

Cake & Discuss

The Uncertainty Study

Organization Committee

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HSE & Other Practicalities



Welcome to “Cake & Discuss”

TODAY:

27 August 24

The Uncertainty Study

Past sessions:

13 April 23

The Structural Framework

22 August 23

The Grid

7 November 23

The Property Model – Part1

23 April 24

The Property Model – Part2

<https://www.sodir.no/en/force/archive/>

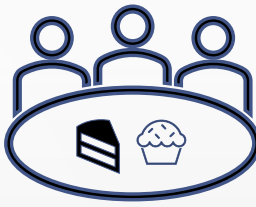
Future sessions:

XXX

Data Sharing: Input and Output
From static to dynamics. History matching iterations

Well planning

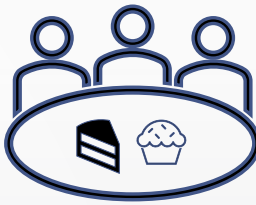
Operational knowledge sharing.



Welcome to “Cake & Discuss”

- Fundamental spirit of FORCE
 - Cooperative forum
 - Facilitate cooperation within the industry
- Group discussions
 - Discussion based on impulse talk
 - Small group: Mix of experience and expertise
 - Summary session
- This is not a place where we can solve all the issues but discuss and share experiences
 - If you want to bring up a topic: suggest an impulse talk





How this works

- Welcome and introduction
- Divide audience into groups
- Each group chooses a discussion keeper
- “Impulse” talks round today's topic
- Discussion time after talk
 - Have you seen this?/What's your best practice?
- Round the room: each group present findings
- In total 3 impulse talks and follow-up discussion in groups and presentation to other groups
- Closeout and feedback
- Mingle, talk & enjoy food and drinks throughout the afternoon

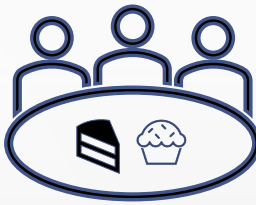


Time	Duration	Activity
12:30-12:50	20 min	Intro to concept Presentations "who is here today" Sort groups
12:50-13:00	10 min	1. "Impulse" talk
13:00-13:20	20 min	Group discussion
13:20-13:25	5 min	Break (deliver talking points)
13:25-13:45	20 min	Presentations and overall discussion
13:45-14:00	15 min	2. "Impulse" talk
14:00-14:45	45 min (20+5+20)	Group discussion Break (deliver talking points) Presentations and overall discussion
14:45-15:00	15 min	3. "Impulse" talk
15:00-15:45	45 min (20+5+20)	Group discussion Break (deliver talking points) Presentations and overall discussion
15:45-15:55	10 min	Closeout / feedback



Choose a discussion keeper

- Role:
 - Keep the discussion going
 - Make sure everybody in the group gets talking time
 - Time keeping
 - Make sure the key ideas are on the flip chart
 - Find a presenter to other groups - 1 presenter per impulse talk
 - When problems are raised
 - -> probe for solutions
 - TAKE A PICTURE OF YOUR FLIP CHART / SHARE YOUR PPT
 - Send it to marine.seignole@akerbp.com
 - Mention your group number in the subject



Impulse talk topics

- Uncertainty study design
- Implementing different concepts in a model
- QC of multiple realisations



Impulse talk 1



Uncertainty Study Design

Cake & Discuss Impulse Talk for FORCE Discussion Series on
Practical Geomodelling

August 2024

Impulse talk...



