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Using AI to Address Hidden Inefficiencies in Gas-Lifted Wells

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At every critical transition,
first, you can do something faster;
then, you can do the impossible.

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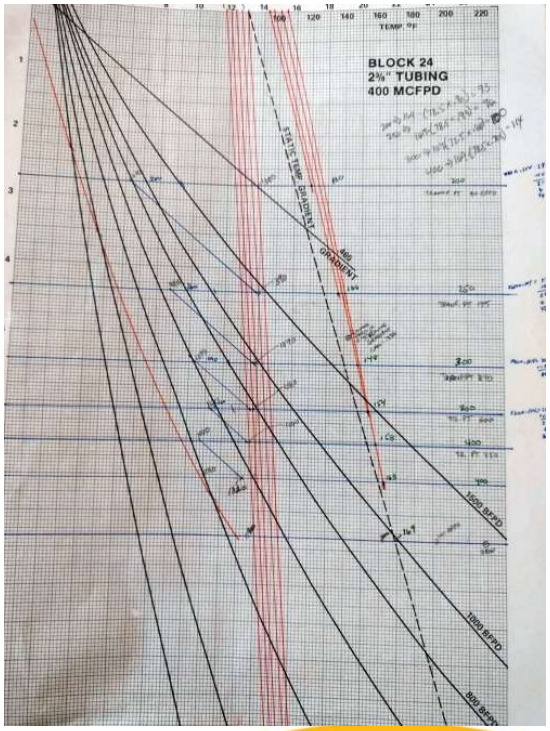
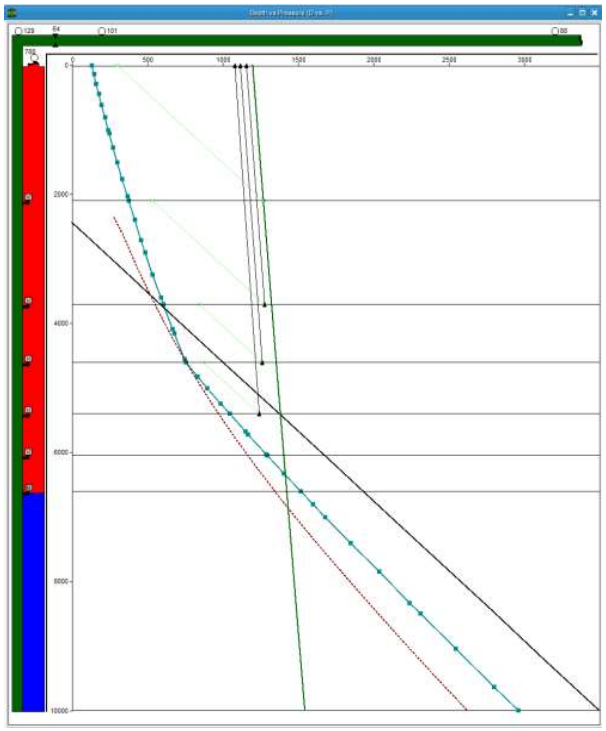
Who remembers this transition?





We are at another transition to the impossible

- Research and draft an article? → 30 seconds
- Write code for a JS calculator? → 5 seconds
- Make a logo for a new business? → 30 seconds
- Create an advertising jingle? → 30 seconds

What is suddenly possible, now that it's faster?

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Gas Lift Hides Its Inefficiencies

Inefficiencies

- Instability
- Shallow injection
- High back pressure
- Wrong injection rate

Finding Inefficiencies

- Opportunities
- Higher production
- Greater revenue

GL Reviews

- Every 1 – 2 years
- 5% – 15% production boost
- Value capture

GL Reviews = Surveillance and Analysis Steps

1. Gather data (updates to the completion, well tests, pressure surveys, tracer surveys, real-time data, etc.)
2. Identify old, missing or conflicting data
3. Calibrate the well model using the latest good data
4. Evaluate factors such as tubing size, the potential for liquid loading, injection depth, gas lift rates, back pressure, etc., in a systematic manner
5. Identify the main problems and opportunities
6. Evaluate production improvement economics
7. Repeat for each well
8. Rank all of the opportunities

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Problem	Impact
O&G companies cannot find all inefficiencies right when they develop.	Lost production. Lost revenue
WHAT IF an operator producing 5000 bopd finds a 10% boost every year?	On average, 5% of 5000 bopd is not produced for 6 months

