Automating Field Development Insights

Sabahattin Topdemir, Petoro AS
Petoro – key player on the Norwegian shelf

### Petoro 2018

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
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<tbody>
<tr>
<td>Net cash flow (billion USD)</td>
<td>13</td>
</tr>
<tr>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Liquid (kboed)</td>
<td>370</td>
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<tr>
<td>Gas  (kboed)</td>
<td>714</td>
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<tr>
<td>Investment (billion USD)</td>
<td>2.6</td>
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<tr>
<td>Number of licences</td>
<td>208</td>
</tr>
<tr>
<td>Number of fields in production</td>
<td>34</td>
</tr>
<tr>
<td>Number of employees</td>
<td>65</td>
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- Petoro has 1/3 of the remaining reserves on the Norwegian shelf.
- 1 mboed daily production in NCS (26% of total)
Schlumberger and Petoro are together actively researching technology and processes to increase productivity, quality and value. In December 2018 a 2 year collaboration agreement was signed.

- Explore how to utilise emerging technologies like Artificial Intelligence and Machine Learning.
- Deliver working systems which enable higher quality and more rapid decision making.
- **Ensemble IQ** is the first project being undertaken within this agreement.
New modeling workflows and digitalisation key to accelerate field evaluation time and reduce risks

• Ensemble based modelling is a better way of capturing uncertainty and reduce risk in future field development

• Field development optimisation using all ensemble is the next step to enable screening more scenarios quickly
Challenges with ensemble based reservoir modeling

• Mean or the small number of selected models are used in optimising future of the fields due to limitation in number of licenses and computing capacity.

• Establishing confidence or quality of ensemble are demanding in time and resources.

• Working with ensemble of models requires new workflows.
Close collaboration

“A collaborative team to deliver the upmost value”
Updated personas
Extended the Petoro personas to cover the FMU workflow.

As-is workflow research
Maps today’s typical ensemble workflow
Identifies pain-points, needs and opportunities for improvement.

To-be workflow collaboration
Describes a joint vision for the future (to-be) ensemble workflow
Starts to narrow in on our areas of focus.

Story mapping of the solution
Sketching and prototyping
Starting to turn the future vision into a solution.

Delivery slices
Functional slices are defined to introduce functionality into the prototype for validation and testing of value with the Petoro engineers and their data.

Prototype delivery
Labs for functional testing of key developments with integration into a workflow which will be in our commercial offering in the future.
Project focus area

1. RECEIVE DATA FROM OPERATORS
   - EI/Q Workflow

2. UNDERSTAND THE PROPOSED STRATEGY
   - Insights
     - Quality control
       - Deeper understanding

3. LOOK FOR ADDITIONAL OPPORTUNITIES
   - Hotspot identification

4. REPORTING / DIALOG WITH OPERATOR

- Facilitate data links with current technologies and workflows
- Full ensemble analysis
- Perform the study
- Petrel
- Data Analysis Tools

Current Technologies & Workflows
Example workflow Insight and automation

Visibility

• On receiving an ensemble the user wants to understand the field development plan without requiring knowledge of ECLIPSE keywords or Petrel

QC

• On receiving an ensemble show me the worst distribution of a parameter used for history matching

Example showing well operations in time for the entire ensemble
Hotspots

Workflow steps for algorithm (1)

• For each realization create an opportunity index for each cell
• Create a hotspot property for each realization
• Screen the hotspots using a minimum recoverable volume

Opportunity index in current prototype similar to methods used for Olympus challenge

Hotspot property calculated using graph based search for connected volume limited to a minimum viable recoverable volume
Hotspots

Workflow steps for algorithm (2)

• The user selects areas which are risky or not desirable on 2-3 realizations

• ML searches the rest of the ensemble (100 models) and finds and removes similar objects

• User is presented with a probability map of these more realistic targets for selection

• Early testing indicates we have more focused realistic targets, quicker

User selected hotspot is removed as a candidate from all realizations by shape/similarity utilising a deep CNN and ensemble decision tree.

The resulting targets are more realistic and focused than existing best practise
## Project status – Plan for slice delivery

<table>
<thead>
<tr>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
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<tbody>
<tr>
<td><strong>Slices 1 &amp; 2</strong></td>
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| Understand the ensemble:  
Visualize well connections and k-layers; See a timeline of key events. |           |         |         |         |         |         |
| Well placement hotspots:  
Visualize the opportunity index map. |           |         |         |         |         |         |
| **Slice 3** |           |         |         |         |         |         |
| Understand the ensemble:  
View history match errors; automatic abnormality detection. |           |         |         |         |         |         |
| Well placement hotspots:  
Show hotspots on a map |           |         |         |         |         |         |
| **Slice 4** |           |         |         |         |         |         |
| Understand the ensemble:  
Filter the reservoir map; Understand the well operating conditions. |           |         |         |         |         |         |
| Well placement hotspots:  
Rank hotspots |           |         |         |         |         |         |
| **Slice 5** |           |         |         |         |         |         |
| Understand the ensemble:  
Automatic abnormality detection; Understand the well operating conditions; View ensemble KPIs |           |         |         |         |         |         |
| Well placement hotspots:  
Configure the hotspot parameter ranges |           |         |         |         |         |         |
Digitalisation – Petoro's 3 perspectives

Industry
- Drive faster and broad implementation
- Drive innovation through greater openness and increased data sharing

License
- Drive faster and broad implementation

Internal
- Reduce time on routine tasks
- Streamline reporting and obligatory tasks
- Improve the power of influence through better insight, analysis and decision-making
Thank you!
Questions to be asked

• Expectation? Reduce evaluation times from months to weeks

• Field development optimization tool plans and ambition

• Experience with working in collaboration style and using UX elements