



Maximize Safety, Sustainability and Productivity by Turning Unplanned Downtime Into Planned Downtime

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The Wide-Ranging Impact of Unplanned Downtime

Nothing hurts productivity and profitability like unplanned downtime. It's a theme we've covered before, but it really only tells part of the story. The effects of unplanned downtime reach far beyond the financial, as forced shutdowns also have a major impact on plant and personnel safety as well as greenhouse gas emissions and environmental compliance.

From a safety perspective, forced shutdowns represent one of the most dangerous conditions a plant can experience. A refinery typically spends less than 10% of its time in transient operations (shutdown, startup or maintenance) — but a staggering **50% of all process safety incidents** occur under those conditions.¹ To make improvements in safety, it's absolutely critical to minimize these transient operations, especially those that occur unexpectedly.

From an environmental perspective, unplanned shutdowns are also disproportionately damaging. Just a single unplanned shutdown lasting hours can result in **the release of years' worth of toxins into the atmosphere**. An emission event following a forced shutdown at a California refinery in 2017 resulted in 31,000 lbs. of sulfur dioxide being released in one day² — more than the refinery had released over 2015 and 2016 combined. This is just one of many such examples.

And that's in addition to the **losses in profitability** that we know these events result in, stemming from reduced productivity, higher maintenance costs and the waste that comes from irregular operations.

If there's a single plant process that illustrates this issue clearly, it's gas flaring, or the combustion of excess product that is typically released when a plant experiences over-pressuring operation — such as during an unplanned shutdown. Excessive flaring is a visual sign that something is outside of normal parameters in the facility, which means the safety risk is increased.

Flaring is also a significant source of greenhouse gas emissions; in fact, the World Bank estimates that 1% of the world's total greenhouse gases are the result of gas flaring. In addition, it's a tremendous waste of fuel, with the World Bank also estimating that about US \$20 billion of gases are flared or vented every year.³

This paints a somewhat grim picture, but there's good news from the industrial technology front. By tapping into the power of machine learning and predictive analytics, **companies can begin to reduce unplanned upsets and capture all the benefits that come with that.** With technology that eliminates the surprise of unplanned downtime, companies can minimize the most dangerous conditions, reduce the amount of gases released into the environment and realize significant financial gains by maximizing uptime.

Without question, there's a lot at stake — financially and beyond — in avoiding unexpected shutdowns.

The Solution: Technology for Decision Agility

So, what if we could actually plan for downtime? What if we could know which pieces of equipment are going to fail, and when, so we could perform the repairs as part of a managed shutdown? The benefits are significant, and they cover improvements in safety and emissions reduction as well as profitability.

Today's asset performance management technology can deliver advanced warning of failures through a combination of predictive and prescriptive analytics, enabled by integrated software that incorporates artificial intelligence (AI) and machine learning. This type of solution provides a detailed view of all equipment, systems, facilities and networks, thereby enabling a capability we call "decision agility."



This means that, with the time to plan around predicted downtime and a holistic view of the operation, plant personnel can see exactly how a decision that changes any business process also affects the entire organization. They'll immediately know how it impacts planning and scheduling, how it determines which feedstocks are purchased, how it affects inventory and even how it may impact the Sales team and the potential for missed orders.

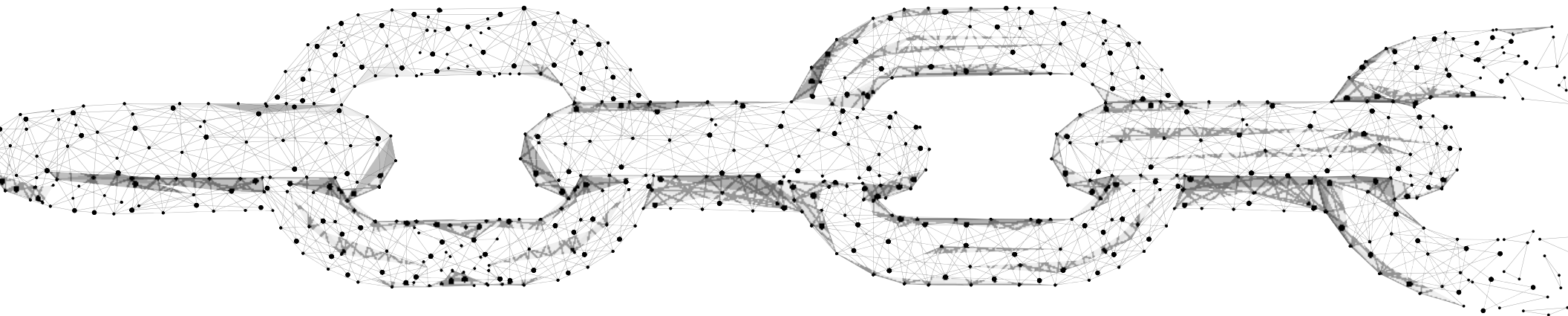
The right technology can simulate how any event will impact the system, the process and the asset. When the outcome is known in advance, operators and engineers can collaborate to make the safest and most profitable decisions; they can work together to develop a plan.

