Achieving Better Design and Sustainability Outcomes with Concurrent Engineering

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Process Industries in Transition

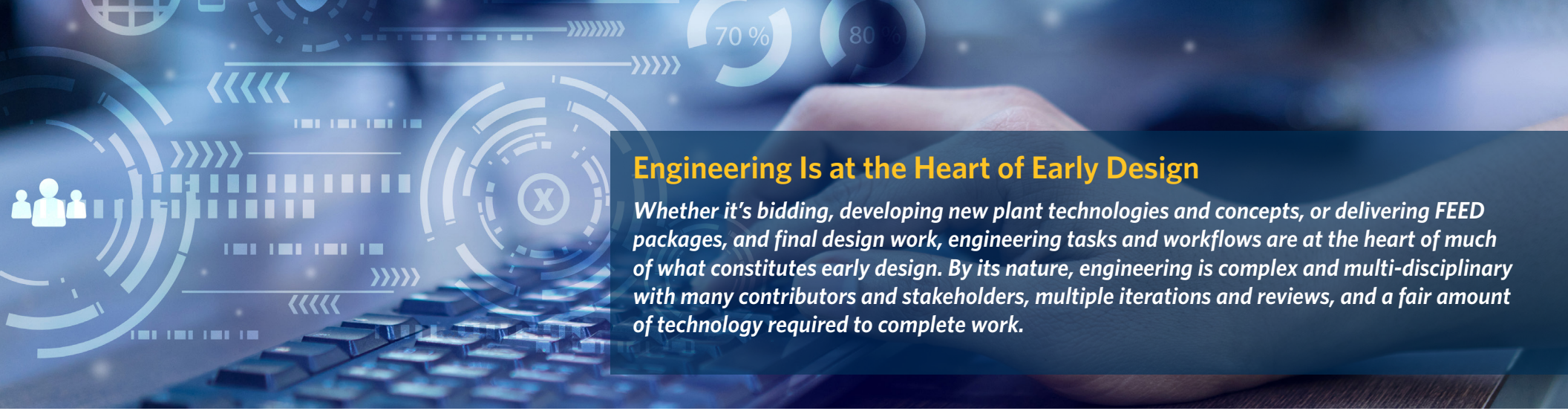
Even before the most recent global challenges emerged, traditional firms in the process industries, such as energy, chemicals, and EPCs, were already under stress. Generally low net margins, high-risk capital projects, and an overall push to move away from carbon intensive industries were resulting in financial underperformance by the sector. Adding in the complications inherent with digitalization initiatives and the energy transition in seemingly full swing, and you can understand how the executives managing these firms have their hands full.

However, these same forces also represent opportunity. Capitalizing on sustainable projects, shoring up firm finances while preserving core capabilities, and improving engineering workflows through digitalization initiatives can put these organizations on the road to improved overall performance and profitability.

Why Change Is Necessary

When project team members work in a more traditional, siloed, and sequential engineering approach, the process is slow, prone to error and struggles to accommodate the inevitable project changes. This approach results in waste, inefficiencies, and suboptimal results for the customer.

Consider a typical bid situation where process engineers, mechanical engineers, safety experts, estimators and others need to have input. Each member creates a set of relevant engineering data that needs to be considered and incorporated into the overall concept. The data from one specialist often has an impact on the work of the others. When working sequentially, the opportunities for early collaboration and sharing are lost, and every change introduced results in a reset of the process. The bid is essentially done when the team runs out of time, not when the best alternative and estimate are developed.



