Accurate Asset Level Production Forecasts

Be Sure with BetaZi™

Accurate & Fast EUR Forecasts

BetaZi Statistical & Verified Type Curve

BetaZi Type Curve Validation

Statistically Correct Production Rollups
Accurate Asset Level Production Forecasts

Be Sure with BetaZi™

**OIL**

- Proved UnDeveloped (PUD)
- PDNP
- Producing Developed Producing (PDP)

**GAS**

- Production line graph with data points and trend lines for historical and forecasted values from 2012 to 2021.
PREDICTIVE ANALYTICS SOLUTIONS FOR QUANTIFYING WELL PERFORMANCE AND FORECASTING FULL FIELD PRODUCTION OF OIL & GAS ASSETS

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Discussion Outline

- The Issues
- The Science
- The Solution
  - Decline, Forecasting and EUR
  - BetaZi Statistical Type Curve
  - BetaZi pScore™
- Applying the Knowledge Learned
- How to get it
The Issue

PRODUCTION FORECASTING: predicting the next 7 years of proved production from existing wells and fields

THE BULK OF OIL AND GAS ASSET ECONOMIC EVALUATION IS BASED ON PRODUCTION FORECAST NUMBERS.

— NOT RESERVES: number can never be tested
— NOT EXPLORATION

BUT >90% of production forecasts are currently made or adjusted by hand. This makes them:

- Slow
- Expensive
- Subject to bias

During Due Diligence it is prohibitively expensive and time-consuming to recreate a production forecast from first principles. Instead, all you usually do is spot check an Aries or PhdWin database. In fact, you have no idea how accurate your forecast is and no way of knowing how far off it could be.
Production Forecasting 101

- Production forecasting is made very difficult by noisy, complicated data.
- Human tendency is to overthink the problem.
- Decide which data is relevant.
- Pick a decline curve (exponential, Arps, Duong, etc.)
- Find the parameters of a curve that fits.
- Adjust.
Different Possibilities

- Lots of curves fit the data but...
- Every judgment call introduces potential bias
- It takes a long time (why it’s usually only spot checked)
- Forecasts are not consistent
- No rigorous definition of high, medium and low (PRMS)

10 year Production forecast

- PV10 High = $12.8m
- PV50 Medium = $6.2m
- PV90 Low = $0.7m
EUR = 112,959 BBL oil
$3.4 m

EUR = 787,822 BBL oil
$23.6 m

Multiply by 100 wells -> $2b choice
The Science – ‘The New Standard’

1. Start from first principles.
2. Insist on independent verification.
3. Use statistics.

ANALYTICS:  “Figuring out what’s there”
Forecast future production based on what it’s done in the past.

ENGINEERING: “Making it work”
Improve the well.

WE HAVE THE SCIENCE.
- Fast enough to meet data room deadlines.
- Gives you actionable intelligence.

You don’t want to waste your engineers’ time doing rote forecasting.
You don’t want your forecasts to be engineered.
Predictive Analytics Methodology

Explain in terms of physics:

- Flow regime changes
- Time-dependent permeability
- Drive mechanisms

Explain in terms of statistics learned over big data:

- Shut ins
- Stimulations
- Bad allocations
- Bad luck
The Internal BetaZi Model

- Find all possible curves capable of explaining the data
- Let the answers range in complexity
- Let them deviate from purely physical behavior
- Run statistics over them to produce percentiles that have real meaning (90% of the time production will exceed p90)
- Get a comprehensive answer

Generates EVERY potential decline curve for the data by computing a million samples ranging from simple to complicated, using a sophisticated physio-statistical model.
Results = Significant Statistics

Samples are then aggregated into true probabilistic percentiles.