That plan becomes a clear roadmap of where to spend every dollar to maximize the return on capital employed. The technology can even be scaled to cover multiple plants across a region to provide a look at how facilities are tied together and to better understand their co-dependencies.

So when there is an issue in one location, the software can show how it will affect the pipeline coming in, the ships going out and whether the facility is at risk of defaulting on any contracts.

By driving the best decisions, this technology also reduces risk across the entire operation, and there's a recognized value in doing that. Some providers in the insurance industry, which is also driven by data, have actually begun advising their customers about digital solutions for prescriptive maintenance and decision support. They're promoting these technologies as ways to reduce unplanned downtime and associated events — and also as an incentive to lower their insurance rates.

The ability to see wide and deep enables new ways of running the business. Digital transformation is knocking down the data silos and delivering the tools necessary to make sense of the data available at the enterprise scale.





Putting it Into Practice

Achieving this level of technological integration starts with a ramping up of the organization's digital capabilities. Companies in every sector now have access to technologies such as high-performance computing, artificial intelligence and advanced analytics to generate deeper insights from their operating data.

Fueled by these data-driven insights, leading-edge simulation programs enable operators to quantify the true value or cost of any renovation or improvement project, maintenance change, operations improvement or supply chain constraint. This technology utilizes statistical sampling techniques to predict the future performance of a system, analyzing equipment behavior patterns to derive a "time to failure" estimate.

With the broad view of operations that simulation programs provide, plant personnel can be alerted to impending failures and understand the potential impacts to the wider system. Operators can also model flow through the pipes and tank levels, as well as the utilized and available capacities of all units.

This is how it's possible to discover exactly which events are robbing an operation of money or negatively impacting performance in ways that can lead to environmental and safety issues. With a prioritized list of every single event in the business that's negatively impacting performance, the company can apportion budgets and put people where they are needed — and every decision is based on data.

If the software is in place at a mining operation, for example, it might alert to a failure of a major conveyor coming within the month, which would cause significant disruptions throughout the business. But with the advance notice provided by the software and time to plan before the failure happens, personnel can then use scheduling models to find the best time to take the conveyor offline, and even insert additional maintenance activities to make the most out of the planned downtime.

The greater the window of predictability over the planning horizon, the more powerful the business options are.

And if the alert comes even further in advance, perhaps six to eight weeks ahead of failure, this enables the staff to load the information into a longer-term planning model that can account for impacts on sales or operations planning or integrative business planning.

Through those two models, not only is the organization protecting itself from unplanned events, it's actually accounting for economic impacts. Personnel are making informed decisions to take the best possible action in a multi-network supply chain with equivalent manufacturing facilities that can produce multiple goods.

The greater the window of predictability over the planning horizon, the more powerful the business options are. This moves the conversation from "what's feasible" or "what's going to get us by" to "what's going to give us the best results as we're trying to deal with this issue."

In short, management can always know when is the best time to take downtime, as well as what activities should be completed during that downtime, in order to preserve orders and maintain commitments to key customers.

The Results: Delivering the Business Trifecta

An investment in the right advanced technologies not only delivers a significant return on investment by reducing unplanned downtime, but it also greatly improves a company's ability to maintain safe operations and meet environmental goals. Let's look at each area of this "business trifecta."

