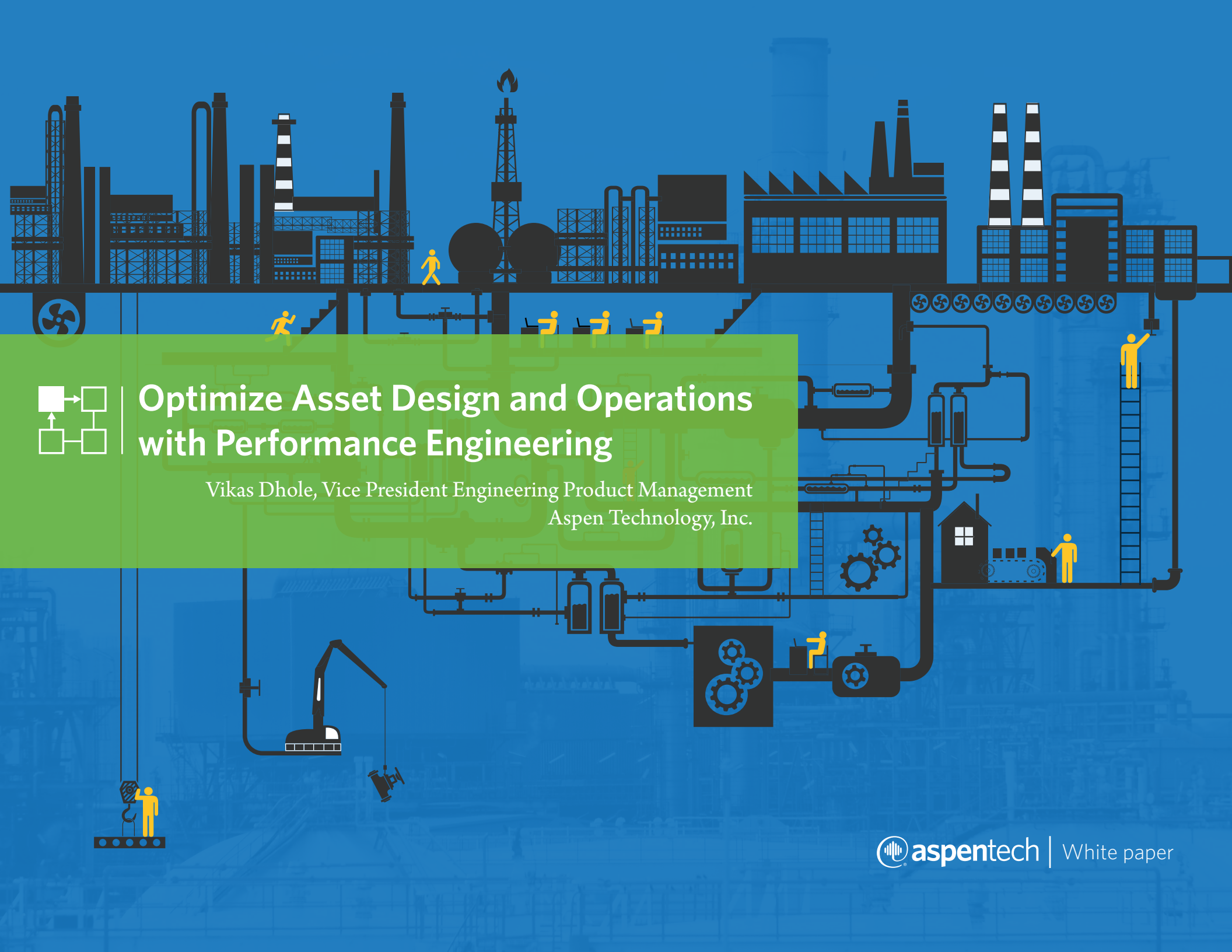

Optimize Asset Design and Operations with Performance Engineering

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aspentech | White paper

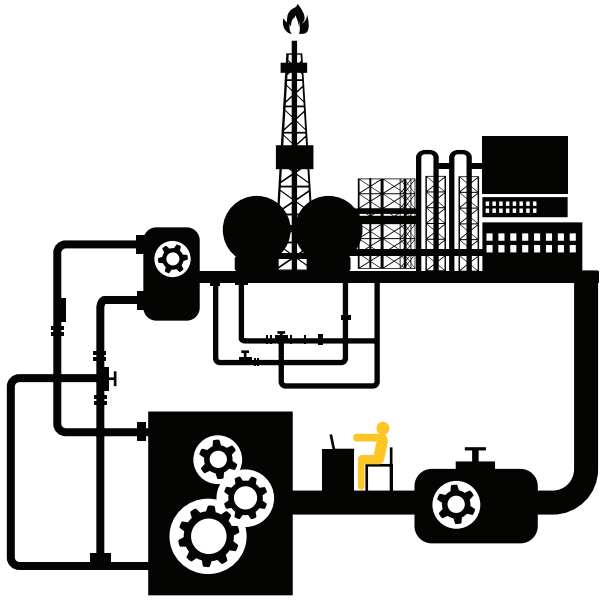
Engineering Design that Pushes the Boundaries of Performance

To realize the maximum potential for optimization, process plants must simultaneously address multiple dimensions and factors. The most successful organizations bring together people from across the business to optimize design and operations through process improvements. There are multiple groups involved in this optimization; they need to build on each other's contributions rather than working in isolation or at odds. Cross-disciplinary teamwork that takes a big-picture, integrated approach to optimization delivers superior business results, including reduced CAPEX and OPEX, faster time to market, greater energy efficiency and higher profit margins. For example, a project that addresses capital and energy concerns can't ignore safety, environmental issues, controllability and yields. Advances in engineering tools help organizations improve collaboration and integration to deliver comprehensive asset optimization strategies that yield significant financial returns.

Technology alone is not the answer. However, digital transformation enables best practices that drive significant value. These best practices call for organizations to rethink the way they operate and the tools they use to make decisions. AspenTech has identified best practices in performance engineering over the last three and a half decades serving the process industries. More relevant than ever, these approaches help companies succeed in today's market as they contend with changing market conditions, the constraints of aging equipment, a shifting workforce and increasingly strict environmental and safety regulations.

New Possibilities Drive Performance

Performance engineering is about pushing the boundaries of existing concepts, designs and asset constraints to create new higher performing designs and operations. Using asset models consistently across the CAPEX and OPEX cycle multiplies the value delivered. Shared models support conceptual engineering, FEED and economic evaluation, safety, sustainability and operations optimization, driving performance improvements at all stages. Explore the best practices that can deliver value at all stages of plant design and operation.



Conceptual Engineering

Develop the Optimal Process

Organizations in the process industries, particularly specialty chemical producers, must overcome technical challenges to introduce new products that meet market demands and create clear differentiation. Quickly evaluating process development options, understanding how operational changes will impact product quality, and accelerating scale-up, calls for collaboration across sites and functional groups.

