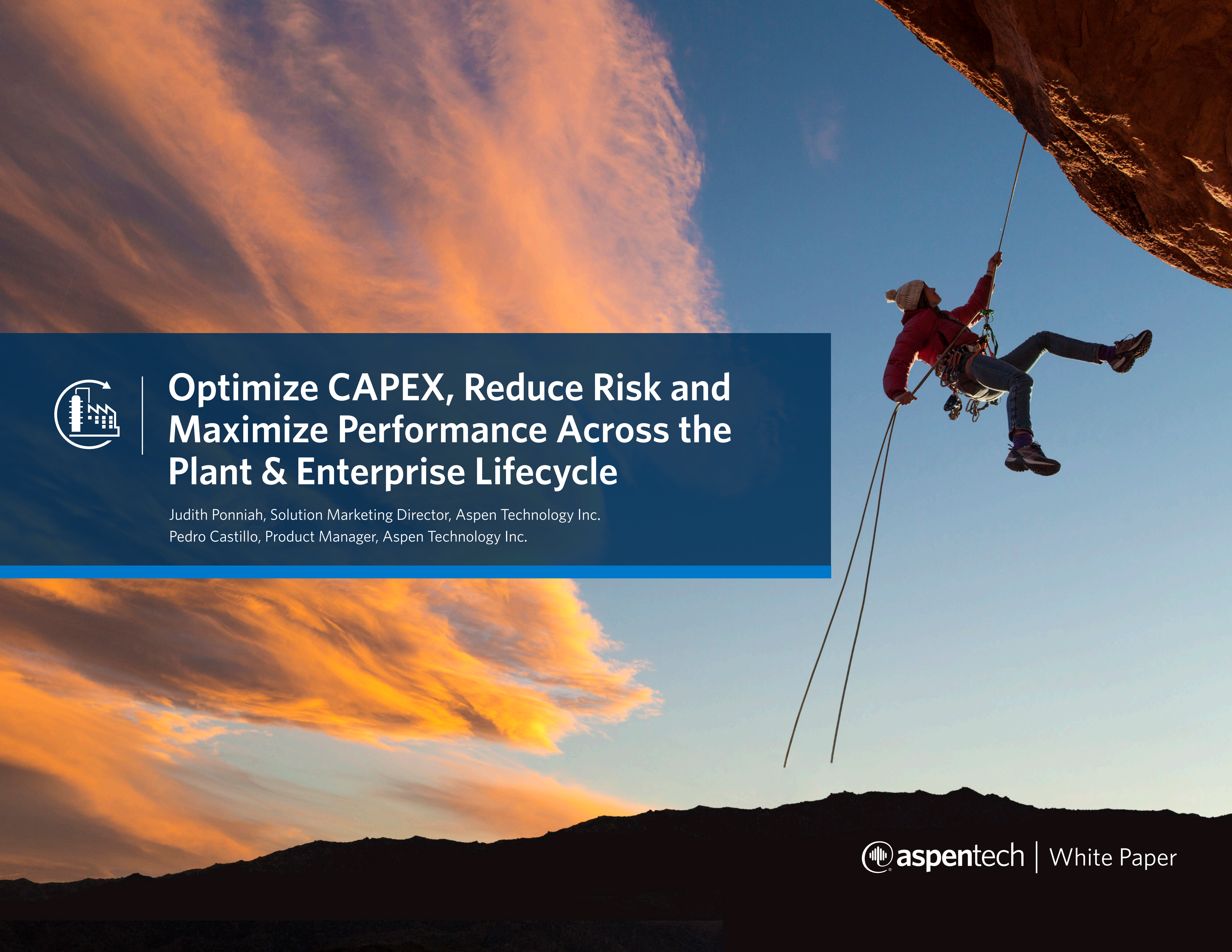

Optimize CAPEX, Reduce Risk and Maximize Performance Across the Plant & Enterprise Lifecycle