Engineering Is at the Heart of Early Design

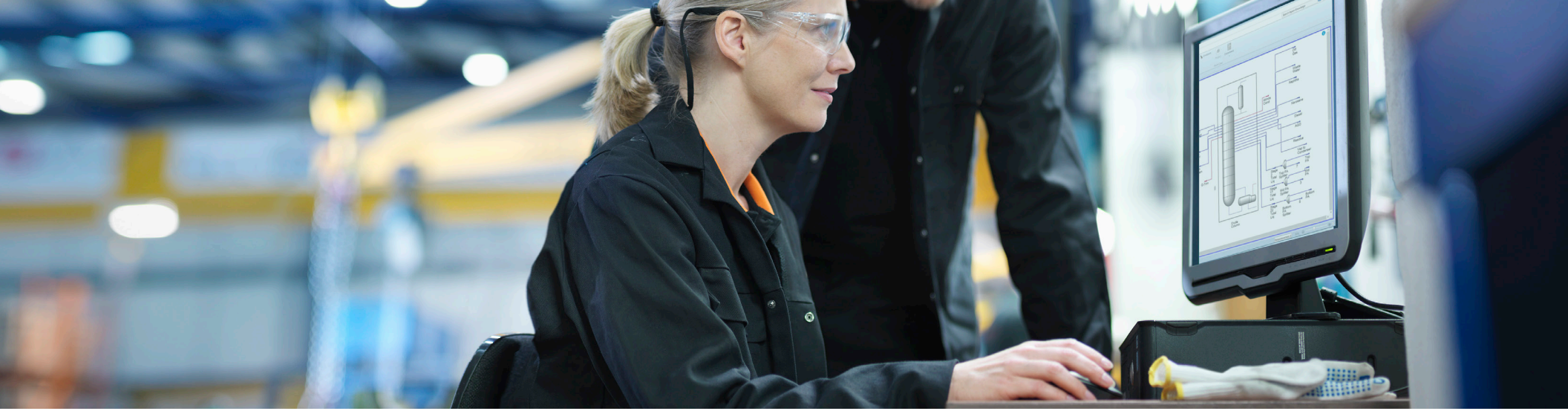
Whether it's bidding, developing new plant technologies and concepts, or delivering FEED packages, and final design work, engineering tasks and workflows are at the heart of much of what constitutes early design. By its nature, engineering is complex and multi-disciplinary with many contributors and stakeholders, multiple iterations and reviews, and a fair amount of technology required to complete work.

The same situation occurs during execution of front-end and detailed design (FEED) projects when the engineering disciplines work in a sequential process. Data is isolated in spreadsheets or disconnected modeling tools and is not available to inform the work of others. When incorporating data from another specialty, it is entered manually introducing errors and often omitting valuable information. Instead of overall project wisdom increasing, it is often lost or left behind and not available to inform a broader, systems-based approach to the design. Specialists miss opportunities to collaborate early in the process, when their collective decisions would have the greatest impact on the project outcome.

What's needed is a comprehensive solution that can bring disciplines and data together into holistic workflows spanning concept, layout, estimating FEED and detailed design, with mechanisms for more seamless sharing of data across parties and phases.

Concurrent Engineering Solution

AspenTech's Concurrent Engineering solution incorporates process simulation and modeling, concept design, estimating, 3D layout, risk analysis, construction planning and management of engineering data and deliverables. It is a holistic solution for evaluation of concepts and development of FEED packages. The development of design packages is a complex phenomenon due to involvement of process development, safety engineering, mechanical design, cost estimation, piping layout and many other disciplines, often located across various offices. The solution is integrated so that project data can be more easily shared across multiple disciplines, offices, stakeholders and software tools. Data is consistent and mobile, with the ability to automatically share changes and updates without the need for manual data entry and the entire project execution process can be expedited considerably.



Concept Design

The AspenTech solution allows for fast evaluation of different concepts using the most widely adopted process simulation software in the world, enabling more optimal design approaches to be determined early. Aspen Multi-Case™ functionality leverages cloud computing and multi-core processing to simultaneously evaluate thousands of potential design options. This vastly increases optioneering and results in availability of better design options. AspenTech's patented "activations" provide immediate guidance for process engineers on the capital and operating costs of design alternatives, directly within the process modeling tool.

Our unique decision support and risk analysis tool enables data to help drive critical design tradeoff decision making, speeding the design process and helping to avoid decision-making based on opinions, rules of thumb or a "that's how we've always done it" mentality.

Conceptual Plant Layout

AspenTech solutions now offer the ability for fast evaluation of different 3D layout concepts aligned to the process models. Imported sized equipment can be efficiently laid out in Aspen OptiPlant 3D Layout™ based on the real estate. Parametric structures can be added quickly with intelligent data associated for material take-offs and weight calcs. Based on the layout, the 3D piping, cable tray and conduit can be automatically routed without clashes using artificial intelligence (AI).

The 3D model can then be leveraged for collaboration, conceptual engineering analytics, for module versus stick-built studies, and high level Construction Planning. The material take-offs (MTOs) from the 3D model can be exported to the estimating tool to bring additional accuracy to final estimates. The fast AI approach to 3D layout provides greater optionality to drive down cost and improve safety, sustainability and reliability.

Economic Analysis

Receive feedback on capital and operating costs as you evaluate concepts. Data from different design options can then be exported to Aspen Capital Cost Estimator™ (ACCE) for a more detailed understanding of cost elements, either directly from the simulator, or from Aspen OptiPlant. The volumetric-based costing approach helps ensure accuracy as the design evolves. More detailed material and quantity takeoffs from 3D layout also enhances estimate accuracy. Reports and dashboards are available for keeping stakeholders at all levels informed and costing data is available for reuse and to inform future estimates.

