Automated Production and Reservoir Surveillance Systems…

…And Why We Screw It Up!

SPE - Perth

Chris Fair

August 10, 2018

Oilfield Data Services, Inc.

But First…

Have You Ever Heard…

…From the New CEO:

“Wow! The Last Guy/Gal did Such a Great Job!
I’m Just going to keep doing what They were doing!”

…or from the New PM, President, New Supervisor?

A Quick Question or Two…

How Does Blaming People Below You (or Before You) and Creating a Culture of Fear/Blame Improve Efficiency?

Do You Want People to Be Productive, or Just Look Busy?

How Does The Way Decisions are Made Affect:

Your Company,
Your Finances/Retirement;
Your Life?

A Few Quick Examples:

- **The GFC**
- **The Great Shale Boondoggle**
- **3 Pipelines & 3 Plants**

How do Investment Bankers "GET PAID!"

The Macro Cycle

A. **Find Something that You Think Someone Else Might Value (soon) -> BUY!!!**
B. **Talk it up**
C. **Find Suckers**
D. **SELL!!!**
E. **Short Sell Suckers**

FIFO

GFC: Investment Bankers + Real Estate

The Micro Cycle

A. **Find Something that You Think Someone Else Might Value (soon) -> BUY!!!**

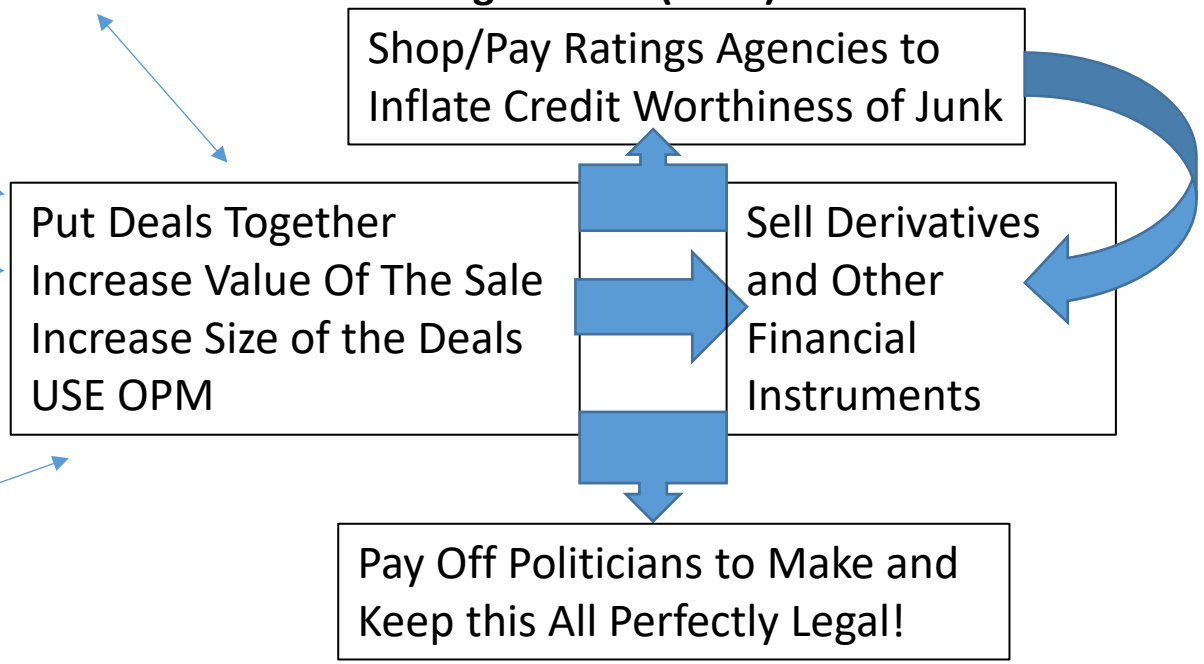
B. **Talk it up**

C. **Find Suckers**

D. **SELL!!!**

E. **Short Sell Suckers***

* Pass Laws So Investors can't short sell You!



Make That Commish!

