Building an Effective Reservoir and Production Monitoring System

November 1, 2017

Data Driven Production Conference - Aberdeen

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Results-Driven Surveillance System

- The Right Instrumentation in the Right Place
- A Way to Get That Data somewhere useful, without losing quality
- Easy Access for Engineers and Other Services
- A Way to Automate the Recognition of Important Events and Present the Information to the Engineers/Managers
- Getting Past the Process and Silos to Understanding the Results (Cultural)
- Making Decisions in a Non-Biased Way!

What are the Consequences of Automated Monitoring/Surveillance?

- Democratized information/results
  - Can spend time discussing what it means
  - Easier to translate to other departments/silos
  - Less finger pointing and more inclusive work processes
- Quicker Decisions
  - Reach conclusions on what the data/results mean(s)
  - Easier to focus on NPV of Decisions
- Quicker Actions/Inactions

Is Your Organization Set-up to Handle This Work Flow?

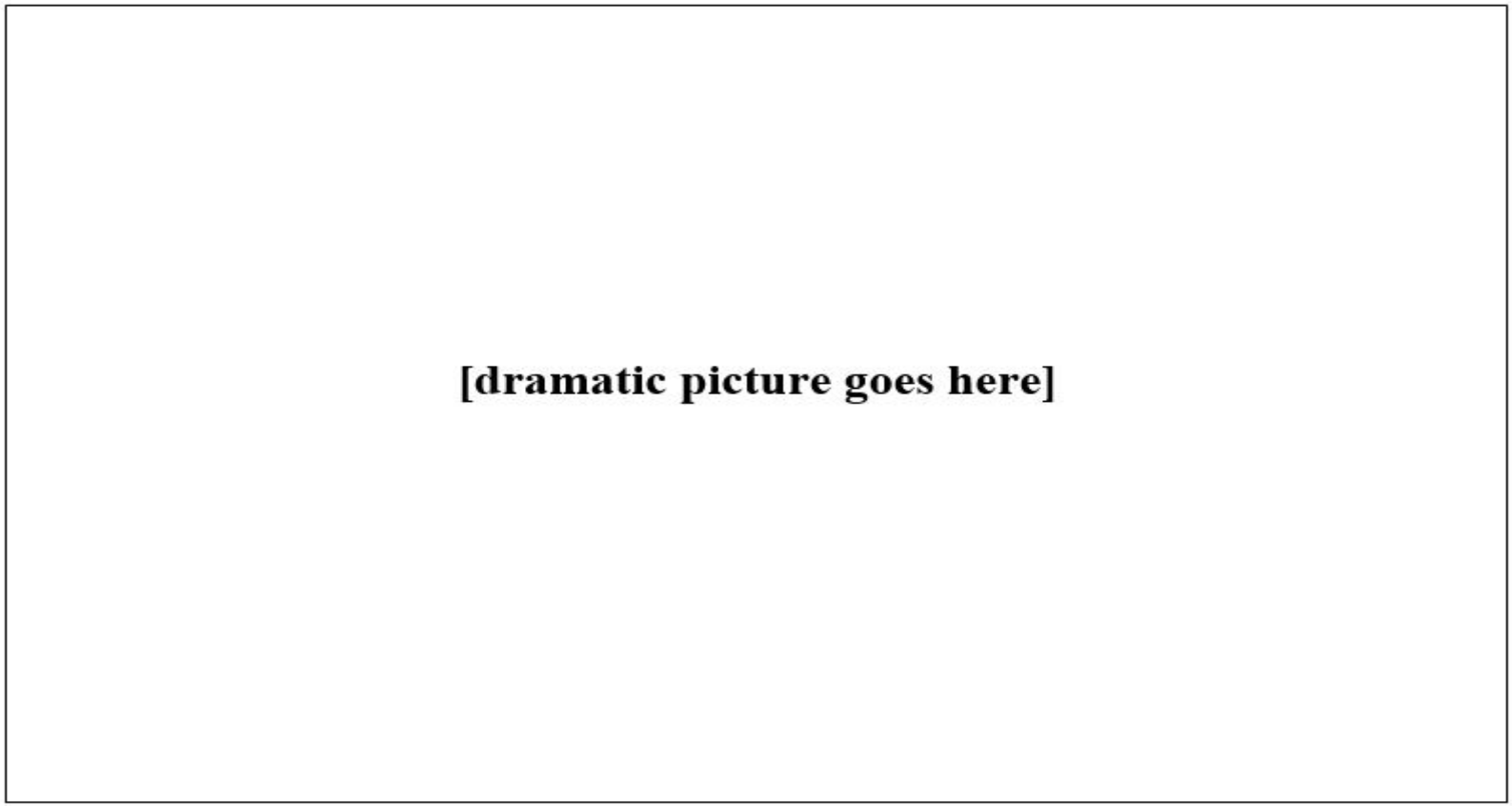
Outline

- Getting Past the Buzz Words!
- Bias! How do we Make Decisions?
- Good & Bad Surveillance
- The Technical Bits…Getting the data where you need it
- What Went Wrong with the Physics?
- What Can Be Done NOW?
- Other Cultural Impediments
- Conclusions

Digital Energy Buzz Words

- Digital Energy
- Data Driven Production System
- Big ((Data) Analytics)
- Expert System (very blasé)
- Rules-Based Decision Trees
- Neural Network
- Machine Learning
- Artificial Intelligence

Eye-catching Phrase for Product Goes Here



Macho description of how cool your digital energy solution is and how it will solve every problem in the world goes here.

Smart
Well Thingee

(Snappy product logo here)

A question to consider…

Is This Just the S.O.S.

…or is it Something New?

And More Importantly:

What are you using this 'big data' and magic software to accomplish?

Funny sentence….doesn't sound right to me

Bias in Decisions

- Confirmation/Expectation Bias
  - Decision Already Made
  - Answer Already “Given”
- The Inside View
- Risk Compensation
- Gambler’s Fallacy
- Ownership/Sunk Cost Bias
- Unintended Consequences - Incentives
- Gotta Spend it…(Budgets)

The Turds in the Pool

- The “Expert”
- The “Smartest Guy in the Room”
- The Information Hoarder
- The Bully
- The Amateur Epidemiologist
- Mister Minutia
- “NIH” Disease
- The Investment Banker

