Presentation #1: Combined use of MWD and gyro surveying to reduce wellbore position uncertainties
(Simon McCulloch)

- Location of subject matter is in Persian Gulf off Qatar. Most wells have 25,000 ft horizontals. Desire was to improve accuracy of BGGM by aeromagnetic anomaly survey. Unable to do so due to proximity with Iran. Instead performed marine magnetic vector survey. Compared this data to wellbore survey data, which showed good agreement. Comparison to historic surveys led to doubt in the accuracy of the declination correction; reverted to BGGM.
- Compared 1000 ft of magnetic MWD survey to gyro wireline survey. Did this for many wells to try to assess the declination value. Showed good agreement with BGGM.

(Stefan Maus)

- Inferred declination from well sections where magnetic MWD and gyro surveys overlapped.
- Total field and dip angle anomalies analyzed from magnetic MWD survey-rich sections of wells.
- CHAMP satellite predicted no large scale anomalies. Same result expected due to thick non-mag. sediment layer.
- No indication of a declination anomaly from MWD survey analysis. Same conclusion for total magnetic field and dip angle anomalies.
- The analysis led to a significant tightening of the reference field uncertainty values.

Questions:

- Bill Allen: What do you call your tighter error model and how do you handle assigning it? Simon: MWD model applied as drilled, SAG applied after verification. Enhanced MWD (IFR+SAG+MSA) applied in smaller hole size. Bill Allen: Do you give yourself credit for the magnetic enhancements? Simon: We did modify the model by going halfway.
- Question: Aeromagnetic data and Marine data accuracy seem to be significantly inconsistent. Stefan: There was a misunderstanding. No aeromagnetic survey took place due to necessity of 40 km radius for transformation.
- Angus Jamieson: We did the survey. No magnetically clean survey vessel available in Qatar, but now we use a clean specialized towing vessel. On this particular job you could see an influence from the vessel used.

Presentation #2: Statistical Methods for Calculating the Risk of Collision between Petroleum Wells

(Bjorn Erik Loeng)

- Examine the assumptions of normal distribution for shortest distance between two wells. This distribution is defined for negative distance values, which is not mathematically possible. Should use a modified chi-squared distribution instead. Results in much larger p-values. The

original separation factor underestimates the collision risk because it is based on the normal distribution that allows negative values.

- Can also consider probability of collision instead of the hypothesis test represented by factor of separation. Collision probability appears to be the least conservative approach.
- Considering only the two closest points is an approximation. Can examine the accuracy of the approximation by examining sections of wells via monte carlo simulation. Taking into account several points increases the calculated probability of collision.

Questions:

- Harry Wilson: What is your recommended method based on these results? Bjorn: Using the new distribution will change the results. I'd use one of the results marked in green on the presentation. Harry: What do you recommend Statoil move to? Bjorn: Probably the monte carlo-based solution. Harry: How much more conservative is this solution: Erik Nyrnes: It depends on well geometry. Harry: Does this modeling fit what you've seen in the field? Erik Nyrnes: It depends on what we choose as the significance level of the test. Harry: So you don't see a contradiction of these results in your experience? That they are too conservative? Erik Nyrnes: We'd need to look at it more.
- Ross Lowdon: There's a very insignificant probability of collision even with a separation factor of 1.
- Steve Sawaryn: Did you look at different types of wellbore trajectories for the monte carlo analysis? Bjorn: We used the joint probability distribution for points along the wellpath. Steve: Is your thesis publically available? Bjorn: Yes, it's available through my university.
- Benny Poedjono: What is acceptable risk/probability for Statoil? Erik: About 1 in 10,000, depending on the situation. Can be 1 in 1,000 or 1 in 3,000 as well. Benny: How do you get the shortest point? Bjorn: I put an algorithm together to calculate it.
- Question: Your observation about the modified chi-squared distribution matches my experience and previous analyses well. I also think the monte carlo approach may be on the right track. In support of the chi-distribution, think about throwing darts at a dart board and plotting the distribution of the distance. The distribution will look similar.

Sub-committee update #1: Report on Error Model Sub-committee activity

(Steve Grindrod)

- Minutes will be posted on website.
- Joint meeting with anti-collision group to discuss how to handle inclination-only surveys.