The Great Shale Boondoggle

Investment Bankers and Oilmen

A. Find Some Dirt that You Think Someone Else Might Value (soon) -> BUY!!!

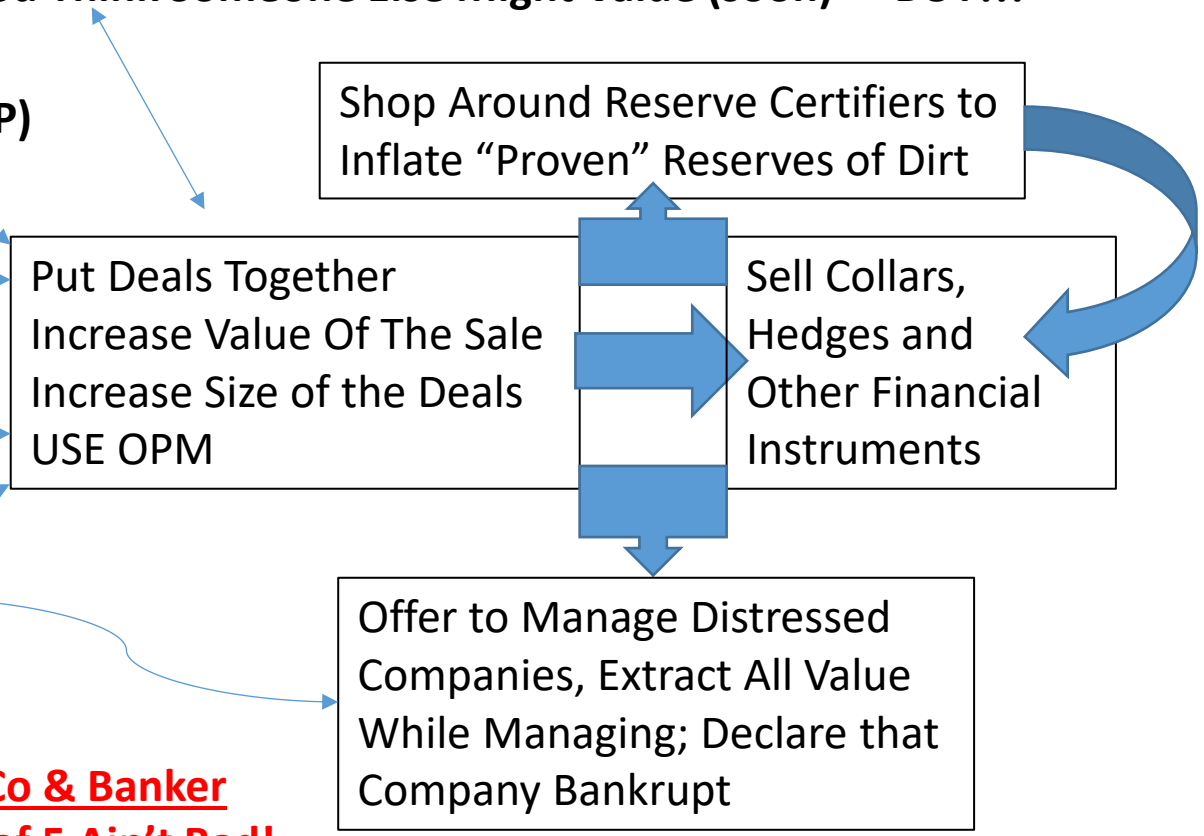
i. **Drill up Sweet Spots**

B. Talk it up (Game the IP)

C. Find Suckers

D. SELL!!!

E. Short Sell Suckers



Seller, Landowner, Svc. Co & Banker
All Make Money: 4 Out of 5 Ain't Bad!

QLD CSG: Shoot Self in Foot, then Head

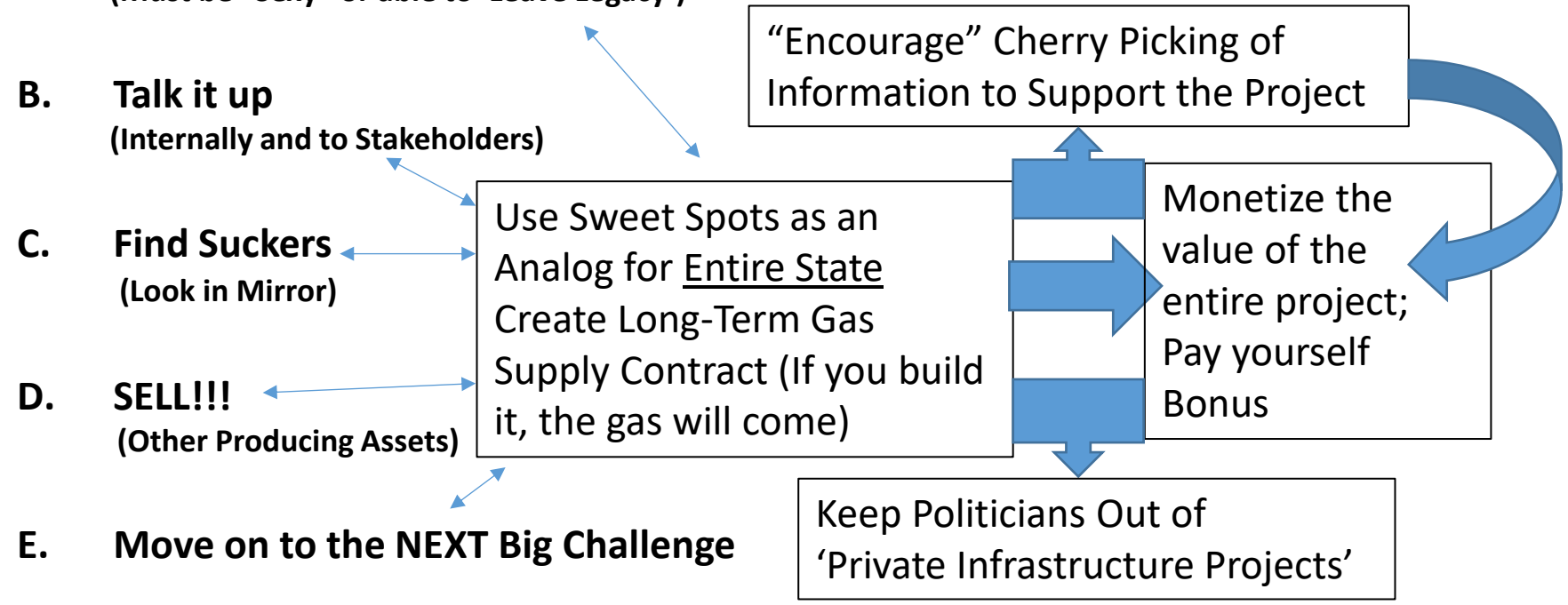
A. Find Some Dirt that You Think YOU Might Value -> BUY!!!
(Must be "Sexy" or able to 'Leave Legacy')

B. Talk it up
(Internally and to Stakeholders)

C. Find Suckers
(Look in Mirror)

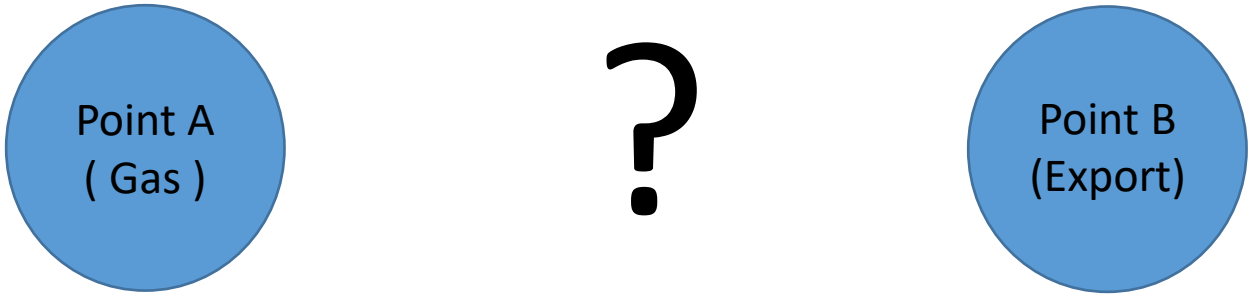
D. SELL!!!
(Other Producing Assets)

E. Move on to the NEXT Big Challenge



Collect That Bonus!

How Do You Get From Point A to Point B?