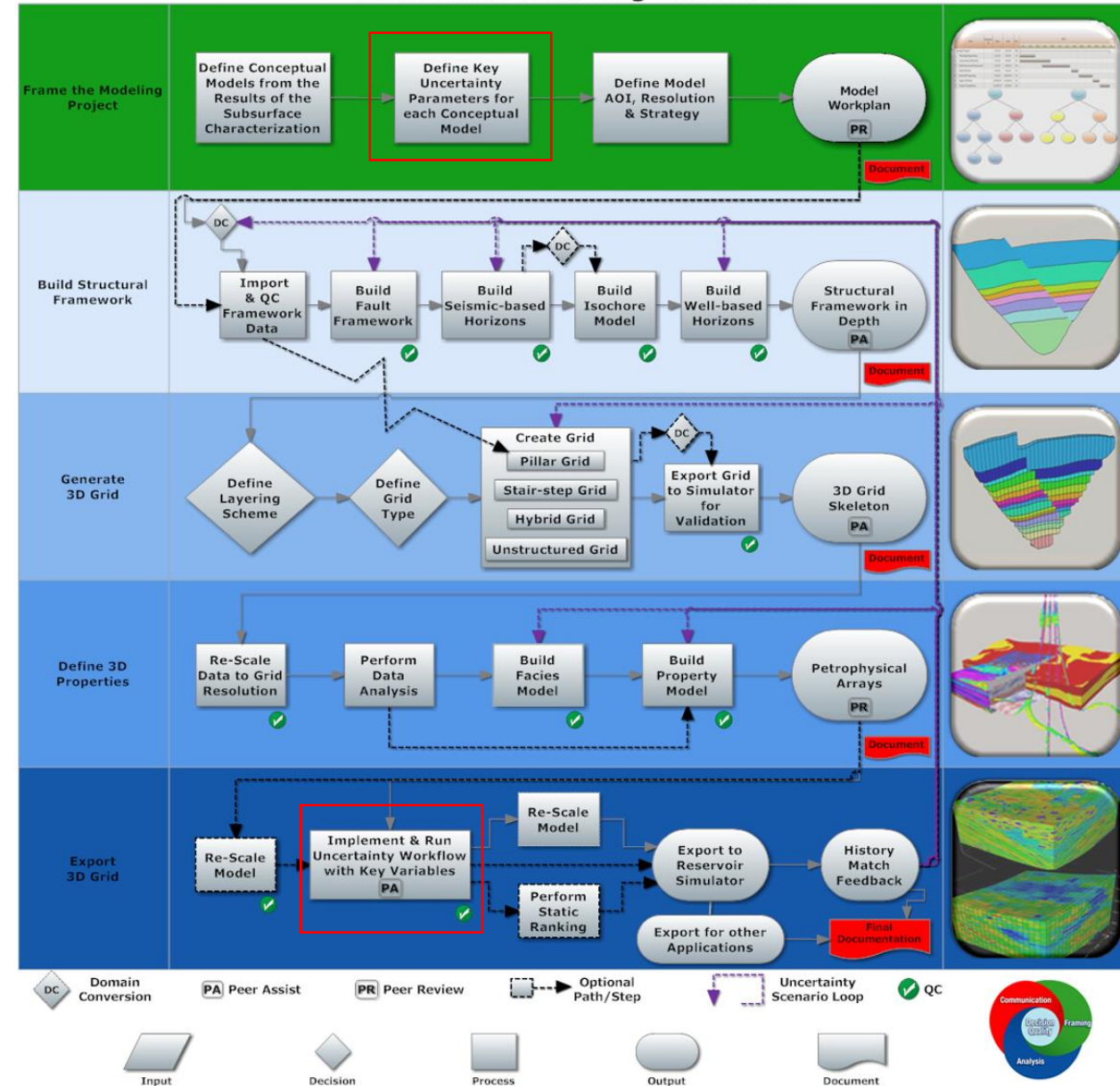
Aim of this Impulse talk...

- To initiate a discussion around how uncertainty studies centred on reservoir models are designed and planned....

