Realistic Automated Scenario Drilling Through Implementation and Validation of Physical and Machine Learning Models Using a Real-Time Drilling Simulator

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Outline

- Background
- Research Objectives
- Methodology
- Simulation and Evaluation
- Conclusions and Future Work

Background: Challenges in Drilling

- High cost in drilling an oil, gas, or geothermal well
- High non productive time (NPT) drilling time efficiency in certain drilling operations
- Automated drilling simulation to optimize the drilling process

Background: Factors of Inefficiency in Drilling

(DrillSim:600)

- Natural factors
- Technical factors
- Human resources
- Equipment availability

Research Objectives

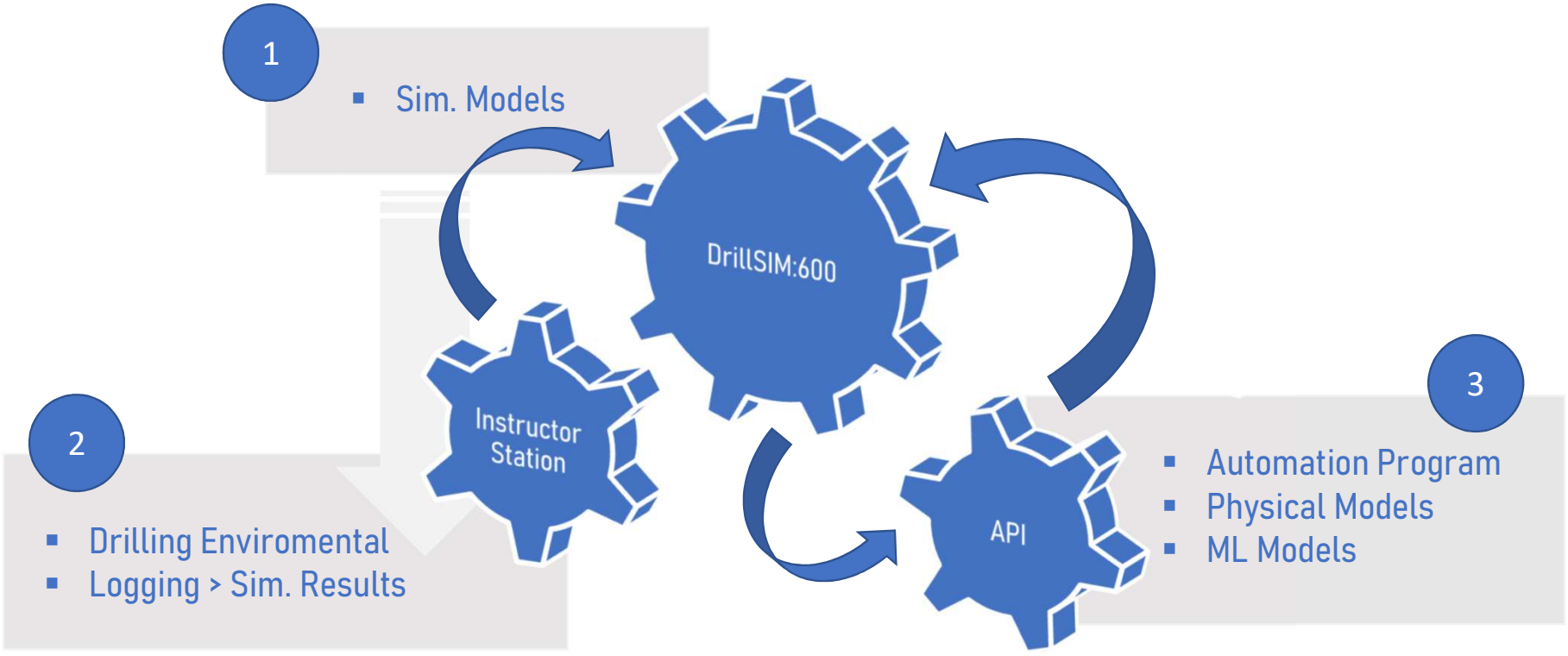
- Project: Optimization of geothermal drilling operations through real-time advance simulation
- Research purpose: Create realistic drilling environments to simulate and execute complex drilling processes in real-time
- Research scope: a certain section of a drilled well which is simulated in the advanced DrillSIM:600 Training Simulator

Methodology – Software Simulator at DSC

(Instructor Station)

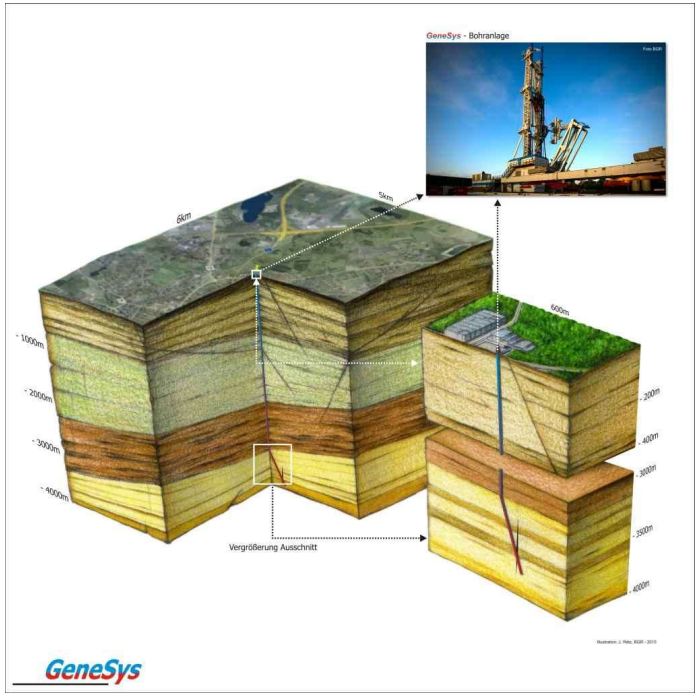
(Student/Drillers Chair)