$3,000,000 in LOST revenue

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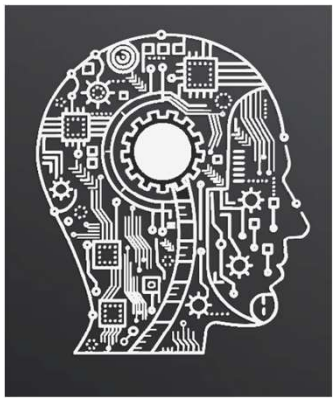
Root Causes of Problem

- Talented Engineers are rare and valuable
- GL surveillance and analysis (S&A) requires training
- GL S&A is repetitive, tedious, and repetitive
- GL S&A often has a high turnover rate
- GL S&A takes significant time (1-4 hours per well per review)
- Other work is more urgent (safety, mandated) or important ($$$)

Solution: Build AI Interns



- Define the analyses used by experienced, skilled gas lift engineers
- Create software to automate data flows and physics-based calculations
- Automate every analysis and rule-of-thumb check
- Interview the most experienced gas lift engineers about example wells
- Use a variety of AI techniques to replicate the thought processes and decisions of the most experienced gas lift engineers
- Ensure tuning and extensions are possible for each different field
- Test against a large database of wells
- Refine and repeat

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How the Gurus Can Assess Every Well Every Day

- AI Interns Guru:
  - Analyze every well and rank opportunities economically
  - Presents summaries with graphical analysis and reporting

- Human Gas Lift Guru:
  - Reviews ranking, results, plots
  - Conducts any further analysis & designs, if necessary
  - Creates and documents recommendations for every new opportunity
  - Communicates with client engineering and operations about opportunities
  - Tracks ongoing and completed work results
  - Shares everything in web format with client engineers and managers

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AI Intern

GL Guru

Inputs

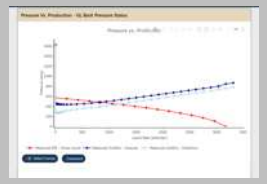
Well config data
Reservoir data
Well test data
Static / flowing gradient
Real-time data

Processing

Well modeling
- Physics-based
- Rules-of-thumb

AI technologies
- Pattern matching
- Decision trees
- Associative memories
- Supervised ML
- …

Outputs



- Well assessment
- Recommended actions
- Graphs & text explanations
- Opportunities (production and $$)

Expert Review

- Review results for accuracy
- Refine reports as needed
- Collaborate with client staff

Why not before now?

- ✅ AI techniques have improved with experience
- ✅ Digitization of data is now common
- ✅ Computational speed is cheap and ubiquitous
- ✅ Scalable architectures and cloud computing are ubiquitous

- ❌ O&G staff numbers and experience shortages
- ❌ GL experience being lost

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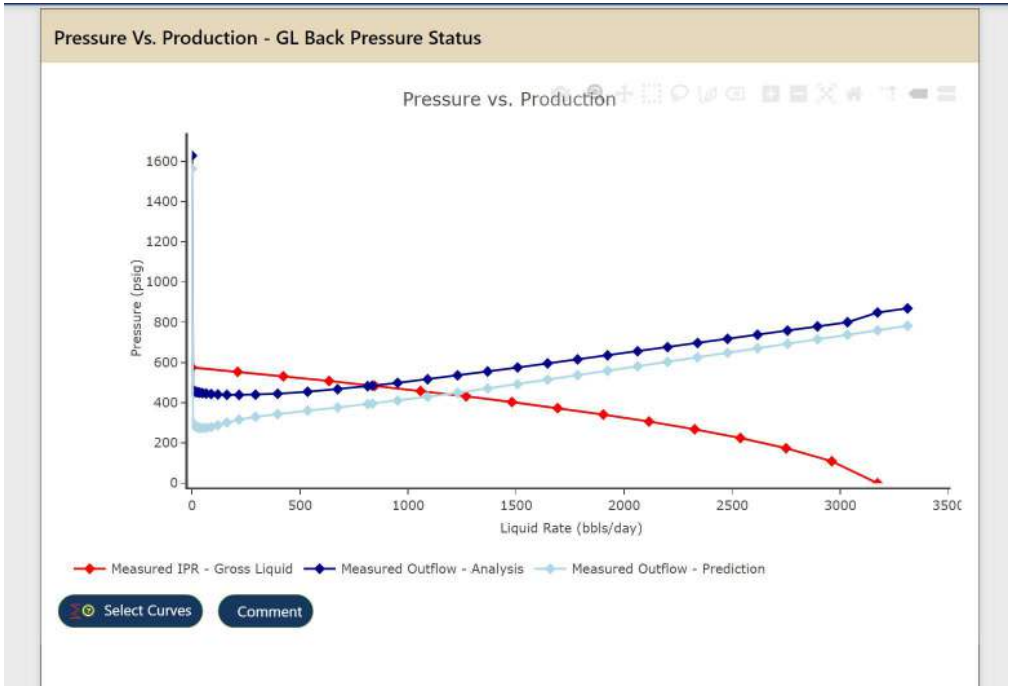
Begin with analysis for a Single Well (2 of 20+)



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Analysis Results for Single Well

Data Verification:

Major problem well test data.