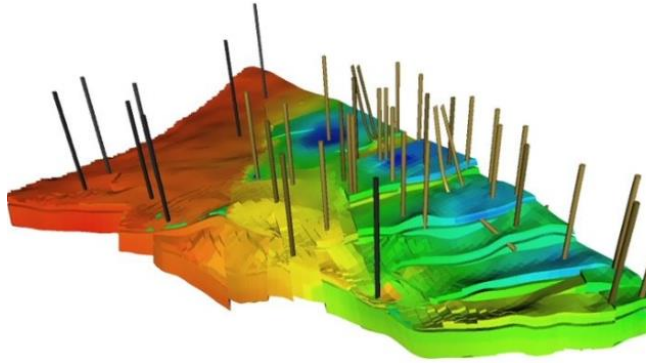
Why ?

- Typically, a key component of project evaluation often with significant human and machine resources required.
- Experience has shown us that there is value in allocating time and resources *before* we head to the Petrel Uncertainty workflow tab and begin creating 1000's of runs...
- For Practical Geomodellers it is integral to the model build..

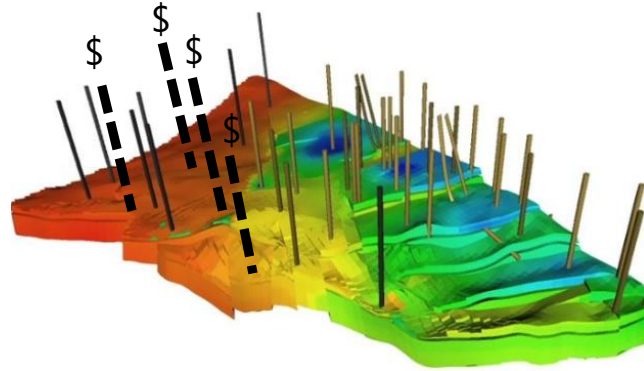
Geocellular Modeling Workflow



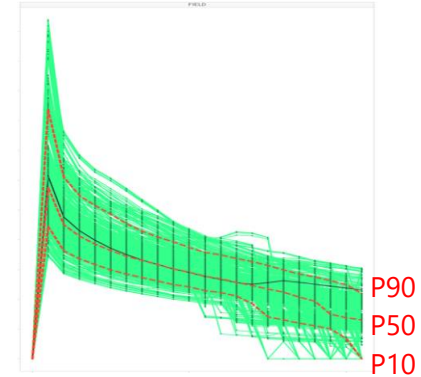
Impulse talk...Why are we doing an uncertainty study? E.g.



..because we've got an existing history matched reservoir model...



...the model tells us an additional 4 wells will have healthy incremental production....



...but there is uncertainty that will impact our production forecast....

..so we need to identify the key uncertainties
...and produce a range of production profiles capturing their impact...

What are we going to vary &
How are we going to vary it?

} Planning
& Design

Impulse talk...Deciding what we are going to vary



- **Making the uncertainty study fit-for-purpose**

- Multi-discipline team
- Agree the deliverable/objective/outputs
- Define key uncertainties : Agree long lists and then the short lists prior to testing through sensitivity study

"The key to success is the formulation of the uncertainty list." Ringrose & Bentley

- **Sensitivity Study** vary individual parameters one at a time to quantify impact

- Static Parameter Sensitivity
 - Impact on in-place volume relatively straightforward
 - Impact on production forecast requires step to simulation model (i.e. becomes a dynamic parameter)
- Dynamic model parameters/forecast parameter sensitivity
 - Impact on history match
 - Impact on production forecast

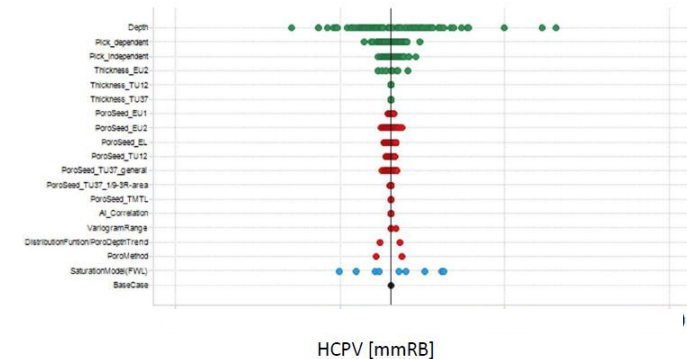
Discussion Points..