Safety: Reducing the Most Dangerous Conditions

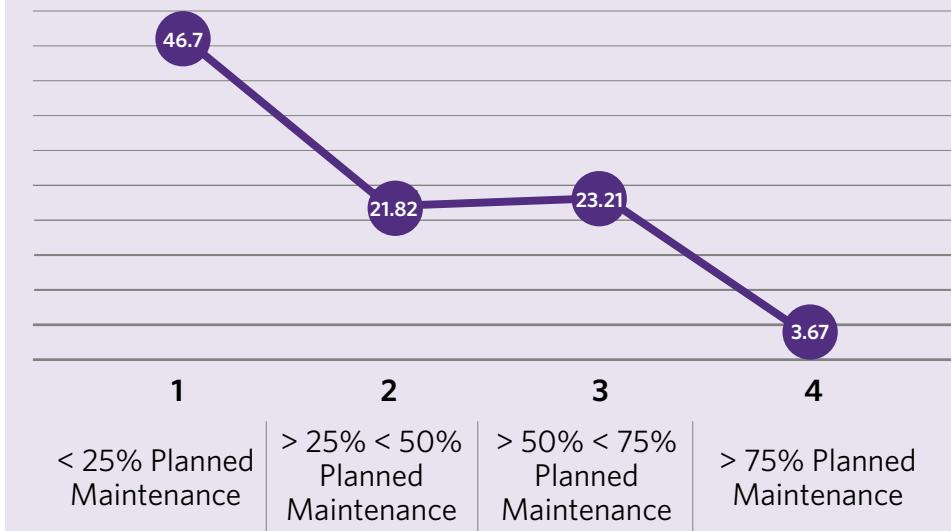
The single biggest change that can be made to improving safety is reducing unsafe conditions in the facility, namely unplanned shutdowns and other transient operations. The beauty of an integrated technology solution that drives decision agility is that it removes uncertainty. It does this by collecting, aggregating and conditioning data from across the entire system and feeding into digital models to evaluate scenarios, gain insight and drive continuous operational improvements.

As soon as uncertainty is removed from the process, operations become more predictable, which means personnel can plan better to significantly reduce safety concerns. By eliminating the unexpected, plants become safer. In fact, statistics show that **safety can be improved by about 90%** when most maintenance activities are planned, as opposed to when most maintenance is reactive or unplanned.

Sustainability: Minimize Emissions That Come With Unplanned Shutdowns

Unplanned downtime and transient conditions lead to flaring, which means product is released into the atmosphere. This is an area where predictive analytics integrated throughout the system can make a major impact. Flared natural gas alone produces more than 300 million tons of CO2 emissions globally every year (the equivalent of approximately 77 million cars),⁵ and much of that could be avoided by eliminating unplanned shutdowns.

Number of Accidents With Injuries Per Million Working Hours (Maintenance Workers)



Workplace injuries decrease significantly with the implementation of planned maintenance. ⁴



What if we could see a pending problem on a piece of mining equipment before it starts degrading? What if we could be alerted to a failure on an offshore oil platform before it developed into a serious issue? All of this is possible, and it means that unplanned downtime can be turned into planned downtime.

In addition, this technology can be integrated with planning models that will provide specific recommendations and advice on what actions to take to **maintain greenhouse gas emission limits** and quotas.

Profitability: Maximize Availability-to-Plan for Optimum Operations

Beyond the safety and sustainability implications, companies also stand to gain financially as a result of the increased production that comes with more uptime. Those that have optimized their maintenance processes to reduce unplanned shutdowns have realized incredible payback on their investment in predictive analytics technology.

Unplanned shutdowns cost oil and gas companies an average of \$38 million a year — and up to \$88 million a year in the worst-case scenarios.⁶ At chemical plants, the cost of unplanned downtime ranges between \$10,000 to \$250,000 *per hour*.⁷

Just eliminating a portion of the abnormal events that rob an operation of productivity can **add millions of dollars to the bottom line**. And when companies are able to quantify exactly how much any particular event affects revenue, they know exactly where to target their technology strategy for maximum impact.