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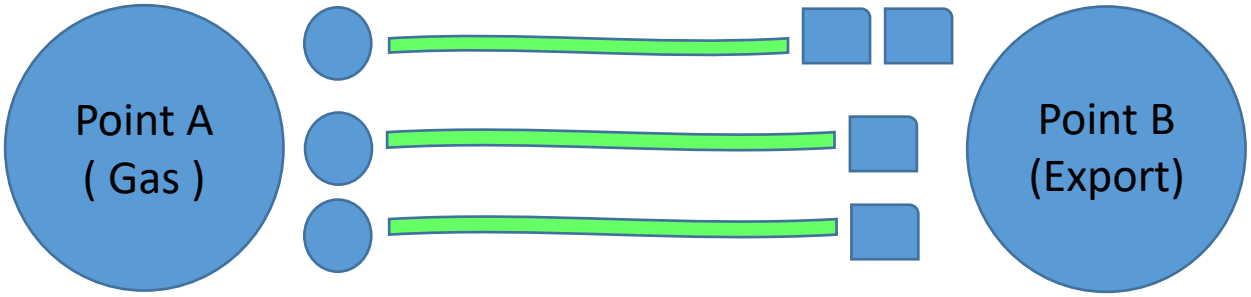

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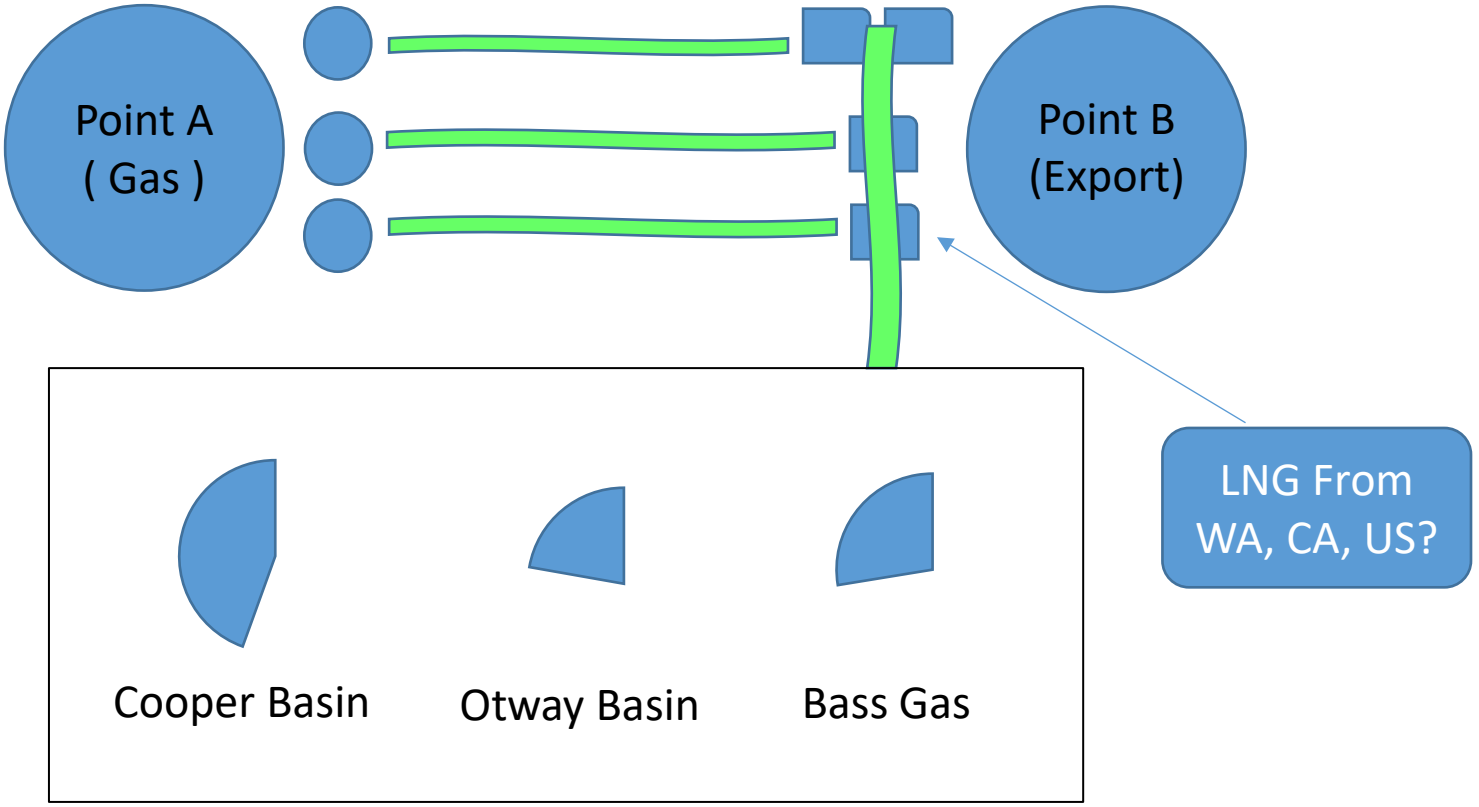


Do Any of These People

Ever Give Their Bonus Back?

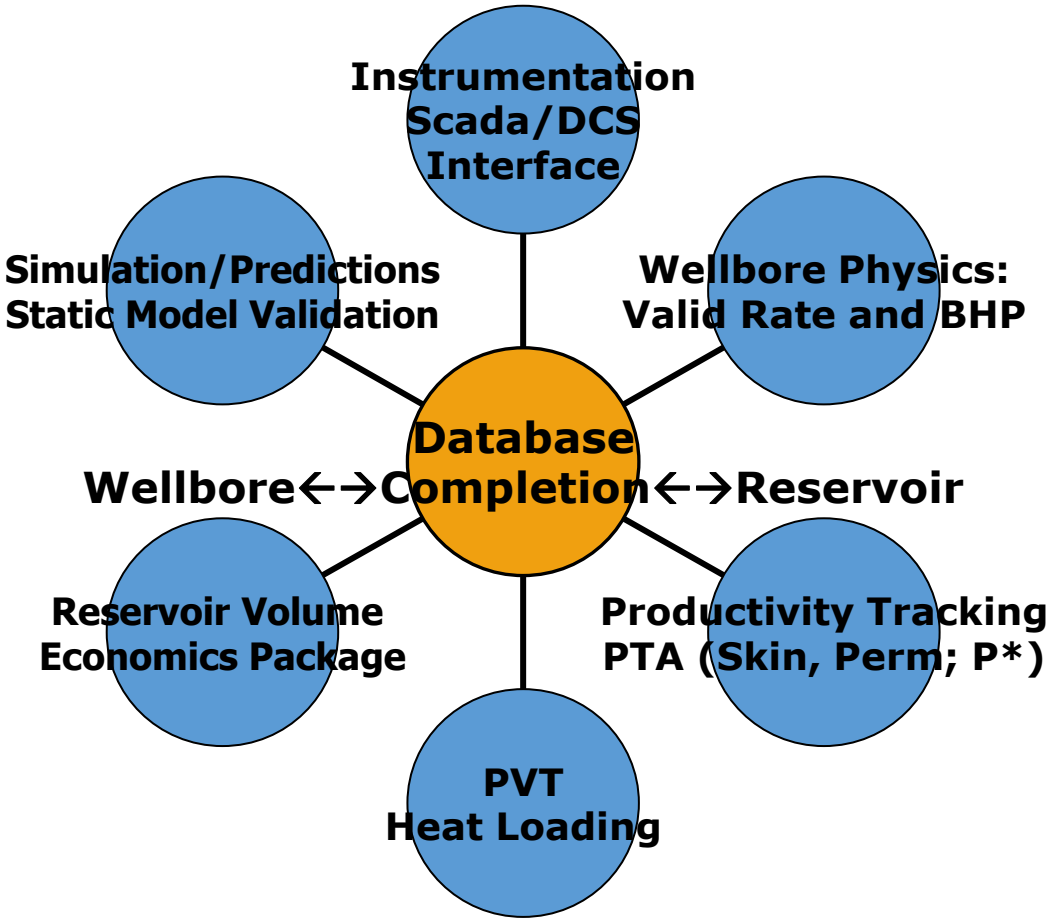
Drowning in Data?