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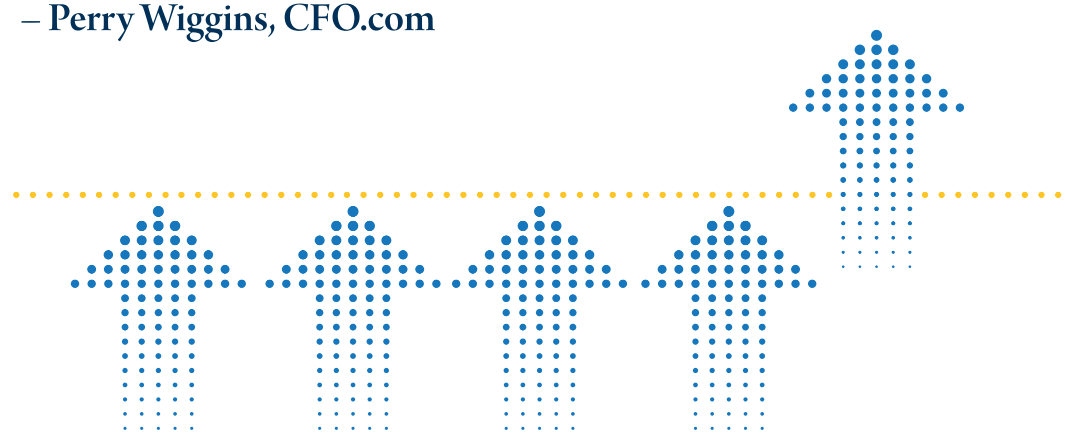
Introduction

With an estimated one in five capital projects running over budget, every spending decision matters for capital project owners. From design to operations, a multitude of concerns and decisions, big and small, can arise throughout the lifecycle of a project or the lifetime of a plant. Whether it is a major question like where to build a plant or a more minor one like how to size a recirculation pump, every decision made can lead to uncertainty or risk, while potentially impacting the project's budget and schedule, customer satisfaction and the likelihood of success.

Decisions are often made based on tradeoffs between cost and the plant's ability to deliver on reaching key metrics: throughput, quality, uptime and safety. Careful evaluation of these tradeoffs fundamentally determines whether a project will succeed, meet its overall objectives and result in satisfied customers. However, considering so many alternatives, tradeoffs and decisions can also be time consuming and fraught with risk. What's needed is a way to quickly prioritize these decisions and keep the project on track, with the confidence to know that the design will meet its objectives and make on-the-fly operational adjustments to deliver maximum system performance and ROI.

"One out of every five capital projects goes over budget.[1]"

