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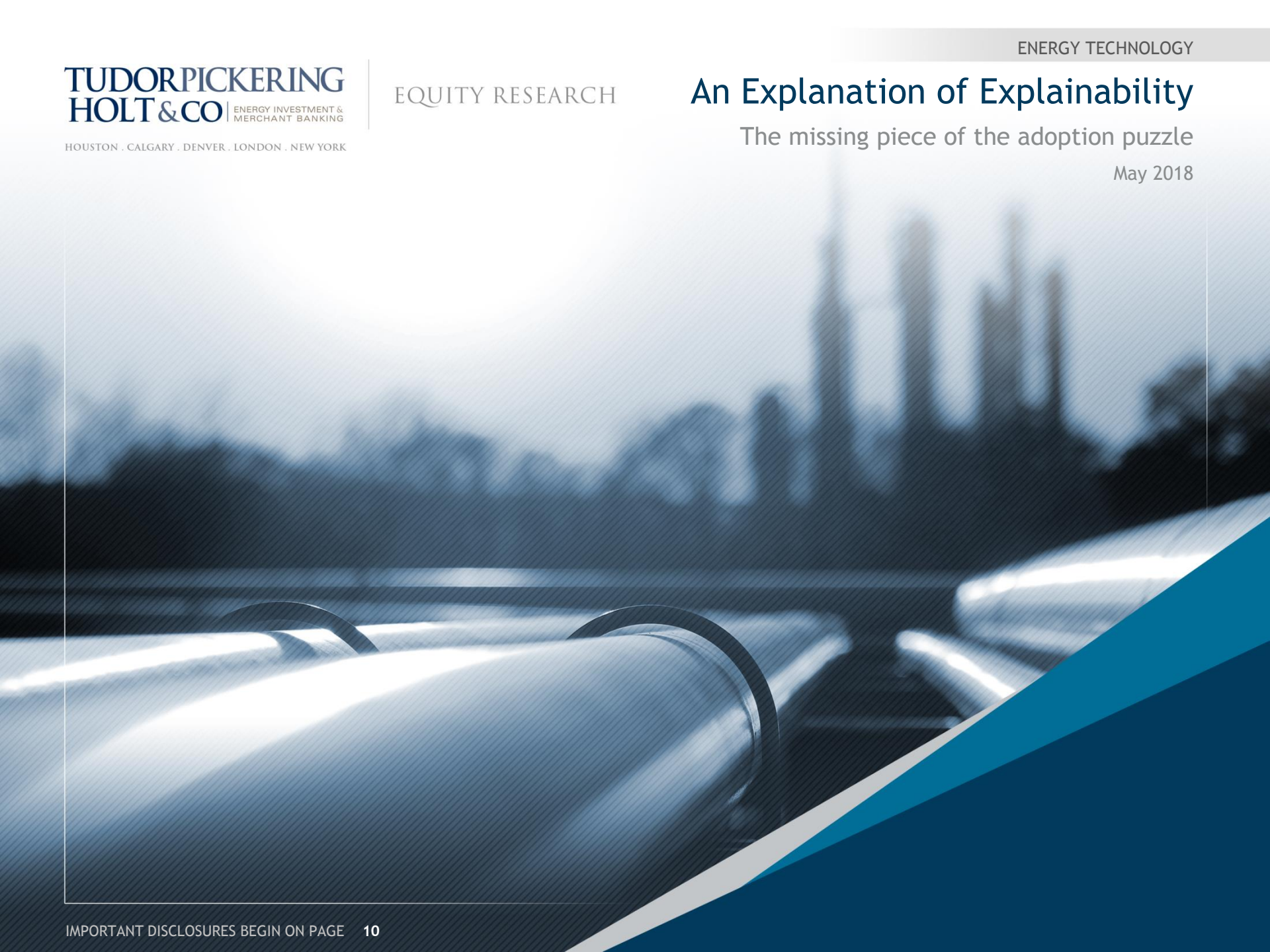
EQUITY RESEARCH