SK E&C

Using ACCE, SK E&C created bids with **50%** fewer engineering and estimating hours.

Customer Spotlight: SK E&C

Using ACCE, South Korean EPC firm, SK Engineering & Construction Co. Ltd. (SK E&C), reduced waste in engineering and functional man-hours to shorten its estimate preparation time by 50%, while also improving estimate accuracy by 50%. With a consistent costing model, ACCE helped SK E&C accelerate project execution, make better decisions early and increase reliability of its capital cost estimates.

Risk Analysis and Design Tradeoff Decision Support

During the design process you encounter many tradeoff decisions that will impact the cost and performance of the project. Wouldn't it be helpful to be able to evaluate those tradeoffs using data? Improve design confidence with integrated risk analysis. Understand key design decision tradeoffs and use data to ensure your design will meet expectations and guarantees. The risk analysis tool helps you answer questions such as: do I need a redundant pump to meet my uptime target? Do we have enough buffer storage to prevent unplanned outages of feedstocks? What supply chain risks do we face for a given plant location?

Engineering Data Management

Aspen Basic Engineering™ (ABE) provides a robust data management solution for engineering data developed throughout concept and FEED. This globally accessible database facilitates work sharing across offices, keeps engineering data consistent and up to date, and enables FEED packages and deliverables to be generated directly from the database, avoiding manual processes. When the inevitable changes occur, update the database and deliverables update as well.

It is also critical that the engineering and cost data developed during FEED can be transmitted digitally to the subsequent Detailed Design phase for the project. To this end, AspenTech is partnering with Hexagon PPM for digital handover of this data to their detailed design and project budgeting tools.

With Aspen Basic Engineering, EniProgetti has improved productivity, agility and time-to-value.

Customer Spotlight: EniProgetti

Eni's engineering arm, EniProgetti, reduced engineering hours to update deliverables by implementing a single source of truth model using ABE. With ABE, EniProgetti has improved productivity, agility and time-to-value by expediting fast-track engineering projects to completion with less effort while fostering collaboration between disciplines.

