DELFII PILOT
“A CROSS BORDER FIELD”

Performed by: INA – MOL Subsurface Team

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INTRODUCTION

- There are multiple hydrocarbon fields - owned by MOL and INA - split by the border of Hungary and Croatia. Among them the “Z-D” field, discovered a decade ago, and ready to be fully developed and put on production.
- “Z-D” is a gas condensate field with highly heterogenous Miocene age breccia-conglomerate lithology.
- Three wells have been drilled up to date: 2 production wells with considerable productivity and a dry appraisal well.
- New well has been drilled in May 2022.
- During the subsurface preparatory tasks (pre-drill phase) Nov 2021-Feb 2022, the re-evaluation of the field was combined with a company-level piloting of Schlumberger’s DELFI environment.
- The exercise had a double aim:
  - Kick-off a MOL-INA integrated revisit of field development - a continuous daily collaboration among disciplines;
  - Test the DELFI environment benefits to support the future software strategy of the MOL Group.
- The multidisciplinary team tested the software from seismic, petrophysics, reservoir geology and reservoir engineering aspects, including field development planning. The team was geographically separated, as half of the participants work in Budapest, and another half in Zagreb.
- The pilot hasn’t stopped with the production forecasts, “FDPlan” – DELFI native web-based application has been tested in order to evaluate project KPI’s.
Disciplines involved in DELFI testing:
- Geophysics
- Petrophysics
- Geology
- Reservoir Engineering
- Economics
- Management/decision makers

DELFI Environment:
- Cloud solution.
- Access to applications across all domains via Remote Desktop – Petrotechnical Suite
- All applications used for all disciplines are same as on premises (Petrel, INTERSECT etc.) but accessed via subscription on “cloud” VM’s.
- Flexibility in picking packages needed for conducting technical evaluation.
- Shared storage space for all disciplines.
- Collaboration tools for different disciplines (sharing data, result and realizations).
- By introducing “parallelization” of simulations, RE evaluation has a new perspective.
- FDPlan – KPI evaluation (connection between management / decision makers, subsurface technical team and economics).
- **FDPlan and parallelization of simulations caught great attention in process of DELFI evaluation**
**FDPlan Study Overview**

**THE WORKFLOW**

**FDPlan** - is a tool that connects results from dynamic simulation, economical inputs, including all possible business decisions that should be considered.

Calculates and visualizes economical models and KPI’s based on inputs.

And finally, it is used to analyze results and pick the best scenario for future development.
Setting up participants and their roles:

- Each participant can be either Study Manager or Contributor
- Study Manager sets up scenarios and promotes them to contributors.
- Contributors calculate results and propose best one to manager for further processing

This concept allows fast collaboration and connectivity between technical personnel and Management
Study decision: number of wells, type of water disposal, wellhead compressors etc...

➢ After setting up all scenarios (combination of decisions), they are promoted for calculation in dynamic model to appropriate contributor.

➢ Contributor then gets the message through system with details on requested scenario.

➢ Based on scenario details, contributor sets the workflow and calculates the requested forecast.

Scenarios:
For example: 6 wells in production, water disposal in existing dry well, starting with phase one and hydraulically fracked...
PETREL – SETTING UP SCENARIOS BASED ON FDPLAN DECISIONS AND RUNNING THEM IN PARALLEL IN CLOUD

Setting up in Petrel - Uncertainty And Optimization ensembles for well count, date of first gas, and with and without frack as an option:

All workflows (ensembles) are run in cloud HPC each comprised of 100 realizations to capture full span of uncertainties.

Geological and RE uncertainties:

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<th>RE unct. parameters and ranges</th>
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After the results are available, they are proposed, or sent to FDPlan for further processing.

Doing the evaluation on premise this number of simulation would be significantly smaller due to limitation of resources (licences, hardware, etc..)
PARALLELIZATION

- **Parallelization** – simultaneous processing of large number of simulations (Petrel & INTERSECT or ECLISPE processes)
- **Drastic reduction in simulation time** of multiple realizations
- In Z-D project **1200 realizations** were simulated in **one day** (huge time saving)
- Each simulation ensemble is run remotely – **no need for on premises resources** (powerful hardware, storage, etc.)
- Direct connection with FDPlan and data sharing of simulation ensemble results
- Number of available licenses (for simulator) is not concern anymore – different concept – Consumption ‘on demand simulation’

Ensemble result overview:

- **Realizations processed**: 199 / 100
- **Forecast**:
  - **0.16 mcf/d** cumulative oil production (P10)
  - **3.93 mcf/d** cumulative gas production (P10)
  - **0.09 mcf/d** cumulative water production (P10)
- **Injection**:
  - **0.00 mcf/d** cumulative gas injection (P10)
  - **0.00 mcf/d** cumulative water injection (P10)

- **Original in place**:
  - **Oil (STOIP)**:
    - P10: 0.50 mcf/d
    - P50: 6.44 mcf/d
    - P90: 9.37 mcf/d
  - **Gas (GIIP)**:
    - P10: 5.22 mcf/d
    - P50: 5.93 mcf/d
    - P90: 4.58 mcf/d
PREPARING FDPLAN FOR ECONOMICAL CALCULATION

Each scenario has:
- Corresponding simulation ensemble (production forecast)
- General CAPEX
- General OPEX
- Economic Framework
- Price Forecast
- Reference Dates
- Economic Indicators

All data for economic inputs are in tabular format.
30 realizations are picked from 100 cases as simple random (30 is maximum).

Based on all inputs (economical and sim. forecasts) KPI’s were calculated for all 36 cases.
RESULTS – EXTENSIVE RANGE OF AVAILABLE RESULT OUTPUTS FOR ANALYSIS

- In FDPlan there are numerous visualization tools for analysis of results in order to **very quickly gain insight** into key economical/technical drivers for the particular study.
- In our project this has speed up process of determining value and impact of each decision point.

**Spider charts:**

- Comparison of KPO for each scenario

**Tabular output:**

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**KPI's vs. time:**
CONCLUSIONS

✓ Same access to Petrel software on DELFI platform to the same functionalities on the software installed locally on PC-workstations (applies to all disciplines: Geophysics, Petrophysics, Geology, Reservoir Engineering);

✓ Project Explorer in DELFI - Functionality that could add value and give an opportunity of simultaneous work on the one Petrel project at the same time;

✓ Noticeable differences in Reservoir Engineering workflow: Parallelization greatly speeds up the whole process (several months became several days);

✓ FDPlan - Tool native to DELFI platform for managers which connects RE outputs, Economic inputs and calculates all economical outputs while offering good visualization of results for gaining insight into project main KPI’s much faster;

✓ At the time there were software functionality issues which were promptly resolved;

✓ There is room for improvement in the future, mostly in web-based applications, for example FDPlan and workflow can be optimized for more productive user experience.
Many thanks to all Schlumberger experts who participated and helped with their generous support and technical knowledge during the Delfi evaluation!

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THANK YOU!