An Explanation of Explainability

The missing piece of the adoption puzzle

May 2018



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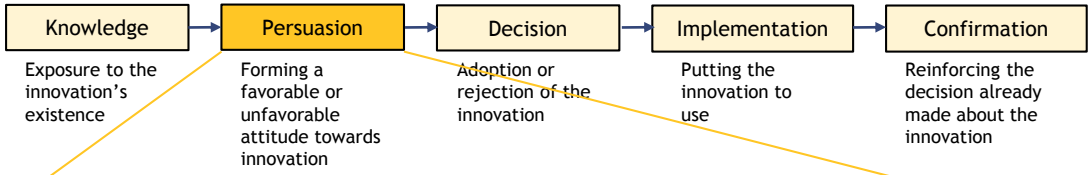
A Framework for Innovation Diffusion

- Diffusion can be defined as the process by which (1) **an innovation** (2) is **communicated** through certain channels (3) over **time** (4) among the members of a **social system**.
- These elements can be further distilled down into two parts: the "unit" process of how an innovation is communicated to and adopted by an individual, or **innovation-decision process,** and the overall social construct that determines the spread of that innovation from the adopter to new adopter (commonly mathematically represented by the Bass model)
  - We believe the key step of the innovation-decision process is "Persuasion" – and the success of this step is determined by the perceived **efficacy and explainability** of a product/innovation
  - Explainability is often an overlooked aspect of tech – and in an industry that is heavily reliant on specialized, technically skilled workers, it is even more important

Elements of Innovation Diffusion

Many iterations of the Innovation-Decision Process



Contributing Aspects to Success:

- Relative Advantage
- Compatibility
- Complexity
- Trialability
- Observability

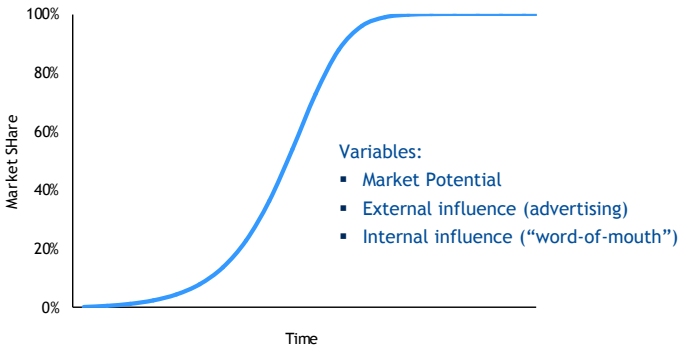
Efficacy of the product/innovation

Explainability of the product/innovation

Focus of this report

Dissemination of innovation through a market

The standard diffusion of innovation shown graphically through the Bass model, a mathematical representation of the rate of adoption of an innovation through a market



Source: TPH Research, Company Disclosure,
Rogers, Everett M. *Diffusion of Innovations*. New York: Free Press, 2003. Print.

Explainability

- There is no scientific definition of explainability – but in the context of technology, it is more or less about trust. Can I trust this product enough to adopt it into or replace an existing process?
- In an attempt to contextualize and measure explainability, **we can characterize it into complexity, trialability, and observability**
  - Explainability is negatively correlated with complexity, but positively correlated with trialability and observability
  - All three are necessary in the process of user adoption
  - To accelerate user adoption, energy technology companies should maximize the combination of these three characteristics; if a technology is lacking in one characteristic, either larger efforts should be made by management to boost that characteristic, or it should be compensated for by outperformance in another characteristic

To put this into context…explainability of several technologies as described by the three characteristics

	Complexity	Trialability	Observability
Cloud Computing	▪ Low conceptual hurdle ▪ High technical hurdle ▪ Overall medium complexity	▪ Relatively easy to trial – can be trialed alongside existing data centers ▪ Initial data transfer may be cumbersome depending on scale of trial	▪ Low visibility – who will know that you're using a cloud?
Advanced Analytics	▪ Usually high complexity ▪ May depend on level of statistical sophistication of end-user	▪ Easy to trial in cases where the set of "answers" is large and can be tested against; hard to trial with limited data ▪ Medium trialability	▪ Low observability as difficult to know from the outside if advanced analytics are being used and whether the results are based on the analytics (vs. luck or incumbent process)
Drones	▪ Low complexity (very easy to visualize and understand the use case)	▪ High trialability – drones are usually deployed with low upfront capital and minimal footprint	▪ High observability as easy to see whether drones are in use, even externally (surrounding operators will be able to observe)

In the following few pages, we provide real-life examples of how current energy tech startups are maximizing explainability

Source: TPH Research, Company Disclosure,
Rogers, Everett M. *Diffusion of Innovations*. New York: Free Press, 2003. Print.

