Pinnacle eBook

The Challenge with Our Current Risk Models

In general, the oil and gas industry is risk averse. Given the serious economic, environmental, and societal consequences that can result from an incident, facility management is typically conservative in how they calculate risk and make risk management decisions. However, facilities must accept some level of risk in order to operate and capturing this level of acceptable risk is key. This eBook will discuss how facilities can overcome these challenges by focusing on quality data, analyses, and decision-making processes.

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A Brief History of Risk-Based Inspection (RBI)

RBI has evolved over the past couple of decades. While the oil and gas industry really took off in the 1850s with the establishment of the first refinery and oil well, it wasn't until about 100 years later that the industry truly started to focus on proactively managing risk. Prior to 1950, the industry took more of a "run until it breaks" type of approach. The first industry codes started to roll out in the 1950s, and facilities began conducting inspections on regular intervals throughout the 1960s and 1970s.

In the 1980s, the industry started to shift to an approach that conducted inspections based on an equipment's condition. The 1990s were a pivotal time in the industry as additional regulations were released. Technology that could implement this new approach was also developed during this time and facilities across the industry were starting to implement it. However, most facilities were still conducting inspections on a fixed interval. Finally, in 2000, the industry started to shift to a more risk-based approach to inspection. A risk-based approach to inspection balances the condition of the equipment with the consequences of failure of that piece of equipment.

History of Refinery Utilization and Availability

Has a risk-based approach to inspection had an impact? There have been some interesting trends in capacity, utilization, and throughput rates for North American refiners over the last 40 years. Interestingly, in 1980, there were about 300 refineries in the US. Now, there are about 130.

Today, these 130 refineries refine almost as much crude oil as the 300 refineries did in 1980. While many of these refineries are bigger than the original 300 were, they are also able to process the same amount of crude oil because they are operating more reliably.

We see large jumps in the average availability and utilization for US refineries between 1980 and 2000. While market challenges have impacted utilization over the past 20 years, we see a smaller increase in utilization & availability after 2000 despite technological advancements.

Are the solutions that led to a 15% gain in average US refinery availability the same solutions in place today? If so, this smaller increase in availability and utilization makes us wonder: Are these solutions still working?

	US Utilization Prior 10 Year Period	Average Global Refinery Availability*	Average US Refinery Availability*	Top 10% US Refinery Availability*
1980	67%	62%	74%	85%
1990	77.7%	72%	82%	89%
2000	90.3%	78%	89%	92%
2010	88.4%	81%	91%	94%
2020	87.4%	83%	92%	96%

15% Gain

3% Gain

Table 1 – Refinery Utilization and Availability
** Availability numbers after 2000 are +/- 1%, 2000 and prior are +/- 3%*

Why Not?

We need better risk models. While the industry has made significant advancements over the past couple of decades, this slower increase in the growth of utilization shows that we need better risk models.

Douglas Hubbard, an expert on risk management, gives four primary reasons why risk models fall short across multiple industries. These reasons can also be applied to the oil and gas industry.

Models can be too dependent on expert input.	Models aren't always validated against what happens in the field.	Models can be siloed.	Models aren't always used by people with shared incentives.
When models are overly dependent on expert input, there's too much subjectivity from areas like behavioral economics and decision psychology. Expert opinion, unfortunately, often has decision biases.	When this occurs, we may find ourselves implementing a model and moving on to the next challenge to solve. However, if no one challenges the model on whether or not it's accurate, there's a chance that the risk model will be inaccurate.	In some cases, models are only used by certain people for specific functions and do not consider all aspects of business operations. Sometimes, especially in complex systems, various factors can cause risk models to go askew and if our models are not considering those things, the risk models might fail.	If the people using these models are not incentivized to reduce risk, they can sometimes skew those models in the wrong direction. For example, a fixed equipment engineer who is motivated to not let a leak occur may skew the risk models to be conservative.

Is There Value in Closing the Gap?

Even refineries operating at high levels of availability can recognize significant economic benefits from better risk models. Whether that's obtaining an additional 2% of availability or minimizing wasted inspection costs, refineries have significant motivation to incorporate better risk models.

For example, a 2% increase in availability and utilization across US refineries equates to about $1.5 billion annually. If these same refineries recognized a 10% reduction in the maintenance and turnaround costs associated with inspection, this would also equate to about $1.5 billion annually.

With a $3 billion annual opportunity across US refining at stake, it's clear that there is significant value in building a better risk model.

