Virtual Well Construction

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V3

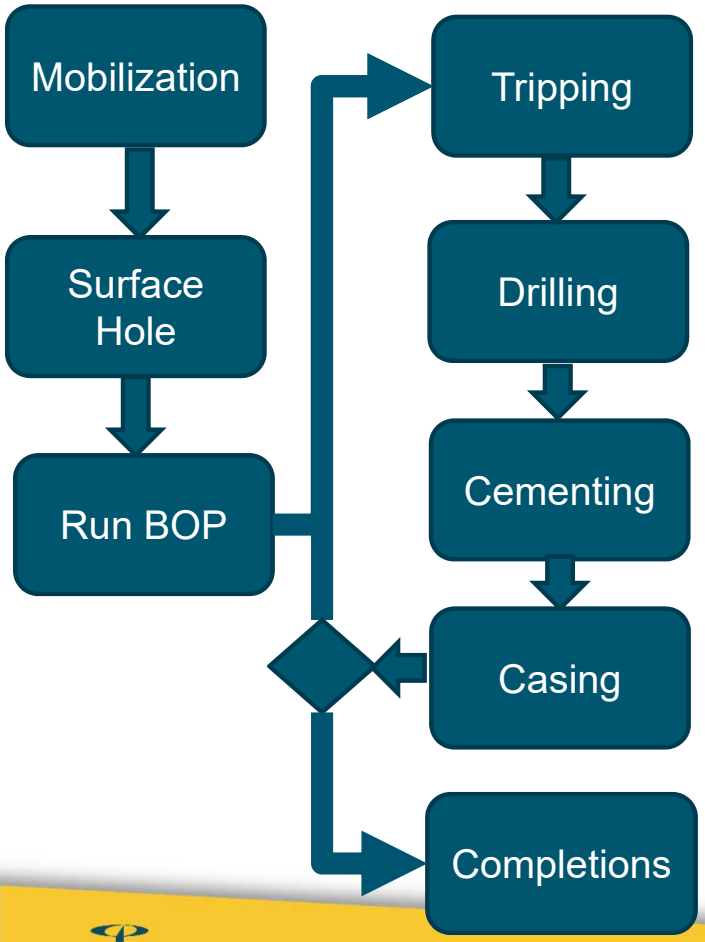
Offshore Drilling Rig

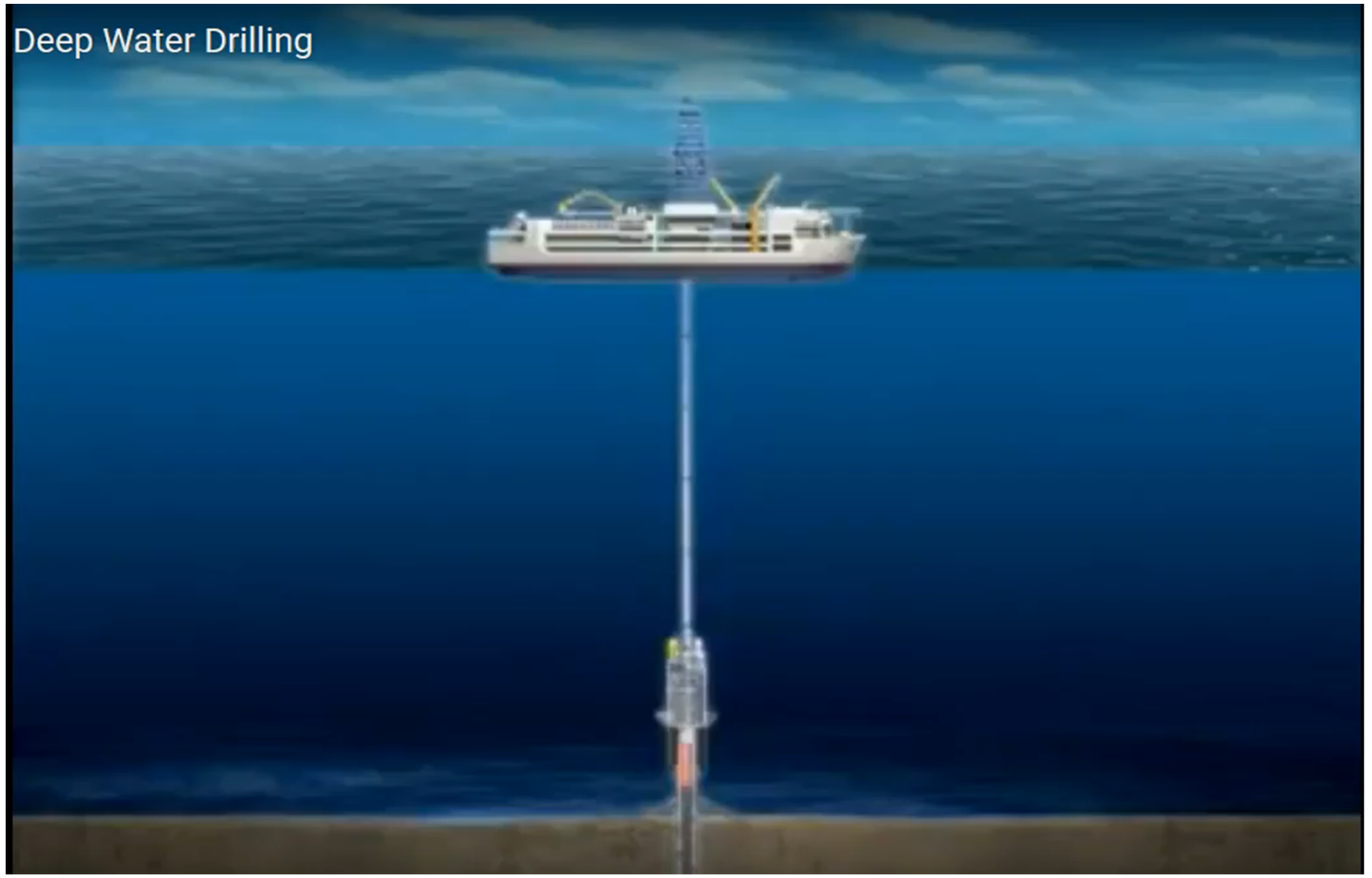
Complex System of Systems

- Dynamic Positioning
- Power System
- Derrick Hoisting
- Mud Systems
- Cementing Systems
- Racking Systems
- Blow out prevention
- Diverter Systems
- Cranes & Conveyors
- Deck Management
- Supply Warehouse
- Living Quarters
- Helideck

