



## Expected Lifetime Performance of a Well

There is potential for value from simulations of the lifetime performance of production wells, in order to make better decisions on which types of enhancements to make to the wells, and when to let them die.

Typically, statistical models are used to make these kinds of decisions. For example, looking at all the wells in the field, one might be able to draw conclusions such as “The average life of our wells after they produce 10 barrels a day or less is 4.5 years.” Similarly, one can use statistics to draw conclusions such as “The average increase in production from a well after an acid treatment is 25%, lasting for 6.5 weeks, after which the production reverts to prior levels.”

Different types of wells will not be characterized well by these global averages. A well with production stimulated by a nearby injection well will have its performance influenced by the performance of the injection well. A well that does not need acid treatment will not respond noticeably if an acid treatment is administered to it.

For these reasons, it is possible to get more accurate measurements of lifetime productivity and shorter-term benefits if we consider features that distinguish individual wells. These features might include the condition of the rods, how long ago the last pump repair was done, the past production curves, and so forth. Data mining could be used to relate these features to expected future repair rates, production levels, and economic viability, but agent-based models can be used to derive even more accurate predictions.

As described above, the difference between statistical models, data mining models, and agent-based models lies in the types of information used by the agent-based models when modeling future well performance. For example, suppose there is a rule of thumb used by the production engineers that when the daily production of the well does not exceed the costs of production, the well will not be repaired after its next failure. Whether the well is repaired or not would then depend, at its next failure, on the price of oil, the price of power to run the well, and the price of the repair. These numbers could vary substantially over time, and their variations would not necessarily be correlated. It can be of great interest to simulate the probable future production levels and repair events for a well, against a background in which the prices of oil, electricity, and repairs can fluctuate in a historically realistic manner.

Perhaps the most important difference between the statistical models, data mining models, and agent-based models lies in the fact that the agent-based models include agents that make decisions based on the current state of the simulation, and these decisions feed back into the simulation to influence its further behavior. At the same point in two otherwise identical simulations, the same decision could be made differently if oil prices are low in one simulation. In this case, a repair might seem uneconomical, and the well would be retired. If oil prices were higher, in the second simulation, then the repair might be judged to pay off, the well would be repaired, oil prices might rise again, and the lifetime of the well could be many years longer. The feedback between actions made by human experts and actions of the economy and the well itself make the simulation process quite complex, and complex systems of this type are not best represented by statistical models.



It seems likely that a more accurate and more informative model of lifetime economic value could be implemented using the agent-based modeling approach. Armed with such a model, production engineers could add the effects of various well treatments and repairs to the model, enter their best estimates of behavior of the economic and vendor components of the model, and then run the model thousands or tens of thousands of times. The model would give the engineers a best-case, worst-case, and average case for the well's production levels and economic benefit. Such models could discount the value of money over the simulation period, and thus provide support for current decisions regarding the well.

**Partial Conclusion: Agent-based models of lifetime value can help in assessing what procedures to apply to a well to achieve their full value.**