Questions:

- Question: Are you considering the effect of different drill pipe lengths? Steve: For frequent surveys the effects should be negligible.
- Robert Wylie: Can you talk anymore about suggestion for inclination-only surveys? Harry: I'll tell you at the coffee break.

- Bill Allen: Is there any interest in documenting how a survey supplier would justify an error model they're using. Steve: The standard sensor values are common to most systems, but the environment terms vary more due to implementation. We don't have anything documented, especially for field implementation, but it should be done.

Presentation #3: When is it valid to assign a tighter error model to MSA processed data?

- Notes not taken here because the note-taker was presenting.

Sub-committee update #2: Report of Collision Avoidance Sub-committee activity

(Harry Wilson)

- Very committed to creating documents as a working group. They are on the website. Also there are some publications pending, including recommendations for validating inclination-only surveys.
- Recommend that inclination-only surveys be plotted as perfectly vertical, with the inclinations used for error propagation. An error model using ISCWSA terms is being worked.
- Harry is resigning as committee chairman. To be replaced by Steve Sawaryn.

Presentation #4: Application of continuous multi-axes sensor data for navigation

(Ross Lowdon)

- Continuous single axis inclination measurement problematic at low inclinations. Same problem for continuous single-axis azimuth measurements going North-South. Requires stopping to take more static surveys.
- Continuous 6-axis measurements from roll-stabilized sub in a rotary-steerable tool can mitigate this issue. However, there's an error due to power setting of the tool that still has to be investigated. There is good matching between the continuous 6-axis surveys and the static surveys for raw data.

Questions:

- Hans-Hendrik Ronneau: Could you give stations every 30 ft or so to make the interpolation look smoother? Ross: Yes. However, this was developed primarily to solve the low inclination problem.
- Pete Clark: What is being sent uphole? Ross: Right now things are being calculated downhole, but soon sample data will be sent up.
- Steve Sawaryn: Will this be connected to wired pipe to get all the data up? Ross: Yes we'd like to do that, but haven't yet.
- Bill Powers: Have you tried to combine azimuth surveys with regular MWD data for combined surveys? Ross: Not yet, but it's contemplated.

Sub-committee update #3: Report on Well Intercept Sub-committee activity

(Ross Lowdon)

- Bibliography is in development. It will be published as is and added to.
- Document developed to detail well intercept technologies (to be put on website next month).

Questions:

- Hans-Hendrik Ronneau: How much will you be working with anti-collision? Ross: We do talk frequently.

Presentation #5: The need to use ranging for collision avoidance in a relief well

(Anas Sikal)

- We want to intersect the target well at a specific position. Ranging is used to shift the surface location of the target well to make it consistent with the ranging measurement.
- First challenge is that, after each ranging run a new plan is needed for interception. This re-planning will be required frequently.
- Second challenge is that ranging uncertainty window is not jointly normal.
- Also want to know how to propagate error models for relative positioning.
- Following the plan is also a challenge (directional control).
- After a ranging shot, the relief well uncertainty at that point is zeroed (propagated forward with ISCWSA error model); target well uncertainty is initialized at that depth as a sphere surrounding the ranging uncertainty window. This initializes error propagation that can be used to determine how far we can drill before we need another ranging shot.

Questions:

- Someone from Sperry Sun: What model do you apply to the target well when you don't know what its trajectory is going forward? Anas: It depends on the data we have on the target well (gyro, MWD, etc…). Based on all of this we'll determine the most accurate model to apply. Ludovic Macresy: We can also make an estimate of error propagation based on maximum dog leg severity that the BHA of the target well was capable of producing. Addendum by Ludovic: The customer may have to adapt their software to adapt to the error model. This was reiterated by Pete Clark.

Presentation #6: Making the most of directional surveys

(Angus Jamieson)

- This is intended as a presentation that can be downloaded and used to educate the general public about surveying. Want to emphasize that poor surveying costs production.
- Can download and present ourselves, or can download a video of Angus giving the presentation on the University website.