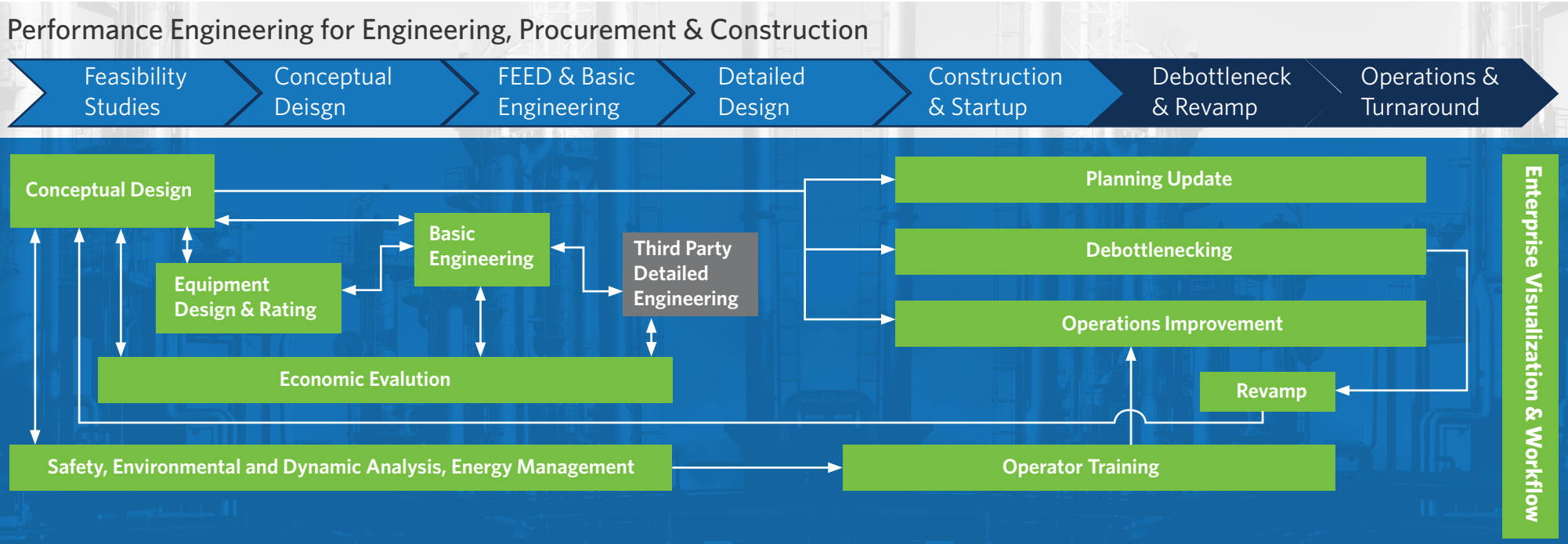
Process models that enable modeling and optimization of batch and continuous operations involving both solids and fluids operations offer a way to fast-track innovation. Process development staff can evaluate different processes and equipment configurations, to design fewer and more targeted lab experiments and reduce investment in experimental and pilot plant facilities. Process simulations allow teams to find the optimal process and assets in hours instead of weeks. Combining modelling exercises that traditionally took place across several tools reduces engineering time by consolidating information and streamlining collaboration between research and engineering.

Optimize the Design with Concurrent Conceptual Engineering

Typically, process plant conceptual designs go through numerous iterations in a time-consuming sequential path. A process engineer develops a process alternative using simulation, then shares that information with an equipment expert who sizes the equipment then shares the information with an estimator. By the time the estimate for the proposed design comes back to the process engineer, weeks have passed.

Due to time constraints, organizations typically evaluate only a few alternatives and settle for a feasible design rather than the optimal one. Moving from this sequential approach to concurrent engineering, where different tasks involved in the process design cycle are performed simultaneously, allows companies to evaluate myriad design options from different perspectives in a short time.

Concurrent conceptual engineering tools allow firms to quickly analyze an asset for energy, economics and equipment while optimizing for maximum yield and ensuring process safety and environmental compliance.



Cut CAPEX and Conceptual Engineering Time in Half Worley reduced capital expenses by 51% in an upstream project through concurrent conceptual engineering, taking advantage of dynamic modeling during conceptual design. ExxonMobil reduced the time for concept selection from 6-12 months to 3-6 months, bringing new upstream projects on stream early, potentially delivering millions of dollars in benefits.

Front End Engineering Design (FEED)

Accelerate Multidisciplinary Collaboration for Greater Speed and Agility

Performance engineering can automate the handover from conceptual engineering to front-end design delivering greater efficiency. In addition, capturing updates in real-time and cascading them to everyone who needs the information enables global engineering teams to work concurrently, with automated handoffs around the clock. Providing a single source of truth for FEED collaborators reduces manual data reentry and improves accuracy, which can translate into as much as a 30% reduction in FEED time.