– Perry Wiggins, CFO.com

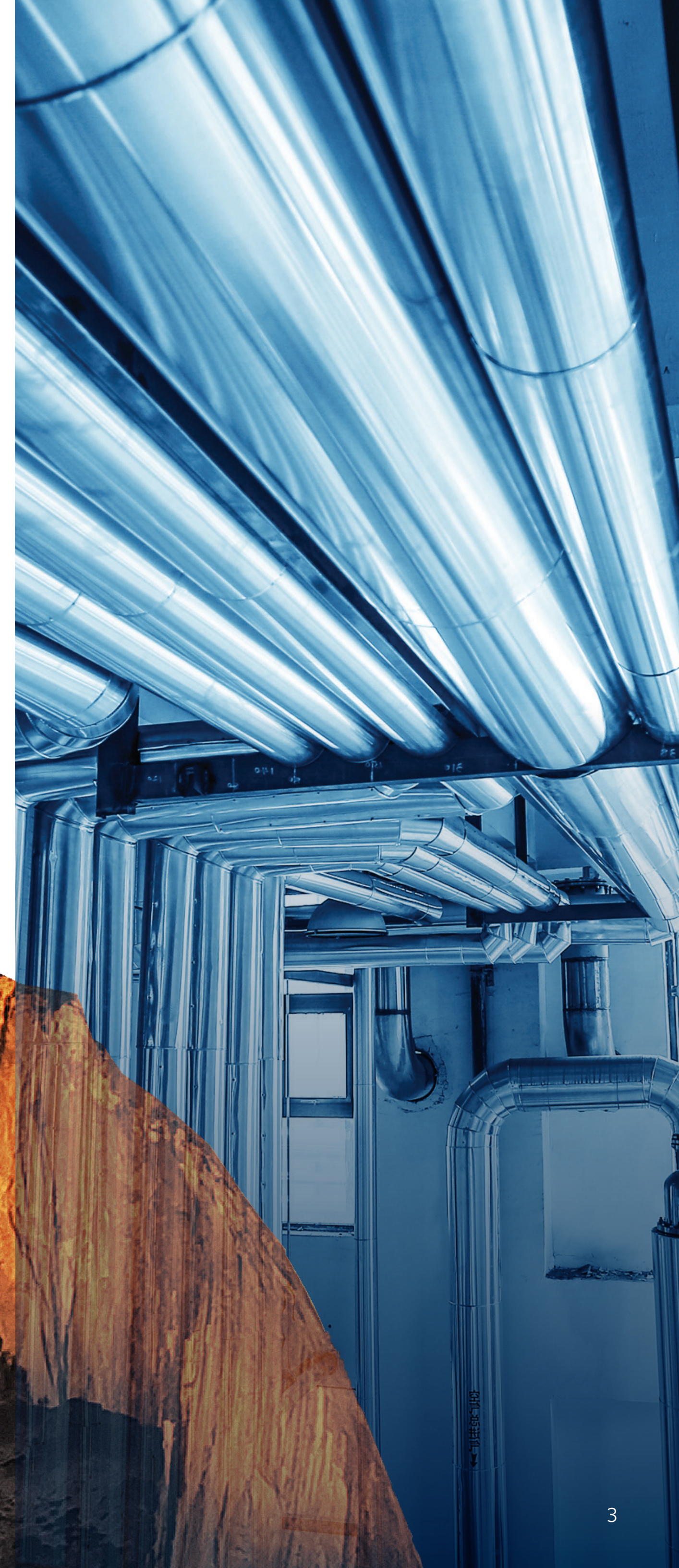


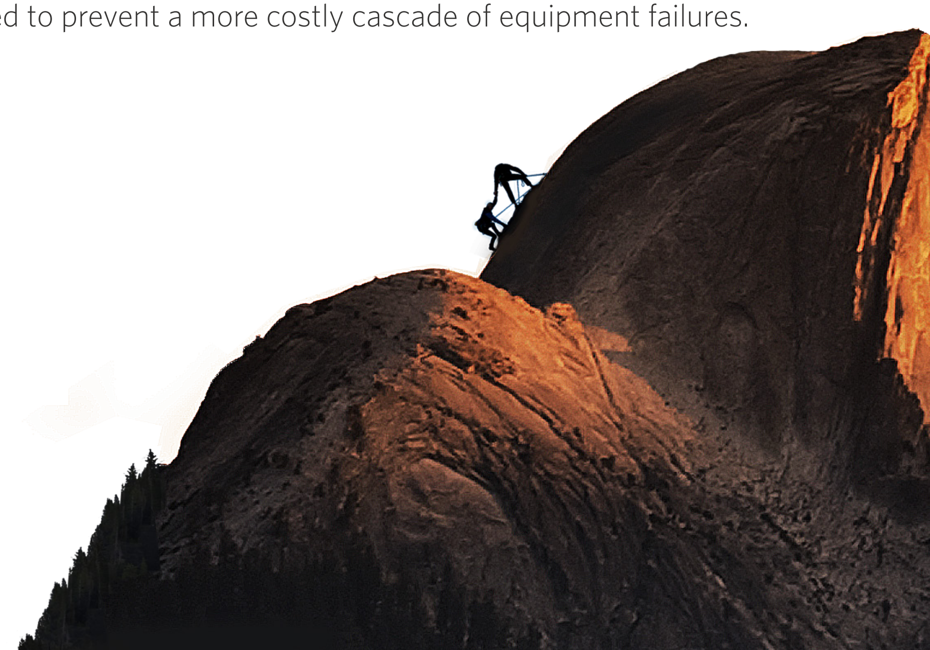
Quantifying Risk for Improved Decision-Making