Operating in Remote and Harsh Environments

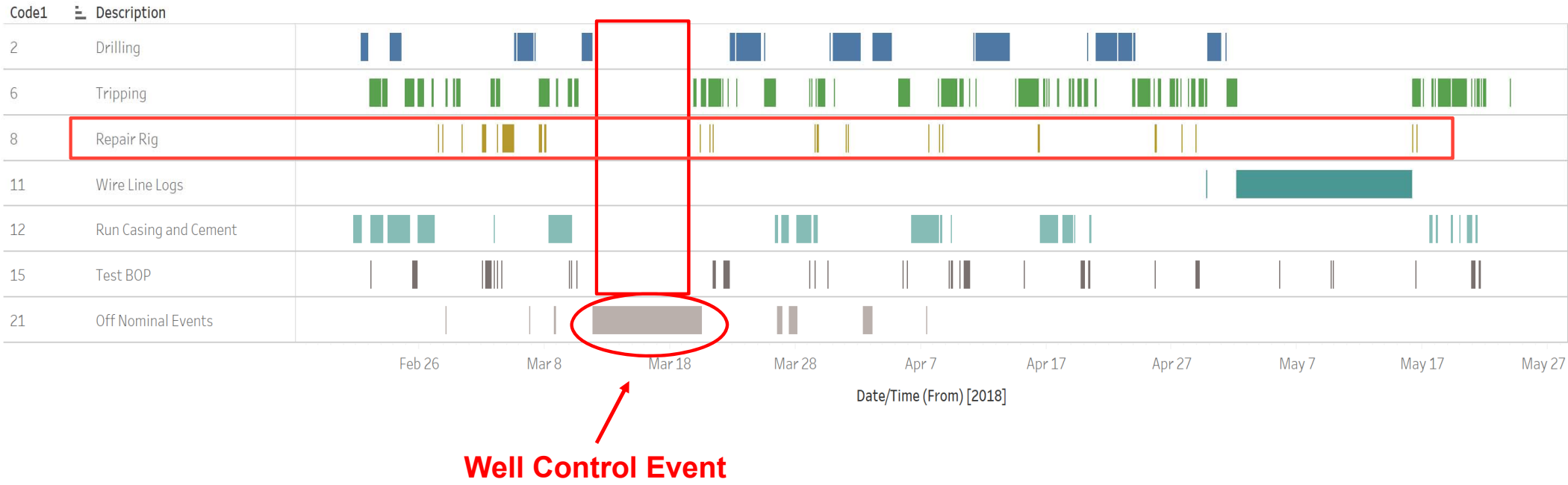
Well Construction Process Flow Chart



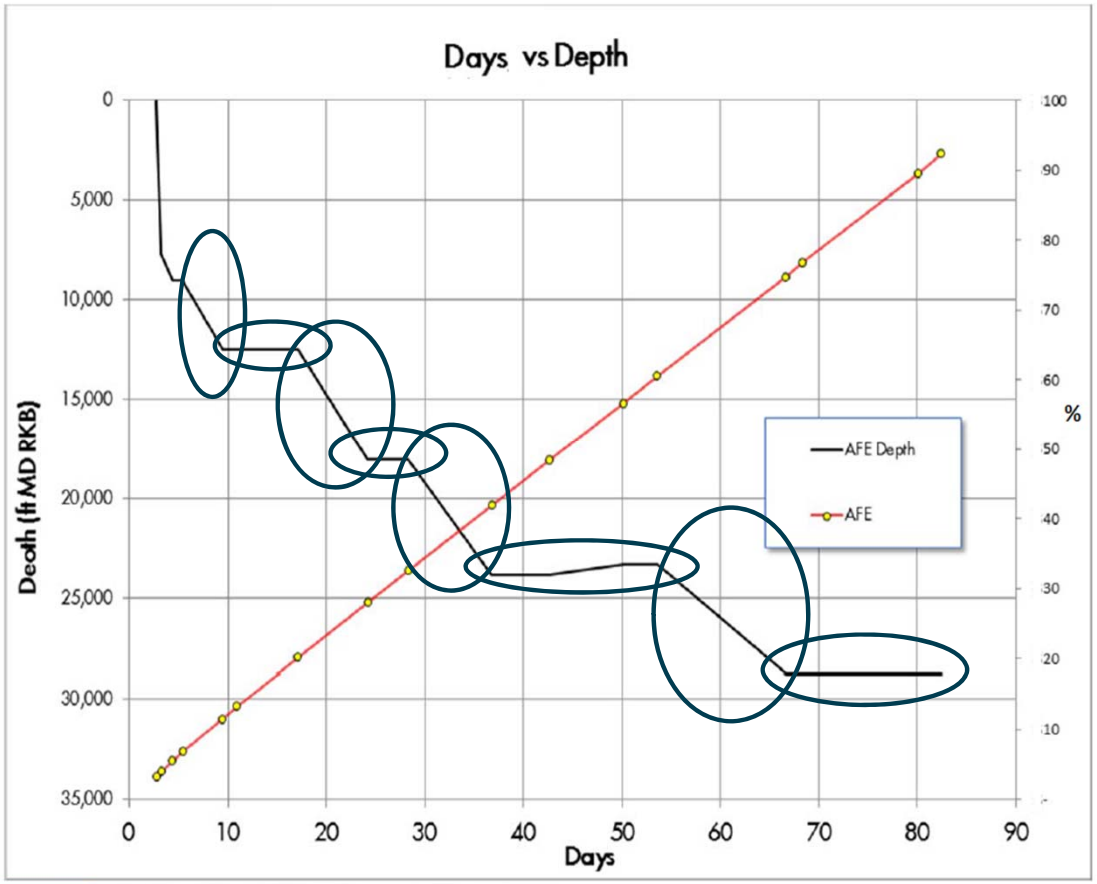


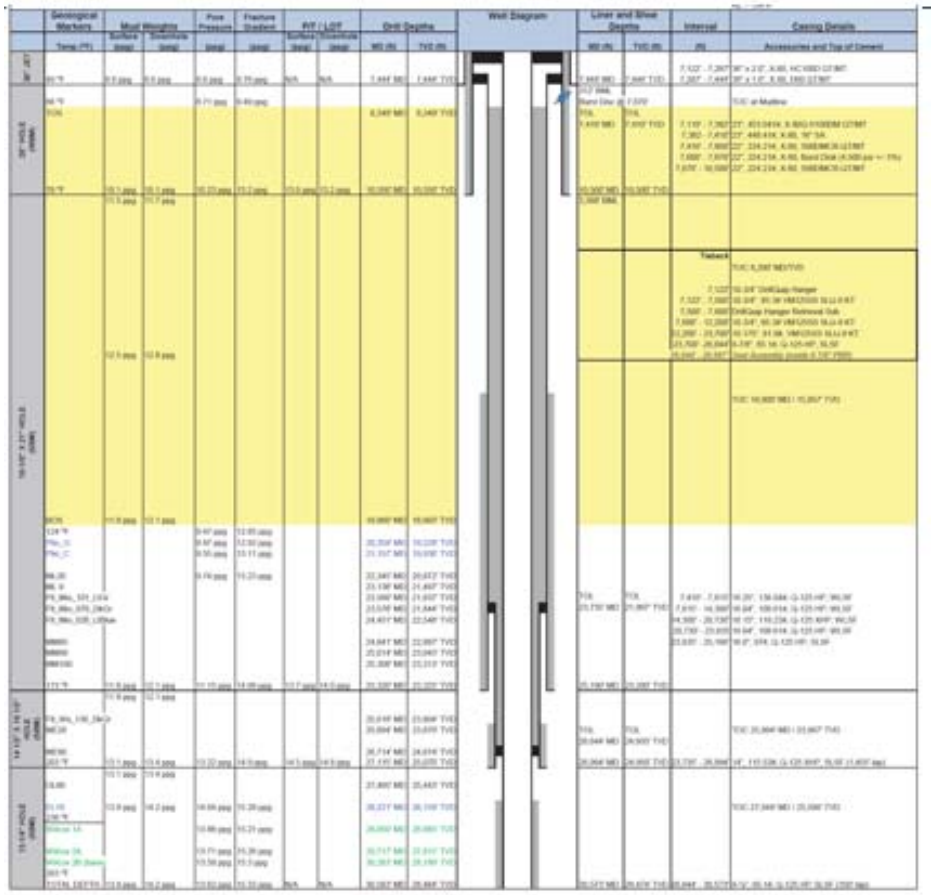
Reference : Center for Deep Earth Exploration