Real Examples of Companies and Explainability

QUANTICO Energy Solutions

Quantico, formed in 2012, focuses on using machine learning for a variety of subsurface-related purposes: to generate "predicted" well logs, offer real-time drilling optimization, build Earth models, etc.

Reducing complexity

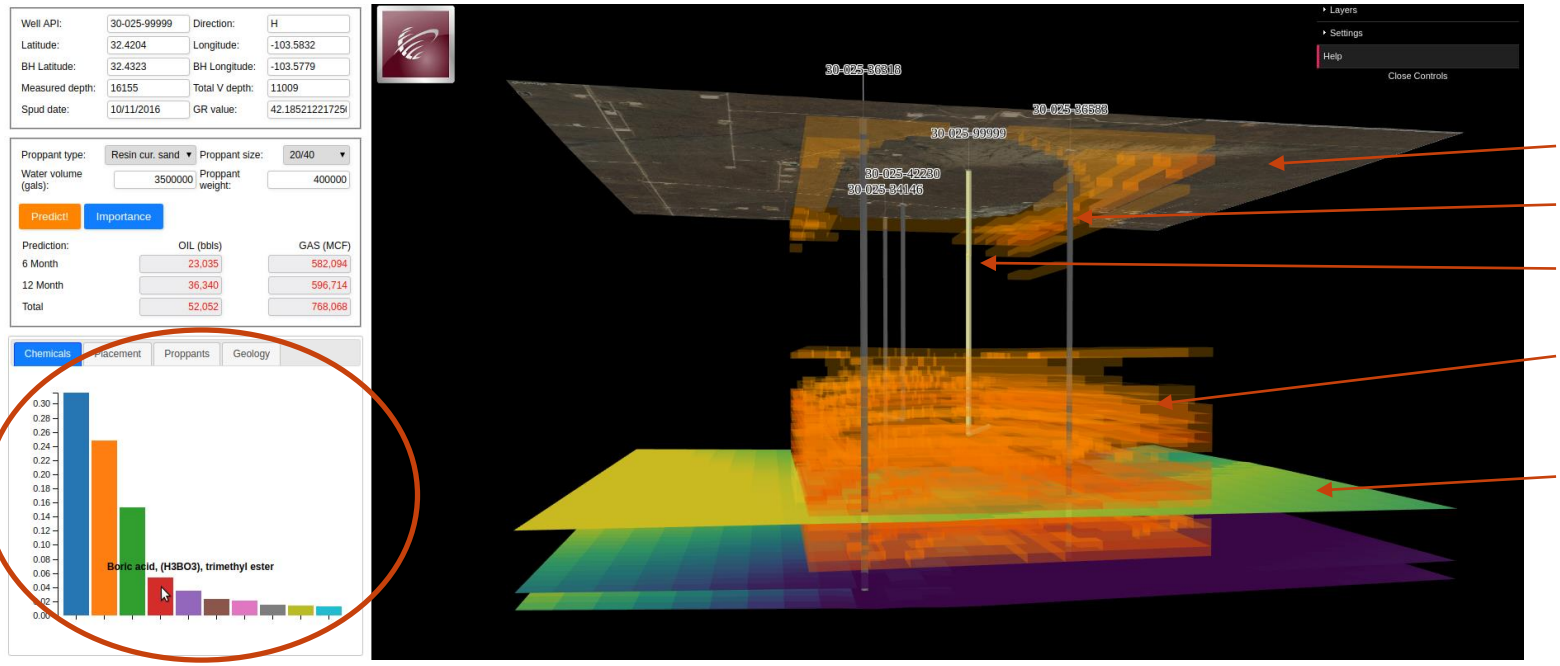
- Quantico uses neural networks, a traditionally difficult-to-penetrate form of artificial intelligence – but has recently pivoted to a modified, explainable version of its neural networks
- "Explainable AI" reverse engineers the neural network to assign semantics to nodes in the network, allowing us to see what semantics (e.g. "proppant type") contributed what weights to the end result – alpha tests have received extremely positive feedback so far