Lifting Condition

The reservoir SBHP is too low for the well to flow naturally. Gas-lift is recommended to continue producing. The current lift gas injection rate is 1156.555 MCF/day. Tubing and casing pressures indicate that gas-lift is possible to a depth of 3395.99 feet.

GL Back Pressure

Differences in the case summary between analysis and prediction mode indicate that removing the wellhead choke from the system is recommended because it may improve the production rate by 221.4 bbls/day.

Tubing state

The tubing size for this well is acceptable. The liquid rate is high enough for the tubing size but very small changes in conditions can dramatically affect the well.

GL Optimization

Based on the amount of lift gas injecting into this well, this well is currently under injecting.

Well Producing

Current well test data:

- Lift gas rate: 1156.555 MCF/day
- Total liquid production rate: 835.1 bbls/day
- Formation gas production rate: 310.063 MCF/day

Well Stability

Real-time data analysis suggests this well is reasonably stable.

Liquid Loading

Well could be liquid loading and may need more lift gas injection to displace all liquid.

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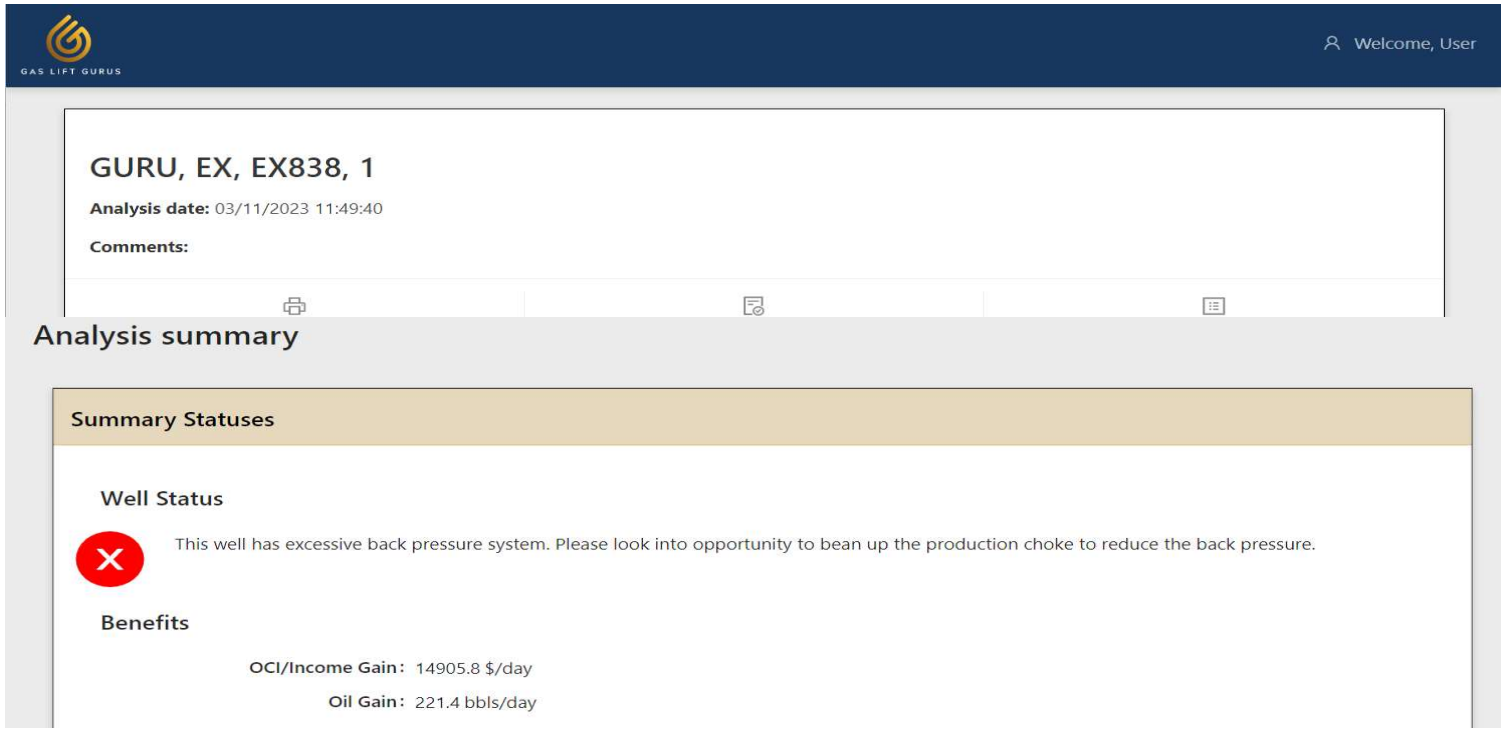
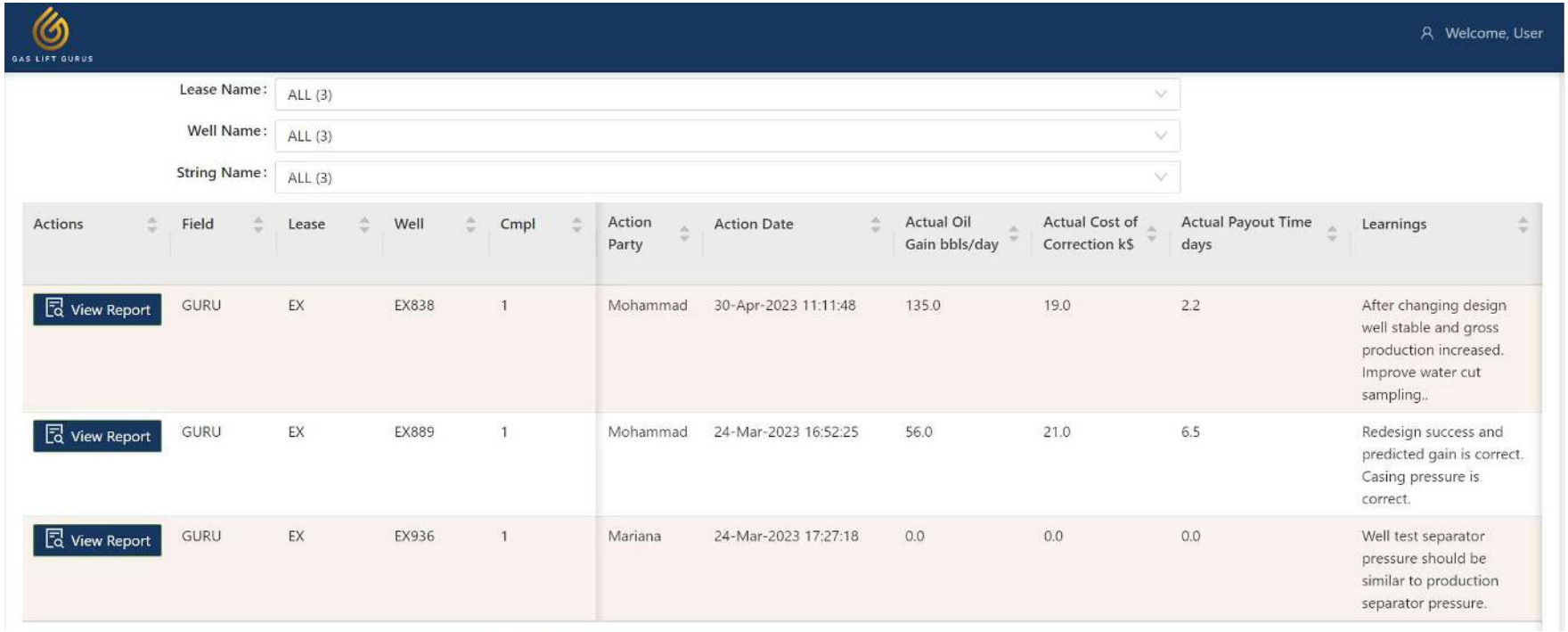
Summary for Single Well



Ranked Opportunities for All Wells in Field



Actions	Field	Lease	Well	Cmpl	Action Party	Action Date	Actual Oil Gain bbls/day	Actual Cost of Correction k$	Actual Payout Time days	Learnings
View Report	GURU	EX	EX838	1	Mohammad	30-Apr-2023 11:11:48	135.0	19.0	2.2	After changing design well stable and gross production increased. Improve water cut sampling..
View Report	GURU	EX	EX889	1	Mohammad	24-Mar-2023 16:52:25	56.0	21.0	6.5	Redesign success and predicted gain is correct. Casing pressure is correct.
View Report	GURU	EX	EX936	1	Mariana	24-Mar-2023 17:27:18	0.0	0.0	0.0	Well test separator pressure should be similar to production separator pressure.

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Question Time

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Question Time

Common questions:

- Is this a way to cut staffing costs?
- How do you know it will work?

Question Time

Q's for the audience:

- What do you like about this service?
- What's your best argument against?

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