Because every decision comes with some level of uncertainty, it's important to understand how risk can be quantified to help ensure that optimal decisions are made. In addition, combining historical industry data and individual experiences, it is possible to predict the probability or likelihood of a future event occurring. That information can be used to make decisions more confidently and data can be leveraged to justify a chosen solution to a design problem. This provides confidence that future results, based on a decision made today, will be within our expectations and tolerances, resulting in faster decisions, grounded in data, to move forward.

What's also needed is the ability to quantify impacts holistically. Solving design challenges concerning a specific piece of equipment or unit might optimize one area of the plant, but it could also introduce inefficiencies or problems elsewhere. That's why such decisions are best made in the context of the rest of the system.

For example, understanding the result of decreasing buffer storage capacity on plant uptime could help save money on CAPEX. Alternatively, it may be decided that the potential savings are not worth it because it increases the risk of more downtime beyond an acceptable limit. Moreover, maintenance decisions can be optimized during operations through modeling intervention options—sometimes running to failure may deliver the highest ROI and sometimes immediate intervention is needed to prevent a more costly cascade of equipment failures.





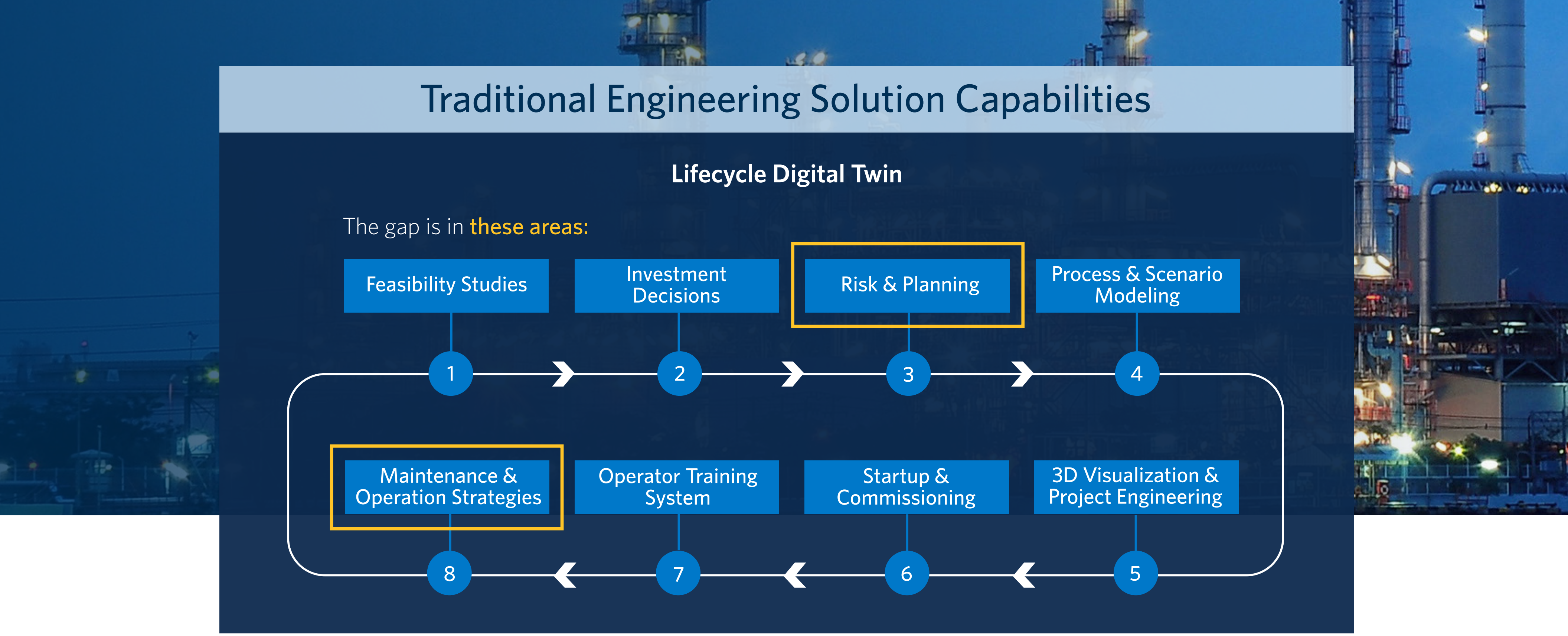


Figure 1. The two yellow highlighted areas above represent gaps in traditional engineering solutions.

Simulate Future Performance at a System-Wide Level

System performance, quantification and risk analysis software, such as the Aspen Fidelis™ solution available from AspenTech, uses a systems approach to reliability, enabling users to quantify the actual value or cost of any design or improvement project, maintenance change, operations improvement, or supply chain constraint.

Aspen Fidelis is used by systems and reliability engineers to analyze the impact of critical decisions (**see page 5**) by running simulations that predict the future performance of an overall system. It can evaluate various “what if” operation scenarios to determine and quantify the availability, criticality and financial impacts of each option and determine the optimal mitigation strategy. Aspen Fidelis essentially answers all the “what if” questions traditionally addressed with guess work or intuition. Common scenarios are CAPEX justification/prioritization, quantifying and reducing risk of cost-cutting projects, real-time operations and maintenance decision support.

Here are some typical questions that could arise during a project's lifecycle:

- How much redundancy must be engineered into the design to ensure 90 percent uptime, and is doing so worth it?
- How much buffer storage capacity is needed to ensure that production would continue despite a one-week supply disruption?