Is this a formal process in your companies or more ad hoc..

Is it done per-discipline Static/Dynamic or integrated from the start?

What metric to use to exclude parameters from the uncertainty study? Or are all short-listed parameters typically carried through to full uncertainty?

Many variables on a base case will widen range but narrow the distribution, giving illusion of less uncertainty and over-confidence in the base case.. Is this a consideration?



Impulse talk...Deciding how we are going to vary it



- **Application of Static Uncertainty**

- Is uncertainty to be centred on a best guess ?
- Or Is there to be stochastic variation around a base case? i.e. Petrel uncertainty workflow
 - How is the base case defined within the acknowledged range of parameter uncertainty?
- Or Define and generate a range of alternative concepts without defining a base case?
 - Allow the mid case/P50 to become apparent from the generated scenarios?

- **Application of Dynamic Uncertainty**

- Typically applied across the static range by Sampling of static grids
- Dynamic uncertainty performed with or without assisted history matching?
- Objective function screening of history matched models prior to running forecast uncertainty

Fig. 5.6 Alternative approaches to uncertainty handling

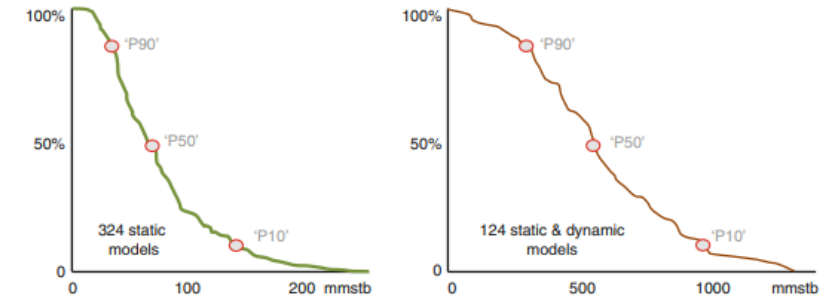
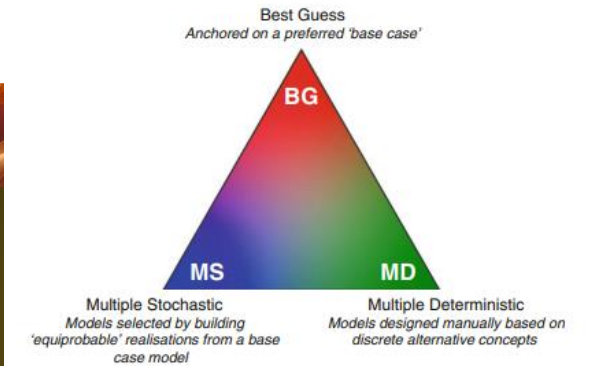
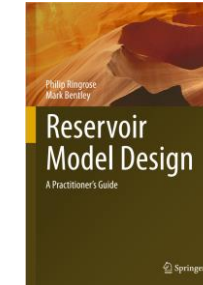


Fig. 5.14 Multiple deterministic cases for STOIMP (left) and ultimate recovery (right)

Discussion points...

Are base cases defined in your companies? How is that done?

How to avoid anchoring on a base case model and it becoming your P50?

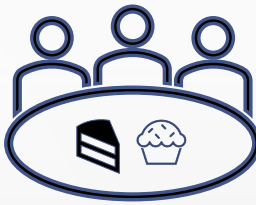
Is there an argument to perform uncertainty study with fewer, more targeted deterministic (manually designed) cases? Or is "ensemble" always the way to go?

Do you use assisted history matching within the uncertainty workflow or work without feedback loop?