Conclusion: The Opportunity Is Available Now

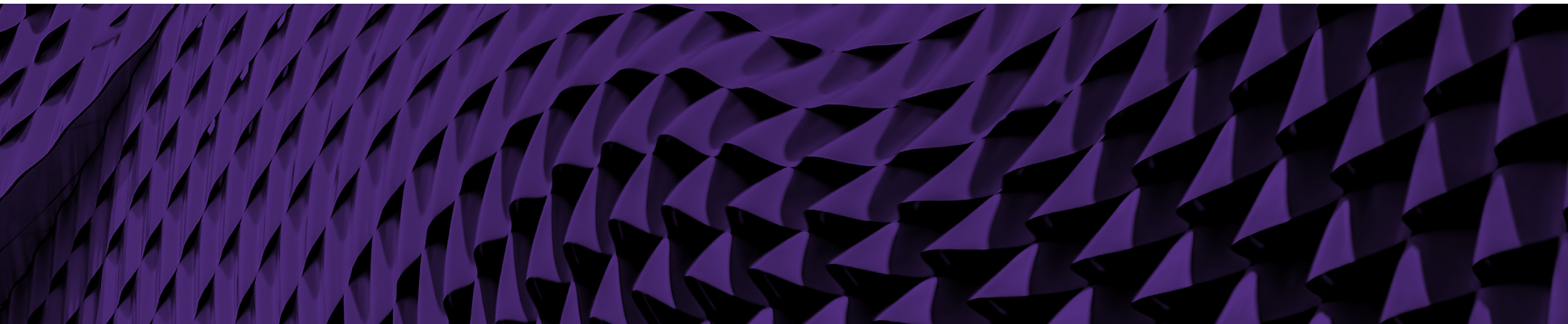
The companies that implement this technology first can put themselves at a distinct competitive advantage, reaching new levels of profitability while also maintaining their “social license to operate” with improved safety and sustainability performance. Many are already putting the solutions in place to help them avoid the most dangerous conditions, reduce greenhouse gas emissions and maintain the most efficient operations.

Here are just a few examples of organizations who have embedded advanced technologies in their equipment and processes to significantly reduce unplanned downtime:

- A European petrochemicals producer has used a predictive analytics solution to develop a data-driven approach to maintenance planning. With the new plan in place, they **eliminated two days of shutdown per year** on each piece of equipment and saved \$1.8 million in downtime costs.
- A refinery with 300,000 barrels per day of capacity has been able to predict failures with significant lead time — and has done so without false positives. These capabilities are expected to **reduce unplanned shutdowns by up to 10 days**, increase revenue by 1-3%, reduce refinery maintenance costs and cut operating expenses by 1-5%.

- A refinery has implemented solutions to **predict failures with nearly 30 days of lead time**, enabling the staff to schedule maintenance, shift production where necessary and improve the way they look at root cause analysis.
- A leading pulp and paper manufacturer has seen how advanced technology improves safety, as their predictive analytics solution **alerted to a major fire with nine days of advance warning**.
- A metals and mining company has deployed a leading-edge predictive analytics solution across more than 300 of its assets. It is managed by essentially one person, and the company has **improved availability enough to get full return on investment** in less than six months.

As companies face growing pressures from shareholders and consumers alike, the need for agility is greater than ever. By reducing risk and uncertainty through the implementation of the advanced technology solutions available today, companies can put themselves in the best position to win in the marketplace of tomorrow.



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](https://www.aspentech.com) to find out more.

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¹Tame Your Transient Operations, Scott W. Ostrowski and Kelly K. Keim, *Chemical Processing*, June 23, 2010

²Valero's Benicia Refinery Outage Triggered "Huge" Release of Pollution, Ted Goldberg, KQED News, June 12, 2017

³Zero Routine Flaring by 2030, The World Bank, 2015

⁴Wim Vancauwenberghe, Belgian Maintenance Association, presented at 2011 Society for Maintenance and Reliability Professionals Annual Conference

⁵The IoT Transformation of Gas Flaring Operations, Lana Ginns, *Flow Control*, Oct. 4, 2016

⁶The Impact of Digital on Unplanned Downtime, Baker Hughes, Oct. 2016

⁷Asset Performance Management: Blazing a Better Path to Operational Excellence, Aberdeen Group, November 2017