- Analysts spend 60-80% of their time looking for and manipulating data
- My ROUGH Estimate:
  - 50% time looking for data
  - 50% time stuck in mtgs
  - 50% time preparing reports for non-technical managers

Automated Surveillance System

- The Right (Quality) 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!

Production/Reservoir Surveillance Components



A List of Things That Have Already Been Automated

- Wellbore Rate & Pressure Calculations/Validations
  - Spot Rates of all Phases (Oil, Gas & Water)
  - Datum Pressure (BHP)
  - 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 (In-Place)
  - Decline Analysis (Connected & Mobile)
  - Flowing MBAL (Maximum Recoverable)
- Auto-feed, Auto-run Simulators and Economics

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 Autocratic Organization Set-up to Handle This?

Digital Energy Buzz Words

- Collaborative Framework
- Digital Energy
- Data-Driven ~~(Physics-Based)~~ Production System
- Advanced Digital Visualization Platform

- Expert System (very blasé)
- Rules-Based Decision Trees (Yawn…Soooo 1985)
- Neural Network (Sooo…1991…puh-leeeze)
- Big Data Analytics (Oooh…Sexy!)
- Machine Learning (You mean like my Smart Phone?)
- Artificial Intelligence (Like ‘Terminator’, only ‘Good’?)

A question to consider…

Is This Just the S.O.S.

…or is it Something New?

IoT-Enabled Magic

Automated Scada

Digital NRG Transformation

~~Model-Driven~~ Umm…we mean Data-Driven!

Collaborative Digital Environment

Smart Wells

Really Smart Wells

Field of the Future!!!

Open Source Digital Solutions

Computer Assisted Decision-Making

AI-Predictive Modeling

A Few Simple Questions:

Do your Executives say things like THIS?

“Knowing how much oil an individual well is going to produce doesn’t affect our borrowing base.”

Does Upper Mgmt. say things like THIS?

“We know our wells have no skin. That’s why we only look at PI”

Note 1: PI = Q/DP
Note 2: DP being “floated” to maintain const PI
Note 3: DPskin/Q increasing (a lot) with time
Note 4: Actual PI decreasing (a lot) with time
The Well Completion Failed Due to Excessive Drawdown

Do your Managers say things like THIS?

“Upper Management isn’t Ready to See these Small Reserve Numbers!

Please STOP Those Calculations!”

Do your Engineers say things like THIS?

“I Can See the Pressure on My iPhone!

Now We’re Doing REAL Surveillance!”

Really???

What are you Using this 'Big Data' and Fancy (insert buzzword) Software to Accomplish?

And More Importantly:

Who is Going to Show Up and Explain What it All Means?

So…

How Do Decisions Really Get Made?

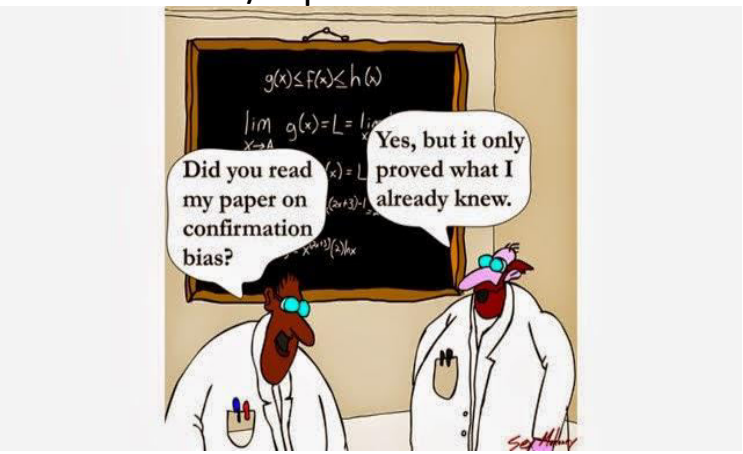
A. Carefully Considering Most Likely Outcomes
B. Determine Which Path Leads to the Highest NPV
C. Build a Real Consensus between All Parties
D. Do What You Already "Believe"
E. Whatever Boosts the CEO's Ego the MOST
F. Do Nothing!

Bias in Decisions

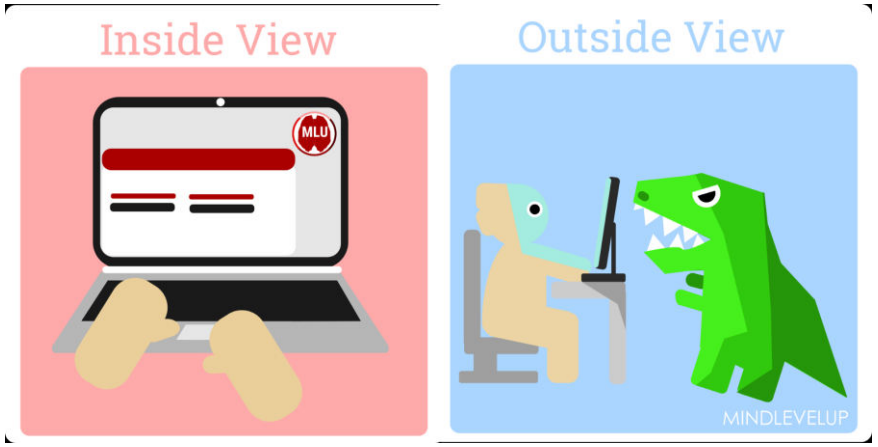
- **<u>Confirmation/Expectation Bias</u>**
  - Decision Already Made
  - Answer Already "Given"
- The Inside View
- Risk Compensation
- "NIH" Disease
- Ownership/Sunk Cost Bias
- Unintended Consequences – Incentives & Budgets

Bias

Confirmation/Expectation Bias



The Inside View



Risk Compensation

NIH

Budgets and Incentives

The Turds in the Pool

- The “Expert”, esp. self-proclaimed S.M.E!
- The “Smartest Guy in the Room”
- The Amateur Epidemiologist
- Mister Minutia
- The Investment Banker
- **The “Gatekeeper”**

The R & D Paradox

A.R.S.E. (Applied Research Search Experiment)

Why use a Developed Product, if you can spend 10-20 years Researching the Alternatives?