Impulse talk...Discussion points



- Is framing & planning of modelling/uncertainty studies a formal process in your company? Is it truly a multi-discipline exercise from the outset. GGRE/Facilities/Economists...?
- What proportion of total uncertainty study time would you expect to spend on framing and planning?
- What process do you follow to identify key uncertainties?
- How are the relative importance of static, dynamic and forecast parameters evaluated up-front? How do you determine what to exclude following sensitivity? Any rule-of-thumb?
- Do you typically define a base case? If so, what is the process for its selection? How to avoid anchoring?
- Is anyone doing “lighter” more deterministic uncertainty studies or are heavier ensembles performed by default?
- Is assisted history match incorporated in your uncertainty workflows or use of objective functions to screen poorly matched outcomes?
- Anything else.....



Group - Notes

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1. Not a formal process
- once it is done

- Subsurface focussed - G & G & RE & PdR
 - forecast uncertainties maybe not as integrated
 - room to consider wider impacting parameters, other field experiences, analogues
 - fast track workflow understanding thresholds eg. capacity constraints
 - Biggo team early to focus uncertainty workflow

2. Depends on where in field life
- Could be 90% framing & planning
 - Past too experience on field driving (less planning)
 - Partner & reviewer bias
 - Usually focus on base case, usually less time on multiple concepts/deterministic concepts
 - Not enough time to test different concepts
 - Base case focussed, should we consider uncertainty at start. Base case does not fall out.
 - Rare low/high case definition before modelling workflow (screening) for redetermination

Team 2

- Some company examples of strong framing and peer assisted up-front processes to agree workplan *and* post-modelling process to ensure learnings are recorded.
- Key uncertainties typically identified through the characterization phase “get a feel for it”
- Some good experience of forcing all disciplines to contribute an uncertainty early (even the petrophysicists)
- Sensitivity study not typically allocated significant time and resources
- Typically no corporate best practice on design – left to the individual contributors
- Some examples of use of deterministic scenarios – but not done on a routine basis, but good way of learning whether things matter. Maybe the place to start.. simple deterministic models? Then add complexity
- Base case – dependent on amount of data.
 - Less data - generate a few deterministic cases
 - More data – full stochastic
- Key uncertainties – sometime small impact on static case can have an important impact on dynamic, so often need to test through to dynamic model to be sure what to remove from the uncertainty study (.... iterative process)



Do we define a Base Case?
↳ Process for

Do you name it Base Case?
↳ Ref. case, P&O, B.E., BTE

Depends on maturation of field
↳ Still a lot of unc. in mature fields

Disputed problems w/ ensembles.

↳ Limitations of structural
uncertainty

↳ ~~structural~~ QC results

↳ Difficult to tweak and check.

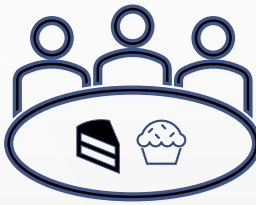
Det v. ens.: Varies a lot

"Drive for ensemble, not seeing it working."



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- Big difference between operator and partner.
 - We do attempt to make a list of uncertainties up front
 - Partner just test what you judge as most important
 - Static model always include everything – but most parameters don't have much impact
 - Important uncertainties don't cancel each out
 - Dynamic, we also take in all uncertainties.
 - We try to include everything. Should we?
 - Benefit of Scenarios. We include multi deterministic scenarios. One of these may be a reference case.
 - Sense check of making low ref high models. Check the ensemble distribution.
 - Ask partners to give their low and high. Often very different (value of getting second opinions),



Impulse talk 2

Implementing different concepts in a model

Force Cake and discuss – August 27th 2024

Introduction

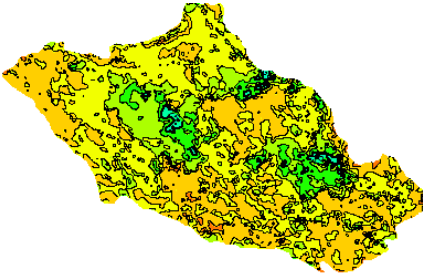
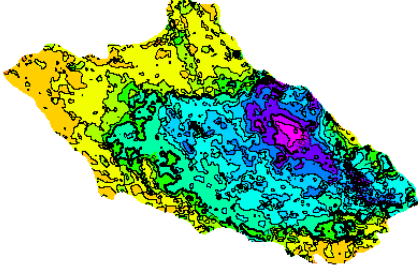
Initial modelling

- Development based on very limited appraisal data.
- Several concepts exists with similar probability – no “base case”.
- How can we merge everything into one model?