Well Construction Process Gantt Chart (Actual Log Data)



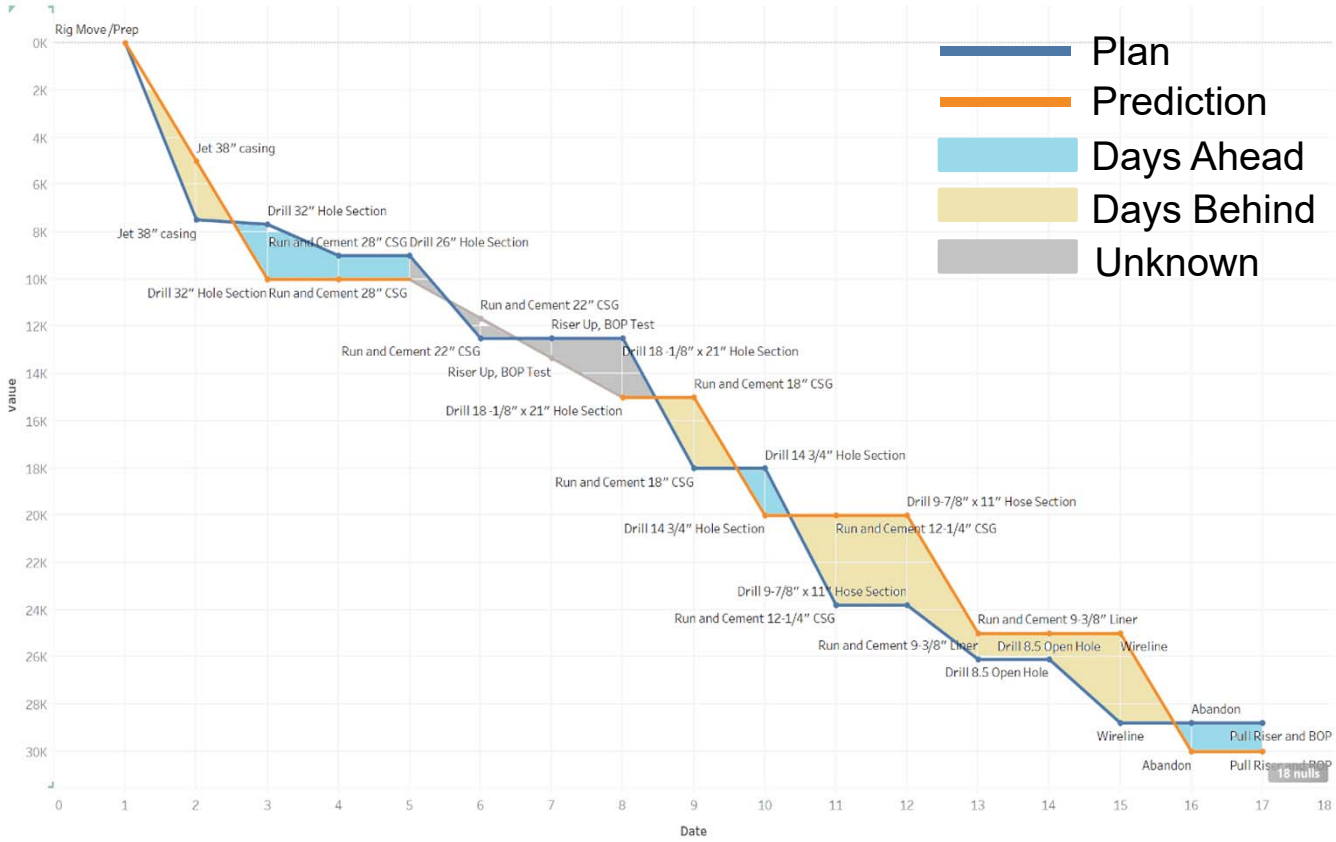
Time Depth Curve





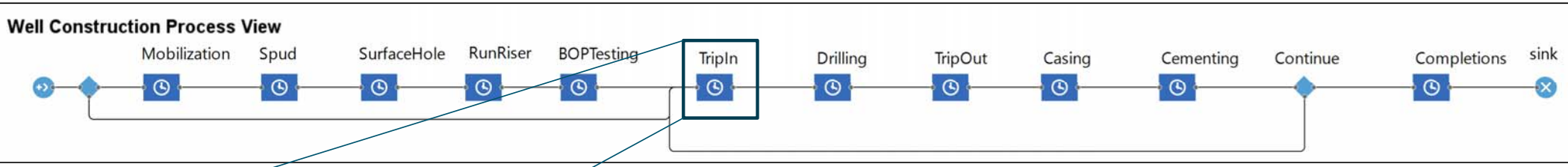
What if we could simulate the process and predict the Time/Depth?