Taking a data-centric approach means the entire team has up-to-date information and no one wastes time waiting for the latest project iteration. Using a single asset data model improves accuracy as well and allows teams to share best practices and reuse designs. The latest basic engineering capabilities also enable faster hand-off to mechanical and detailed engineering.

Driving collaboration between process engineering, mechanical engineering, estimators and other groups to optimize assets maximizes the potential benefits plants can achieve in terms of CAPEX, OPEX and energy savings.

Economic Evaluation

Improve Estimating Efficiency and Reduce Project Risk

Many engineering and construction firms struggle to create accurate estimates based on limited information at an early phase in the lifecycle. Providing reliable quotes is especially critical for markets where the Lump Sum Turnkey (LSTK) contracting model prevails.

Today's model-based estimation tools can quickly generate conceptual estimates from the process simulation, and then continue to develop detailed cost estimates for equipment and associated plant bulks, as well as indirect costs.

Using volumetric models that are regularly updated on the cost basis derived from five well-established

regions paired with historical data from completed projects allows EPCs to calibrate for greater accuracy. Costs like labor, materials, bulks and equipment can be adjusted based on specific project information. Increased estimate accuracy, reduced man-hours and less rework mean significant savings for engineering firms. For owner-operators capital cost estimation including risk analysis enables collaboration with EPCs and minimizes chances of project overruns.

Pemex Corporation and Worley Prove Estimate Reliability Pemex Corporation validated Aspen Capital Cost Estimator™ estimates for Class III and Class II with actual project costs, reporting under 10% estimate variability on 11 Class II estimates. Worley uses AspenTech's Economic Evaluation Suite as the foundation for the company's "SpeedFEED™" process, which created 30% cost and schedule savings. On one $750 million project, actual costs varied less than 2.5% from the estimate.

Safety and Sustainability

Develop Inherently Safe Design and Operations

Safety is a top priority for owner-operators and EPC companies. Analyzing assets for safety across the lifecycle helps minimize risk to staff, reduces downtime and protects process equipment. While firms want to ensure they operate as safely as possible, an overdesigned safety system can increase project costs or delay already constrained projects.

Performance engineering enables complete over-pressure protection safety analysis starting from equipment to flare system including relief and blowdown. Using integrated steady state and dynamic simulation including safety analysis helps identify asset designs that can support current demands while accommodating capacity growth, extending asset life and safety.

BP Halves Estimated Peak Flare Load
Using AspenTech's safety analysis tools, BP was able to ensure safety and reduce estimated flare peak load by 50%.

Optimize Energy for Supply and Demand Simultaneously

While both process engineers and utility engineers focus on improving energy consumption, they're examining the problem from different sides. Process engineers typically look at a process' energy consumption and assume the utility system as given; utility engineers consider the process as given and optimize the utility system. The greatest savings occur when both aspects are considered simultaneously: optimizing processes to minimize the utility demand and the utility system for maximum efficiency.

Achieving the maximum potential in energy management calls for both design and operations improvements. Design improvements typically provide the maximum impact but require capital investment. Operational improvements, such as planning and scheduling the utility system and optimizing processes, also deliver additional savings. Combining design and operational opportunities holistically can save 10% to 20% for the asset.

Operations Improvement

Update Planning Models Based on Actual Performance

Accurate refinery planning tools are critical for sustaining profits. Unfortunately, these tools depend on models that can easily become outdated when there are changes in crude slate, operating conditions, equipment or catalysts.

