The Self-Optimizing Plant: A New Era of Autonomy, Powered by Industrial AI

by Antonio Pietri, President and CEO, Aspen Technology, Inc.

aspentech | Executive Brief

Introduction

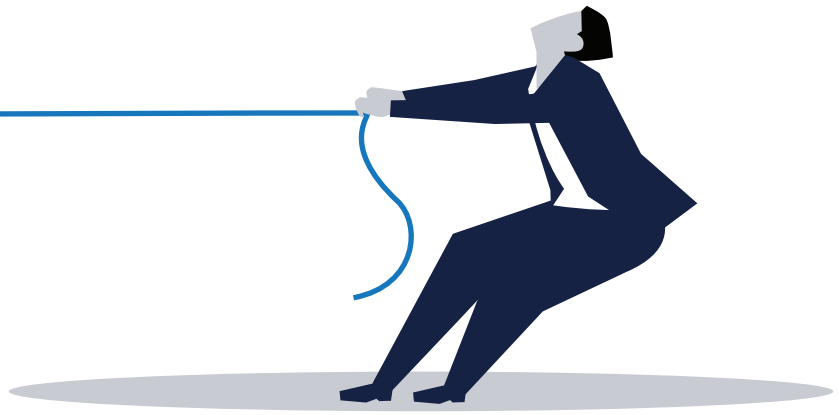
As we adapt to the "new normal" of extreme volatility, uncertainty, complexity and ambiguity (VUCA), businesses around the world are recognizing the need to operate their assets and value chains with greater resilience, flexibility and agility so they can respond to shifting market conditions. As a result, the digitalization of industrial facilities is becoming critical at the highest levels of the organization — and it represents the path to new levels of safety, sustainability and profitability.

Specifically, the development of autonomous and semi-autonomous processes — augmented by the latest advances in artificial intelligence (AI) — will be necessary to win in this environment, and the transformation is quickly becoming feasible for asset-intensive companies.

Closed-loop automation systems are becoming more pervasive and higher-performing, complemented by a variety of online monitoring, analytic and predictive systems. These must all be aligned to drive closer to operating limits and rapidly respond to disruptions. Key to this is the emergence of technology that combines data insights enabled by AI with industry-specific first principles models and domain expertise to support business objectives and launch the journey to the **Self-Optimizing Plant**.

In today's extreme VUCA environment, organizations are looking to increase their competitiveness by enabling tighter collaboration across functions, optimizing increasingly complex assets to achieve multiple objectives simultaneously and empowering workers to make informed and strategic decisions. The Self-Optimizing Plant will deliver these capabilities, allowing companies to achieve operational excellence that is sustainable, even in challenging market conditions.

Each step on the path to autonomy will create incremental value along the way, as companies target this technology to address specific business needs throughout the operation. As an example, companies that have implemented AI-powered predictive maintenance across hundreds of assets and multiple sites are already realizing gains, recouping their investment in just a few months. Beyond that, a number of companies are combining dynamic optimization in a closed loop with advanced process control of multiple units, thereby unlocking millions of dollars in margin.



Here's what the creation of the Self-Optimizing Plant can offer:

- **Greater agility to thrive in an extreme VUCA environment.** Companies can meet customers' shifting product demands, achieve higher levels of quality, respond to important supply chain events, meet dynamic production requests and provide transparency into order status. They also gain the ability to rapidly optimize production for different business conditions.
- **Technology to enable the next-generation workforce.** By democratizing information, workers will make better decisions and be upskilled faster. This will also allow those working remotely to do so seamlessly.
- **The ability to meet safety and sustainability goals.** As workers demand safer conditions, the Self-Optimizing Plant can significantly reduce dangerous conditions and repurpose the staff's role in operations or production floor. In addition, companies can avoid the greenhouse gas emissions associated with process upsets or unplanned shutdowns and startups as they respond to calls to reduce production waste and carbon footprint.
- **A pathway to greater profitability.** By unlocking new levels of production efficiency, companies in the process industries and beyond will find new and previously untapped areas for margin optimization and achieve greater stability, even during downturns.