- Enables advanced planning capabilities for supply chain
- Enables strategic incentive based contracts
- Enables known performance bounds
- Enable ‘what if’ scenarios for machine/process/policy changes
- Enables optimization and performance improvement

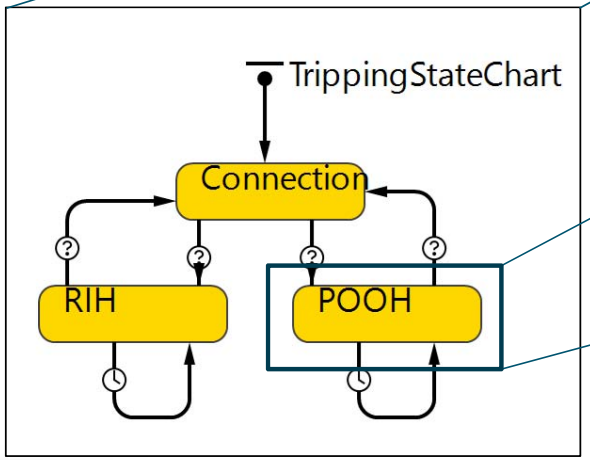


Prediction Simulator – AnyLogic Process Logic

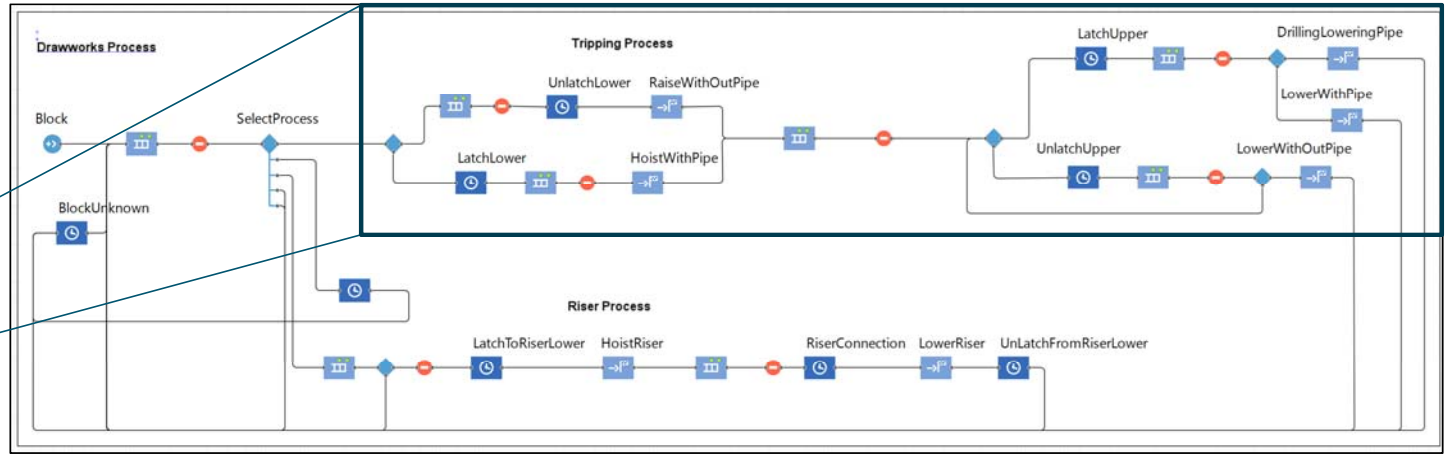
Main Process



Process States

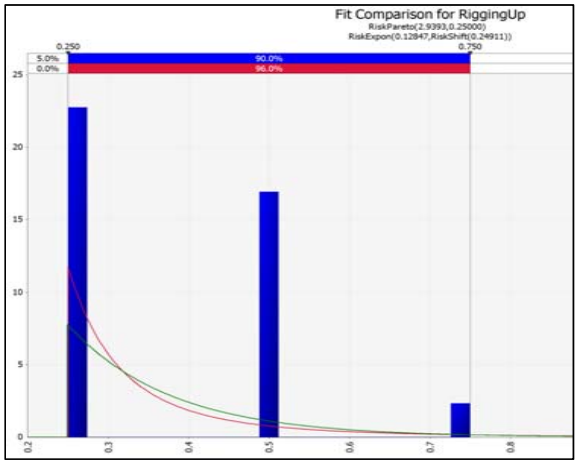