Methodology – Workflow



Methodology – Well Information

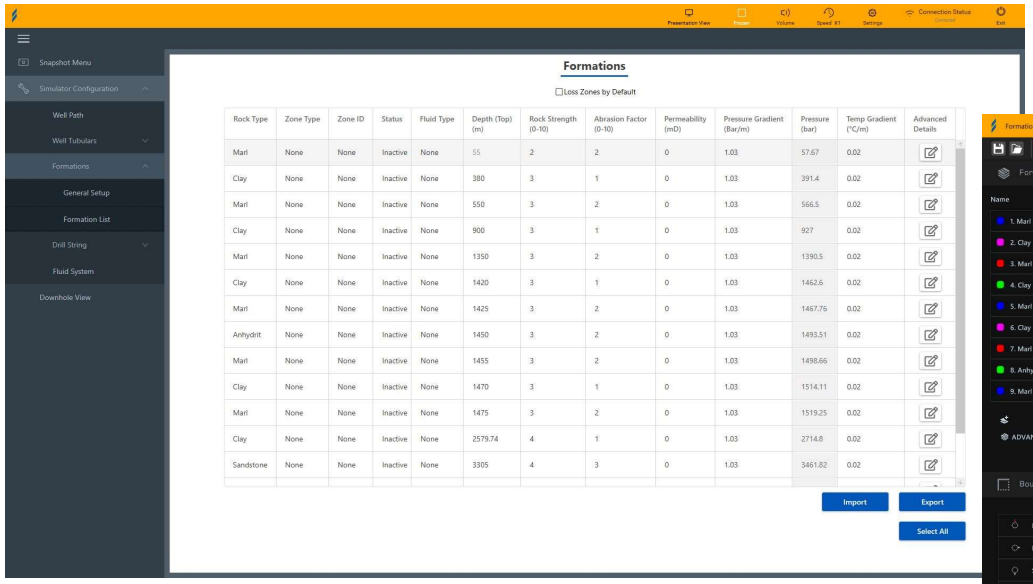
- Wellbore Information: GeneSys
- Location: GEOZENTRUM Hannover
- Target Formation: Mittlerer Buntsandstein
- Type: Geothermal Well
- Depth: 3.901 m
- Simulated section: 1542 – 1562 m



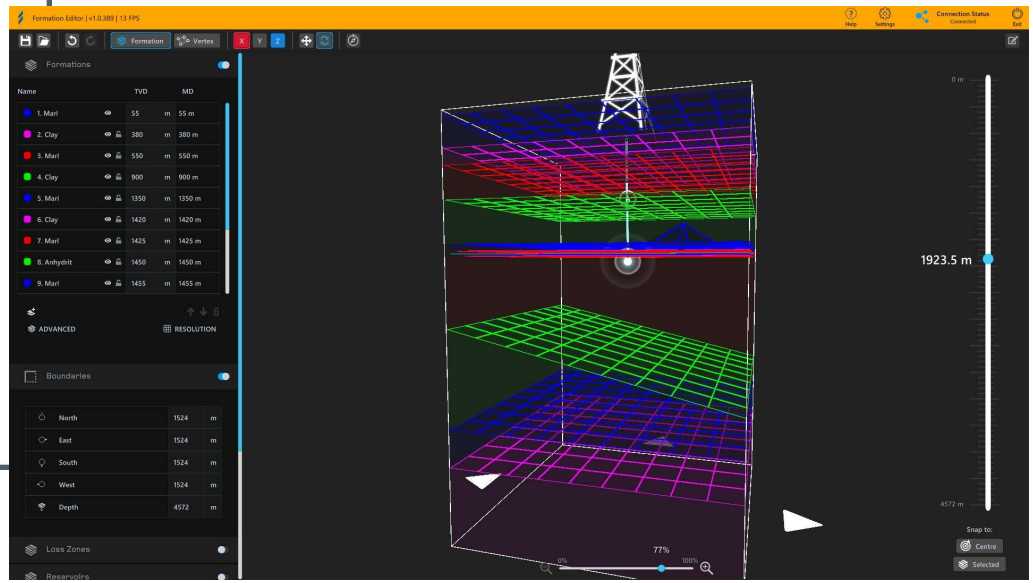
(https://www.genesys-hannover.de/Genesys/DE/Home/genesys_node.html)

Methodology – Setting Simulation Environment

- Formation



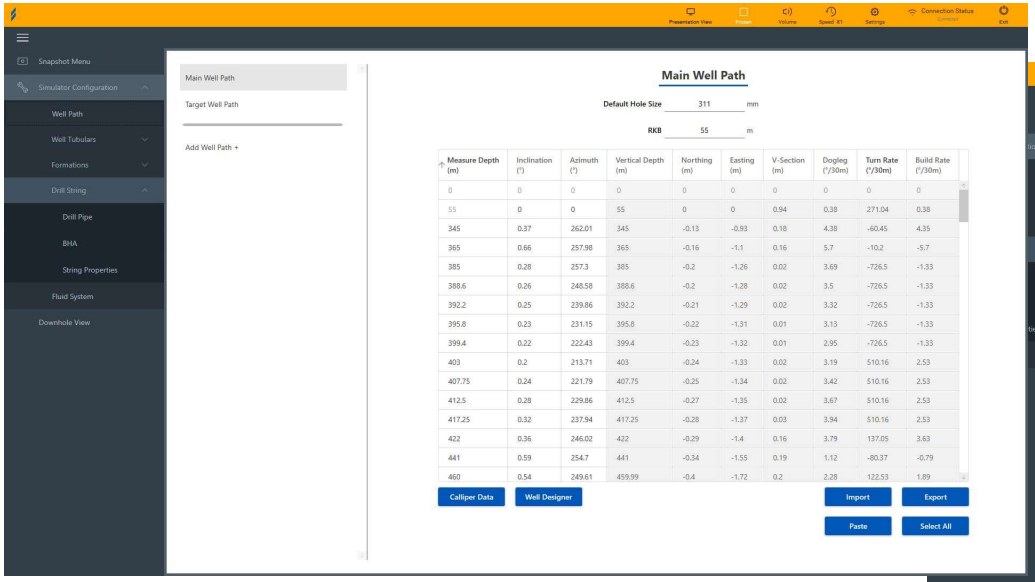
(Instructor Station – Formation Editor)