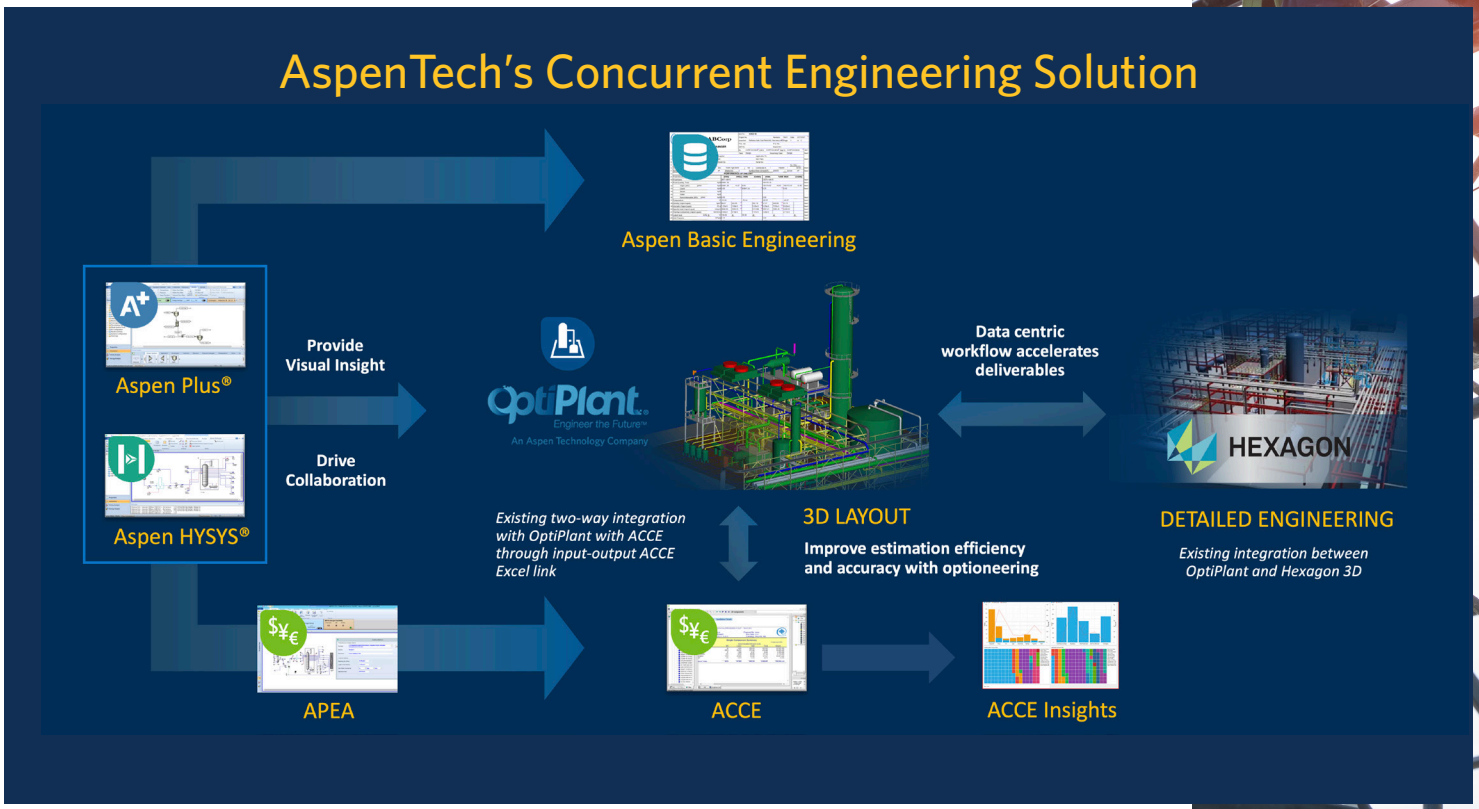
Early Construction Planning

The Construction Industry Institute (CII) research demonstrates that Advanced Work Packaging (AWP) implementation can result in up to 10% decrease in total installed cost (TIC), with increased savings for owners and increased profitability for contractors.

Aspen OptiPlant provides unique functionality to define Construction Work Areas (CWA) and Work Packages (CWP) during the early stages of design. It enables the engineering and construction work packages to be different and yet incorporated in the same 3D model for quick and easy visualization to empower better decision making. These are the core AWP principles for the pre-FEED and FEED stages of capital projects which helps to drive down TIC. Another key advantage is that as the layout or scope changes, the CWAs and CWPs can be automatically updated and reviewed to drive accurate and up to date construction planning.

Customer Spotlight: Black & Veatch

Engineering and Construction company Black & Veatch improved its detailed estimate work process by deploying ACCE Insights™ and Aspen OptiPlant. Black & Veatch is already using ACCE to manage estimates with excellent results. By incorporating OptiPlant and ACCE Insights software into its workflow, the company has improved collaboration and bulk estimation, resulting in expected savings of more than 400 hours per project.



AspenTech's holistic Concurrent Engineering solution delivers projects faster, with better accuracy and at a reduced cost.

What is a Front-End Digital Twin?

AspenTech's solution for Concurrent Engineering yields a "Front-End Digital Twin" for use in design, planning and decision-making. Such a twin provides early insights on design performance, construction execution and project costs while still in the "digital world," where making changes is efficient and cost effective. It enables the owner or firm to:

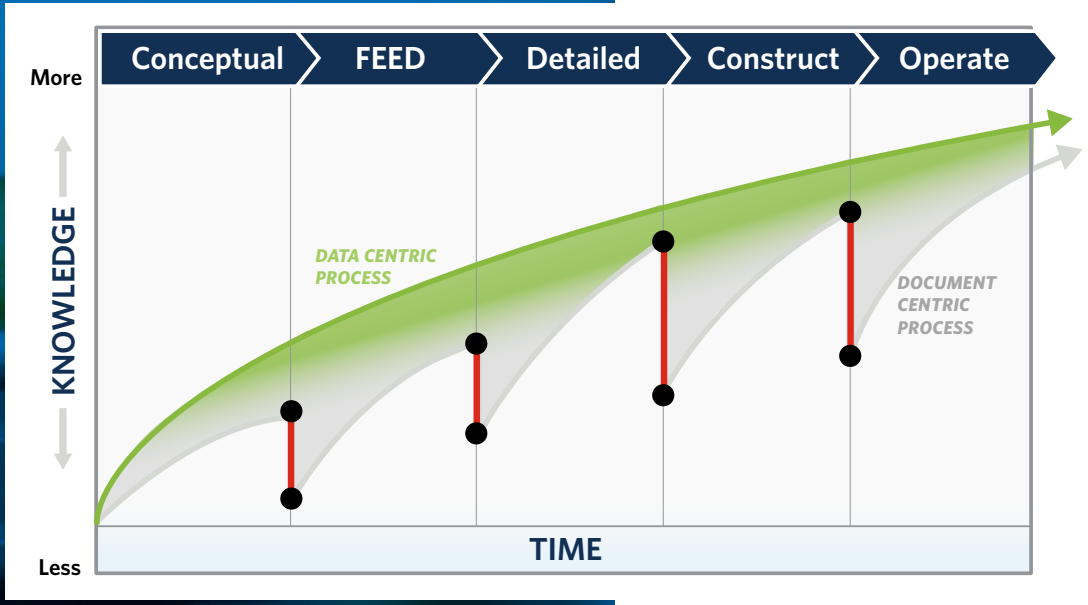
- Quickly evaluate concepts
- Understand design tradeoffs around cost and performance
- Get early alignment on the construction approach from a broader set of stakeholders
- Better understand the environmental health and safety implications of the approach
- Develop the best overall design concept