Better Models

We know that there's value in building better models but how do we achieve this? Better risk models should:

Validate against actual results	Better use data	Minimize the impact of human bias	Separate degradation and uncertainty	Evaluate the entire system, not just one asset alone
Verifying the model's results is critical.	With the massive amount of data that is available to facilities today, the challenge that many facilities face is not how to get more data but what to with their data.	Human subject matter experts (SME) will always play a critical role in assessing risk. However, all humans carry a certain level of bias. Finding the optimal balance between human SMEs and data science is critical to building successful models.	Instead of just inflating corrosion rates based on how uncertain an SME may be, the SME should assign a corrosion rate along with the uncertainty so that these numbers can be used more quantitatively.	Evaluating your asset in context with the entire system will help these models determine the impact of one asset on the entire facility.

Case Study: Better Use of Data in a Crude Unit

In this crude unit case study, we studied 42,000 condition monitoring locations (CMLs) across four independent crude units along with its associated inspection history, equipment information and process data.

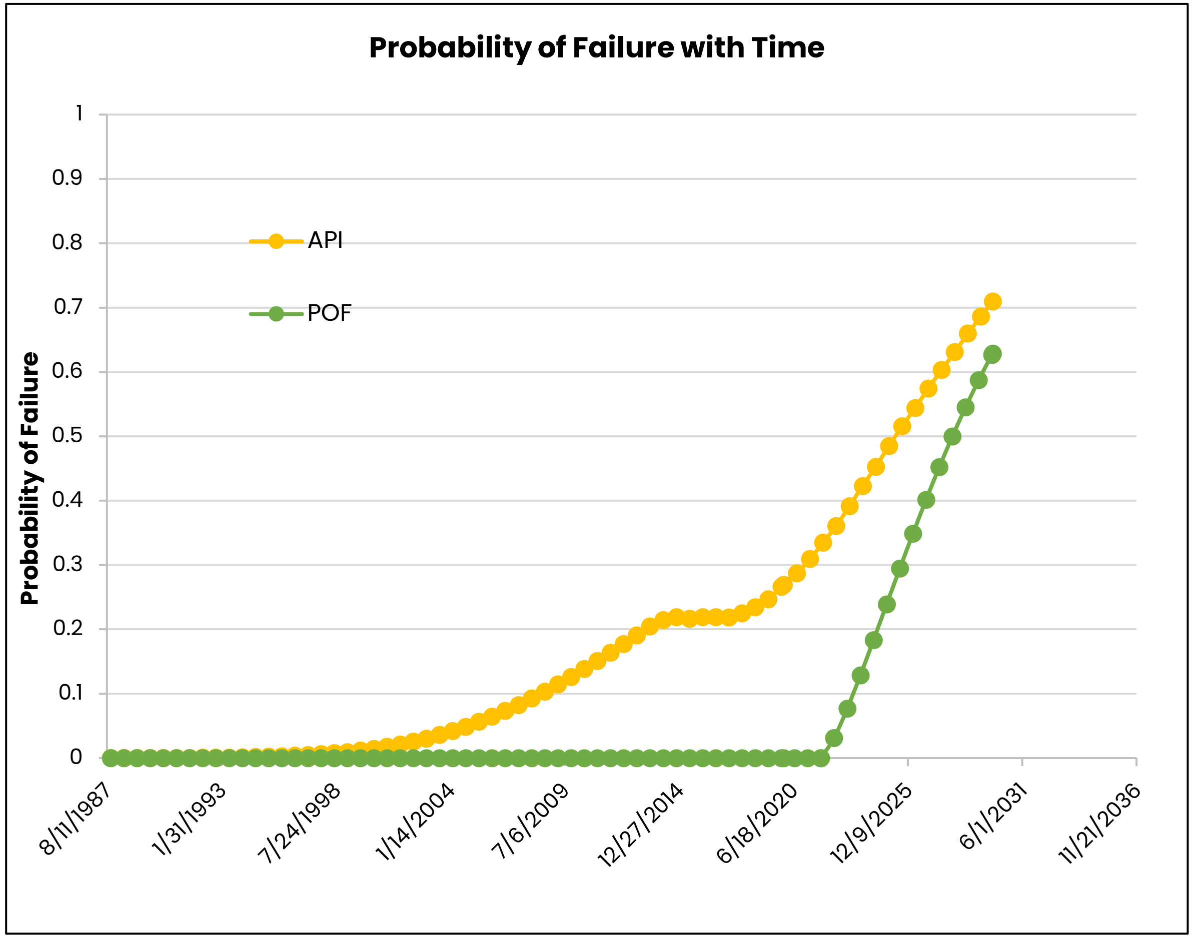
We found that the corrosion rates for these four units varied from 2 to 31 mpy. Because 31 mpy is a high corrosion, we used data analytics to further evaluate the units' historical data and the conditions associated with this unit, and then predicted the corrosion rate. We compared the model's rate to the measured rate and found that the model could predict corrosion rates accurately. Most importantly, we were able to home in on the areas that had a corrosion rate greater than 5 mpy and predict the corrosion rates within 1.6 mpy.

