

Create Accurate Type Wells

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- 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



Industry Standard Practice

- 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.



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- 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.



Theory



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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.



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Wells Drilled in Random Order



ISP matches the known answer.



Wells Drilled in Random Order



ISP matches the known answer.



Sequence Bias

- Gaps are not filled with representative rates
- Profit Optimization
 - Best wells drilled first
 - Type wells are optimistic
 - 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



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

Best Wells Drilled First



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

Best Wells Drilled First



Winter Field

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.

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Hugoton Field

 Standard Practice has large EUR error

 Type Well is near perfect when forecast is included

EUR mmcf	Error %
1466	
1439	-2%
1948	33%
2049	40%
2562	75%
	EUR mmcf 1466 1439 1948 2049 2562

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



Hugoton Statistics



Hugoton Time Slice



Hugoton P75 Wells



Gas Rate, mcf/d

Wild River



Wild River Alberta Field - Cardium / 2WS Gas Production 84 Wells Drilled from 2000 to 2010

Wolfcamp Pool

Wolfcamp Pool in New Mexico & Texas 102 Wells With 1st Production from Feb 2000 to Nov 2011



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



Use Of Cross Plots



- Valid groups have log normal distribution Initial Production Expected Ultimate Recovery
- Use cross plots to validate groups
- r² 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 superhyperbolic's.

Require accurate auto-forecasting!



Auto-forecasting

Easy!





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Auto-forecasting

Not so Easy!





Conclusion

 ISP type wells are defective

- Combine history & forecast to create type wells
- Use the right tools

- 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
- Accurate Quality improves with forecast
- Flexible Use some or all of data to build type well
- More Data Extends useful period of historical data
- Statistics to validate grouping and well selection
- Reliable auto fitting
- Forecast recent wells using type wells, then update the type well



Conclusion

Forecasts are inevitable

The best forecast will include the benefit of knowledge and experience, not serendipity.