Increasing trialability

- Quantico takes ~5-10% of the data given to them to use as "testing" data vs. "training" data in order to validate the model

Increasing observability

- Public events, releases, conferences, and white papers



"Explainable AI" Weights – in this screen, it's showing the relative importance of chemicals

Source: TPH Research, Company Disclosure, Darpa

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Real Examples of Companies and Explainability (cont'd)

Austin-based Novi uses machine learning for well planning and production/production economics optimization

Reducing complexity

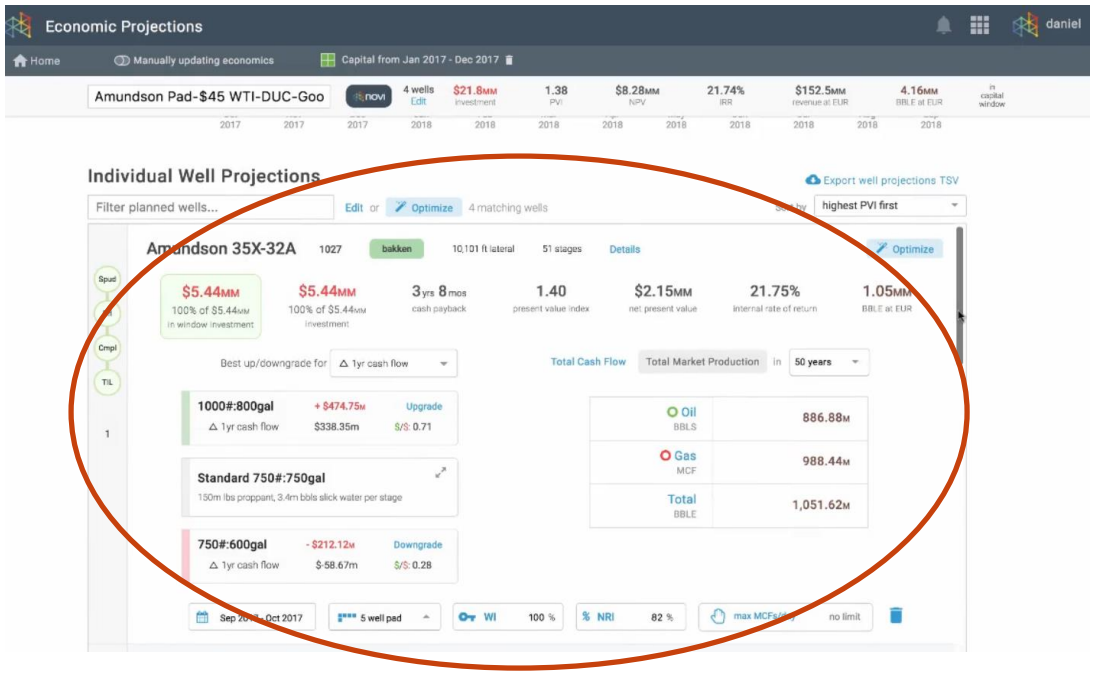
- In the current version of the platform, users upload their data, the model is trained, and the resulting economic projections for each well (or group of wells) are outputted
- Currently developing incorporation of explainability features such as partial dependence plots, which show the relationship between the model predictions and a single variable in the model. This helps the human user confirm known physical relationships between variables

Increasing trialability
Increasing observability

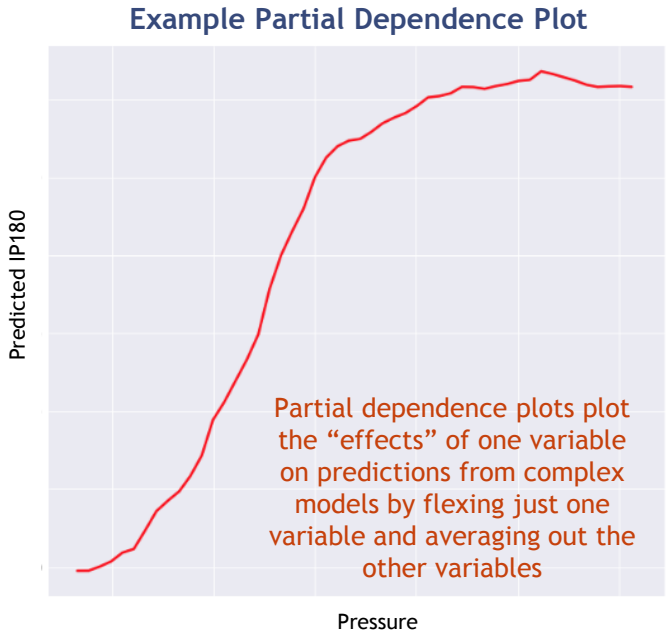
- Novi participates in machine learning "competitions" with competitors that test the accuracy of a known set of production data (usually IP180) against its model; successful runs in these competitions have increased the perceived trialability and observability of Novi's platform