‘p90’ means that 90% of samples fall above the p90 line.
The Solution
BetaZi Forecast – Single Well

**INPUTS:** oil, gas, water, monthly volumes and working days

**OUTPUTS:** forecast with calibrated uncertainty

Monthly production is expected to exceed p50 forecast 50% of the time.
In a Quantile-Quantile (Q-Q) Plot, a straight 45 degree line denotes that 90% of the time holdback data production exceeds the p90, 80% of the time it exceeds the p80, and so forth.
BetaZi Statistical Type Curve Verified with Cross Validation

Statistical model computed over 20 – 500 wells. A type curve to rapidly determine that the well population used is based upon truly analogous wells. Results are tested using cross-validation to ensure accuracy.
Accurate Forecasts = Accurate Roll-Ups

The p90 of a group of wells is not the sum of the individual well p90s. **Statistics don’t add.**

Ratio of uncertainty to production for a single well is 1:1

Ratio of uncertainty to production for 20 wells is 1:4

We use roll-ups to determine if company forecasts are outside of reasonable bounds.
Field Level Roll-ups
Proved Reserves: PDP, PDNP, PUD

Roll up showing PDP, PDNP and PUD production based on sanctioned drilling program.
pScore is a ranking process assigning a value of 1 to 99 to every well in the population as the well relates to its type curve. This is a very robust way of evaluating the performance of wells that is independent of vintage.

With p-scores you can rapidly plot the relationship of wells to each other.
Reserves vs. half life

Oil and gas fields are usually described in terms of current production and total volume

- Barrels of Oil Equivalent per Day (boepd)
- Reserves or Estimated Ultimate Recovery (EUR)

Reserves and EUR are estimated numbers that are very difficult to test. They constantly change.

Usually the decline rate is embedded in reserve and economic models as hyperbolic parameters but not reported.

Instead, we suggest wells and fields be described in terms of current production and *half life*: the number of years it will take for production to decline by half if no new investment is made.
Exponential decline rates converted to half life

\[ H = \frac{\ln(2)}{\ln(1 - r)} \]

- 50% = 1 year
- 18% = 3.3 years
- 8% = 9 years
- 3% = 23 years

\[ H = \text{half life (years)} \]
\[ r = \text{annual decline rate (years)} \]
North Dakota | USA | Saudi Arabia
--- | --- | ---
Production | 1.1 M bbl/day | 10 M bbl/day | 10 Mbbl/day
Reserves | 7 – 24 B bbl (Bakken alone) | 29 (1p) - 264 (2PCX) | 70 (1P) – 212 (2PCX)

1P: Proved Reserves, conservative estimate in existing fields
2PCX: Most likely estimate for existing fields, discoveries and yet undiscovered fields.

http://www.rystadenergy.com/NewsEvents/PressReleases/united-states-now-holds-more-oil-reserves-than-saudi-arabia
Add half life to analysis of production and reserves

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<td><strong>Decline rate</strong></td>
<td>18%</td>
<td>8%</td>
<td>2 – 5%</td>
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<td>3.3 years</td>
<td>9 years</td>
<td>24 years</td>
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<tr>
<td><strong>Replacement cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(Total)</strong></td>
<td>$26 B</td>
<td>$2.2 T</td>
<td>$10 B</td>
</tr>
<tr>
<td><strong>(Annual)</strong></td>
<td>$7.8 B</td>
<td>$244 B</td>
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## Back of the envelope analysis

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Not equivalent assets
Applying the Knowledge Learned
Case: Production Decline Example

- **Eagle Ford**
  - Oil
  - Gas
  - Water

- **Bakken**
  - Oil
  - Gas
  - Water

Legend:
- Blue: Data seen by BetaZi
- Yellow: Holdback test data
- Red: Forecast
Case: Application of pScores

pScore trends clearly indicate that newer wells have higher production.

The scatter could probably be reduced by controlling for lateral length.

pScores provide stable data points for further analysis
Case: pScores New Well performance

Evidence that the field was in severe pressure decline or well spacing was not optimized

Moral(s) of the story:

- Trends indicate reservoir depletion
- You need verification tools that start from first principles.
- More importantly what wells are used for the type curve?

