Recent SPE ATCE paper presents first "official" case study of learning curve

Ryder Scott documented learning curve in shale plays four years before 2018 PRMS guidelines

Eight years ago, Ryder Scott built a database of the Wolfcamp play in the Permian Basin to examine correlations between recoveries and drilling-and-completion and reservoir variables.

The firm noticed that despite thick, reasonably consistent upper, middle and lower sections in Wolfcamp, drilling results were not consistent from operator to operator.

Ryder Scott assigned reserves to some locations in Wolfcamp that were significantly lower than what the firm estimated for reserves in adjacent locations.

The answer was at hand. The Wolfcamp database showed the strongest correlations were between recovery levels and operator. That logically addressed the cumulative knowledge and operational practices of each operator.

Ryder Scott was onto something then — the effect of a learning curve. In simple terms, the more someone performs a task, the better he or she gets at it.

Now "machines" in iterative processes provide reliable analysis through machine learning.

The learning-curve phenomena, first formalized in 1885, was introduced by the PRMS in 2018, giving producers valid arguments for boosting future net cash flows and reserves based on the curve.

The PRMS stated, "In oil and gas developments with high well counts and a continuous program of activity (multi-year), the use of a learning curve within a resources evaluation may be justified to predict improvements in the time taken to carry out the activity, the cost to do so, or both."

Latest ATCE paper breaks ground

Ryder Scott staff wrote an SPE technical paper of a case study that factors in the learning curve concept in the PRMS, making it the first published study to do so.

Lead author **Jeremy Xia**, senior engineer, said, "The recommended workflow in our paper will enable evaluators to book PUD reserves more appropriately, but not necessarily more PUD locations. I mention this because there is a tendency to believe the learning curve usually leads to positive results."

The paper, "Integrated Workflow for Reserves Evaluation in Permian Basin based on Monograph 3," is available at onepetro.org.

Other contributing authors are **Eric Nelson, Larry Connor, Dan Olds** and **He Zhang** — all from Ryder Scott.

"Monograph 3 does not fully address most situations and challenges in the paper, and some of them are common," said Xia.

The recommended workflows that lead to reliable resources reporting are not enshrined in the PRMS or blessed and codified by regulators.

Background, premise

In 2011, the Society of Petroleum Evaluation Engineers (SPEE) published Monograph 3 as an industry guideline for reserves evaluation of unconventionals, especially for probabilistic approaches. However, stochastic methods are not applicable during the early stages of field development, state the authors.

"From the start of a project, evaluators can only book reserves based on adjacent locations using the traditional analogy method, which, along with volumetric analysis, are used in evaluating conventional reservoirs," the paper states.

The authors considered more than 300 shale well locations in the Permian Basin. They identified analogous wells based on location, geology, and drilling-and-completion (D&C) technology. The next step in the workflow was to estimate technically recoverable resources (TRRs) of analogous wells.

The authors developed five type wells, identified drilling opportunities and conducted a Monte Carlo simulation to develop a statistical distribution for undeveloped locations in each type-well area.

The paper illustrates the construction of type wells and statistical distributions in some of 22 figures (charts) in the paper. Zhang presented the paper at the 2021 ATCE in Dubai.

Workflow

The use of probit plots and binning strategies were key in developing the type wells. Categorizing wells in accordance with their characteristics is referred to as "binning" in Monograph 3.

"That step can be subjective when done by inexperienced reserves evaluators, which may cause inconsistent, highly variable reserves evaluation results," stated the paper.

A common mistake in binning strategy is to include too many type wells based on a single criterion, which usually results in a very small sample size for each type well and indistinguishable differences in type well bins.

The authors illustrated this problem in a binning strategy that just considered well locations.

To determine the number of drilling opportunities, the authors had to consider similar ownership and operations management to factor in the learning curve.

Monograph 3 recommends using anchor wells to determine proved areas of a resource play.

The paper stated that the anchor well method to define a geological proved area is time consuming and offers limited benefits to enhance the reliability of evaluation results.

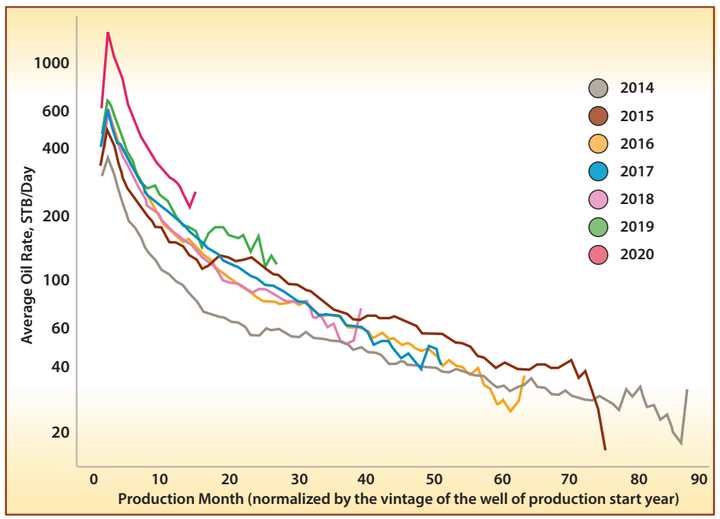
Consequently, the authors visually examined undeveloped well locations on a series of bubble maps and used their professional judgments based on knowledge and experience. Visualization was vital to the study.

Following the workflow steps in Monograph 3, the authors developed a lognormal distribution for the type wells.

When categorizing volumes, a common error is to multiply the number of undeveloped wells by the mean value from a log-normal distribution. This implies that the mean of the distribution is achieved regardless of the number of wells drilled. Fewer drilling locations create a greater risk of achieving the mean with fewer wells.

The Monte Carlo method yielded P10, P50 and P90 values and the per-ft P values were multiplied by the lateral lengths for each location to calculate 1P+1C, 2P+2C and 3P+3C TRRs.

Over a 10-year period, wells from 2011 to 2013 (not shown in chart) had much lower oil production rates than wells drilled and completed after 2014. Please see the following chart on this page with learning curve influence on production after 2014.



Those performance metrics established D&Cs as a primary benchmark for learning-curve applications. The statistics incontrovertibly show successful optimization of D&C strategies.

Monograph 3 does not address cases where sample sizes are smaller than recommended minimum numbers. However, evaluators might exclude noticeable outliers and proceed with caution.

The authors concluded that new concepts have evolved since the publication of Monograph 3, including the learning curve concept in the PRMS. It is especially relevant where well production performance is enhanced with optimized D&C technology.

The SEC has not commented on this concept to date.

Shale plays as challenging as ever

Over the past few years, news media, investors and others have singled out some overly optimistic production forecasts based on type well profiles (TWPs) in the Permian Basin and other unconventional plays.

In 2017, SPEE set out to provide guidelines on TWPs. Ten society volunteers working on the monograph set a "soft" deadline of a year to complete a draft while conceding the goal was optimistic.

Some five years later, mid-2022 is an "unofficial" target to finalize a draft of Monograph 5, "A Practical Guide to Type Well Profiles."

Keeping it simple

Perhaps the problem is not that convoluted. The SPEE monograph committee reported a year ago that a tweak to a common approach has led to more reliable TWPs, and that is to normalize production curves while keeping the well count constant.

The modified Arps hyperbolic model is still the most widely used method to develop decline curves for tight formations. If built properly, the model works well.