Presentation #7: Accurate determination of the crustal magnetic field for drilling all wells within an oil/gas field

(Xiong Le)

- This presentation revisits a presentation made in Fall of 2012 in San Antonio.
- Presented conditions to accurately calculate the crustal field model for any well in a given volume at some future date, even if the reference model to be used is different from that upon which the original crustal model was built. Different reference fields are tied together by their baseline values at a given specified time. Then the assumption is made that the crustal field doesn't change significantly over time (at least 10 years).

Questions:

- Benny: We developed this to allow us to easily handle calculations with different error models.
- Patrick from Sperry: Why can't you just compare DIF? Why do you have to convert to XYZ coords? Xiong: Crustal XYZ and Reference XYZ is a linear relationship. DIF is not a linear relationship. Benny seconded this explanation.

Sub-committee Update #4: Report on Operator Wellbore Survey Group (OWSG) activity

(Son Pham)

- Mission: To promote practices that provide confidence that reported wellbore positions are within their stated uncertainty.
- Always start with reading of an anti-trust statement.
- Meets roughly every 2 months (5 meetings held to date). Meetings and materials to be put on the ISCWSA website going forward.
- Highest priority is standardization of reporting and data transfer formats (raw sensor data transfer format and revised P7 format).

Questions

- Kevin McCaird: Are you looking at WITSML or P7 format only? Answer: P7 will be a data exchange format that will dovetail with WITSML.
- Steve S.: Are you using the wording "good practices" or "best practices?" I think "good" is the word to use. Bill Allen: That was written by a legal team, but "good" is probably the word to use.
- Ross Lowdon: Do you have a timeline for deliverables? And will you mandate data be delivered in this format? Pete Clark: We're not going to mandate it.

Administration: Treasurer's report

(Robert Wylie)

- (see report)

Presentation #8: Field experience with a North Seeking Gyro system while drilling horizontal wells

(Steve Mullen)

- GWD 40 degrees was enabled by a more sophisticated downhole processing technique (somewhat akin to Kalman filtering downhole).
- Looked at sensors in the Aerospace industry to go past 40 degrees, but did not see a sufficient solution in terms of accuracy, shock, and temperature. Still wanted spinning mass gyro for accuracy, but had to be built in-house. This led to MXY Gyro, which allowed operation up to 70 degrees.
- Now that capability has been expanded to 90 degree inclination.
- Large errors come from gravity dependency and from signal attenuation as the sensitive axis of the gyro moves away from vertical.
- MXY Gyro has a larger mass and higher spinning speed to increase accuracy. Also has improved SNR and better bias stability.
- Can be used for real-time gross error detection from another survey, high-inclination close approach drilling, and for decreased positional uncertainty.
- To go beyond 70 degrees, had to use 2 MXY gyros to get 3 orthogonal axes. There's a new mechanization for those 3 gyros to control bias in all 3 axes. Also the CAP system corrects for g-sensitive error in all 3 axes. Uses total Earth rate as a robust quality control.
- Random noise error results in increased azimuth uncertainty at high inclinations for the 2 axis system. But the new 3-axis system has essentially eliminated this problem.
- Mass unbalance error now peaks at 45 degrees with the 3-axis system.

Questions:

- Steve S.: The error equations imply the errors at 90 degrees are similar to those at 0 degrees. Is that borne out by reality? Steve M.: Yes because of the design of the system.
- Hans-Hendrik Ronneau: Do you use the magnetics as QC for the gyros? Steve M.: Yes to check for gross errors and to verify it meets the error model. Hans: What is the effect of being in a crowded field? Steve M.: You would be in the position of having to rely completely on the gyro at that point. There is also internal QC that is independent of the magnetic data.
- Bill Allen: I like the idea of combining the two data sets (magnetic and gyro).
- Angus Jamieson: How close can this go to the bit and how expensive is it? Steve M.: Right on top of the motor; typically the closest sensor to the bit (40 ft). We want high utilization to drive day rate down.
- Question: Is the second gyro spin axis in the vertical plane when you go up in inclination. Steve M.: Yes.
- Erik Nyrnes: Can the accuracy match magnetic accuracy? Steve M.: Yes, we think it can be better.

Sub-committee Update #5: Report on Education Sub-committee activity

(Steve Mullen)

- (see report)

Update from the Webmaster

(Phil Harbidge)

- (see report)