There's a REASON we all called it the "Arco Turkey Farm" ;)

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
- Change the "static" or geologic and/or simulation model until you get the answer you want (data is irrelevant)
- 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*

*See: Refusing to Admit You Have a Problem, Blaming Others, Data "Cleaning"; Just Say the Well Watered Out

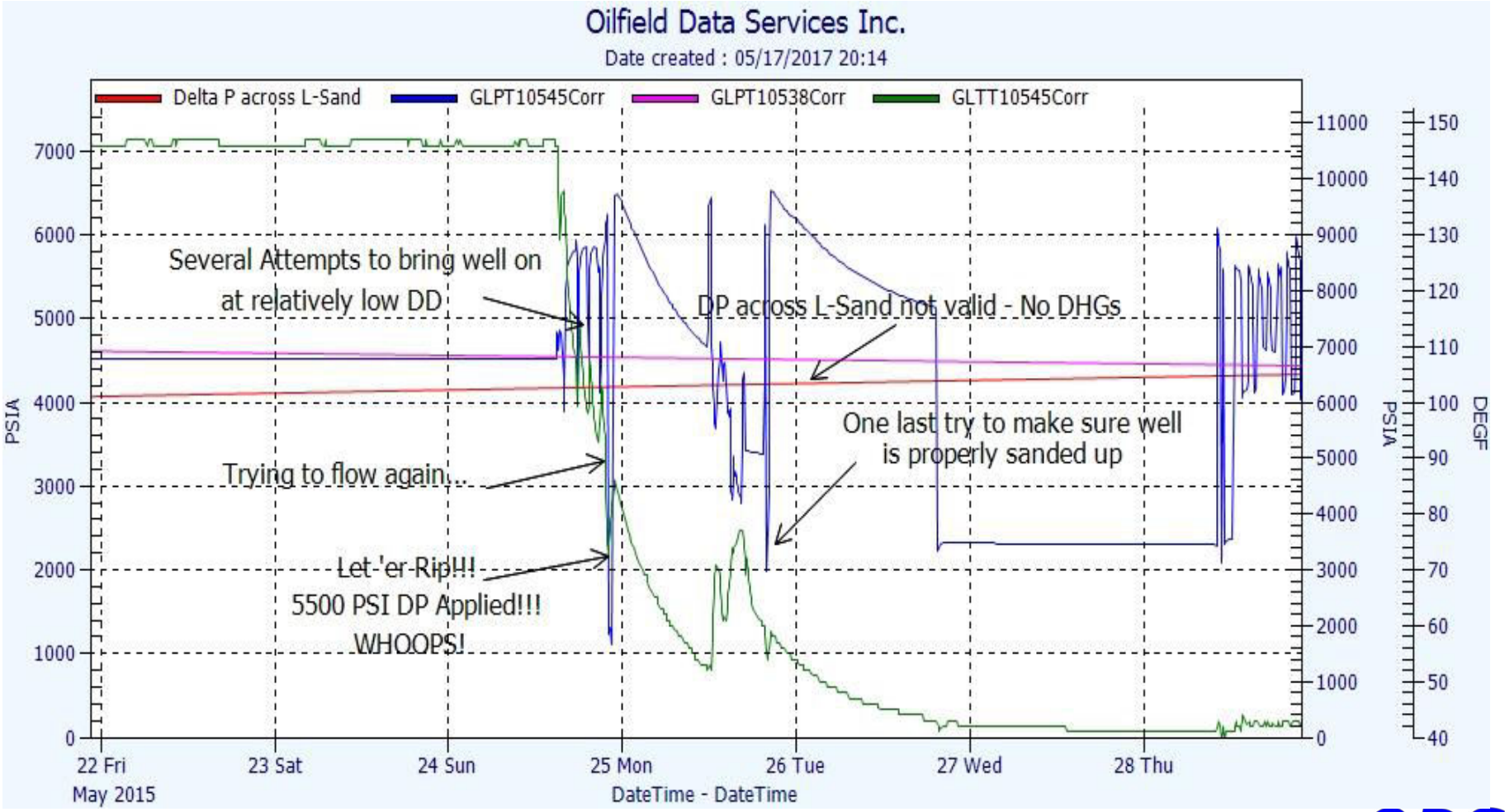
Oh, Darn! My Well Just Watered Out!

Or…

How to Sell 15 MM STB for Abandonment Liability

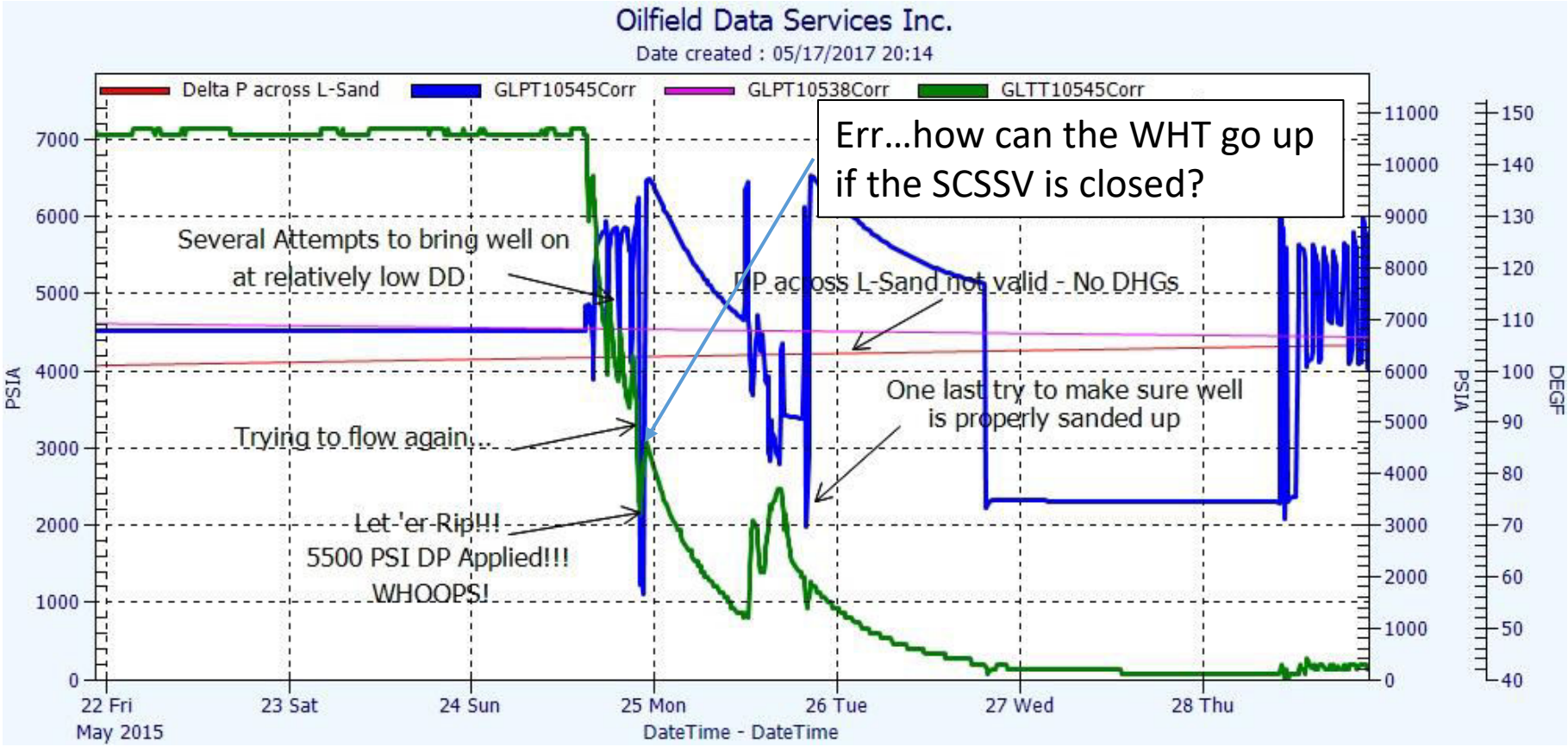
May 24, 2015 Excessive DD Event: 5500 psi

