LEO by Fracture ID

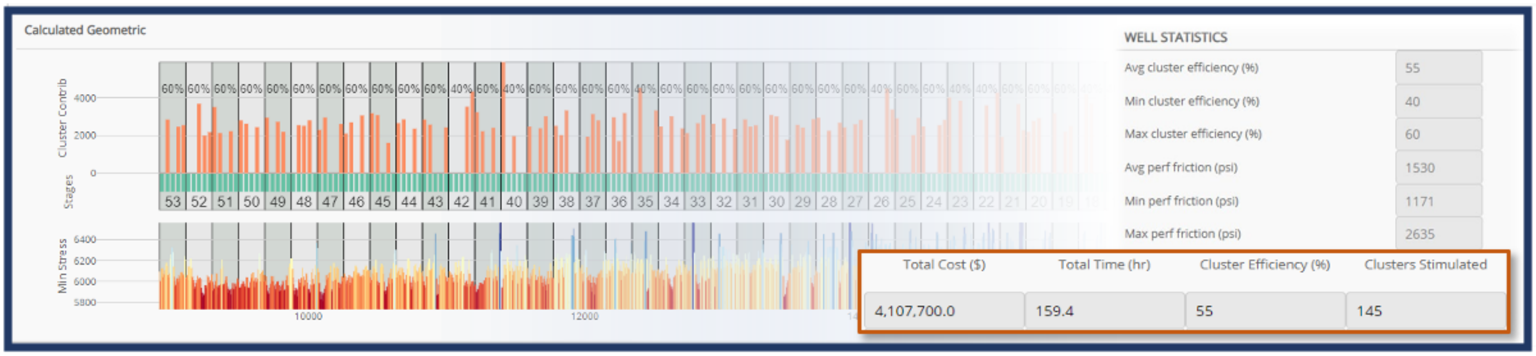
How do you reduce costs and increase production in a multi-stage, hydraulically fractured well? By optimizing the number of effectively treated perforation clusters with fewer stages.

The “Limited Entry Optimizer”, or LEO, is an analytical, web-based application that allows you to do just that. LEO incorporates the rock properties from Fracture ID’s Drillbit Geomechanics™ and your unique completion design to identify where more clusters can be stimulated with less stages.

Is your perforation design up to the task? LEO lets you know.

How the LEO Optimizer Tool Works

Based on the user’s completion design and geomechanical properties, LEO determines if there is enough predicted perforation friction in a stage to overcome the measured cluster-to-cluster stress variability.



Non-optimized, base geometric completion design – 53 stages

Users can make realistic changes to the perforation design to increase cluster efficiency and reduce stage count as well as evaluate the cost savings of those design changes.

Optimized, geo-informed design – 46 stages

Using LEO, one operator **saved $400,000 in completion costs** by increasing stage lengths and effectively stimulating more clusters per stage. In this case, the 40% improvement in cluster efficiency is expected to provide a **production uplift equivalent to an NPV of $430,000.**

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LEO Technical Bulletin

How LEO Works

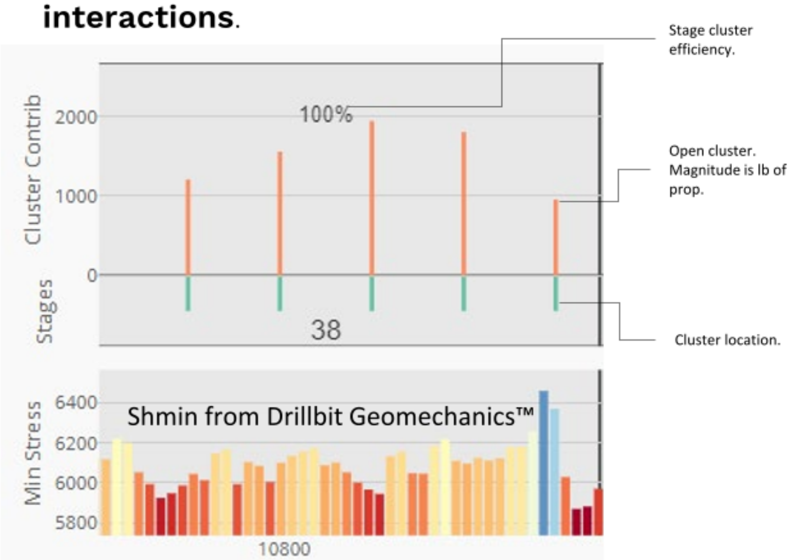
LEO calculates the minimum horizontal stress (Shmin) variability around individual clusters within each stage and determines, based on user inputs, if there is enough predicted perforation friction to overcome that variability.

Perforation friction is determined using the industry standard Bernoulli equation:

$$P_{pf} = \frac{1.975 Q^2 \rho_f}{C_D^2 N_P^2 d_p^4}$$

Where;
P_{pf} = pressure drop at the perforations, psi
Q = total pump rate, bpm
ρ_f = slurry density, g/cc
C_d = discharge coefficient
N_p = number of open perforations
d_p = perforation diameter, inches

Even if every cluster in a stage breaks down, not every cluster takes an equal amount of fluid and proppant. LEO uses the plane-strain relationships outlined by J.L. Elbel et.al (1992, SPE-23982-MS) (also published in Economides and Nolte's Reservoir Stimulation Third Edition as side bar 11C) to calculate the fractional flow through each cluster. **Reducing the variability** of proppant placed in each cluster means **optimal uniformity and less fracture-driven interactions**.



Validation

- Step down and RA tracer analyses for stage cluster/perforation efficiency
  - LEO cluster efficiency predictions are within 8% when compared to step-down and RA tracer data.
  - Hundreds of step-down tests analyzed.
  - Over 50 RA tracer stages analyzed.

- Fiber data for cluster contribution
  - LEO's cluster contribution predictions (also known as uniformity), have been shown to correlate with fiber data measurements.

List of Features

- Web-based, interactive display.
- Limited entry optimization tool.
- Geometric stage builder tool.
- Custom (engineered or geo-informed) design integration. Tapered schedules are compatible.
- Perforation schedule export.
- Geometric vs custom design comparison.
- Base case vs sensitivity analysis for both geometric and custom designs.
- Stage-to-stage cluster efficiency prediction.
- Stage-to-stage cluster contribution (uniformity) prediction.
- Trouble stage indicator.
- Economic analysis that compares completion costs for custom and geometric designs.

- Parameters that can be adjusted in the optimization tool:
  - Hole diameter, discharge coefficient (Cd), shots per cluster, slurry rate, net pressure (PZS), treatment fluid specific gravity, safety factor (accounts for tortuosity, stress shadowing, etc.).

For more information visit us at www.fractureid.com

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