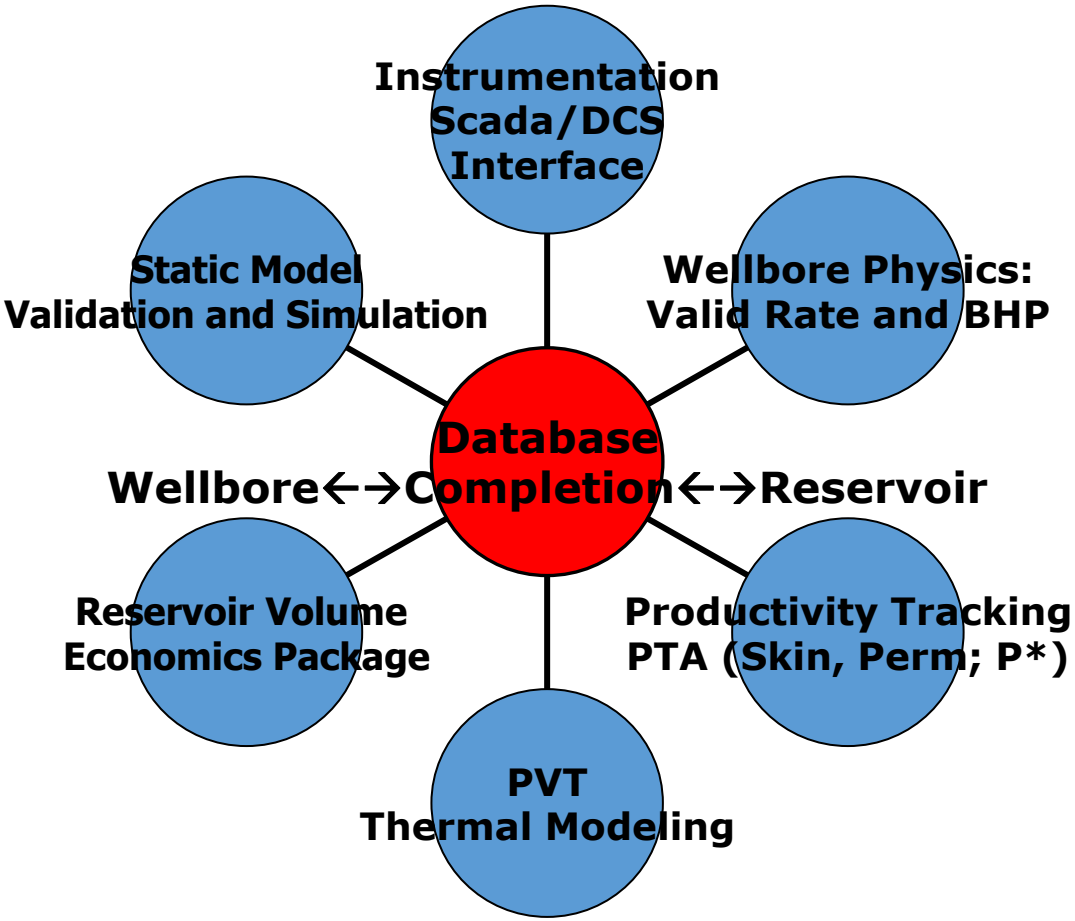
What is Good Surveillance?

- Always have a handle on:
  - How much oil or gas is in the ground
  - How much of it is likely to be recovered
  - What is the current well performance? Can anything be done to improve the performance?
  - Are there problems developing in the well bore?
  - Are there problems developing in the completion?
  - Are there problems developing in the reservoir?
- Is anything changing?
- If something happens, what is the current NPV of the asset?

What is Bad Surveillance?

- Only accept information about the well/reservoir that fits your or the company's beliefs - ignoring data!
- Change the "static" or geologic and/or simulation model until you get the answer you want- doesn't fit the data!
- Wait until something bad happens:
  - Call it bad luck & move on
  - Say it's too late to fix it & move on
  - Call in a technical expert & move on
  - Use Nodal Analysis or Simulation to muddy the waters
- Be reactive…or just do nothing

Data Driven Production/Reservoir Components



The Technical Bits…DAQ, Storage and Access

- The Right Instrumentation for the Right? Purpose
- Getting the data back to the beach (w/o screwing it up)
- Getting the data into a database that accessible (w/o screwing it up)
  - Storage
  - Visualization
  - Plug and Play with other Tools

Who determines the instrumentation spec's?

WHO DETERMINES WHO HAS ACCESS TO THE DATA?