Please note that downhole gauges failed by that time already and the DP was evaluated from the wellhead pressure (WHP is on the left-hand scale)



May 24, 2015 Excessive DD Event Zoom

Wellhead Temperature clearly indicates flow (not SCSSV closure) at 10pm and the excessive DD (5,500 psi) was the cause of the sanding event. The pressure responses indicate that only the L sand was flowing here.



Calculated Water Cuts Around 1%

Date-Time	DPwb	Wbgrad	Water Fraction	Oil Fraction	Comment
01/05/2013 02:25	3704	0.323182968	0.009	0.991	
01/20/2013 08:00	3700	0.322833959	0.007	0.993	
02/20/2013 06:40	3700	0.322833959	0.007	0.993	
04/10/2013 00:25	3700	0.322833959	0.007	0.993	
07/18/2013 10:15	3700	0.322833959	0.007	0.993	
08/16/2013 16:35	3700	0.322833959	0.007	0.993	
10/02/2013 09:10	3700	0.322833959	0.007	0.993	
11/23/2013 03:30	3725	0.325015269	0.024	0.976	<<-- Just the L Sand
11/25/2013 15:55	3706	0.323357473	0.011	0.989	
12/16/2013 03:05	3749	0.327109327	0.040	0.960	
01/07/2014 09:00	3711	0.323793735	0.014	0.986	
02/09/2014 06:25	3704	0.323182968	0.009	0.991	
04/25/2014 06:05	3708	0.323531978	0.012	0.988	
06/03/2014 17:00	3706	0.323357473	0.011	0.989	
07/21/2014 09:40	3728	0.325277026	0.026	0.974	
09/15/2014 15:30	3690	0.321961434	0.000	1.000	<<-- Just the J Sand
10/06/2014 01:20	3750	0.32719658	0.041	0.959	<<-- Just the L Sand
10/29/2014 01:15	3706	0.323357473	0.011	0.989	
11/22/2014 01:45	3750	0.32719658	0.041	0.959	<<-- Just the L Sand
01/07/2015 14:35	3707	0.323444726	0.011	0.989	
01/25/2015 12:35	3707	0.323444726	0.011	0.989	

Let's Take a Look Back Before we Move Forward…

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 (Sound Circular to You?)

We forgot we made a lot of BAD Assumptions First!

A Quick Question:

Has Your AI System…

STOPPED LEARNING?

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 F.A.N.G.y Teeth!

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

What are you Really Getting?

- Is Your Service Provider Really Giving You an 'Intelligent' Solution…

…Or is it Just Another Way to Take Your Money?

- Does Your 'IoT Magic' Honor the PHYSICS?
  - 100+ Years of Equations, with Not Much Better Decisions!
- Must Develop Workflows that Combat Bias and Develop Democratized Information/Results

- **Checking Automated Results is Much More Efficient!**
- **Have to be able to Communicate The Results!**

Maybe, There's a better way...

