryan Kirby - Superior QC

Scott Farmer - Total

Mathias Mitschanek - XLO

Robert Wylie - xnDrilling, Inc.