Machine Level Process

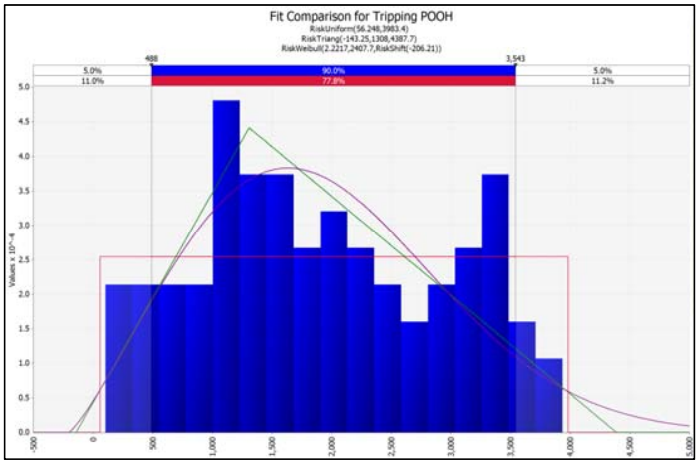


Prediction Simulator – Process Distributions

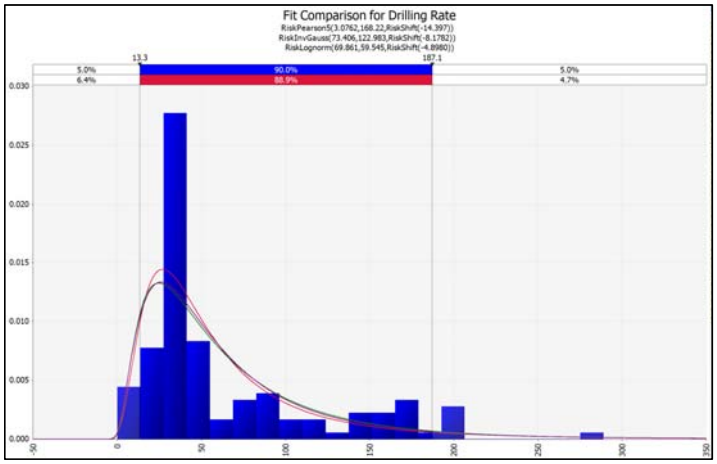
Depth Independent



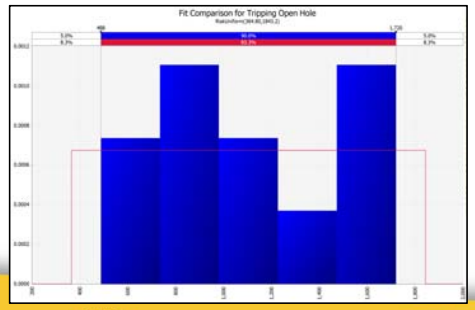
Depth Dependent Rate



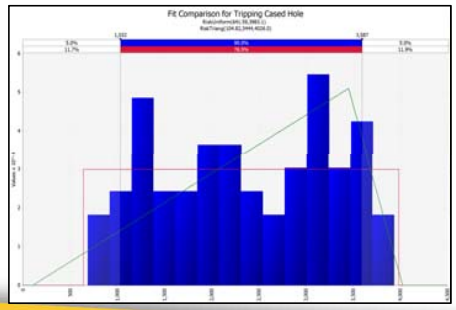
Section and Depth Dependent



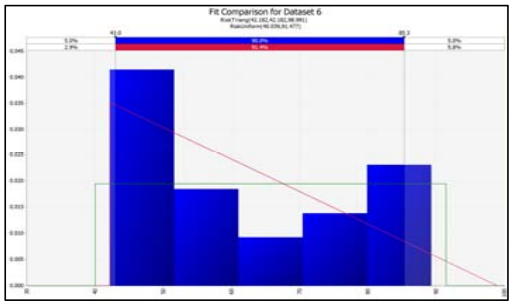
Tripping - Open Hole



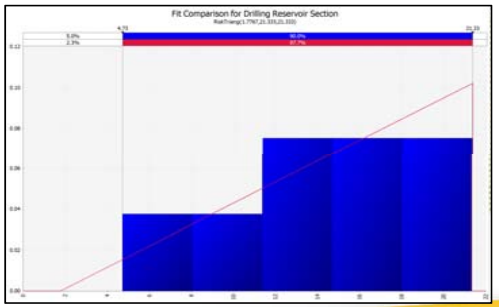
Tripping - Cased Hole



Drilling - Production