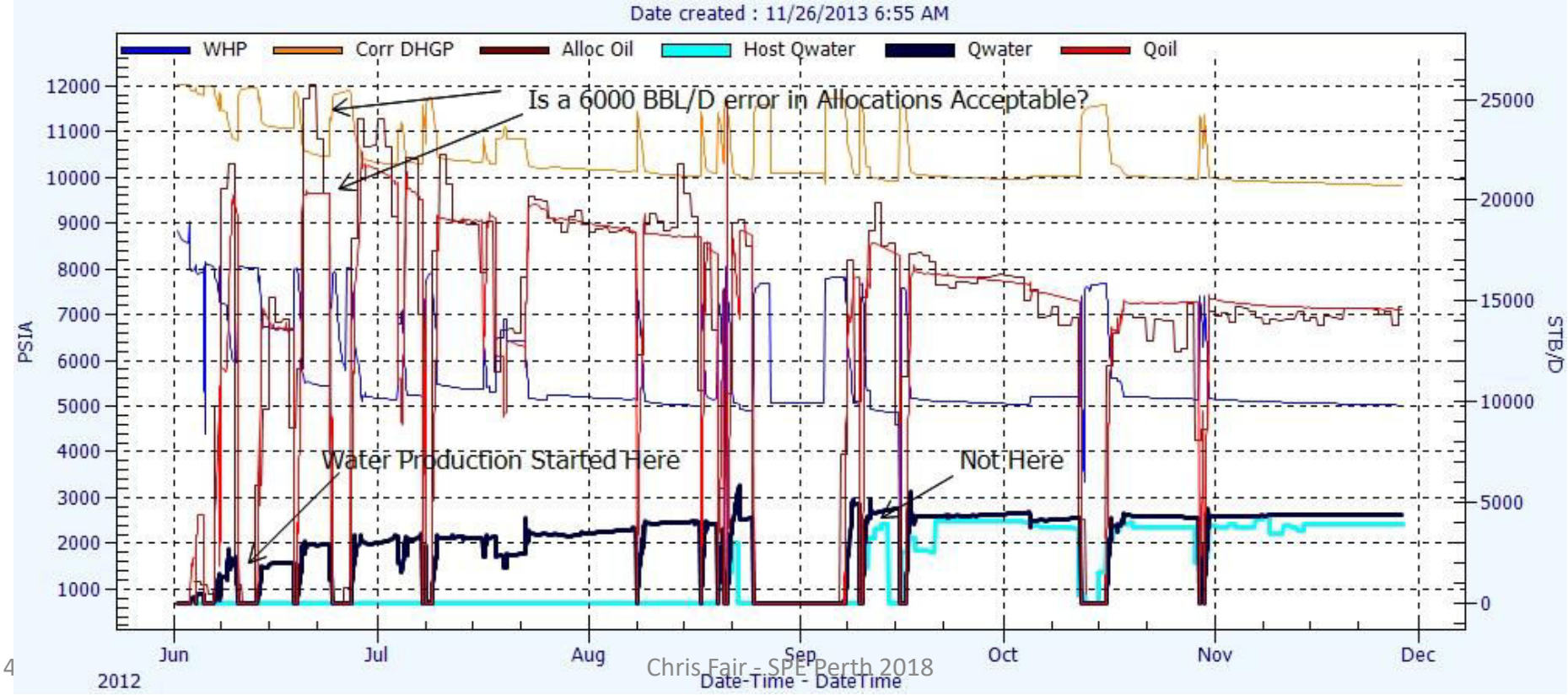
- Start with the Fundamental Physics
- Apply Computing Power to Solve the Equations
  - Make only valid assumptions
  - Don't use correlations
- Don't "doctor" the data
- Don't impose a model on the data!
- Let the well tell you what it's doing!

The Starting Point for Res/Prod Surveillance:

Valid Rate and BHP

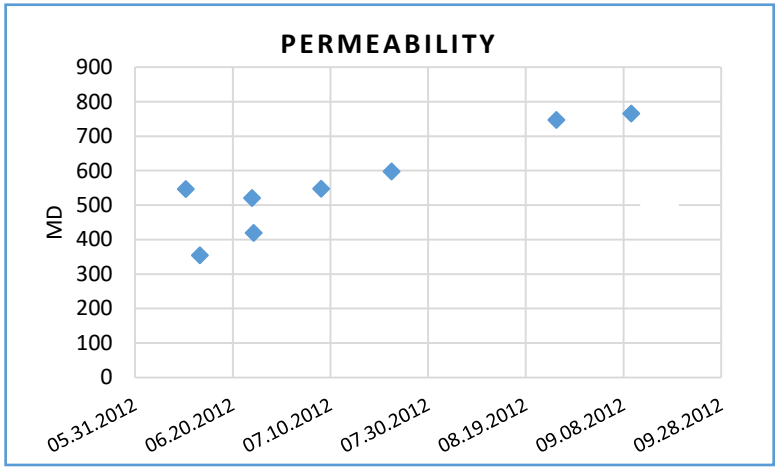
Automation Example - Overview

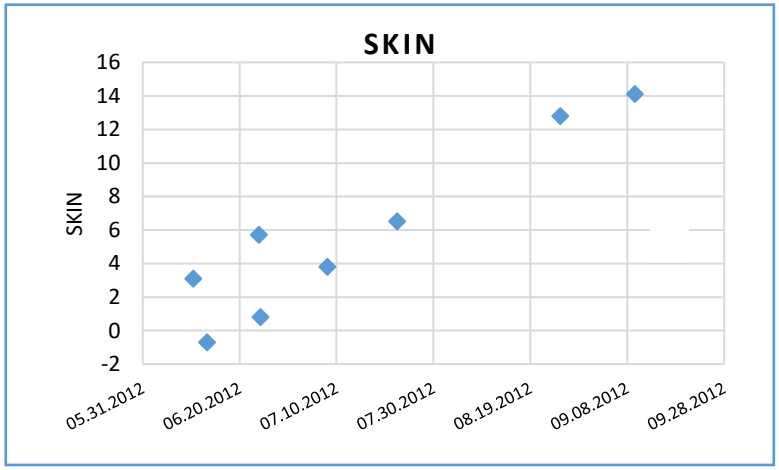
- MPFM rates were Q/C'd and errors in allocations were detected
- Generally, MPFM are accurate on the total liquid rate measurements, but are likely to be off when it comes to individual oil and water rates
- The total liquid rate was split into oil and water rates using the pressure drop in the wellbore and fluids' PVT properties
- As it turned out, the water production started from the day the well was brought on-line. The meter was 6000 BBL/D off in the allocations



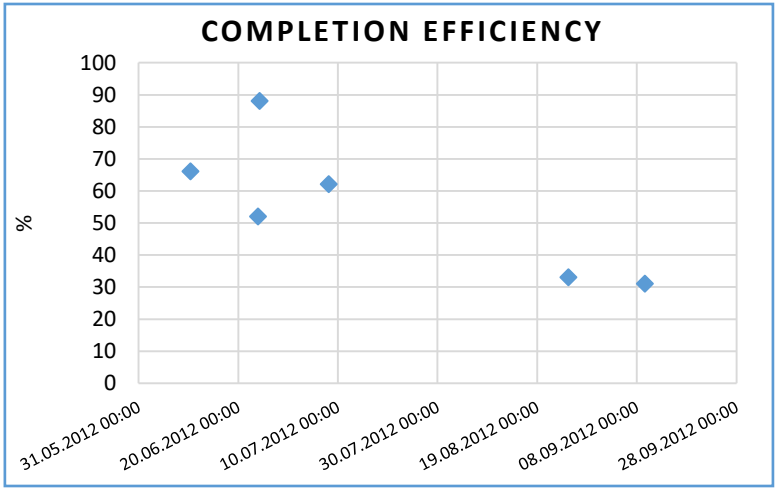
Automation Ex: Auto-PTA

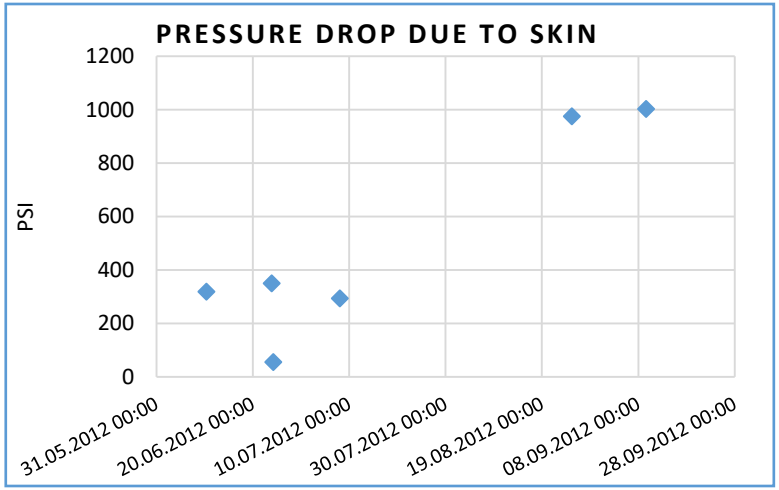
- High perm ~ 500 md
- Skin was getting worse with time
  - From 0 to 14 (screen plugging)
- Productivity was getting worse with time (increasing skin)