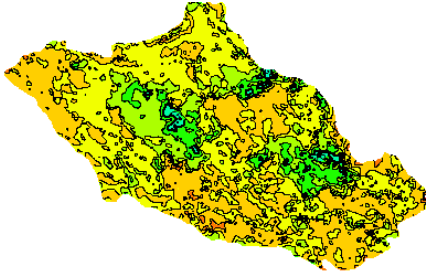
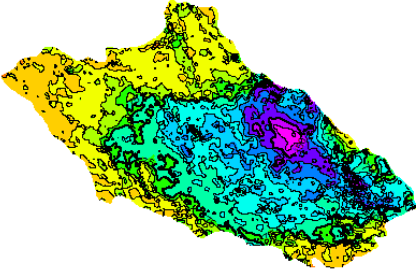
Model update

- How can the set-up be used for fast model update during drilling?
- How can this be history matched once production starts?

Structural options – alternative concepts

Structural uncertainty	Parameters		
Zone thickness	Conformable to main interval	2 lobes Using the 2 lobes trend maps 	1 lobe Using the 1 lobe trend maps 
Well tie radius of influence	800	1600	infinite
Well tops	Correlation method 1	Correlation method 2	Correlation method 3

Property modelling – alternative methods

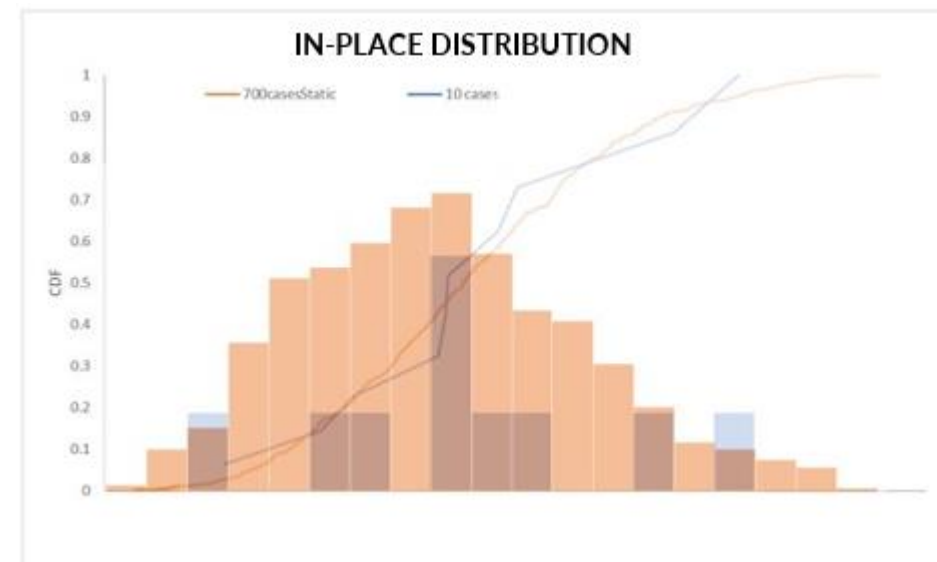
Property uncertainty	Parameters		
Depositional concept	1 lobe 	2 lobes 	
Modeling methodology	Vsh approach		Facies model approach
Rock type (poro/perm assignment)	Reservoir approach rocktyping		Deformation rocktyping
Cementation	Included in the properties/averages		Discrete elements
Azimuth and variogram ranges	Range based on data/concept/testing		
Contact	Range based on data		
Porosity	+ /- X PU		
Water saturation	Reference case	Low case	High case
Poro/permeability	Rocktype 1 – 3 relationships		Rocktype 2 – 3 relationships

Resulting model

- Concepts or combinations ruled out when conditioning to well data.
 - QC
 - End members studied in detail.
 - Run through simulation to understand issues.