- Will the plant meet production targets if the ambient temperature drops below 20 degrees?
- Should more expensive components be used or does it make sense to increase the planned maintenance frequency?
- How do you ensure the best operational decisions are made once the plant is online?

Additionally, Aspen Fidelis utilizes statistical sampling techniques to predict the future performance of a system. The behavior patterns for events involving the plant and its equipment (pumps, motors, weather impacts, operational upsets, etc.) are represented by probabilistic distribution functions. The solution takes samples from these distribution curves and derives a "time to failure" estimate.

Key Capabilities of Aspen Fidelis

- Enable process and reliability engineers to identify future potential process and asset risks
- Identify assets or events with highest contribution to system performance losses
- Analyze potential risk criticality and financial impact
- Compare alternative decisions and quantify the value of improvement opportunities

When an event leads to a failure of a piece of equipment, there will likely be impacts in the broader system, including the unit to which the piece of equipment is attached and other units or equipment that are upstream and downstream. The AspenTech solution can also model flow through the pipes, tank levels, and all units utilized and available capacities.

In addition, any required custom logic—such as dynamic batching, seasonal changes, alternate flow paths, non-time-based failures, conditional logic and equipment aging—can be incorporated into the model.

Aspen Fidelis generates a comprehensive bad-actor list and quantifies maintenance and downtime costs and potential lost revenue. As a result, users can perform lifecycle analyses on assets more effectively, including asset utilization, maintenance effectiveness, overall equipment effectiveness, and much more. With system performance, quantification and risk analysis, decision-makers can maximize ROI with models and predictions for individual pieces of equipment and the entire system.

Primary Use Cases for Aspen Fidelis

Forecast System Performance (production, availability, utilization, revenue, costs)

- Identify bad actors, bottlenecks
- Quantify risks to performance goals
- Lifecycle cost analysis
- Reliability, availability and maintainability (RAM) analysis

What-If Analysis (compare alternatives)

- Site configuration
- Equipment redundancy
- Sizing storage
- Logistics alternatives
- Supplier selection
- Capacity expansion
- Maintenance strategy
  - Frequency of planned preventive maintenance
  - Stock level of spares
  - Compare mitigation options for predicted issues

Benefits for Your Business

With system performance, quantification and risk analysis software solutions, stakeholders and businesses benefit, improving the bottom line and realizing new revenue streams across the lifecycle of every asset.