Increasing observability

- Public events, releases, conferences, and white papers



Machine learning outputs



Source: TPH Research, Company Disclosure

Real Examples of Companies and Explainability (cont'd)

Agile Upstream aims to organize and analyze leases through their flagship product, ALI, helping to streamline A&D processes, land administration, and general operations

Reducing complexity

- Leases are uploaded to the platform and run through OCR and natural language processing algorithms to digitize the lease language and allow classification / analysis of specific clauses
- This tech has a lower conceptual complexity as most people have no problem comprehending the usage of natural language processing and digital lease organization. With users less concerned around how the tech is applied, and more around the usability of the platform, the platform is built such that the UI disguises the intelligence behind it.

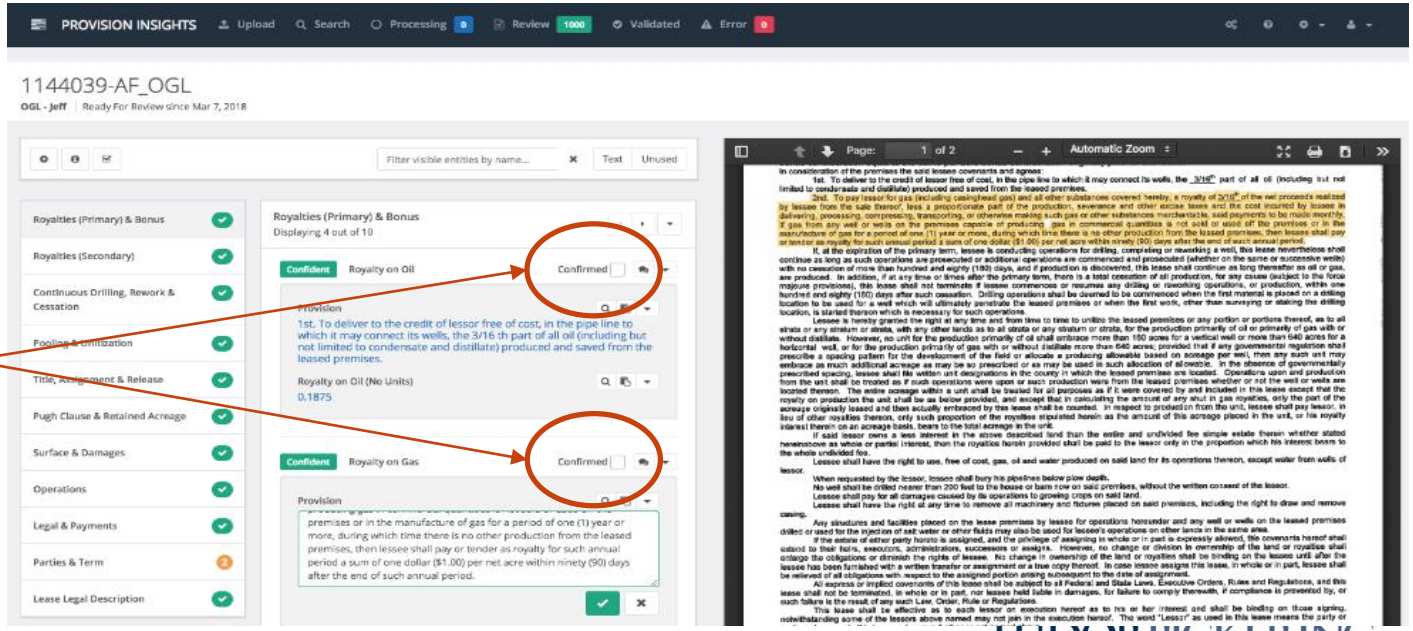
Increasing trialability

- Agile Upstream focuses heavily on trialability. They encourage potential users to submit volumes of leases to get comfortable with the product or re-enact use cases such as an acquisition
- The agility (hence, the name) by which users can trial the product is a selling point
- Community involvement through "confirmations" of the algorithms' outputs builds customer trust and increases model accuracy