As a result, we were able to determine that less than 7% of the total CMLs in the facility were contributing to 99% of the facility's risk. Having this level of knowledge will help facilities better focus their time and resources on the CMLs that have the greatest impact on risk.

API 581 vs. Quantitative Probability

In this example, we compare the probability of failure of an asset using the same data. Using an API approach, the facility will have to inspect the asset sooner and more often than the other approach. This is not an incorrect approach because this is exactly what we want API to do. However, there may be a chance that we are over inspecting this asset. Leveraging a quantitative risk model can help minimize the chance of over inspecting.

This is where building a model that separates degradation from uncertainty is key. We tend to respond to high corrosion rate data, so it's not the corrosion rate itself that's the issue. The primary issue is our uncertainty around the corrosion rate or about what's going on in any piece of equipment. So, a piece of equipment with a low corrosion rate with high uncertainty is higher probability than a piece with high degradation with low uncertainty. We tend to know more about equipment with low uncertainty and a high corrosion rate because we know that it's going to fail in some period of time, and therefore, we inspect more.

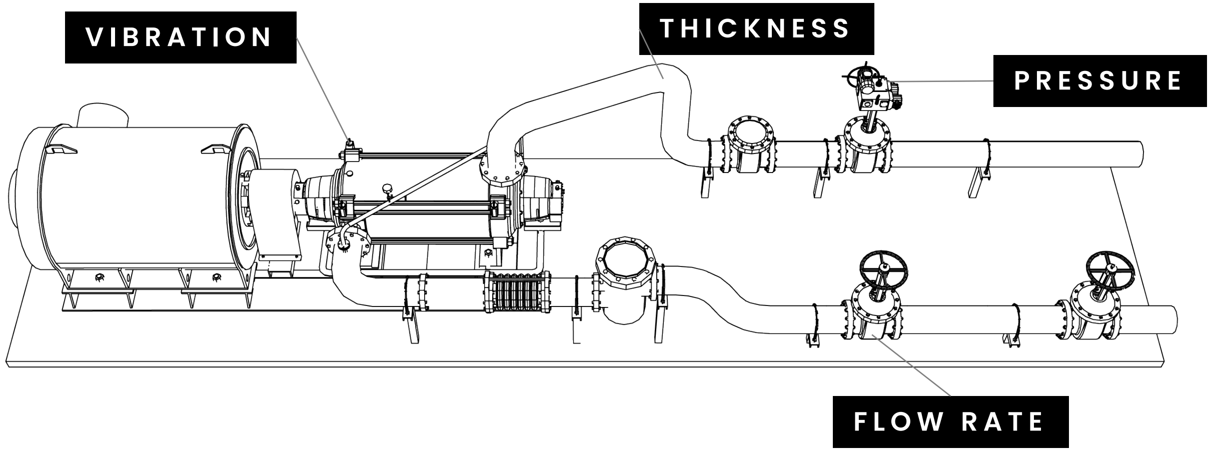


In this figure, API will require an inspection earlier than the quantitative risk model.

Minimize Human Bias

Human SMEs play a critical role in our industry. However, human SMEs often assign inflated corrosion rates to err on the side of being conservative. While this is not necessarily an incorrect approach to take, conservative rates can result in unnecessary inspections. One way that models can minimize human bias is by requiring more quantitative input. Again, separating the degradation rates from uncertainty will help determine when conservative rates should be included to account for uncertainty.

How do you minimize this uncertainty? First, you must evaluate what data you have. Humans tend to limit themselves to the data of one specific asset. For example, if you look at any of the inspection data management systems (IDMS) that we use today, you'll see a component such as a piece of pipe. The data used to calculate risk for that component is the data that's assigned to that component such as the materials, flow rate, joint efficiencies, and inspection history.