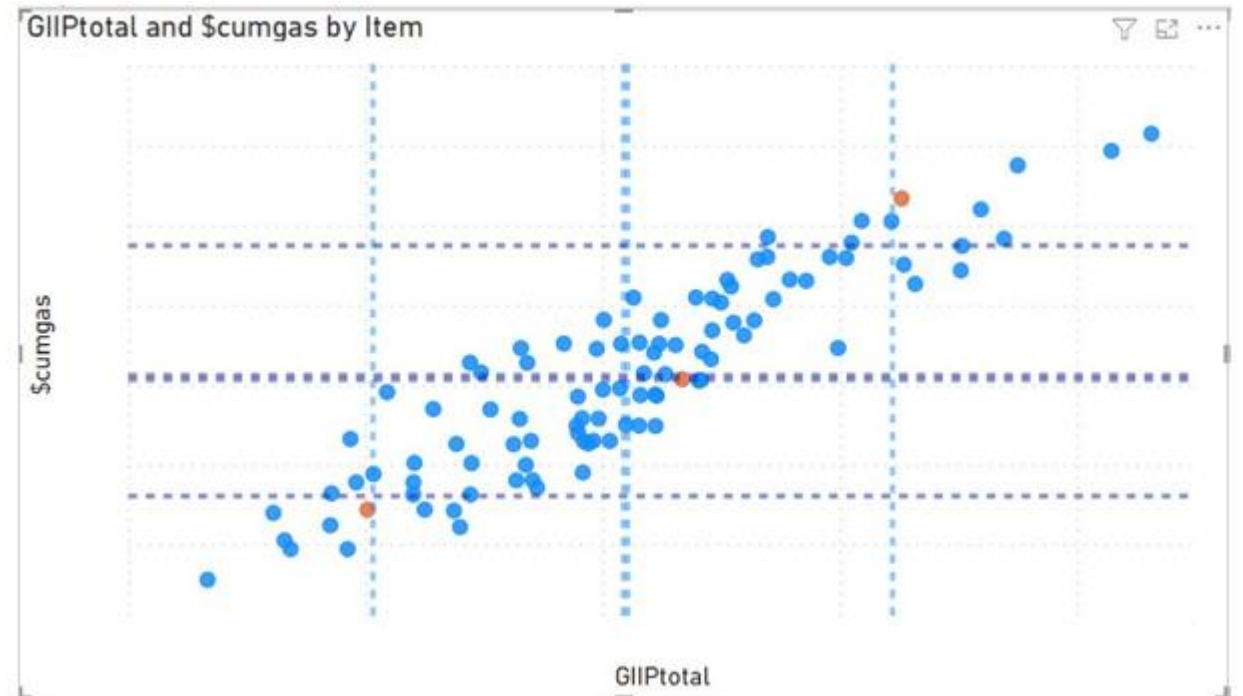
- Uncertainty workflow used to run 100's of combination.
 - Could set up all options in one workflow or split in two/three if gridding changes.

- Select cases for simulation based on statistical distribution of in-place.
 - Rerun with fewer cases until acceptable spread of concepts and in-place.
 - Dynamic uncertainties added.
 - Full set run for different well concepts.
 - Used for final resource distribution once well concept decided.



Deterministic reference case

- “P50” model using what criteria?
 - In-place volume?
 - Cumulative resources at a given year for the selected well concept?
 - Production rates?
 - Plateau length?
 - Water production?
- Extremely important to work with facilities when defining design basis – one deterministic model is not suitable for everything!



