Create Accurate Type Wells

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Agenda

• Current practice
• What’s wrong?
• Synthetic example
• 4 field examples
• Valid groups
• Auto forecasts
• Conclusions
Why is this Important?

• The advent of unconventional resources has radically changed the gas and oil supply landscape in North America.

• Investment decisions with respect to development of unconventional resources depend to a great extent on the ability to accurately forecast future recovery.

• Analog or type wells forecasts are used extensively, especially during a well’s early production period.
What are Type Wells?

- Pseudo-well meant to represent many wells
- Created by averaging the rate from many wells
- Used to determine rate based on analogous wells
- Benchmark to guide forecasts for similar wells
The **Industry Standard Practice** (ISP) is to average the production rate from contributing wells.

- Informal process that has become a standard.
- Relies on production history.
- **Rarely** includes individual well forecasts.
Issue

• Industry Standard Practice is defective

• Type wells rarely use forecasts

• Using combined historical production with reliable production forecasts remedies the defect

• Unreliable forecasts are better than no forecasts
**Theory**

- Forecasts are implicit to the ISP method.
- Implicit forecasts are usually inaccurate.
- Type well quality is compromised.
- Better forecasts yield better type wells.
• Depleted wells must be counted.
Synthetic Wells

- 199 synthetic exponential forecasts.
- IP & EUR log normal.
- Random variation +/- 30%.
- Answer is known.
- 5 year drill cycle.
- Type wells created after 10 years.

Create Accurate Type Wells
Wells Drilled in Random Order

- ISP matches the known answer.
ISPM matches the known answer.
Sequence Bias

• Gaps are not filled with representative rates

• Profit Optimization
  o Best wells drilled first
  o Type wells are optimistic
    o Implicit forecasts for the newer wells created from older, better wells

• Technical Play
  • Wells improve as technology develops
  • Type wells are pessimistic
    • Implicit forecasts for the newer wells created from older, poorer wells
Best Wells Drilled First

- Best wells drilled first: ISP fails.
- Type well changes to an incline.
Best Wells Drilled First

- Best wells are drilled first: ISP fails.
- Type well changes to an incline.
Best Wells Drilled First

Time Slices are Not Immune
Winter Saskatchewan Field - Cummings Oil Production
26 Depleted Horizontal Wells Drilled from 1988 to 1993

- History & Forecast
  - Results in a better type well.
  - Makes Better use of available data.
  - Does not require a perfect forecast.
Hugoton Field

- Standard Practice has large EUR error
- Type Well is near perfect when forecast is included

<table>
<thead>
<tr>
<th>EUR (mmcf)</th>
<th>Error (%)</th>
</tr>
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<tbody>
<tr>
<td>Aug 2011 Forecast</td>
<td>1466</td>
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10 Years of History
- History & Forecast | 1439 | -2%
- History - 75% | 1948 | 33%
- History - 50% | 2049 | 40%
- History - 25% | 2562 | 75%

Hugoton Field, Kansas - Gas Production to August 2011
88 Wells Drilled from 1987 to 1991 - Field is Nearly Depleted

Create Accurate Type Wells
Hugoton Time Slice

Hugoton P75 Type Wells
Statistical P75 = 843 mmcf

Gas Rate, mcf/d

Production Years

Time Slice | 435 mmcf
Time Slice History
EUR (9 Wells) | 822 mmcf
Hugoton P75 Wells

Hugoton P75 IP Type Well
Statistical P75 = 843 mmcf

Gas Rate, mcf/d

Production Years

IP (10 Wells) | 1740 mmcf
EUR (9 Wells) | 822 mmcf
Wild River

- Apparent Sequence Bias
- Standard Practice gives no guidance for cut off
- Data is reliable, forecast good
- Double EUR without forecast
Wolfcamp Pool

- Apparent Sequence Bias
- Standard Practice gives no guidance for cut off
- Auto forecast for all wells
- 40% greater EUR without forecast
Creating Valid Groups

• Requires statistically valid and significantly similar wells.

• Many factors need to be considered for grouping.
  
  Vintage.
  Fracture size and fracture fluid type.
  Completion technique.
  Well location and spacing.
  Operator.
  And many others …

• Vintage should always be one of the groups
• Valid groups have log normal distribution
  - Initial Production
  - Expected Ultimate Recovery

• Use cross plots to validate groups

• \( r^2 \) is for statisticians – visually find and remove wells that don’t fit

• Create type wells from valid groups.
HOW DO YOU FORECAST?

• Resource plays are statistical

• Need to forecast 1000’s of wells accurately.

• Manual forecasts are not practical – too time consuming and subjective.

• Not so easy, especially in unconventional plays with lots of super-hyperbolic’s.

Require accurate auto-forecasting!
Auto-forecasting

Easy!

Create Accurate Type Wells
Auto-forecasting

Not so Easy!

Create Accurate Type Wells
Conclusion

- ISP type wells are defective
  - Forecasts are implicitly created for Gap Wells
  - Implicit forecasts are usually inaccurate
  - Often no guidance when to stop averaging
  - Sequence bias may be too subtle to detect
  - Sequence bias impairs quality – too high or too low
  - Only use when drilling sequence completely random

- Combine history & forecast to create type wells
  - Accurate – Quality improves with forecast
  - Flexible – Use some or all of data to build type well
  - More Data – Extends useful period of historical data

- Use the right tools
  - Statistics to validate grouping and well selection
  - Reliable auto fitting
  - Forecast recent wells using type wells, then update the type well
Forecasts are inevitable
The best forecast will include the benefit of knowledge and experience, not serendipity.