During the design phase of any project (greenfield or brownfield upgrades), customers can use Aspen Fidelis as a design aid to ensure that the right decisions are made from the beginning. In addition, Aspen Fidelis can be carried forward into operations. Customers must continue making optimization, debottlenecking and maintenance decisions, including setting spare part inventory levels. Aspen Fidelis can be used throughout the entire lifecycle to maximize production, minimize risk, create new revenue streams and build longer, stronger relationships with Owner-Operator customers.

Rise Above the Competition

Big design or maintenance decisions shouldn't be left to subjective or over-simplified analysis. Decision-makers need quantifiable, trustworthy answers to make the most profitable decisions possible. In the past, management of capital assets was done through the "gut feel" of experienced operators, some rudimentary spreadsheet analysis or simplified RAM (reliability, availability and maintainability) tools.

Although these methods provide some benefits, they lack a holistic approach to reliability, design and operations. Simple RAM tools do not provide the level of accuracy or consistency needed to answer the hard questions. For accuracy in decision-making, the Aspen Fidelis difference is eye-opening.

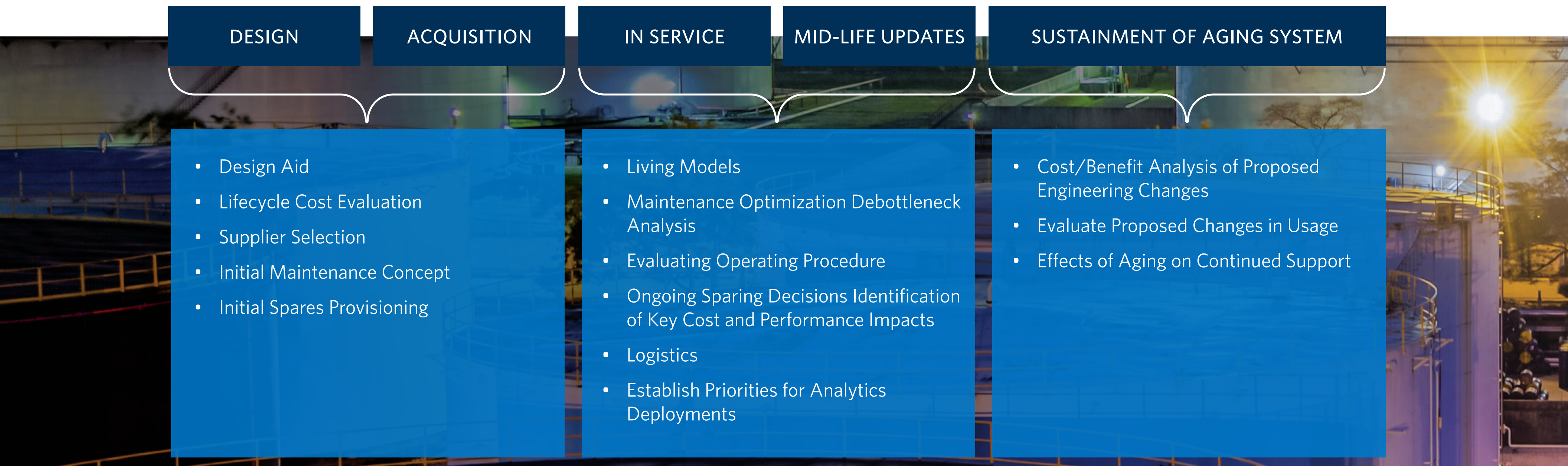


Figure 2. Using Aspen Fidelis Throughout the System Lifecycle

Aspen Fidelis Synergies for Enhanced Capabilities

Synergies exist between Aspen Fidelis and other AspenTech solutions, with the potential to create a process engineering, supply chain and manufacturing and reliability optimization solution that is available only from AspenTech. Some of the potential synergies and resulting capabilities include:

Aspen Mtell® – Integration of Aspen Mtell® and Aspen Fidelis enables quantification of the impact of predicted issues to business KPIs (e.g., how much a pump failure in the next 30 days would reduce production, revenue and facility utilization), and 'what-if' analysis to determine the best mitigation option (e.g., run to failure, early intervention, diverging flow to other process, etc.). Aspen Fidelis risk quantification can also be used to identify equipment at risk that could benefit from deploying Aspen Mtell Agents.