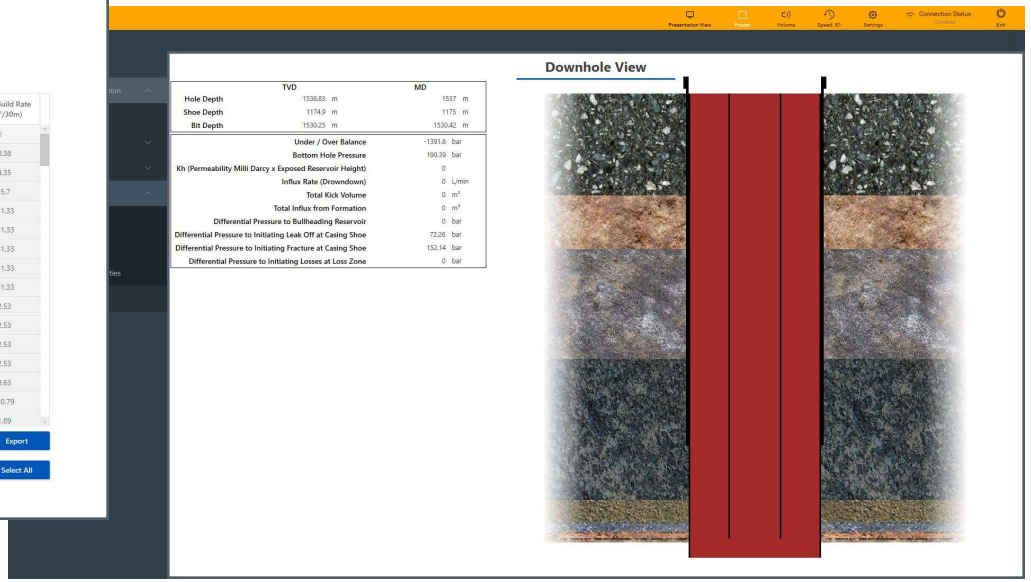
(Instructor Station – Formation Editor)

Methodology – Setting Simulation Environment

- Well Designer & Downhole View



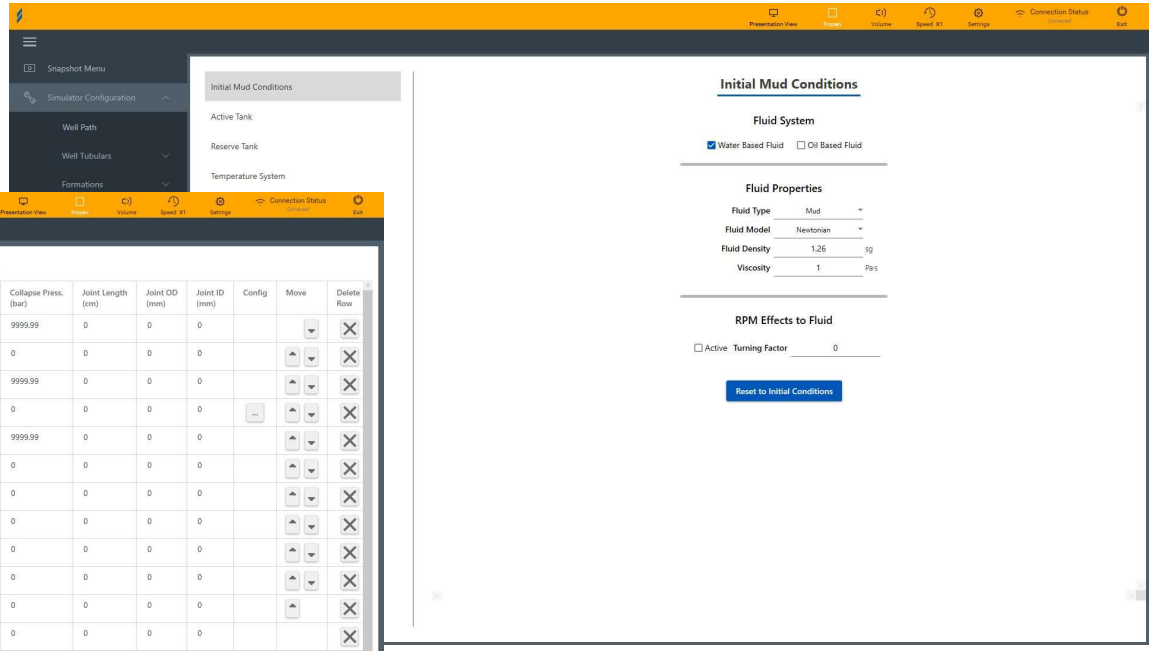
(Instructor Station – Wellbore Designer)