Pressure/Temperature Measurement

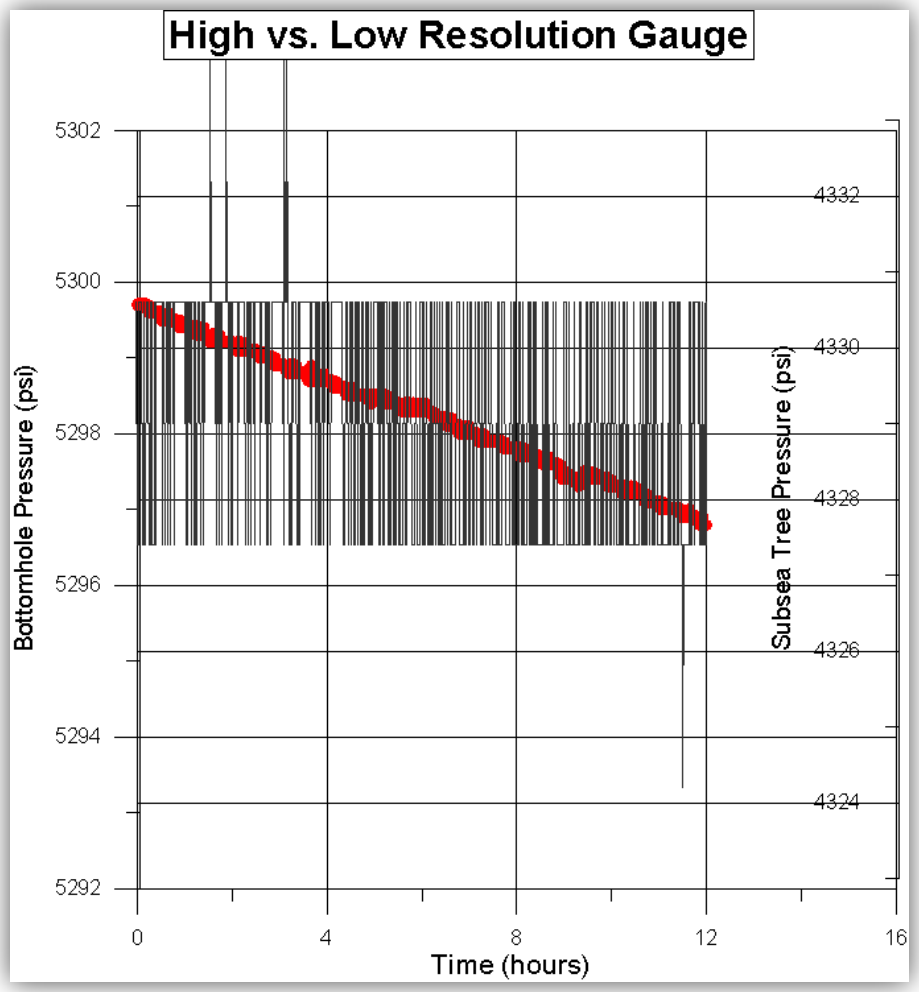
What do I really need to measure accurately?

- Wellhead Pressure
- Wellhead Temperature (Thermowell)
- Downhole Pressure
- Downhole Temperature
- Distributed Temperature (multi-zone wells)
- Line Pressure/Temperature
- Annular Pressures

Rates and Valve/CK Status

- Flow Rates of Oil, Gas & Water
  - Multiphase Meters, Venturi Meters, Turbine Meters, d/p meters (Daniels), Coriolis meters, Ultrasonic Flowmeter
  - Dedicated Test Separator
  - Meter Prover(s)
  - Virtual Rate Measurement (VRM)…based on what?
- Other bits
  - Choke Setting
  - SCSSV, MV, Control Valves
  - Injection lines
  - Artificial Lift Components

Make sure the data can tell you something



Comments on Instrumentation

- Instrumentation is relatively cheap
  - Price difference between good and crap equipment is small
  - Cable (TEC), Intervention Vessels and Rig Time are NOT
- DO NOT STANDARDIZE across an Entire Company
- Don’t drop bits!
  - Most transmitters are 18-24 bit
  - Don’t lose resolution over a $30 vs. a $50 I/O card

Let the end users have a say in the equipment selection!

Applying a ‘Big Data’-Driven, Artificial Intelligence System Using Advanced Neural Networking and the ‘Internet of Things’ via ‘The Cloud’, Facilitating a New Paradigm of Multi-Dimensional Understandings… with Big Fangy Teeth!

HOW GOOD CAN ANY A.I. SYSTEM BE, IF IT WAS TAUGHT THE WRONG PHYSICS?

A Brief History of How We Lost the Plot

- Start with the Fundamental Physics
- No Computers → **Make Assumptions** & Develop Correlations so the math is easier
    - VLP correlations, No Initial Shear, No Inertia
- Build Lab Experiments/Tests based on Assumptions
- Create "Models"
- Match data to models (remove the bits that don't fit)
- Apply Computing Power to iterate between data and models

We forgot we made a lot of BAD Assumptions First!