"Industrial AI" helps make this possible by combining the first principles of engineering (the physics, chemistry and math) with artificial intelligence capabilities and domain expertise in advanced software solutions. This is hybrid technology that is explicitly designed to deliver comprehensive business outcomes for the specific needs of capital-intensive industries, and it will accelerate the transformation of companies around the world.

The Self-Optimizing Plant represents the next major step in the digitalization journey of industry leaders. It is the most powerful tool companies can use to unlock greater value from their production assets — making them safer and more capable, flexible and profitable, regardless of external conditions.

Industrial AI Reduces Adoption Hurdles, Integrates Critical Technology

By incorporating AI capabilities into existing operating technology (OT) and information technology (IT), the industrial systems of tomorrow will be empowered to orchestrate across functional silos and operate semi-autonomously (and eventually autonomously) to drive maximum profit — while at the same time improving safety, minimizing environmental impact and ensuring greater reliability and efficiency.

This is where Industrial AI comes in, overcoming adoption and maturity hurdles by democratizing the application of AI to solve industry-specific challenges. This helps drive business outcomes — within the optimum operating constraints — without the need for data science expertise, and it's critical to enabling the Self-Optimizing Plant. The Industrial AI approach delivers purpose-built solutions for asset optimization across the full lifecycle. These solutions are designed to guide the data science through embedded domain expertise.

Leveraging the ever-increasing amount of structured and unstructured data, Industrial AI improves visibility into operations and delivers insight into the future, providing the basis for increased autonomy. Cloud and edge technologies enable software solutions to be deployed and integrated throughout the plant and support the speed of analysis needed to provide timely insights. In addition, new usability paradigms improve access for decision-making and collaboration across the business.

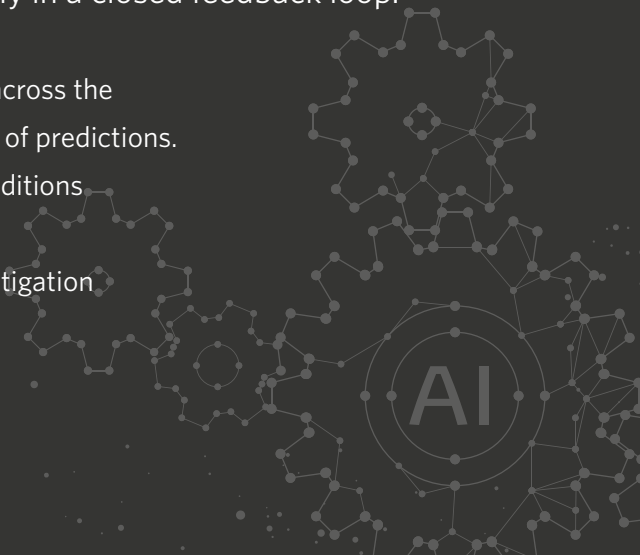
Technology interoperability enables new feedback loops, which continuously inform operational systems at every level to improve overall performance. By connecting the solutions together more effectively, companies can implement new work processes that unlock new possibilities across the entire industrial asset lifecycle.

For example, when a digital twin provides a new insight or a prescriptive maintenance alert occurs, streamlined workflows connect engineering and asset performance management functions to operations, enabling personnel to quickly make the best decisions based on current data. Importantly, humans aren't being removed from the equation in the Self-Optimizing Plant; rather, they're becoming empowered to work more effectively on the highest-value tasks.

The Self-Optimizing Plant: A Definition

A Self-Optimizing Plant is a self-adapting, self-learning, and self-sustaining set of software technologies that work together to anticipate future conditions and act accordingly, adjusting operations within the context of the enterprise. The plant does this through pervasive real time access to data and information, combining engineering fundamentals and AI, and capturing and using knowledge to optimize across multiple levels, provide recommendations and automate actions securely in a closed feedback loop.

- **Self-learning plants** utilize data and information from across the environment to get smarter, increasing accuracy and scope of predictions.
- **Self-adapting plants** react in real-time to changing conditions by making adjustments to meet targets.
- **Self-sustaining plants** detect anomalies and trigger mitigation to improve and prevent performance degradation.



The Journey to Autonomy: Achieving the Self-Optimizing Plant

To start moving toward the Self-Optimizing Plant, many companies are seeking to enhance and better align their existing business processes, with an eye on reducing the gap between planned and actual performance. In particular, they want to execute their economic objectives more directly and quickly, thereby driving higher margins.