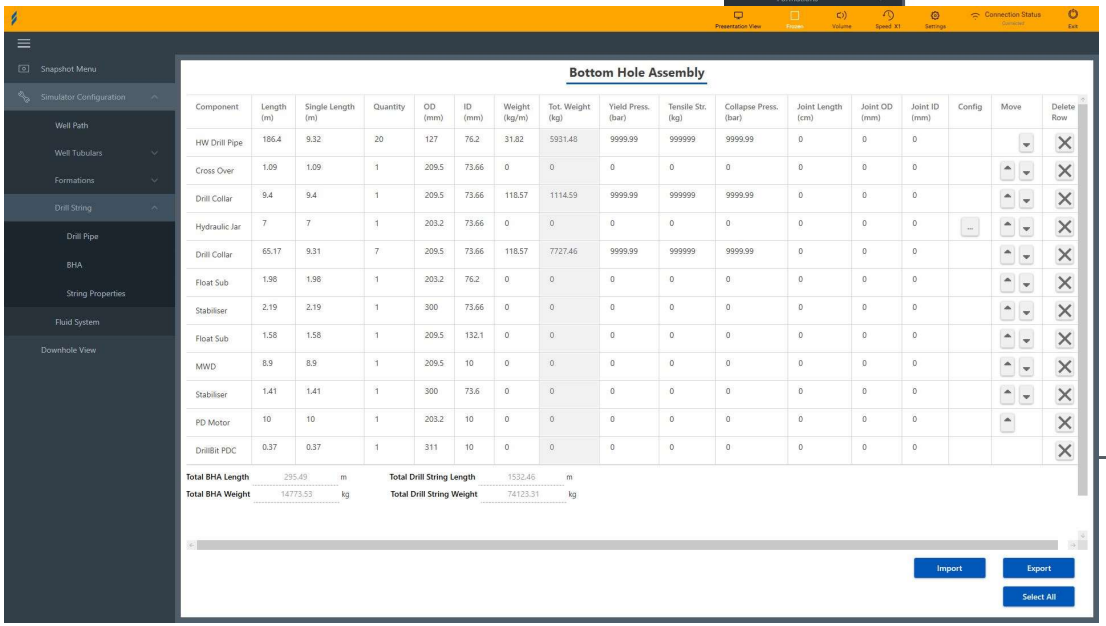
(Instructor Station – Downhole View)

Methodology – Setting Simulation Environment

- Fluid System
- BHA & Drillpipe

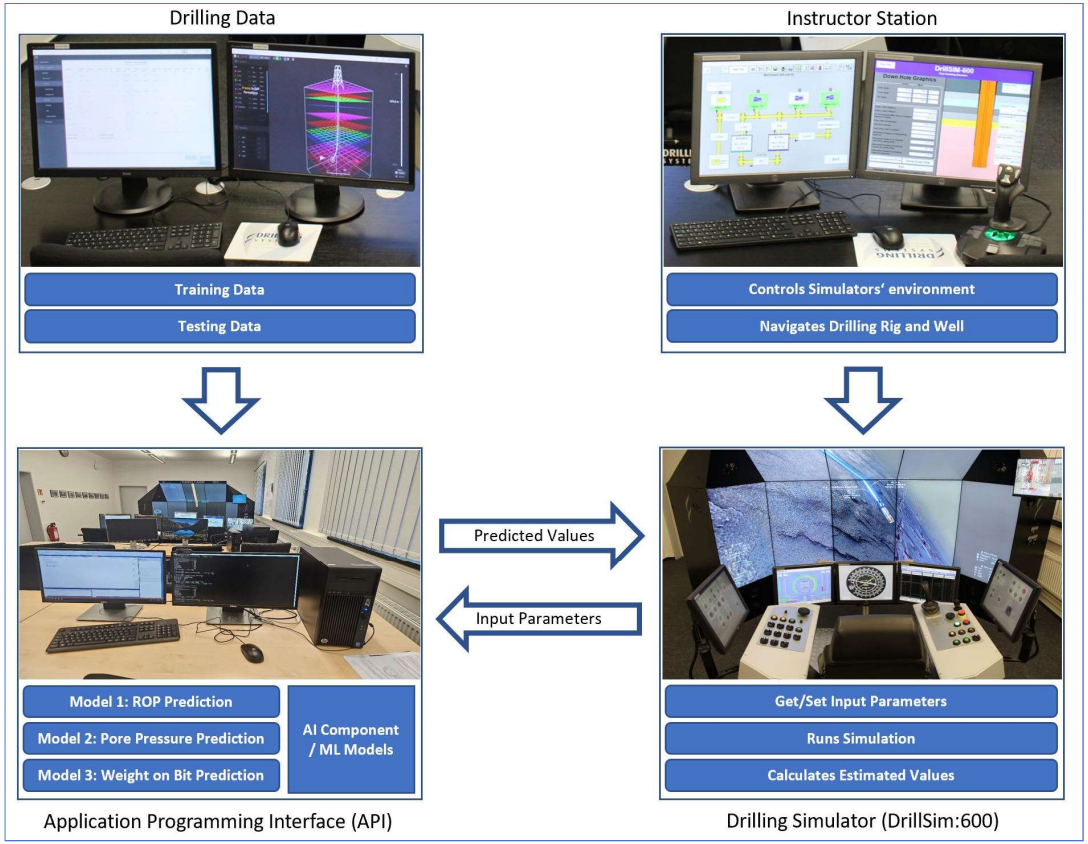


(Instructor Station – Fluid System Designer)



