# Well Intervention Advisor (Training Case)

## Introduction

The Zinc onshore oilfield is an important asset for Claroil E&P, with a daily average production of >300,000 barrels of oil per day (bbl/d) and over 50 active production wells. As Zinc enters its third year of continued operation, oil production has started a natural decline.

Zinc wells are increasingly likely to require intervention jobs (or workovers) in order to prevent or mitigate problems which can lead to suboptimal production. For this purpose, Zinc wells are ‘tested’ on a regular basis. Well testing consists of a light intervention operation in which the individual oil rate, water cut and gas-to-oil ratio are measured. While the benefits of frequent well testing are clear, there are also cost implications and logistical constraints at play. The optimal well testing program is a function of technical, logistics and business drivers.

As the head of Production Operations for the Zinc Field, you are ultimately responsible for maximizing oil production and optimizing operational expenses. Well testing and well intervention falls within your accountability. Recently, Claroil’s Central Digital Transformation Unit has briefed you on the benefits of using MAANA’s Knowledge Platform in support of Zinc’s business objectives. From these conversations, you’ve understood that the MAANA platform would allow you to create a digital twin of your business processes, so that you can improve decision making around which production wells to test and intervene, ultimately targeting an optimal profit in the next business cycle.

## User Experience Mock

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## Top-Level Problem Question

* Given active oil producing wells, what are the profit enhancement opportunities?

Notes:

* Profit opportunities function of (1) incremental revenue (2) cost reduction

## Production Management Drivers

At a fundamental level, production management starts from comparing the production forecasts prepared by the Petroleum Engineering department (from simulation models) with the measurements from Well Tests. If the differences between predicted vs. measured are larger than a given threshold, this might be an indication of an anomaly in the well, which might require intervention. The specific well-by-well variables to be compared are:

* **Oil flow rate**: oil production from each well expressed as barrels per day (bbl/d)
* **Water cut**: percentage of water production over total liquid production for each well. Calculated as [Water Flow Rate / (Water Flow Rate + Oil Flow Rate)], (%)
* **Gas to Oil Ratio (GOR)**: gas production over oil production for each well, expressed as standard cubit feet over stock tank barrels (scf/stb)

Further, a well health index can be calculated according to Business Logic (Detailed later in the document).

## Operational Drivers

These include:

* Cost of well testing operation (on a well by well basis)
* Cost of well intervention (based on type of intervention and well characteristics)
* Operational constraints (well testing crew maximum capacity)
* Intervention budgets

## Datasets

* Expected daily rates for a 2-year period and 15 wells: expected.csv
* Well tests performed during a 1-month period (measured rates): measured.csv
* Interventions and constraints: constraints.csv

# Business Logic

Revenue Increase following well intervention = Measured Oil Rate \* % Increase in Oil Rate \* Oil Price \* 180

Cost of Ignoring a Test = Measured Oil Rate \* Probability of Anomaly if no Well Test is conducted \* Oil Price \* 60

## Business Logic for Determining Type of Well Intervention

IF Water Cut Gap (i.e., Measured – Predicted) > 7%, THEN “WATER SHUT-OFF”

IF Oil Rate Gap [100 \* (Predicted – Measured)/Predicted] > 8%, THEN “HYDRAULIC FRACTURING”

IF Oil Rate Gap [100 \* (Predicted – Measured)/Predicted] > 5%, AND < 8%, THEN “ACIDIZING”

## Health Index Logic

WC\_HI = 1 – ABS [(Forecasted WC – Measured WC) / Forecasted WC]

IF WC\_HI < 0, THEN WC\_HI = 0

IF WC\_HI >1, THEN WC\_HI = 1

GOR\_HI = 1 – ABS [(Forecasted GOR – Measured GOR) / Forecasted GOR]

IF GOR\_HI < 0, THEN GOR\_HI = 0

IF GOR\_HI >1, THEN GOR\_HI = 1

OR\_HI = 1 – ABS [(Forecasted OR – Measured OR) / Forecasted OR]

IF OR\_HI < 0, THEN OR\_HI = 0

IF OR\_HI >1, THEN OR\_HI = 1

HI = 0.33 \* WC\_HI + 0.33 \* GOR\_HI + 0.33 \* OR\_HI

## Business Logic for Determining Well Testing

IF Health Index (HI) >= 0.8, THEN Probability of Anomaly from No Test = 0

IF Health Index >= 0.5, AND < 0.8, THEN, Probability of Anomaly from No Test from Dataset

IF Last Well Test was performed more than 60 days ago, THEN Probability of Anomaly from No Test = 100%

IF Health Index < 0.5, THEN Probability of Anomaly from No Test = 100%

# Appendix

## Supporting Problem Questions

* Given wells and constraints, what are opportunities?

Additional Notes:

* + Opportunities = intervention & skipping tests
  + Constraints = budget constraint and man hours

## Incremental Revenue Related Questions

* Given predicted rate and measured rate, what intervention types are applicable?
* Given a well and an intervention type, what is the intervention incremental revenue?
* Given a well and an intervention type, what is the intervention cost?

Additional Notes:

* + Given a well, what is measured result?
  + Given a well, what is predicted result?
  + Assume fixed cost

## Operating Cost Reduction Related Questions

* Given predicted rate and measured rate, what is the health index?
* Given a well and a test, what are the savings of skipping the test?
* Given a well and a test, what is the cost of skipping the test?

Additional Notes:

* + Refer business logic (formula)
  + Assume the saving is the fixed cost of doing the test
  + How much savings can be made by reducing the frequency of tests
  + Assume it is a function of the well health index, last test time, and the well production rate.
  + Attach to probability of an anomaly and its financial impact (Ex. Probability of anomaly: 5%, oil production loss from anomaly: 80% of total oil production => potential cost may offset the saving in skipping a test)
  + Anomaly in this context refers to an unexpected reduction in oil production rate
  + Question helps determine risks – environmental, regulatory etc.