This implies that key functions like planning and scheduling can become more closely integrated and aligned with closed-loop automation systems like advanced process control (APC) and dynamic optimization — and this is a focus of the next generation of production optimization solutions. By incorporating insights from engineering, maintenance and supply chains, companies gain the holistic view needed to achieve even higher levels of performance and stronger business outcomes.

Leading organizations have already started exploring the approach to augmenting production optimization with Industrial AI, recognizing that the transition to more autonomous operations will require a progression of steps over time.

Envision a journey in which planning and scheduling processes become semi-autonomous and, eventually, autonomous — an accelerated version of the multivariable process control transformation over the past 30 years and the transformation occurring today with autonomous vehicles. The role of the planner and scheduler will increasingly evolve to comprise strategic review and decision-making, instead of manually creating plans and conducting analysis.

The shift toward autonomous operations, however, will likely be faster and more dramatic than other digital advances we've seen to date. The roles of automated decision-making and human decision-making will evolve over time, and the insights gathered from the plant and the actions taken by personnel will be leveraged to drive a new level of intelligence and automation.

Imagine if the system itself could "learn" from what has happened in the past to predict what will happen in the future — and more importantly understand what actions are needed and what the outcome of those actions will be. This is already a reality in the realm of asset performance management. The increased integration of technology will enable the same type of AI "agents"

to permeate and supervise engineering and operations systems to drive even greater insights from across the facility.

Then, imagine the decisions that could be made with wider access to accurate, real-time data and information from all functions. The plant could begin to adapt with greater levels of automation, relying on human oversight only as necessary. This change will not only open the door to new levels of safety, reliability and profitability, but it will also create a pathway for a new generation of workers comfortable with digital technology to lead the transformation of these businesses. To achieve this level of automation, the Self-Optimizing Plant relies on advanced technology that leverages:

- **AI and data science** to create more intelligent systems that instantaneously leverage data across a plant to react to changing conditions and events
- **Advanced usability paradigms,** including enhanced reality and data visualization, to democratize AI and deliver intelligent applications tailored to industry workers' specific environments — without requiring data science knowledge
- **Orchestration of advanced models** that combine AI with the first principles of physics and chemistry to deliver a comprehensive, accurate view of the operation and ensure the feedback loops are accurate and reliable
- **High-performance computing** to apply sophisticated models, accessing all relevant data, to generate insights across operating objectives and constraints, and rapidly present current status and future predictions
- **Decades of domain knowledge** built into advanced modeling systems to provide strong "guardrails" around AI and data-based technology, ensuring that the plant always operates safely, drives to the desired objectives, informs the operator and knowledge worker when difficult decisions must be made and achieves the optimum product quality, yield and sustainability results

When a plant's operating technologies can be effectively integrated, real-time feedback loops will inform operational systems how to improve performance, in addition to making the plant more reliable and enabling the system to self-improve in areas of safety, sustainability and performance. Asset performance and asset health can be continuously monitored — and optimized simultaneously, rather than as separate use cases.