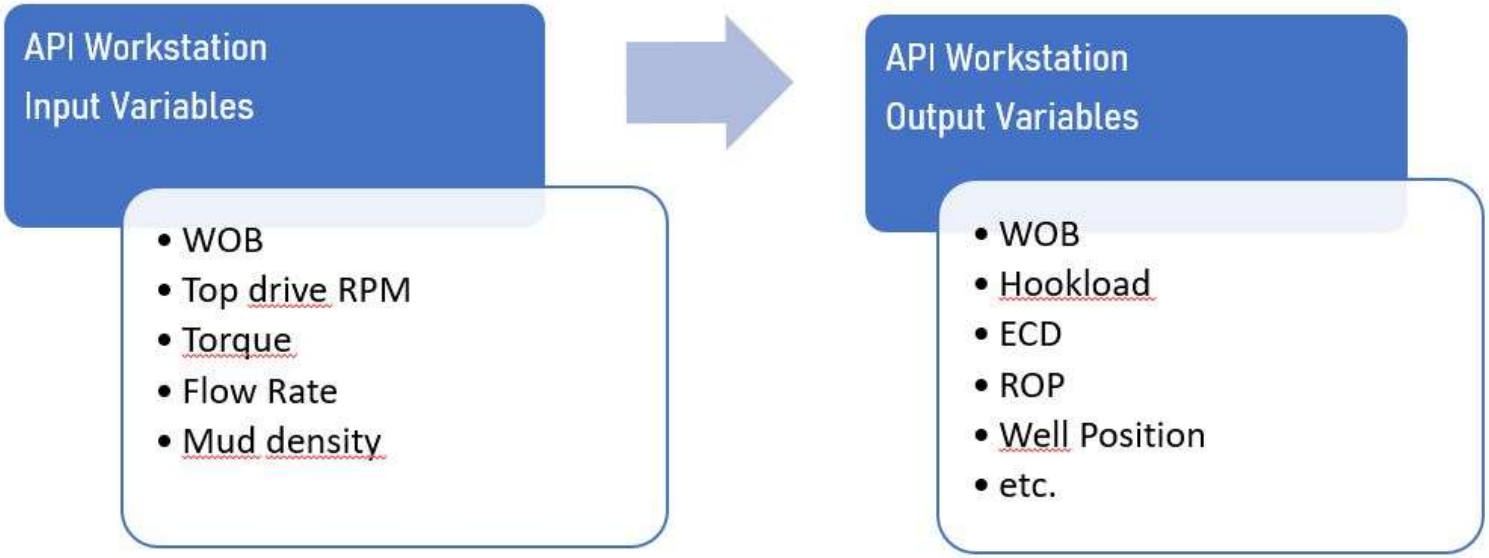
(Instructor Station – Drillstring Designer)

Methodology – API Workstation



(Workflow between API Workstation and DrillSIM:600)

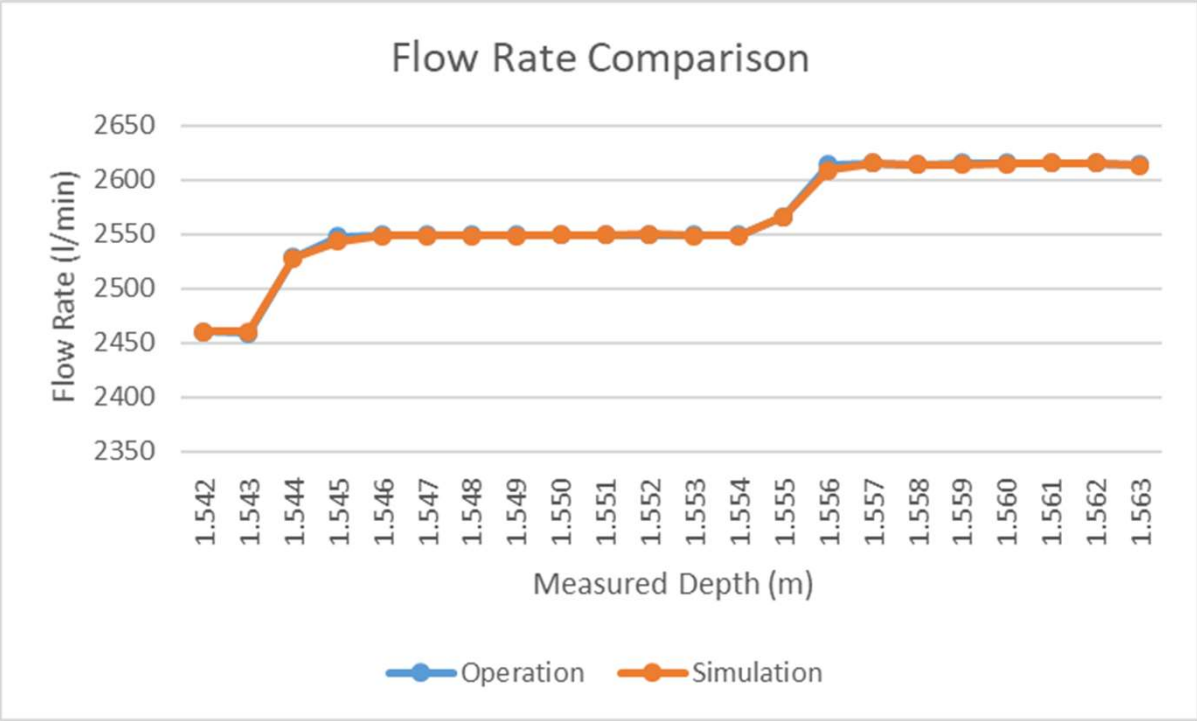
Methodology – Communication with Simulator



Simulation and Evaluation

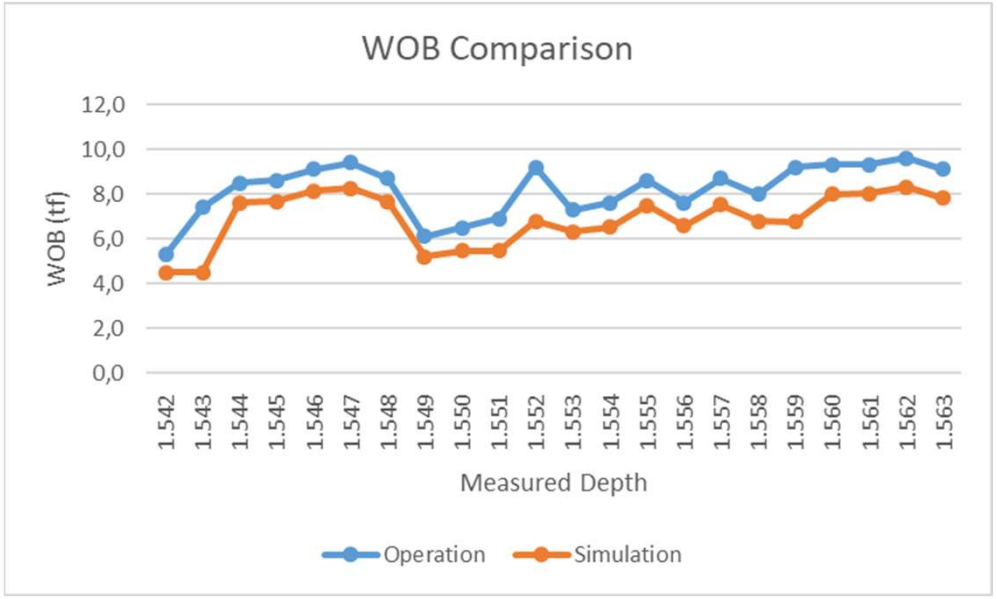
- Flow Rate
- Weight on bit
- Torque
- ROP