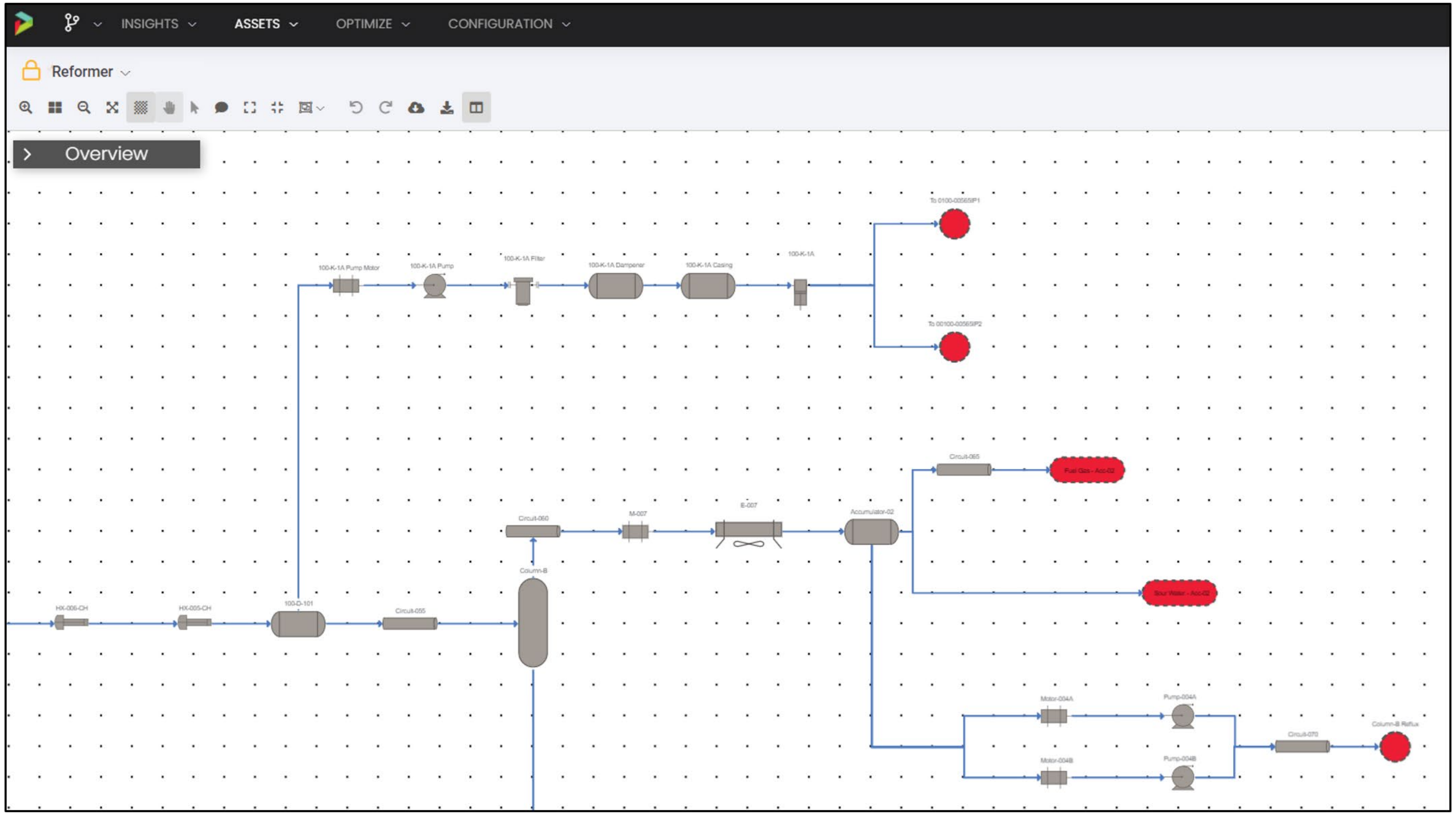


However, the SME doesn't just look at the asset – he or she evaluates everything around the asset. What's happening in the pump upstream of the asset? What's happening in the valve downstream of this exchanger? We must start building risk models that no longer silo our analysis on specific assets. A refinery is not a collection of 50,000 independent assets – it's one big asset with a lot of different pieces that have to work together.

The System

Knowing how individual assets fit into the overall system will help facilities understand how individual assets impact their overall utilization.

One example of this technology is Newton™. Newton™ connects every facet of reliability and intelligently models how every data point, task, and potential change impacts future performance, enabling users to focus on how to best allocate limited resources to yield the greatest return on reliability investment, achieving a strategic balance across availability, cost, and risk.



Conclusion and Takeaways

As an industry, we have to start thinking differently if we want to recognize the massive economic gains and safety impacts that exist. We can't continue to solve the problems of the 2020s using the solutions we had in the 1980s and 1990s.

It's time to take the next big leap in risk models.

Major Takeaways:

- There are major economic gains to achieve
  - An increase in availability and utilization across refineries in the US by 2% equates to about $1.5 billion annually. If these same refineries recognized a 10% reduction in the maintenance and turnaround costs associated with inspection, this would also equate to about $1.5 billion annually.
- To recognize these gains, we are going to have to think differently
  - We don't need more data. We just need to be smarter about the way we use data.
- Time for the next leap in mechanical integrity, reliability, and risk.
  - Knowing how individual assets fit into the system and connect together will help impact utilization. This technology exists today.

Contact Us

Headquartered in Pasadena, Texas, Pinnacle is exclusively focused on helping industrial facilities in oil and gas, chemical, mining, and water and wastewater better leverage their data to improve reliability performance, resulting in more production, optimized reliability and maintenance spend, and improved process safety and environmental impact. For more information, visit pinnaclereliability.com

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