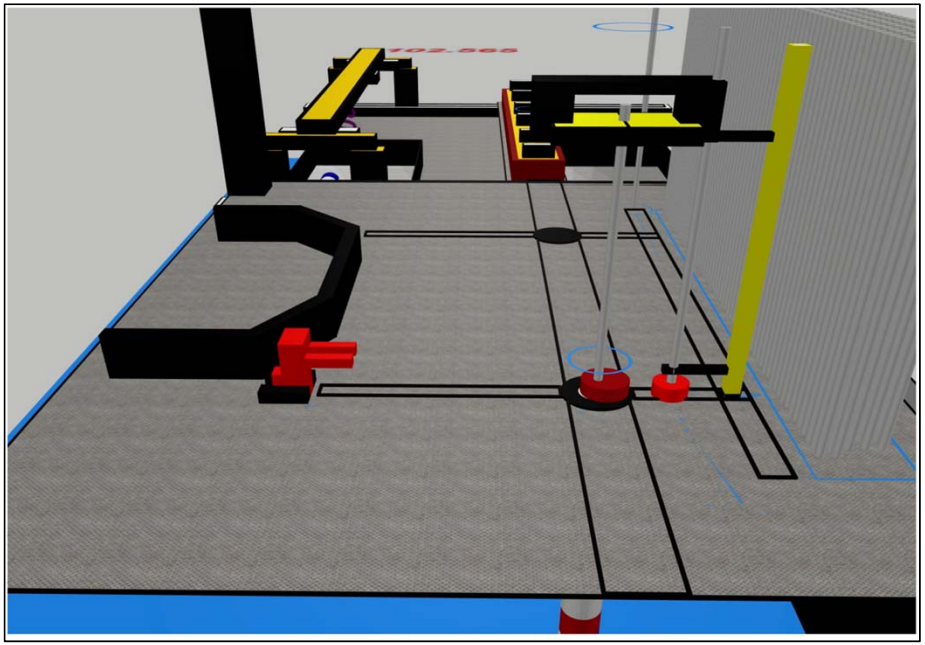
Drilling - Reservoir



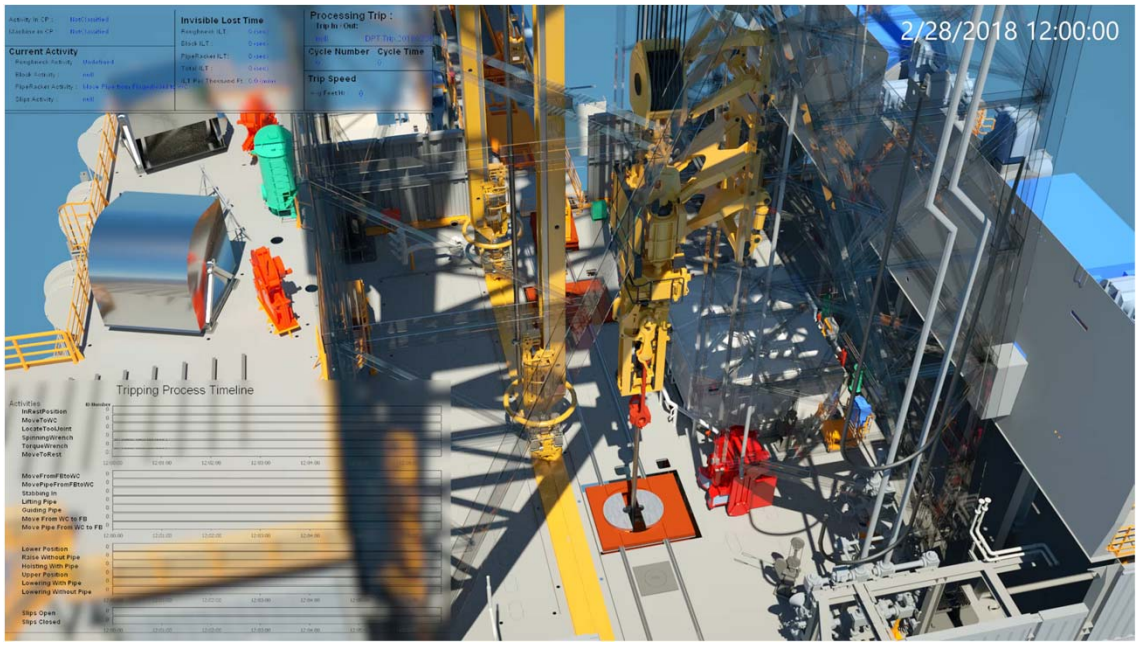
Transocean

Prediction Simulator – 3D Model

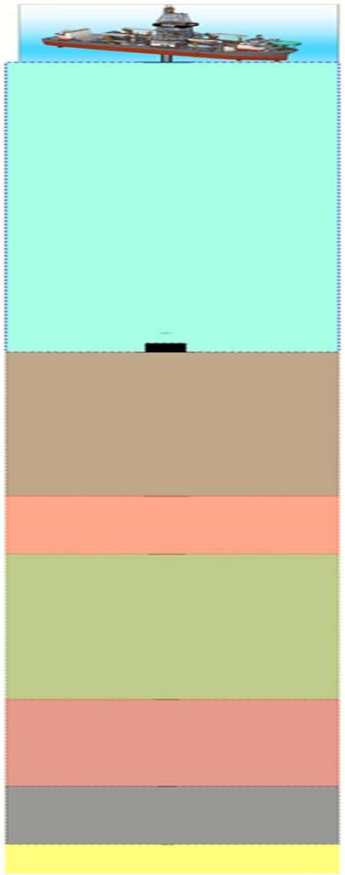
AnyLogic Model

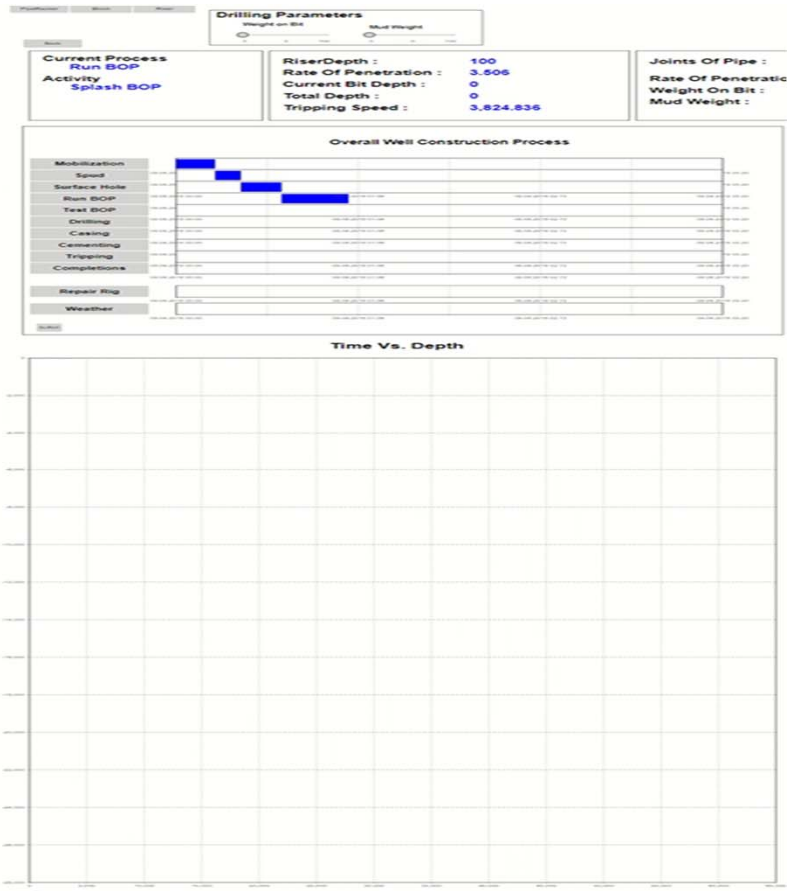


API to Unreal Gaming Engine



Prediction Simulator – 2D Well Profile and Time/Depth



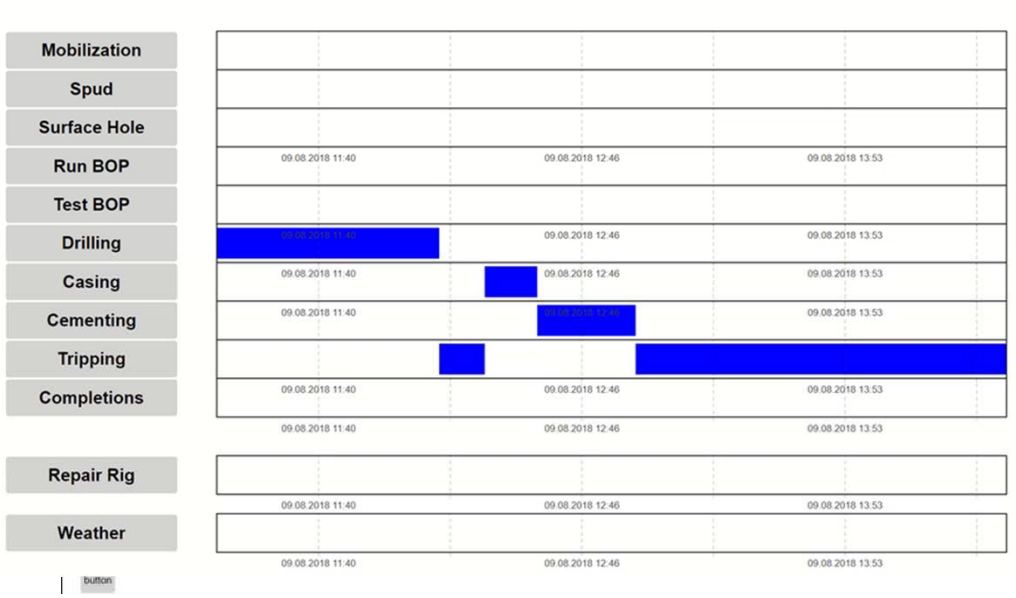


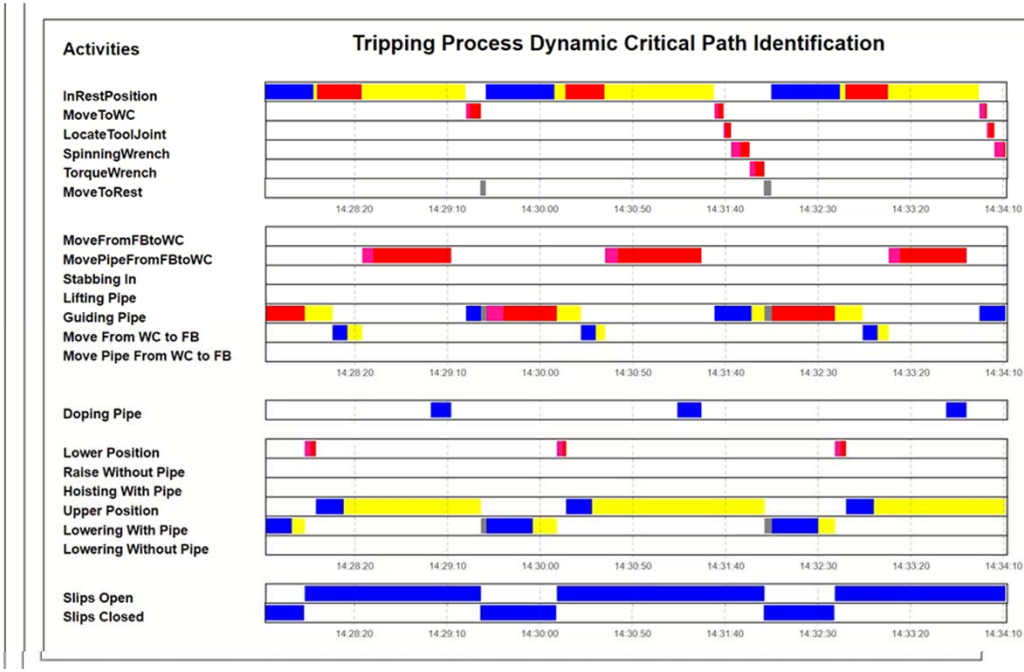
Prediction Simulator – Activity Report Out