Flow rate

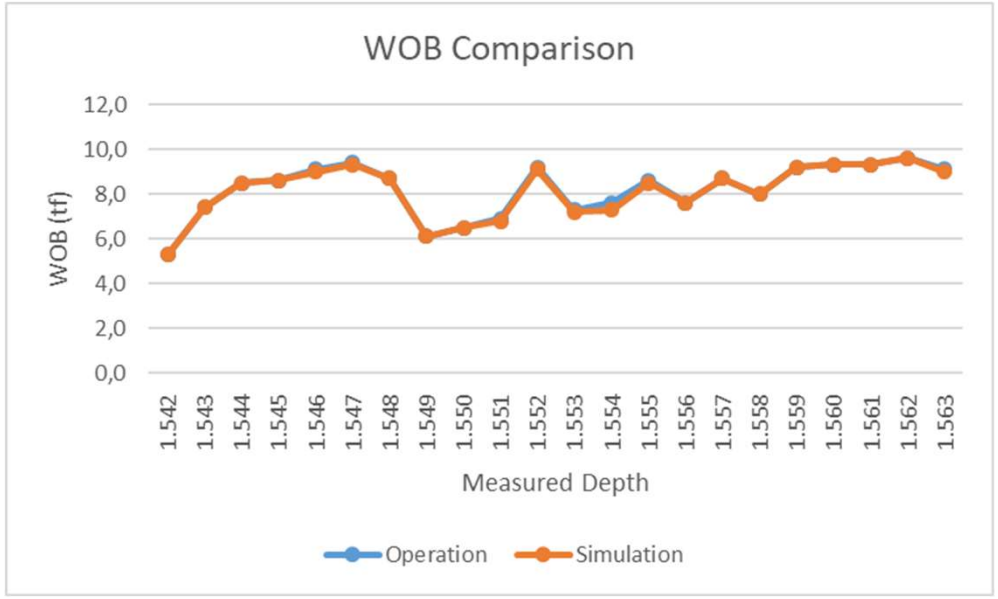


(Flow Rate comparison at parameter input depth)

Weight on bit

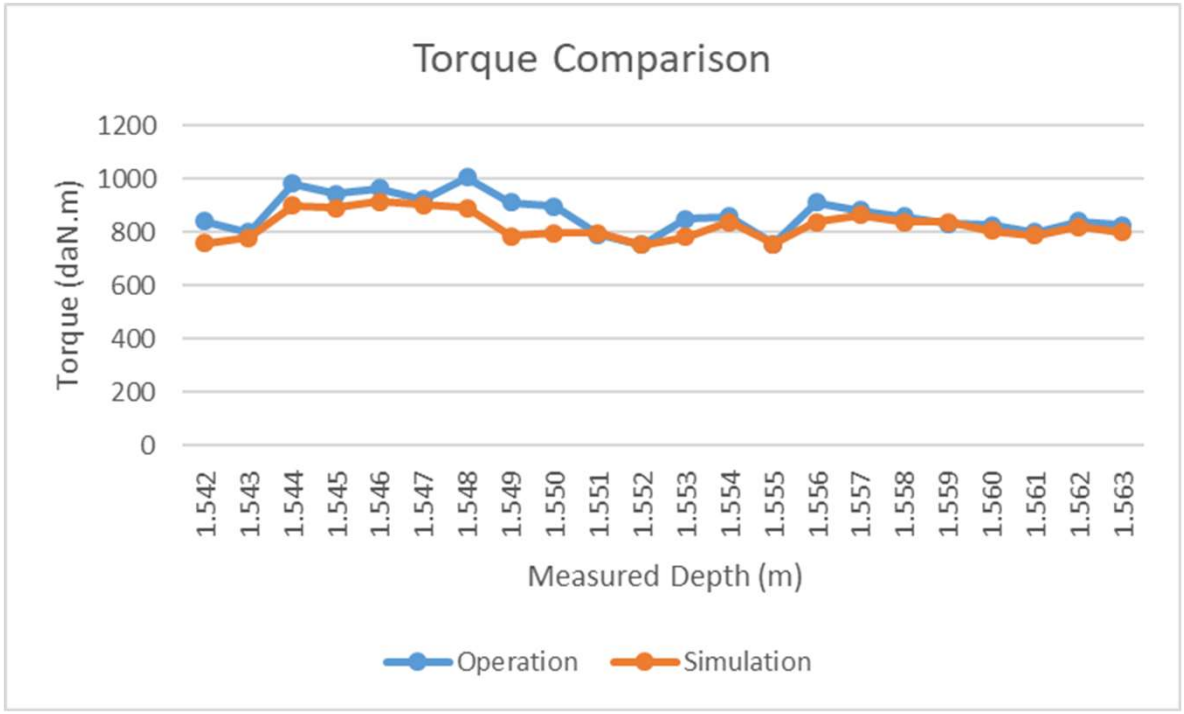


(WOB at parameter input depth)