Concurrent Engineering Benefits

The benefits that companies are realizing from Concurrent Engineering typically fall into four areas:

Better Design and Sustainability Outcomes from Early Collaborative Decision-Making

It is generally accepted that a design team's ability to impact final costs, sustainability metrics and the functional capabilities of a process plant decrease with time. Early decisions such as where the plant is located, which design concept to pursue, the number, size and type of major pieces of equipment, and the constraints of the chosen site—essentially lock in the design approach and sustainability characteristics at the initial stages and limit subsequent alternatives. Better informed early decision making, especially when enhanced with data, also reduces the project risk from both engineering and cost standpoints.



The design team's ability to impact final costs and plant capabilities decrease over time.

Changes introduced after these initial decisions have been made can upset the schedule and be very expensive to implement. Therefore, it is imperative that these early decisions are made with all available inputs and information, from as many stakeholders as possible. By enabling collaboration and input across the key disciplines early, using a concurrent approach, these early decisions are better informed, improving project outcomes, including more sustainable ones. Leveraging this data for early collaboration with procurement and construction experts can also help to avoid expensive problems during project execution.

Preservation of Project Knowledge Across Disciplines and Phases

When design teams are connected by a common engineering and design environment, information from one discipline is available to the others, instead of being locked away in isolated spreadsheets or stand-alone tools. Manual data transfer and replication is eliminated, and the typical errors and omissions are avoided. Collective knowledge about the project as a system continually grows. Handoffs between project phases are smoother and adjacent teams no longer feel like they are starting from scratch.

Accommodation of Project Changes

Changes on large, complex projects can be both costly and disruptive. Yet change is inevitable, and a firm's ability to adjust quickly and efficiently can save considerable time and money for both the project owner and their engineering firm. When teams collaborate around a common engineering environment and set of project data, members can be made aware of the changes and quickly understand the impact to their deliverables. Changes can also be propagated through the common engineering data platform and reflected in dependent deliverables such as equipment lists and data sheets.

Taken together, these benefits enable more efficient work processes, so both owners and EPC firms can do more with the resources they have to achieve improved project outcomes. Because they work more efficiently, engineering teams are able to consider more design alternatives and ultimately deliver a higher quality, more sustainable result, with greater financial certainty.

Winning Work

For engineering firms, project estimating and bidding is a core competency. The quicker they understand the engineering and cost aspects of a potential project, the more efficiently they can bid it. And, as bidding is often a pure cost center for these firms, faster bidding translates right to the firm's bottom line. But it's not just about speed, as EPC firms undertake substantial risk when submitting a bid; it's critical that they develop a sound understanding of the engineering principles underpinning the bid. With a concurrent-based process, the engineers and estimators can collaborate so the estimate stays in sync with the evolving engineering data for the project. The result is more accurate bids created faster and an overall increase in responsiveness to the end customer.

Summary

The pressure to improve engineering processes while delivering more cost-effective and sustainable process plants seems to be constantly increasing. In support of this, digital initiatives now underway at many engineering and owner firms, are poised to enable greater collaboration and work sharing, while laying the groundwork for improving core processes—many of which have not significantly changed in decades. AspenTech's Concurrent Engineering solution, spanning disciplines, locations and project phases, is a critical enabler of these digital initiatives and presents a proven path for executives seeking dramatic improvements in designing and delivering process plant projects for new and existing facilities.

Based on numerous case studies, AspenTech customers are consistently and quickly realizing value ranging from 10-30 percent improvements in engineering productivity; capital savings for their customers ranging from 5-10 percent; and savings during estimating and bidding of up to 50 percent time and effort.

In addition, the ability to model carbon emissions and energy use are placing greater strategic importance on conceptual engineering and design phases.

AspenTech has the most robust and complete engineering and costing solution, spanning feasibility through detailed design, for capital projects in the process industries. We deploy these solutions for our customers globally on a daily basis in support of a wide array of digitalization efforts.

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.

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