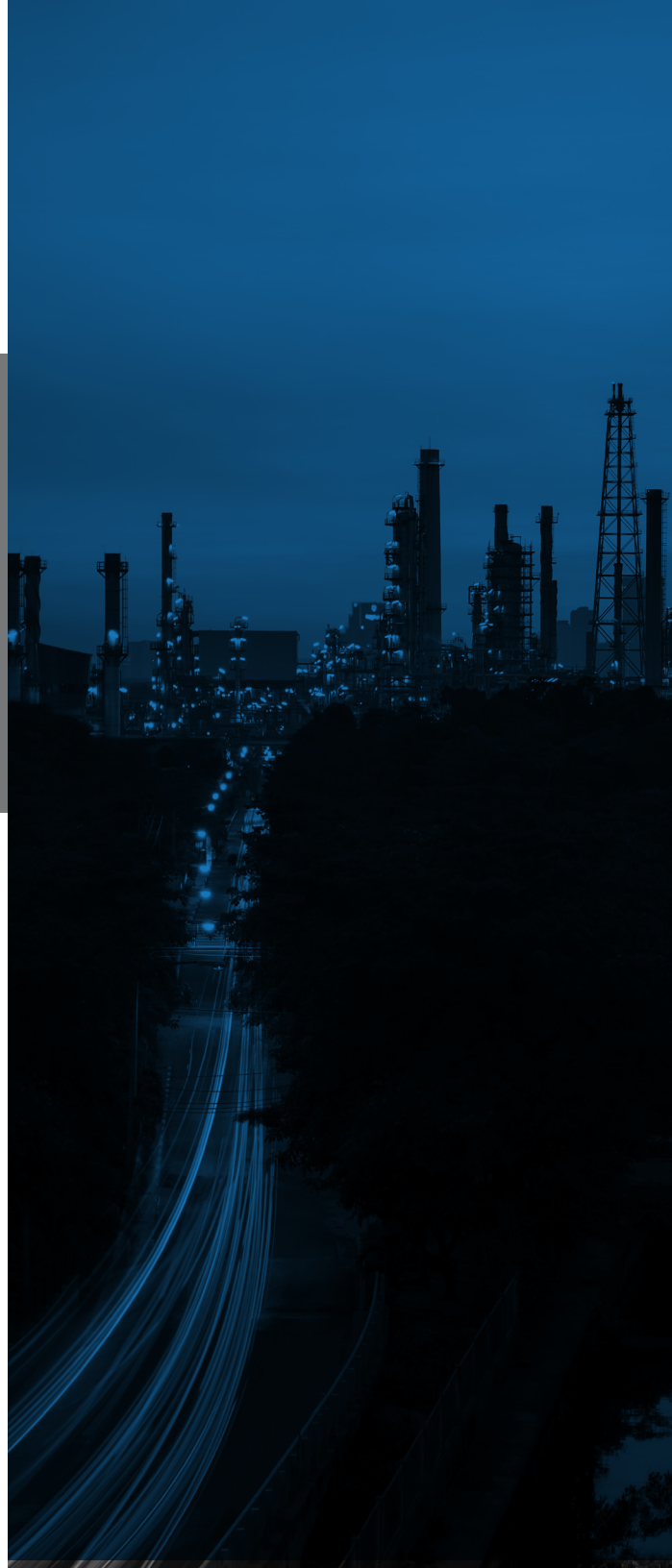
Updating planning models using simulation models tuned to actual operational conditions allows for better decision-making, ensuring production meets or exceeds the plan. Automating the planning model update workflow reduces the planning update time from months to just weeks, giving refineries more accurate plans and a means to improve margins. Most importantly, this tool enables refineries to update the models themselves, in-house, without costly third-party consultants. Companies using Aspen HYSYS reactor modeling for operating advice, unit monitoring and planning model updates report benefits ranging from $8 million USD to $36 million USD per reactor unit.

Hyundai Oilbank Increases Profits by $36 Million USD Using HYSYS process simulation, Hyundai Oilbank was able to factor in feed changes and improve planning accuracy for one of its refineries to 98% while uncovering operational improvement opportunities that would bring in an additional $36 million USD per year in profits.

Use Digital Twins to Drive Operational Excellence

Process engineers work with many teams in plant operations to help optimize an asset. Typically, operations staff bring a problem to the process engineer's attention. The process engineer will analyze the problem using a simulation model and make a recommendation. The more time passes, the more opportunity is lost, causing delays in optimizing operations, ultimately losing margins.