IADC Time Log

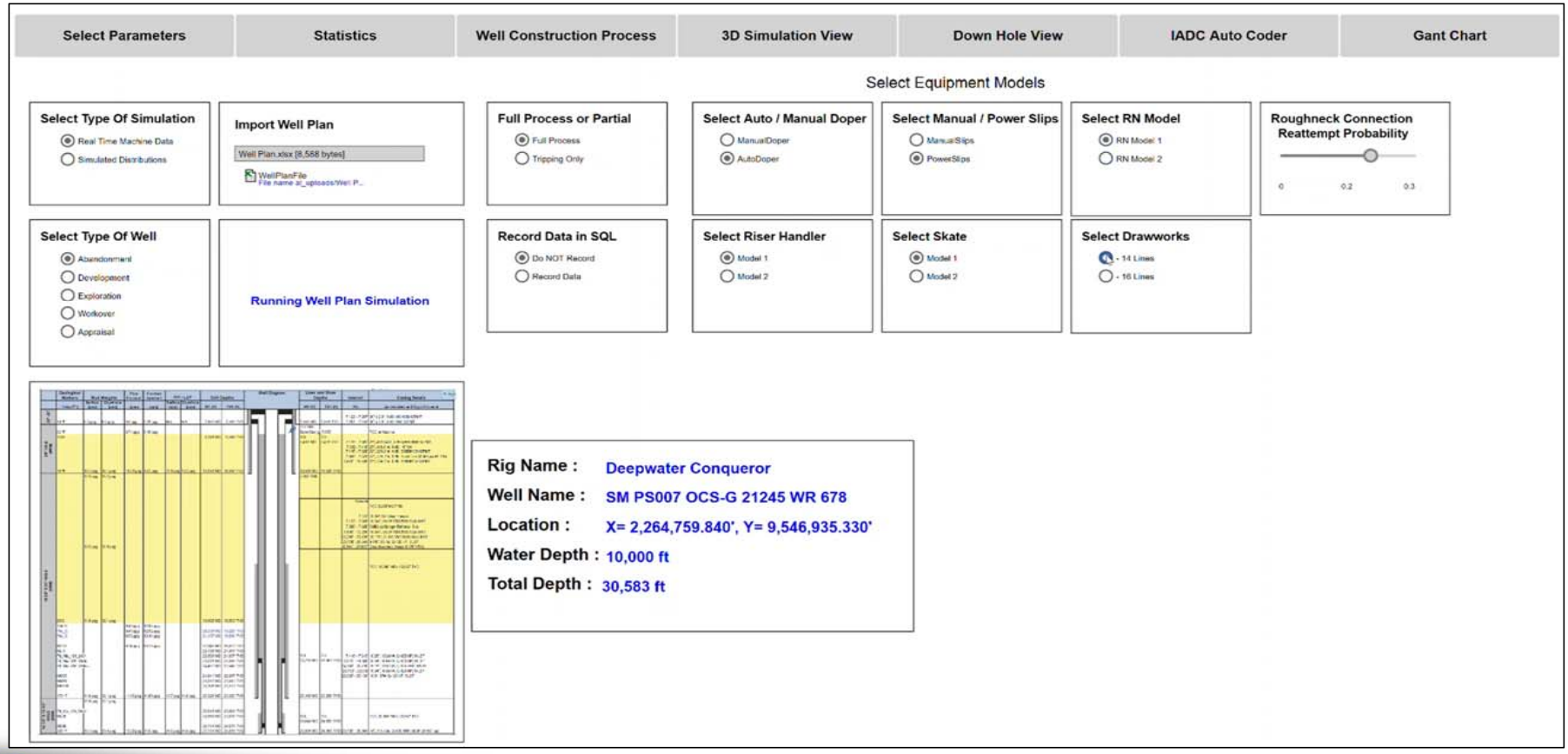
Process	Subcode	Start Time	End Time	Total Duration
Make Up Riser Double	14.2220	08/09/2018 00:38:36	08/09/2018 00:47:25	529
SurfaceHole	3.248	08/09/2018 00:23:42	08/09/2018 00:38:36	894
Spudding	2.034	08/09/2018 00:14:14	08/09/2018 00:23:42	568
Mobilization	1.0012	08/09/2018 00:00:00	08/09/2018 00:14:14	854

Prediction Simulator – Activity Gantt Chart – Critical Path





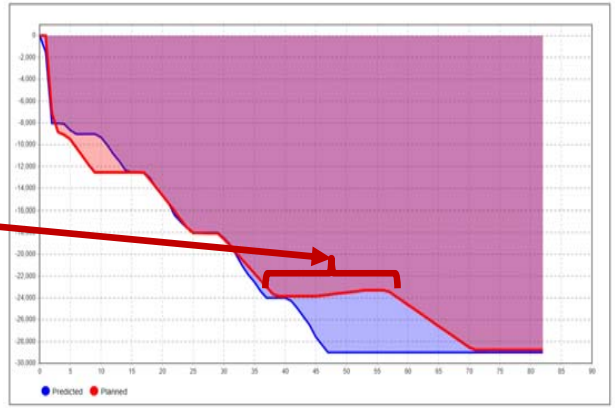
Application Front End

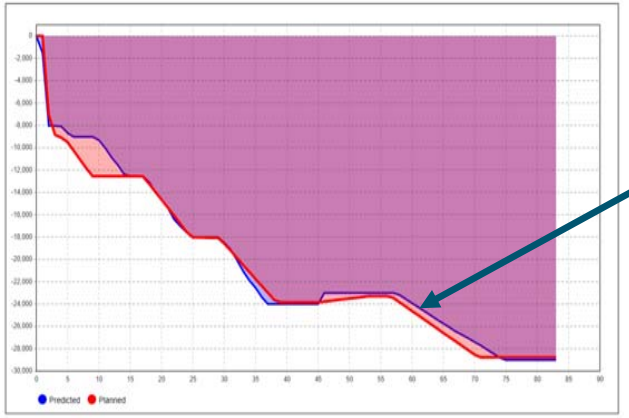


Simulation Results : Planned - Predicted - Actual

Planned **vs** Predicted

Planned Contingency

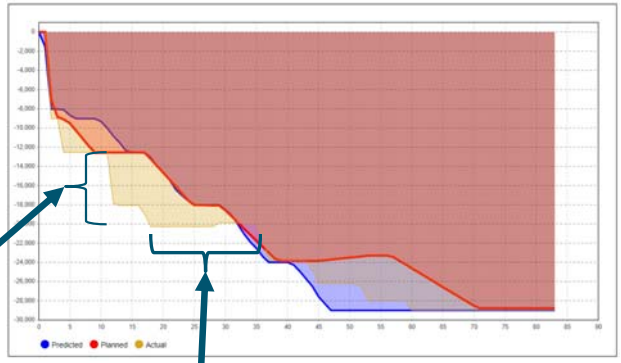




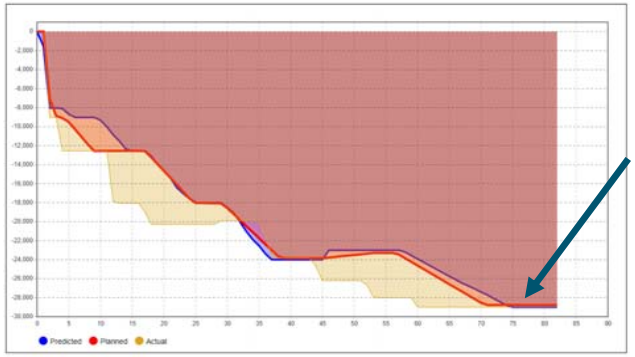
With Simulated Contingency

Planned **vs** Predicted vs Actual

Reached 20k feet
~15 Days ahead of plan!