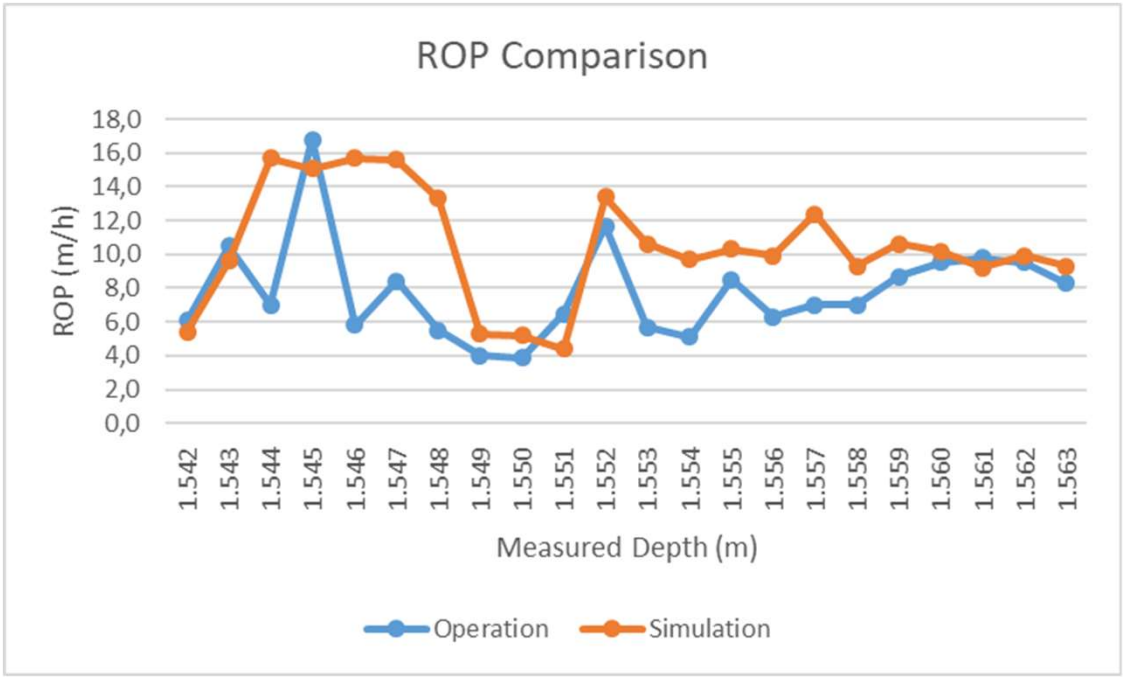
(WOB at parameter input depth with iteration time)

Torque



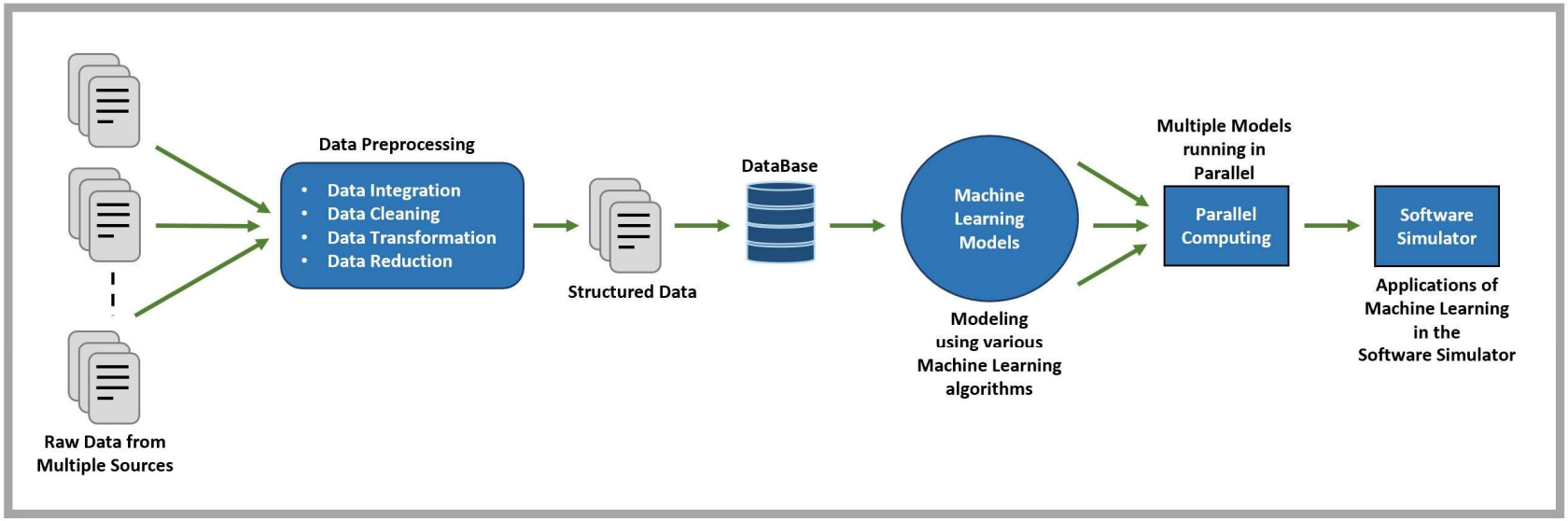
(Torque comparison at parameter input depth)