A simulation model tuned to current operations results in a digital twin of the asset mirroring the



performance of the asset in both offline and real-time modes. This digital twin can quickly identify the opportunities for improvements, accelerating collaboration between process engineers and operations teams resulting in faster decision-making and increased margins. Taking a holistic, collaborative approach and leveraging digital twin technology to quickly evaluate different operational scenarios, including revamps, speeds optimization within a broader business context.

Train Operators in Real-World Scenarios to Reduce Risk and Accelerate Time to Production

Operator training simulators have been proven effective in preparing operators to manage start-ups, shut downs, complex operational changes and respond to equipment malfunctions in ways that reduce risks while improving safety. When operator training simulations reuse the dynamic models created for engineering, owner-operators save time on training development and can start preparing engineers and operations staff sooner.

Plants can confidently prevent safety incidents and improve sustainability with more rigorous training scenarios based on their unique equipment and operating conditions. Post start-up, companies can update models to reflect changes to start-up and shut-down procedures, new operating conditions, or equipment updates and revamps, thereby extending the value from the investment in an operator training system. This best practice of lifecycle dynamic modeling improves operator effectiveness, as well as the safety and reliability of the asset across its lifecycle.

YPFB Andina Optimizes Operations with Digital Twin YPFB created a digital twin that allowed the company to optimize operations for all processing plants and pipelines, resulting in additional gas production that increased revenue by $280 million USD in one year.

Accelerate Time to Value for Advanced Process Control with Dynamic Models

To roll out a new advanced process controller (APC) or re-tune an existing one, most plants conduct step tests on the actual asset. This usually involves introducing a disturbance to see how the plant responds, then using the data to define initial tuning parameters for the controller. Using the actual asset for testing requires high levels of engineering and operations expertise – this approach can introduce operational risks and may impact production.

Performing the step-tests on a digital twin reduces production losses and saves time implementing APC. Control engineers can collaborate with process engineers to leverage existing simulation

models based on actual operating conditions, leading to faster deployment for new APC units, reduced operational risks and less impact on production.

Lyondell Bassell Saves Time and Money

Lyondell Bassell saved 33% in implementation costs and accelerated schedules by 67% using dynamic models to develop initial APC configurations.

Digital Acceleration in Engineering Drives Profits and Productivity

For peak performance and profitability, organizations must simultaneously optimize design and operations across multiple dimensions through strong collaboration between disciplines.

Technologies that enable collaboration across disciplines can help teams combine their strengths to deliver the maximum potential from optimization. Time and time again, we've seen that collaboration across engineering, planning, scheduling and plant operators delivers unparalleled results.

Performance engineering provides a concurrent engineering environment that EPCs, upstream companies, refiners and chemical companies can use to optimize equipment, plants and assets based on consistent models throughout the asset lifecycle. This not only enables optimization across the CAPEX and OPEX cycles but also drives collaboration between process engineering and other groups to capture a wide array of benefits: safer, greener, more profitable operations.

Implementing any of the best practices outlined here will deliver value; saving capital and energy, reducing environmental impact with inherently safe operation maximizing the return on investment.

Choose Tools that Drive Collaboration and Value Across the Asset Lifecycle

Only one technology company has a proven track record of creating value across the entire performance engineering spectrum. AspenTech delivers billions of dollars in value annually across verticals and regions, from R&D and conceptual engineering to FEED, economics, safety, sustainability and operations optimization. Our solutions enable effective collaboration and deliver the insight and intelligence necessary to drive the best decisions for profitable business. Continuous innovation in engineering tools that integrate with operations, planning, scheduling, and manufacturing execution drives unparalleled value for asset-intensive companies working to digitalize and ultimately, digitally transform.

Visit www.aspentech.com/epc to learn more.

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About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster.

Visit AspenTech.com to find out more.