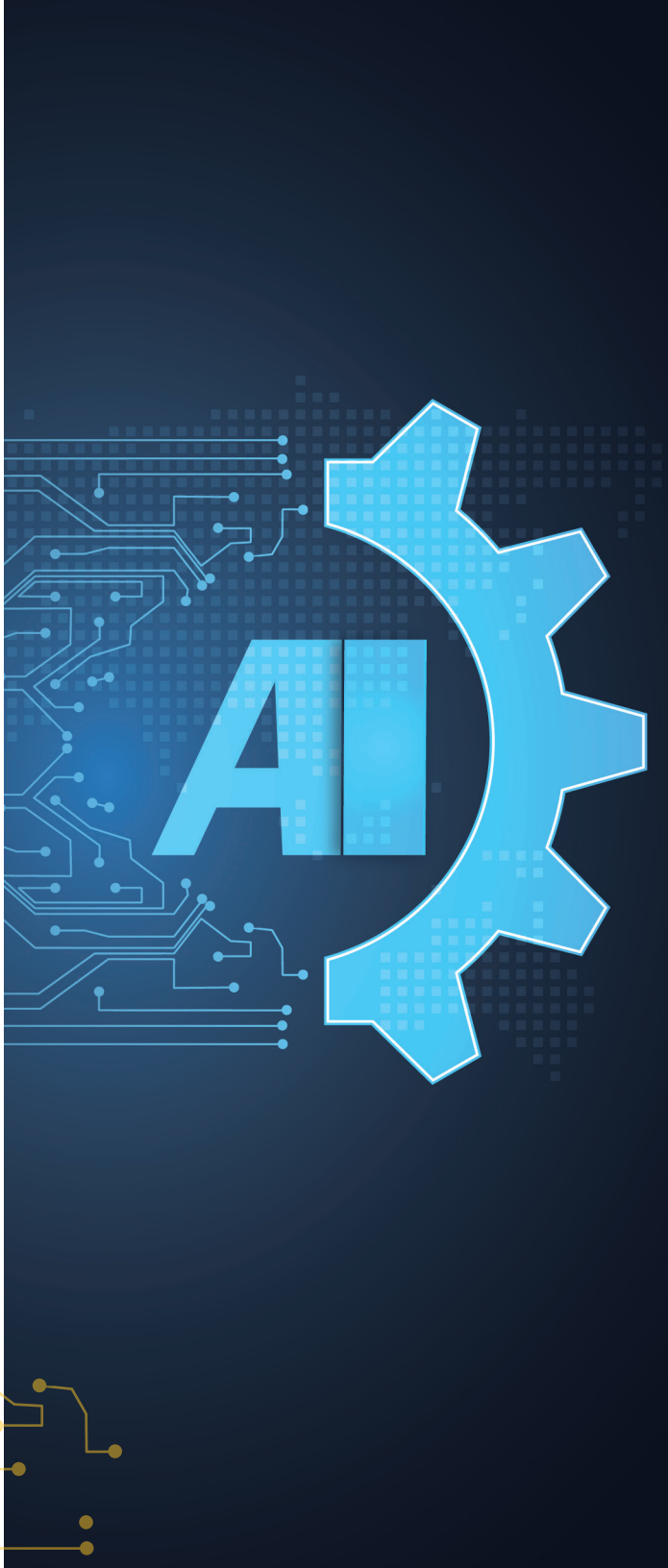
With these capabilities in place, companies can not only boost plant uptime, but they can also maximize personnel safety and minimize greenhouse gas emissions by avoiding the process upsets and unplanned shutdowns responsible for so many releases. The integration of technologies presents a way to optimize for economics and process health at the same time, making plants safer, greener, more reliable and more profitable.

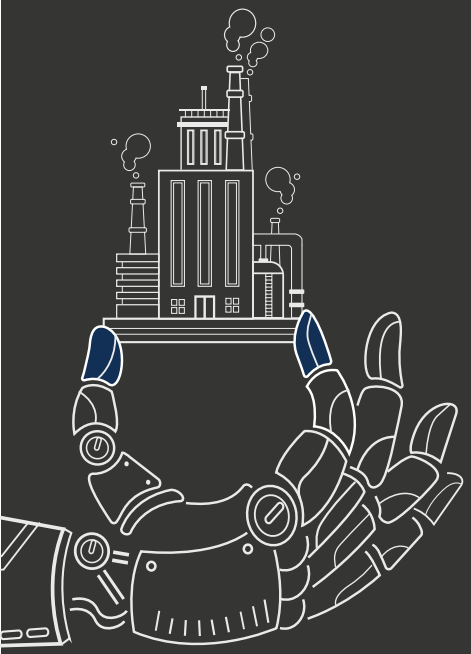
The Technology: What Capabilities Will Drive the Self-Optimizing Plant?

While the Self-Optimizing Plant once seemed like just a promise, recent advances in technology are now making it a reality. These are the building blocks and capabilities that companies can start implementing to create the industrial facility of tomorrow:

- **Closed-loop planning and scheduling** tightly integrates advanced process control, process envelope optimization and planning and scheduling. Technology integration enables collaborative workflows to begin autonomously linking the plan, schedule, execution, optimization and control together to bring the actual performance closer to the plan.
- **Process performance monitoring** becomes a network of online models (first principles, AI and hybrid) supervising desired operational indicators and key performance metrics. This network of models will provide automated 24x7 insights and propose adjustments, building on the resiliency and efficiency of Industrial AI technology.