Green dots are primary fluid (oil); red dots are primary fluid (gas)
Case: Comparison of Operators

- Operator C has lots of low-producing vertical gas wells.
- They are not getting nearly the returns on their horizontal wells that Operators B and C are seeing.
- We concluded that they are getting hardly any return on laterals!
- Suggested several operators who were getting lateral return.
Case: Probabilistic Maps

Enables filtering on:

- EUR
- Lateral Length
- Completion Design
- Toe up Toe Down
- Operator
- Vintage
- Other

**Future production map**

*(sized according to cumulative prediction for next 5 years, saturation proportional to uncertainty)*

- BetaZi prediction and uncertainty pre-computed on public data
Case: Massive Well Studies

Commissioned by Major producers to compare their production to that of other operators in an area and as an exploration tool.
bzAlmanac™ is a play library of every well in the United States and Canada, complete with a full probabilistic BetaZi forecast for each and available for instant download (Browse, Query, Extract).

**Product:**
- Tobin Insight package: Well production history, Rigs, Allocated production
- Well production forecast 20 years ahead, with percentiles (p10-p90)
- Forecast visualization
- Export capability to all major economic modeling programs
- Roll-up driver tool’s (Deal, Company)
- Bubble Maps (Uncertainty by well, EUR’s, filter on demand)

**Add-Ons:**
- PUD PACK: Type Curves, Type Curve Driver Spreadsheet, Development Plan, Relative pScores™, Graphical Selection of Wells, Calibrated testing of Type Curves.

Annual subscription based on the price of oil (BOE) on the WTI. Includes well data. Also available on a per well basis.

No resale or sub-license of results.
What you can do with it (14,300 active wells)

Without constant drilling, future production in North Dakota is a short term game.
Half Life = 4 years

Peak 36m bbl: Dec 2014
June 2016 30.8 M BBL (exactly as predicted)
July 31.8 BBL (within uncertainty)
Half of current production in Dec 2021

Half 18m bbl: Jan 2019

Quarter 9m bbl: Feb 2030
Eagle Ford Basin Study
Eagle Ford

Half Production predicted for 8/2017 (oil and gas)
Company A

Is already a half production in Eagle Ford (and scheduled for 2018 in North Dakota)
Company B

Will hit half production in 2018
If they have the acreage, they can get back to 2015 levels by drilling about 300 wells – current well count is 876.
Compare A to B

You can learn to read off this plot that Company B has about 4x production per well than Company A as well as a conventional base. (Provided with Eagle Ford Basin Study)
Accurate forecasts and type curves are a data point you need to make good decisions.
Case: Production Decline Example

Bakken

Bbls / day

Months

data
model
Gain from oil $\sim 70$ Mbbl, gain from gas $\sim 90$ Mmcf = $85$ Mboe $\sim$ $2.3$m
What was the production gain from Bakken well workover?
Scenario 1: pre-workover
Scenario 2: Post workover
Subtract Pre from Post

Delta = 164,000 bbl

Are you really going to lose pre-workover production?
BZ-P2 partnership

Started in 2013 – Partnership with Merrick Systems

P2 Forecast
- BetaZi powered forecasting engine for ProCount - Carte - Forecasts on demand, Client’s own data.

BZ ALMANAC – October 2016
- Forecasts on every well in the USA, available by subscription
  - Tobin Insight - Resources and expertise to handle 6T of new data

BASIN STUDIES – October 2016
- Snapshot of Almanac for a single basin or play in Spotfire
- Extensive and easily customizable analysis tools.
  - Anadarko Basin: The Scoop/Stack
  - Western Gulf Basin: Eagle Ford
  - Permian Basin: (Midland, Delaware, Central)
  - Appalachian Basin: Marcellus
  - Williston Basin: Bakken
  - DJ Basin: Niobrara
Bottom Line

✓ Production forecasting matters for asset valuation.

✓ There are a lot of devils in the details of a reserve report.

✓ Due diligence should start from the beginning, use statistics and back-testing. This is true independent verification.

✓ New science exists: exploit it. Let engineers do what they do best, analyze data and trends.

✓ Pre-computed forecasts on every active well in the USA with uncertainty are going to change the way deals are done. Adapt now.
Thank You!

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