Aspen Petroleum Scheduler™ and/or Aspen Plant Scheduler™ – Address equipment failures, tankage and logistics issues, quantify the likelihood of success for a given schedule and help identify causes of misses. Results from Aspen Fidelis can be used in the process to optimize schedules and increase equipment utilization.

Aspen HYSYS® or Aspen Plus® – Leverage existing flowsheets and results from process simulators to build the initial Aspen Fidelis diagrams and specify nominal flows.

Aspen PIMS-AO™ – Help planners better understand the likelihood of meeting plans by simulating unplanned events (e.g., mechanical failures, delays in supply chain, price changes, extreme weather, etc.).

Aspen Capital Cost Estimator™ – Determine the best configuration of parallel equipment by estimating benefits (e.g., increase in production, availability) and costs (e.g., CapEx, maintenance costs). This also applies to configuration of multiple process trains, sizing of tanks, any initial design and revamps.

Customer Successes

Aspen Fidelis has been used successfully by customers across capital-intensive industries like energy and chemicals, enabling model-based decision-making. Here are some examples:

An **LNG facility** used Aspen Fidelis to determine the optimal number of liquefaction trains needed to meet production targets given required maintenance and model predicted unplanned downtime. Continuously monitoring the plant model as changes occurred resulted in continued optimization, increasing uptime for the facility from 95.5% to 96%.

A **mega project in the Middle East** utilized the system performance, quantification and risk analysis software to optimize plant design, tank sizing and spare parts purchasing. It was also used to model the entire petrochemical site, including process plants, storage, product demand and logistics. This resulted in over $1B USD in reduced capital, suggesting increased efficiency.

A **buffer optimization was completed for a Gulf Coast refiner**. Product being moved over the water was sold at a premium when compared to deliveries made via truck or pipeline. A study was conducted using Aspen Fidelis to determine the minimum number of new tanks needed to increase shipments from the docks while minimizing capital costs, dock delays and subsequent demurrage costs, resulting in over $250M USD in reduced capital.

At a **refinery, an Aspen Fidelis model was used for supply chain optimization** to increase product deliverability at the docks. Given minimal tidal windows, the model was used to determine and quantify the critical causes of dock delays, demurrage and wasted utilization.

A **refinery required a revamp to optimize utility needs while minimizing capital costs**. Aspen Fidelis was used to model sitewide energy use penalties, emergency rates, maintenance and site production levels. The model identified the most beneficial design case, saving $20M USD.

At **several petrochemical sites**, Aspen Fidelis has been utilized for multiple facets of maintenance optimization. At one plant, a model was created to determine the critical assets to maintain and the optimal frequency of maintenance. This resulted in savings from unnecessary maintenance and planned downtime.

Conclusion

In an increasingly competitive space, EPC firms and Owner-Operators must continue to find new ways to differentiate themselves and add more value for their customers. More and more companies are using system performance, quantification and risk analysis software, like Aspen Fidelis, at the beginning of the design process to streamline risk quantification and make better decisions, faster. Aspen Fidelis is also being used to extend engineering services into the operations and maintenance phases of an asset's lifecycle to generate new sources of revenue and build stronger relationships with customers.

Learn more about the AspenTech solution at **www.aspentech.com/fidelis**.

[1] Perry D. Wiggins, "Metric of the month: Percentage of approved capital projects considered within or on budget," April 1, 2019, CFO.com.

About Aspen Technology

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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