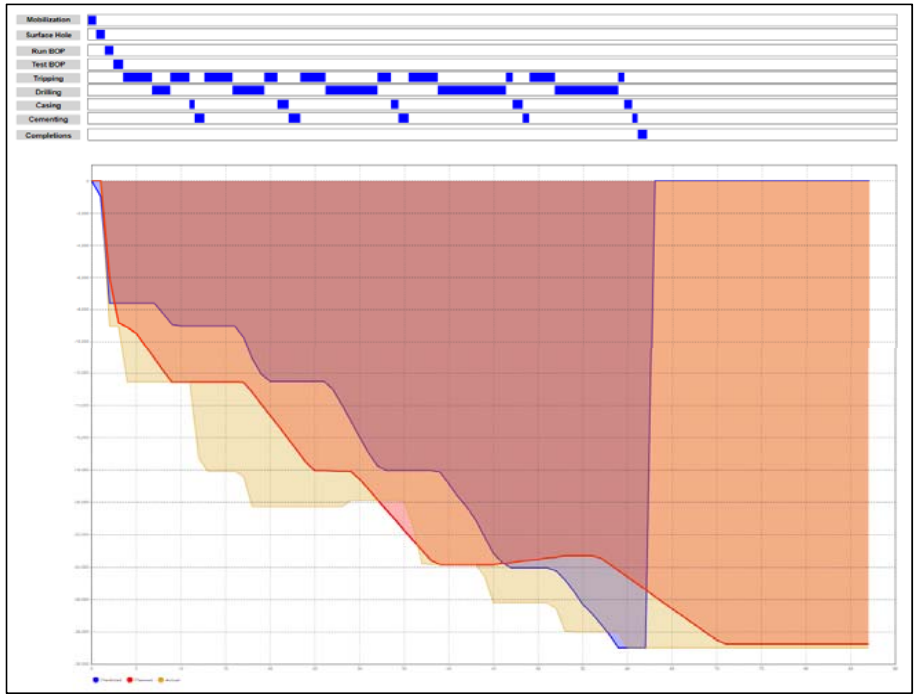
What Happened here?



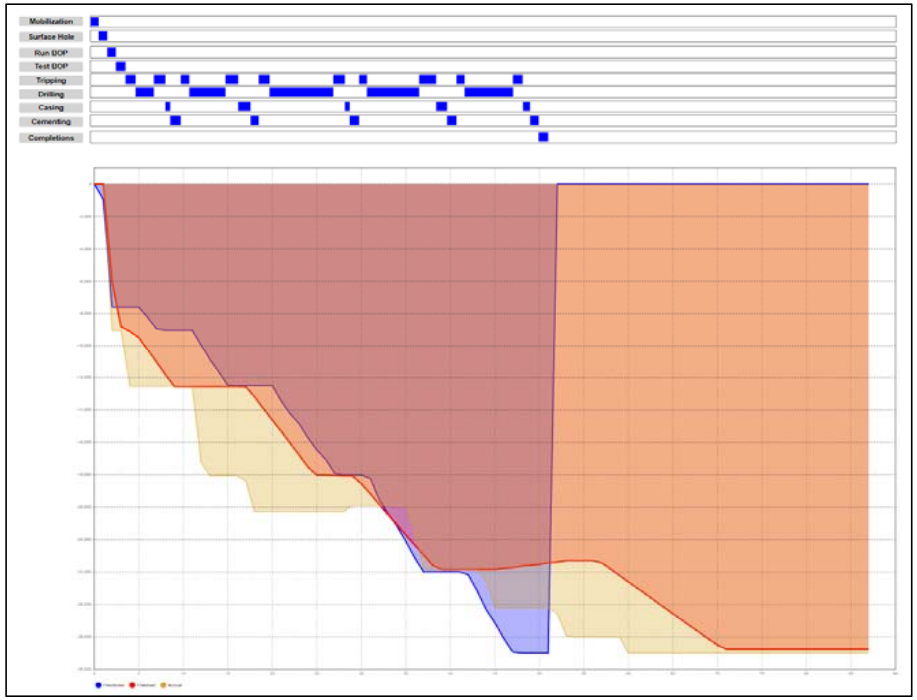
Planned, Predicted and Actual all show well completion times about same time : ~80 days

Drill Floor Equipment - What If Scenario

Existing Drill Floor Package ~ 62 Days



New Auto Tripping Floor Package ~ 51 Days



Given ~11 Day Faster Well Delivery

- Justifies equipment CAPEX to improve efficiency effectively reducing OPEX
- Enables another well can be drilled per rig/year (51 days per well, 7 wells per year)

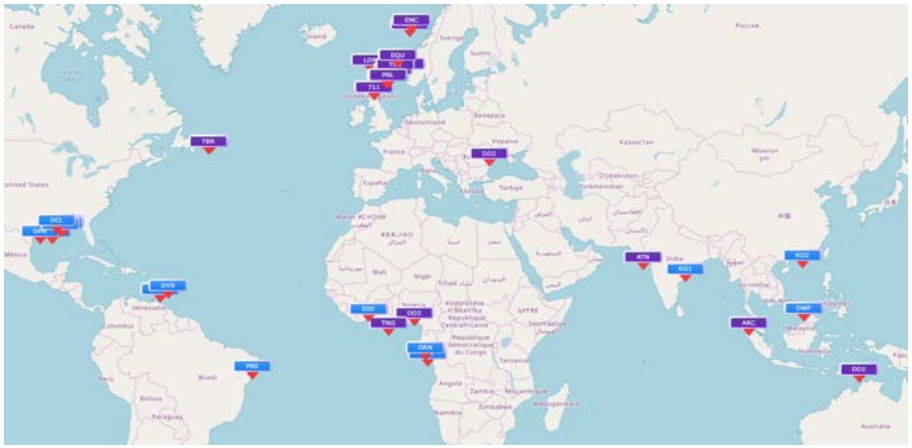
Future Enhancements : Interruptions and Off Nominal Trigger Events

- Failure to Function
  - Repeat Attempts
- Failure to Operate
  - Complete redo back to last process step or milestone

- Dynamic Downhole Conditions
- Out of Consumables Supply
- Equipment Failure
- Waiting on Third Party
- Weather Events
- Safety Events
- Many Others!

Future Enhancements

- Robust Architecture
- Simplifying logic to be rig/well agnostic
  - Multiple Rig Classes
  - Multiple Well Types
  - Multiple Regions
- Process Interruptions
- Off Nominal Trigger Events



Questions?

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V3