Increasing observability

- Public events, releases, conferences, blog and webinars

Validation of model outputs is key to increasing trialability



Real Examples of Companies and Explainability (cont'd)

Ambyint monitors, autonomizes, and optimizes artificial lift systems (reducing downtime, underpumping/overpumping, gas interference incidents, etc.) through the use of IoT and machine learning

Reducing complexity
Increasing trialability

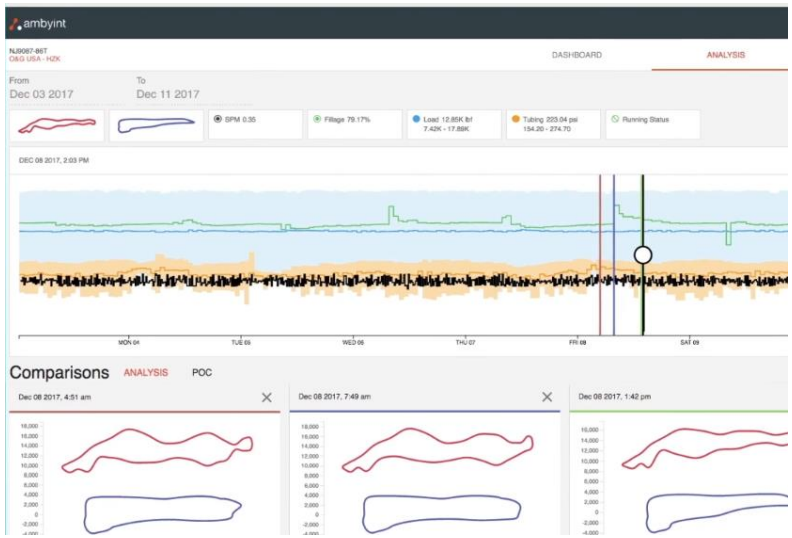
- Pegging themselves as simply the "self-driving car for oil wells," Ambyint offers IoT devices (dubbed "High Resolution Adaptive Controllers") and an automation/optimization platform (that can either integrate with the HRACs or existing SCADA systems)
- Because of the repetitive nature of much of the targeted process to be replaced, less emphasis on explaining the technology as much as showing proof that it will work
- Platform is built to offer opportunities for human validation by visualizing the automation process
- Big emphasis on AI education – company holds teaching sessions with customers during pilots

Increasing trialability

- Focus on repetitive tasks increases trialability, allowing the human users many interations of "validation" through the pilot process

Increasing observability

- Public events, releases, conferences, blog and webinars



Visuals help human user validate the automation process

Deep Customer Engagement

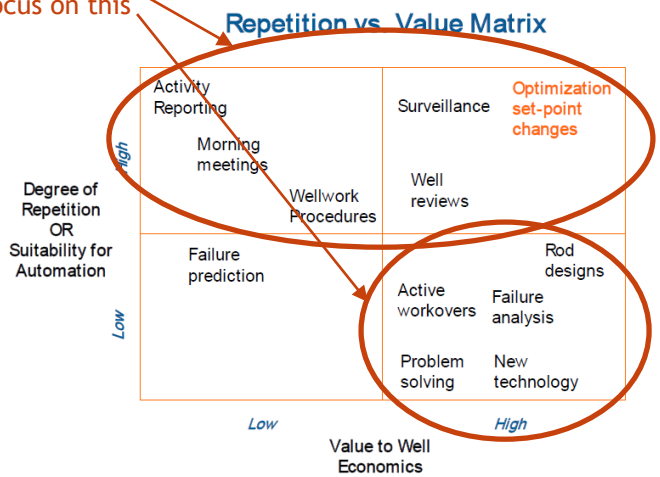
Vision Sharing
- Executive Alignment
- Map to business metrics that matter
- Field Workflows (As Is vs To Be)

Education
- Data Science / AI
- Well Optimization (What good looks like)
- Physics / Math