Model update

Initial well results

- Can some concepts be ruled out, or ranges narrowed down based on well results during/quickly after drilling?
 - Rule cases out or change the probabilities.
- Fast re-running of workflows with updated variables.

History matching

- Set-up used for development with no (very limited) dynamic data.
- Workflow created in a way which is transferable to automatic history matching tool (ResX).
 - Could be required to split in several runs for different structural concepts.
- Not tested yet!

Questions

- When several concepts exist, how can all be covered in the final distribution?
- How handle the modellers wish for probabilistic results and facilities need for deterministic models?
- How can this be history matched?



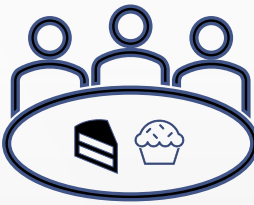
Group - Notes

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- How to incorporate several concepts: ensemble of ensembles. . Combine all the profiles and choose
- Facilities need for deterministic cases. Challenge of weighting different scenarios. Binary distributions where you can have one scenario or another and combining scenarios could gives you a P50 that doesn't match either.
- How can this be history matched. Important to incorporate dynamic data. Is there a risk of choosing P90 P10 models based on volume which aren't P10/90 in production response. Use of analogues.



Impressed & Inspired

1. Several concepts
 - Needs full framing
 - Check concepts match range
 - Decide probabilities of different concepts
 - DC selection eg maps
2. Fit for purpose models for facilities
 - Still share multiple outcomes
 - Sensitivity testing
3. RE integrated in the workflow build & can run it
 - Full team agreement at start



1. Build discrete models -
combine end-result
 - dependant on model objective
 - easier? shorter running timeIntegrated multi-scenario W/F
 - allows for probabilities w/ scenario
 - turn on and off scenarios/processes

2. Probabilistic vs. deterministic
 - close collaboration and communication between disciplines
 - plan for contingencies
 - involve management w/ uncertainties

3. Run the different scenarios with uncertainty ranges through H.M.
 - filter/select cases with best match → prediction

When several concepts exist, how can all be covered in the final distribution?

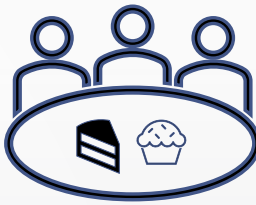
- Do you need to combine? Merging might be a problem
- Otherwise sampling representative distribution for each concept seems the way to go...

How to handle the modellers wish for probabilistic results and need for deterministic models for facilities?

- Difficult if facilities not working with range of outcomes..
- You have to pick representative models ... plan for P50 but check the upside and downside cases have no critical impact..??

How to handle history match?

- If still carrying multiple geological scenarios post-drill it is difficult to have single HM models?
- Sounds like an assisted history match case study You need multiple HM models until the production data tells you otherwise.



Feedback: 14 returned questionnaires

- Participants:

- 15 people in Stavanger (+2): various company (ConocoPhillips-DNO-AkerBP- OMV Norge -university of Stavanger- OKEA- PGNIG Upstream Norway-Petoro-Wintershalldea Norge AS)
- 6 registered in Oslo but people came and go during the talks- various company (AkerBP, Lime Petroleum AS, Pandion Energy)
- ->More companies representation, good mix of recurring participants and newcomers

- Format and length:

- exchange of experience seems to be appreciated by all as well as the social and relax setting .
- 2 topics instead of 3 has allowed more time for discussions
- Some would have like more time to the discussions (2).
- The connection with Oslo has worked but sometimes hard to hear the discussions

- Topics:

- the mix of topics were well received and considered relevant
- One more session about uncertainty would be liked (November ?)
- one commented that practical topics are easier to relate than the general first session.

- Topics suggestions:

- QC of ensemble – full session
- Difference between a scenario and uncertainty within a scenario (PGNIG Upstream Norway☺)
- Number of realizations and methodology
- Uncertainty on Hard Data and its impact