- **Asset health monitoring** leverages prescriptive analytics, built on Industrial AI, to track the performance of equipment and predict breakdowns, so companies can maximize uptime and ensure safe operations. Real-time data and analysis can be fed back to the individual systems, providing insights to react quickly and effectively to unexpected changes (such as failures or weather events).
- **Workforce enablement technology**, such as cognitive guidance for decision-making and interactive operator training, can empower personnel to fully leverage production optimization technologies to provide the enterprise with a strategic advantage. Knowledge workers are supported with guided workflows and with immediate access to organizational knowledge and new insights, substituting for decades of experience.
- **Digital twin** technology uses real-time data to provide an evolving digital profile of the historical, current and future behavior of an asset or process. The connected worker can gain insight, optimize operations, predict performance of the asset and get a holistic view of how to achieve the best possible perfomance.
- **Model alliance** enables sharing of key master data and model components between different applications to maximize synergies throughout the organization, breaking down functional silos across Engineering, Manufacturing, Supply Chain and Maintenance and streamlining application deployment and maintenance.
- **Advanced modeling** solutions allow engineers to quickly build models to optimize plants online and offline, in one consistent environment.
- **Data visualization** can help power a next-generation collaborative, adaptable work environment that enables the organization to rapidly adjust operations to new market, sustainability and business objectives.





Value Created by Industrial AI Is on the Rise

The recent Industrial *AI Market Report 2020-2025* from IoT Analytics identified a total of 33 different use cases for industrial enterprises that employ AI tools and techniques. The study estimates the global Industrial AI market size will reach **$72.5B by 2025**, up from just over $11B in 2018.

These are the business initiatives that can be positively impacted by creating the Self-Optimizing Plant:

- **Energy optimization** (incorporating carbon intensity)
- **Reporting and compliance**
  (greater transparency, as well as visibility into sustainability performance)
- **Innovation**
  (R&D, scaleup and implementation workflow for products and processes)
- **Intelligent workforce**
  (cognitive guidance, augmented reality and simulators)
- **Yield and on-time performance**
- **Product quality**

Conclusion

The Self-Optimizing Plant will deliver the speed, agility, safety, sustainability and workforce enablement capabilities that companies will need to remain competitive in the years to come.

This plant of the future will become integrated with the corporate value chain to support the broader "Smart Enterprise." Value chain optimization technology, underpinned with Industrial AI, will enable close integration between multiple Self-Optimizing Plants and the value chain, and will drive a number of key breakthroughs:

- **Two-way collaboration** between plant and corporate stakeholders to tackle important business opportunities and constraints in a timely fashion
- **Close alignment** of Self-Optimizing Plant systems with value chain systems and enterprise data
- **Seamless communication** of objectives to Self-Optimizing Plants, along with feedback and reporting of production, sustainability, safety and economic status to corporate systems and stakeholders
- **Autonomous orchestration** and collaboration between Industrial AI agents in the value chain and Industrial AI agents in the Self-Optimizing Plants

With this type of seamless integration, Self-Optimizing Plants will be able to act in concert with the economic objectives of the entire Smart Enterprise and enable companies to:

- **Empower their next generation of workers** to focus on the highest value activities, progressively retrain and move away from labor-intensive unproductive areas and dangerous operations
- **Manage safety and reliability** by predicting future degradation and failure and addressing causes of future events
- **Maximize the efficiency and performance of the operation** by running closer to the limits of the asset and optimizing utilization of the entire value chain
- **Achieve sustainability goals** by reducing energy use, optimizing reuse of resources and materials, avoiding greenhouse gas releases and maximizing use of renewable fuel sources
- **Gain the agility** needed to explore new markets and new business models

This is how organizations can truly future-proof their business — with efficient, integrated and intelligent technology that enables them to achieve self-optimization and win in an extreme VUCA environment, regardless of market conditions.

aspentech | Technology That Loves Complexity

About AspenTechnology

Aspen Technology (AspenTech) is a global leader in asset optimization software. Its solutions address 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 artificial intelligence. Its 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.