Value of Information (VOI) Concept to Systematically Justify Observation and Appraisal Wells*

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Abstract

The Oil and gas industry is a world full of uncertainties which covers a wide spectrum, starting from reservoir parameters (static or dynamic) as well as optimal development options and operating conditions. Business decisions, whether to execute the project, determining the size of the development, etc.) often cannot be done amidst uncertainties, so activity to reduce uncertainty is necessary to ensure the success of a project. It was thought previously that exponentially growing computing power and data storage capacity we have in this era would easily tackle the job, but this just adds complexities to the existing problem. We tend to incorporate more data and variables with uncertainties so that realistic results can be obtained. The subsurface project is a classic example of how data can easily accumulate and quickly become unmanageable for the purpose of decision making processes. Uncertainties can arise here and there requiring reduction of data gathering. Surveillance technologies also improve significantly, giving more options and adding motivation to the field operator.

In order to justify this extra cost, is it a necessity or a mere 'nice to know'? A robust flow process needs to be established in order to communicate effectively with the stake holder for the decision making process. Decisions of whether to conduct activities such as drilling an appraisal well, placing observation wells, shoot a seismic survey, obtain core samples, conduct PVT - these often are difficult choose because they typically involve relatively high cost compared to the project size and remaining reserves. There is a point where the cost of additional information (drill new wells, seismic survey, etc.) exceed benefits.

VOI analysis provides a structured method to quantify whether information gathering is wasteful or worth the cost. Therefore, VOI analysis will improve the economics of the project. This article demonstrates a way to address this problem through the use of the VOI (Value of Information) concept with examples from appraisal and observation wells. This method involves translating probabilistic production forecasts of the project into economic parameters, such as DPI, NPV, and payout time. A decision tree is constructed and examined, then a node in the tree is selected to represent the gathering of additional information. Calculations are performed to obtain Value Of the Information, which then is compared to the cost of the activity to determine whether if it is justifiable or not.

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Background

- Oil and gas industry is a world full of uncertainties, from reservoir parameters (static, dynamic) to development options and operating conditions, fiscal regime and regulation to oil price.
- Business decision often cannot be done amidst uncertainties so that activities to reduce them deemed necessary to ensure the success of a project.
- It was generally thought that exponentially growing computing power and data storage capacity will easily tackle the job but it was found out that these facts just add complexities to the existing problem.
- We tend to incorporate more data and variables with uncertainties so that realistic results can be obtained. However this is sometimes not balanced by equally strong systematic decision making process.
- Interestingly, despite the large money/stakes involved, the use of consistent, auditable criteria for subsurface appraisal is not widespread.
- Intuitive decision making are more common. A dominant team member or decision maker tend to be more ‘driving’ the decision than the other eventhough he/she doesn’not have a strong background on the subject. There’s also technology/ ‘good news’ bias (Lohrenz, 1988)

Background

- In the case of appraisal well, the reasoning commonly stated reasons such as: “delineation of the extent of the reservoir,” or “gathering relative permeability data,” or “... the appraisal will add Xxx MMbbl of reserves.” .
- However despite providing a technical basis it still not sufficient reasons for spending resources.
- Just like any activity in the petroleum industry, subsurface appraisal must be justified on the basis of its economic merits, and a “value” must be attached to any appraisal.
- Two principal sources of uncertainty (Warren, 1983):

  (1) estimated distribution of resources and

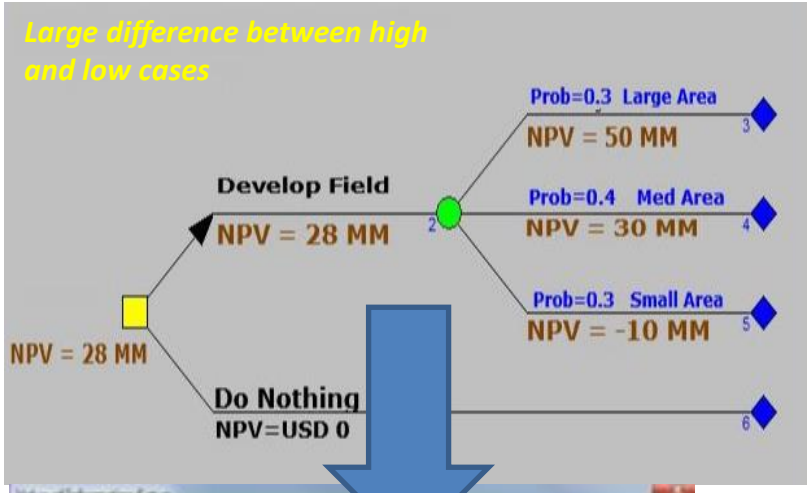
  (2) the cost of development.