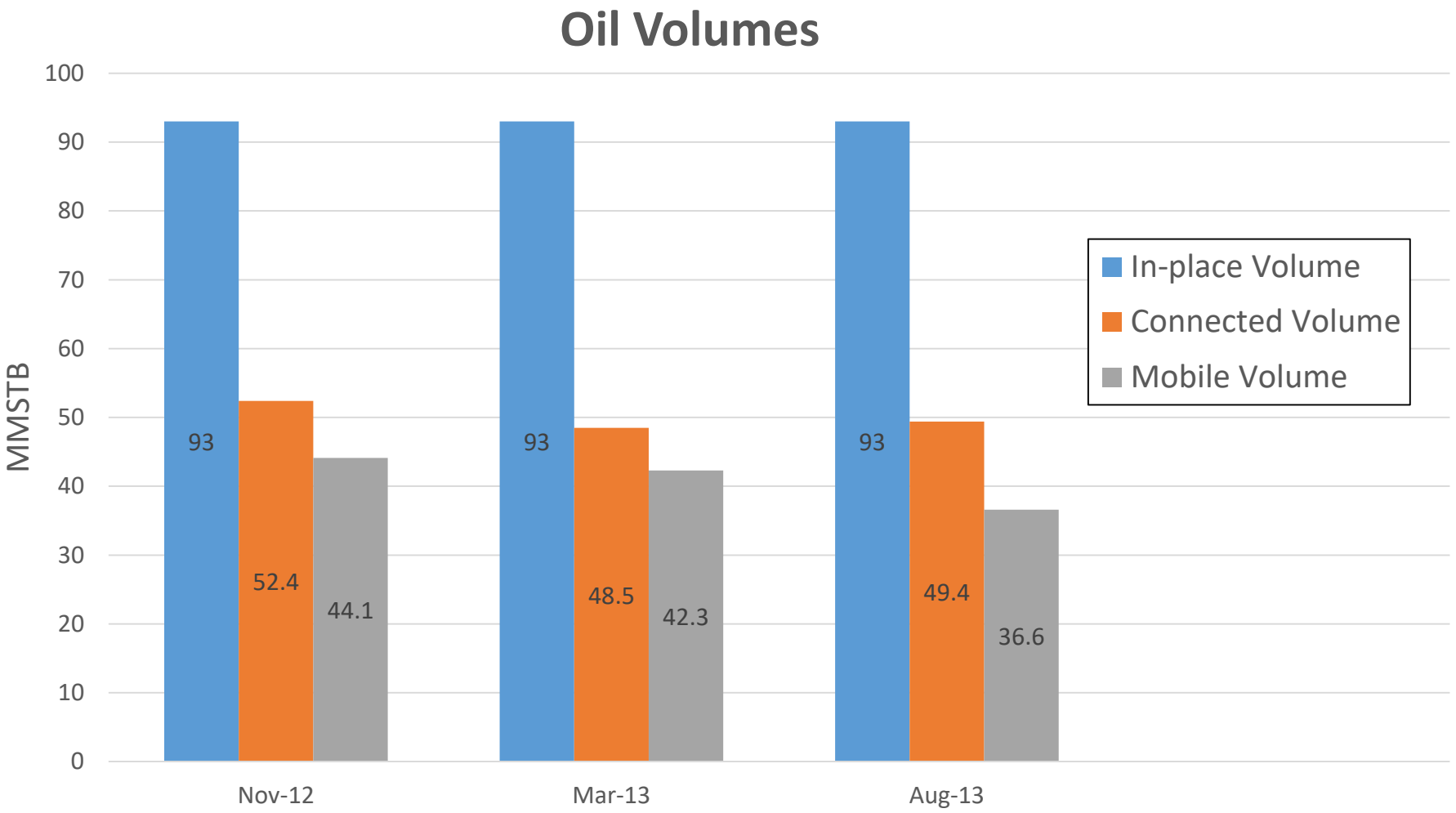


Sample Reports





Automation Ex: HC Volume Calculations



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

Well…We Still Screw It Up! (and by 'We', I mean You!)

There are STILL Organizational/Cultural Issues:

- **Give the Boss the Answer He/She Wants!**
- Silos (Unintentional and Intentional)
- Management Directives (See: Deck Chairs/Titanic)
- **Information Hoarding!**
- **NIH Disease**
- Reactive vs. Proactive
  - Shoot the Messenger!
  - Ass-Covering & Cherry-Picking
- **Don't Forget CONFIRMATION Bias**!

What is BAD Oilfield Management?

- Maximize False Parameters (1st month IP)
- Drill wells you Don't Need
- Eliminate/Ignore Data That Doesn't Confirm Your Beliefs
- 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
- Make the Decision that's Best for You, Not the Company

How Does Artificial Intelligence & Big Data Fix This?

The Problem Is…

Not the Technology, But

How We Make Decisions

How to Get Past The Problem

- Perform Continuous Surveillance (Automated)
  - Look For Changes! Look at the 'Big Picture'
- Democratize the Availability of Data/Results
- Spend Time Discussing What the Results MEAN!
  - Teach ← Present → Learn
- Allow All Interested Parties to Have a Say in the Decision
  - Not necessarily a consensus
- Encourage Ownership of Ideas; Allow People To Take Risks
- Follow-up on the Results of a Decision
- Repeat!
- Use This Process to Become More and More Efficient!

Concluding Remarks

Nothing is Going to Change Until We
Change the Way We MAKE DECISIONS

- **Be Aware of Bias!**
- **Think about what the results mean!**
- **Get Out of Your Silos!**
- **Get Everyone Involved!**
- **Use Computers for What They're good for**
  - **Crunching Numbers!**
  - **Data Analytics is a TOOL, not a Profession**
- **MAKE 'HUMAN LEARNING' GREAT AGAIN!**

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