ROP



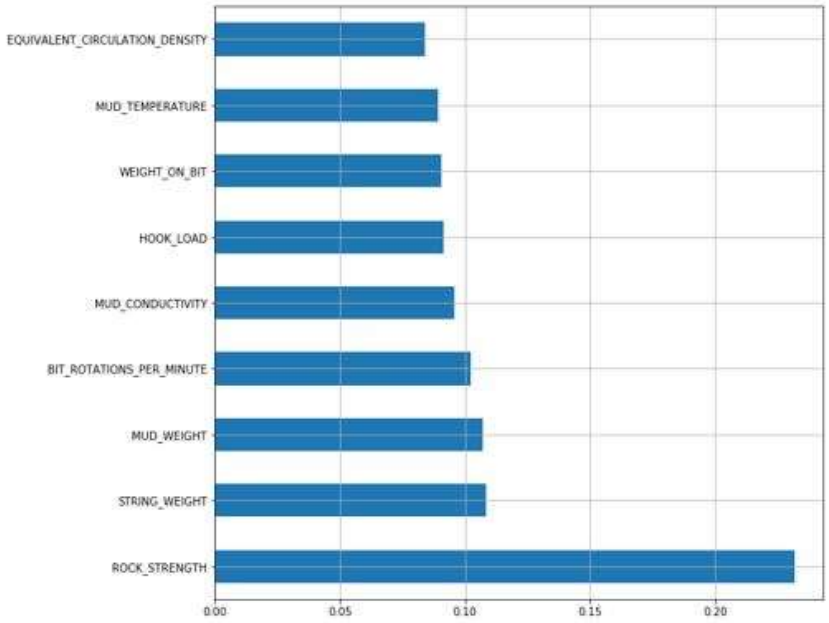
(ROP comparison at parameter input depth)

Machine Learning Application



(Machine Learning Application Workflow)

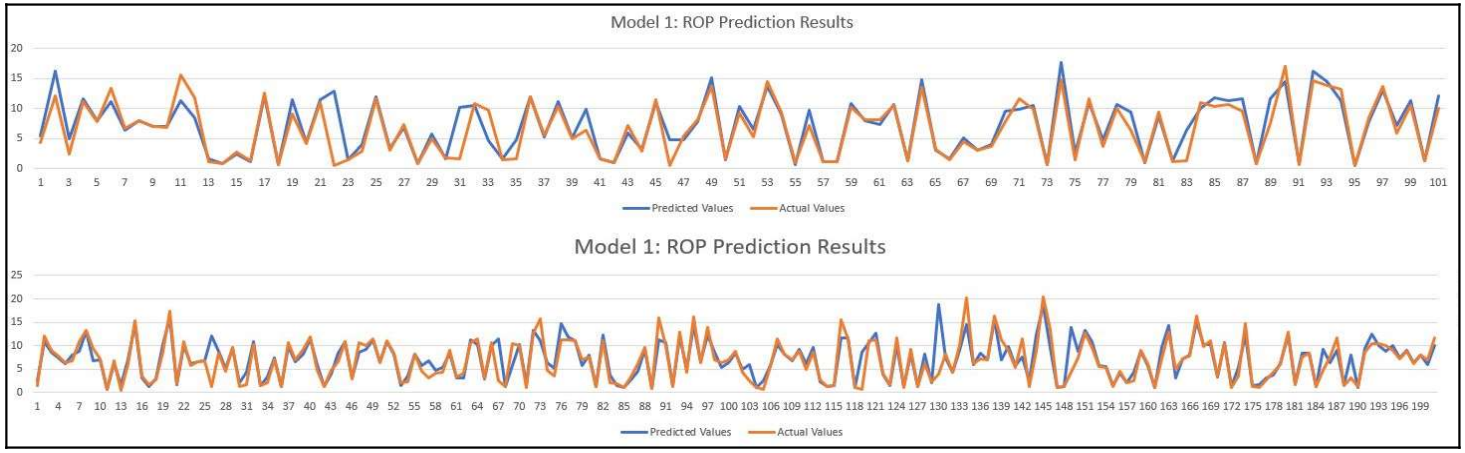
Machine Learning Model Application - ROP



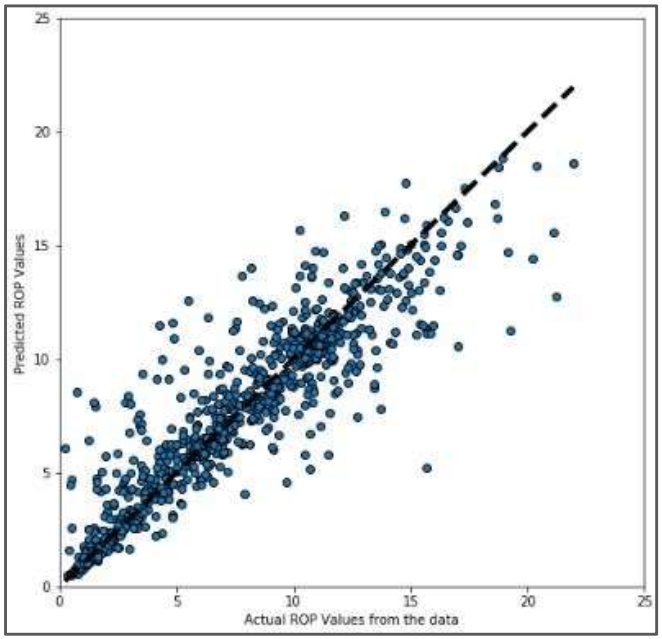
Features	Features Importance
EQUIVALENT_CIRCULATION_DENSITY	8.40 %
MUD_TEMPERATURE	8.90 %
WEIGHT_ON_BIT	9.04 %
HOOK_LOAD	9.12 %
MUD_CONDUCTIVITY	9.59 %
BIT_ROTATIONS_PER_MINUTE	10.25 %
MUD_WEIGHT	10.72 %
STRING_WEIGHT	10.82 %
ROCK_STRENGTH	23.17 %

(Machine Learning Model – Features Importance)

ROP – Machine Learning Model



(Results of ROP Machine Learning Model)



(Comparison between Predicted and Actual Values of ROP)

Conclusions and Future Work

- A wellbore was recreated and a section of the wellbore was successfully simulated
- An automated program was created to utilize the drilling parameters inputs from the original operation
- The scenario drilling simulation outputs were able to follow the same trends and patterns as the actual drilling operation
- Improve the automation program to simulate drilling a complete wellbore
- Improve simulation results by implementing more machine learning and physical models

Thank you

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