High Touch
- Baseline Review
- Weekly Pilot Calls
- Post-Expansion Success

High level of engagement during pilots increases trialability and reduces complexity

Ambyint automates this so humans can focus on this



Focus on repetitive part of matrix for higher trialability

Source: TPH Research, Company Disclosure

Real Examples of Companies and Explainability (cont'd)

Data Gumbo uses blockchain technology to offer smart contracts specially optimized for the oilfield and industrial applications

Reducing complexity

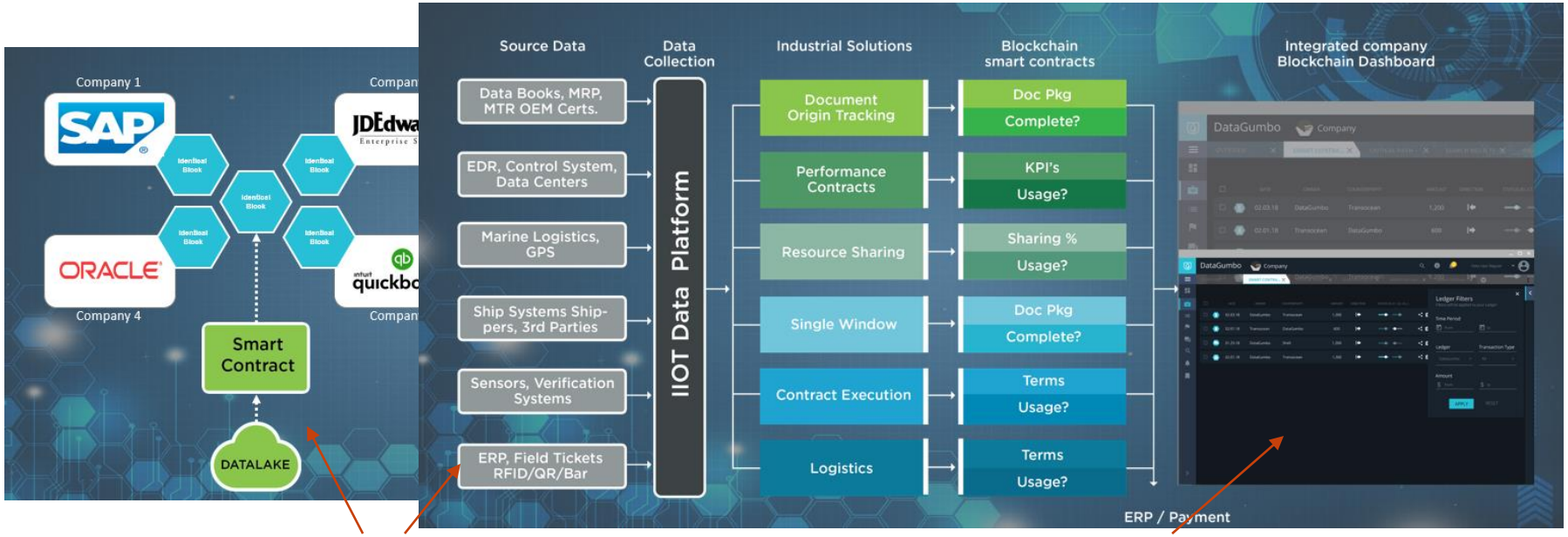
- High complexity tech as blockchain is still not widely understood as a smart contract solution. Data Gumbo combats this by devoting much of its education/marketing materials to the broader blockchain concept before delving into specific use cases
- Though this helps, there is only so much education can do for a concept often shrouded in confusion - Data Gumbo thus places heavy emphasis on its high trialability
- Simple UI and ease of use is also key to reducing complexity

Increasing trialability

- Low-cost, low-footprint pilots are the driving force for explainability in this case; pilots can be run in parallel with existing systems for ease of transition and validation (compare and contrast)
- Ease of use of the platform increases trialability
- Pilots are such a large part of the adoption process that Data Gumbo makes it a goal to convince customers of a pilot in one hour

Increasing observability

- Public events, releases, conferences, and blog



Data Gumbo materials start with general blockchain explanation before transitioning to specific use cases because of high complexity

Clean, simple user interface is key to increasing trialability and reducing complexity

Source: TPH Research, Company Disclosure

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