What you may not know about your Software Package…

- Most software is designed to eliminate or “smooth” data that doesn’t fit “The Model”
  - This is OK if you’re dealing with outliers or impossible data (i.e. DHGP = -259 psia)
- This is known as <u>Imposing a Model on the Data</u>
  - Data that is being filtered by comparison with a model is a recipe for “Get what you Guess”
  - You’ve already introduced BIAS!!!
  - Err…What if “The Model” is wrong?

Maybe, There's a better way...

- Start with the Fundamental Physics
- Apply Computing Power to Solve the Equations
  - Make only valid assumptions
  - Don't use correlations
- Don't "doctor" the data
- Don't impose a model on the well!
- Let the well tell you what it's doing!

A List of Things That Have Already Been Automated

- Rate Calculations/Validations
  - Water Cut Calcs
  - PVT Tuning
  - Loading Flags (inefficient lift)
- Well Test Transient Recognition and Analysis
  - Skin, Perm, Productivity, Reservoir Pressure
- Reservoir Volume Assessment
  - Static MBAL
  - Flowing MBAL
  - Decline Analysis
- Auto-feed, Auto-run Simulators and Economics

Well…

Even with a PERFECT Technical Solution…

There are STILL Systemic Cultural Issues:

- Process over results
- Silos (unintentional and intentional)
- Management Directive (Changing)
- **Model Driven Posing as Data Driven**
- Reactive vs. Proactive
- Don’t Forget Bias!

Drowning in Data?

- Engineers doing surveillance work spend over half their time just looking for data
- Many data systems are still designed as if computer storage/memory were (are?) expensive
- Many software packages cannot handle multi-million point data sets

- Need a common framework that engineers and managers can use, understand & visualize!

Strategies for Dealing with RT Data/Analysis

- Make sure that predictions match actual well behavior
- Look for changes!
  - Perm
  - Skin
  - Apparent Reservoir Volumes
  - Measured vs. Calculated Rates
- Let the well tell you – don't impose models on the well!
- Look for changes in the rate of change

Thoughts, Musings & Conclusions

What is Good Oilfield Management?

- Maximize NPV
- Maximize Recoverable Reserves
- Avoid waste (Time/Money/Resources)
- Mitigate/Minimize Risk (Ops/Reserves/HSE)
- Learn from your Mistakes (and Successes)

- MAKE BETTER DECISIONS IN A TIMELY FASHION

What is BAD Oilfield Management?

- Maximize bonus
- Maximize ‘booked’ reserves
- The INSIDE View – eliminate/ignore contrary data
- Falling in love with a rate
- Wait until a problem is obvious (and expensive to fix)
- Hope no one notices (until you’ve moved on) – make sure no one takes ownership
- Shoot the messenger
- Make the decision that’s best for you, not the company

Remember…

Even with a PERFECT Technical Solution…

People STILL HATE CHANGE!

But, Wait! That's My Job!!!

Are You Really Going to Let a Computer Run Your Oil Field?

Conclusions: Automated Reservoir & Production Engineering Surveillance

- Is it ‘Intelligent’? Or just another way to take your money?
- Proper Instrumentation, Data X-fer & Storage are just the First Step (Don’t Drop Bits!)
- Your Database needs to play well with others
- Make sure your ‘Data-Driven’ Process isn’t really ‘Model-Driven’
- Honor the PHYSICS!
- Must Develop Workflows that Combat Bias and Develop Democratized Information/Results
- **Checking Automated Results is Much More Efficient!**

Conclusions: Real-Time Data Strategies

- Spend time looking for results, not just digging for data
- Validate the results; only analyze manually if you disagree…or if it's important enough to spend time on
- Think about what the results mean
- Think about how this meaning affects your decisions

If you know how much money you have left in the ground, you'll make better decisions!

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