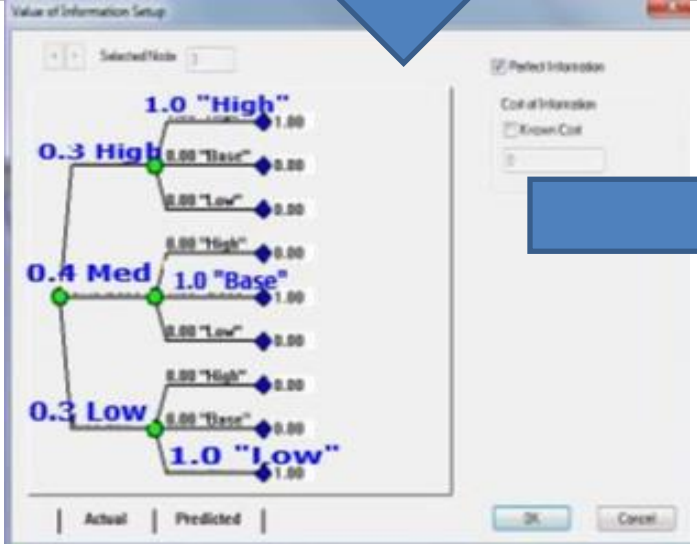
Case

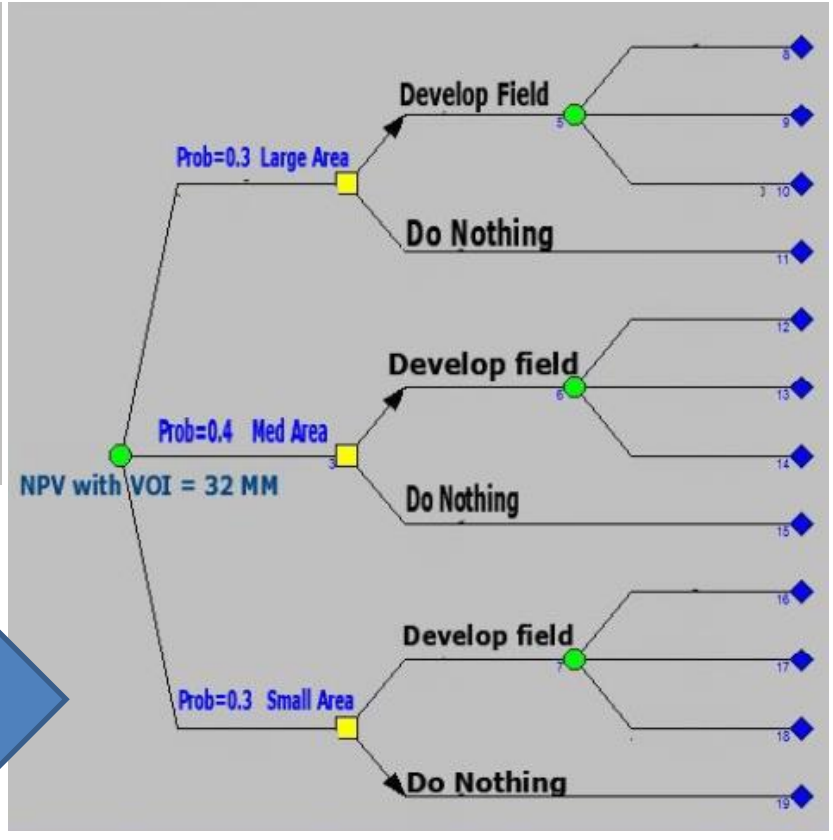
- A sub optimally developed oil field had been planned for a full field EOR development in order to move resources to reserves. Additional energy has to be supplied into the reservoir in the form of thermal/ chemical (Enhanced Oil Recovery/ EOR), otherwise would take an extremely long period to develop the field given the current development status.
- However after conducting subsurface assessment it was concluded that the reservoir model were inadequate to support capital intensive EOR project. Because static, dynamic reservoir data and reservoir quality vary laterally and vertically within the reservoir.
- Hydrocarbon volume are the highest uncertainty as the reservoirs were layered with high vertical and lateral heterogeneity with inadequate well control. Presence of gas cap and water bearing zone in some places add complexity to the field development.

Case

- To reduce the uncertainty and improve earth model and better reserves calculation, appraisal well project was planned.
- Information obtained from new cores and logging data of appraisal wells: lateral continuity/ compartmentalization (critical for EOR), fluid contacts (Gas-Oil-Water), permeability (reservoir quality).
- After Decision tree for main project was constructed it pointed to decision for full field development (EOR), however large difference between high and low case (50 MM VS -2 MM) made decision making process wasn't easy.
- Huge oil price drop in 2014 was the second biggest contributor to the large difference.
- VOI was then compared to the appraisal well project cost to determine whether it is justified or not (hold/ cancel project). For example if the oil price would rise in the future or there is a change in the fiscal regime, the VOI can quickly recalculated and updated.
- Another approach can be taken by reducing the project cost or changing the attribute of predicted information (imperfect - perfect information).







VOI = NPV with information obtained – NPV of project without information

VOI = 32 MM – 28 MM = 4 MM

Summary of Observation

- Decision tree and VOI analysis are valuable tool in both project or day-to-day activities in high risk oil and gas industry to :
  (1) formalizing and quantifying decision making. Intuition is less encouraged in high risk project decision making.
  (2) facilitate further analysis efficiently and conveniently. Exercise can be easily performed. Production component and uncertainty reduction component are put in one framework and can be easily exercised to better reflect business objectives.
  (3) communicate efficiently. Decision making process become transparent and accountable (less degree of freedom). The D-tree file can be handed over to subsequent project or other functional team.
  (4) promote efficient meeting. Agreement can be achieved quickly.
- A 'regular' infill well monetary value can be added using VOI, not just barrel of oil, that it will also improve reservoir model both static and dynamic. Best location for oil production is often the worst in term of VOI and vice versa. Balancing VOI and oil production sometimes required to get the project justified.
- VOI concept can also be used as a ranking tool in a portfolio of subsurface appraisal activities.