

Maintenance: the hidden profit generator in pulp and paper manufacturing

Dynamic, proactive condition monitoring approaches increase uptime, optimize productivity, and maximize profits



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Executive summary

Ts'ai Lun, a Chinese court official, is recognized as the inventor of paper, almost 2,000 years ago. Fibers from old rags and clothes were the original "pulp" used in papermaking, ushering in a significant innovation. While today's pulp and papermaking has evolved to impressive levels of sophistication and maturity, the magnitude of impact on humanity, relative to most other innovations, remains unrivaled.

Now, pulp and paper manufacturing is at a crucial inflection point. Facing increased global competition, rising raw material costs, skilled workers retiring en masse, and the impending Fourth Industrial Revolution (4IR), pulp and paper manufacturers must pivot.

New approaches and fresh mindsets are required. Capital-intensive pulp and paper operations must find novel ways to profitably compete. An essential enabler is one long overlooked path to profit: maintenance.

A key impediment to realizing the profit potential in maintenance is the ability to quantify the full financial impact of maintenance-induced losses to productivity and profit. Consider these pulp and paper industry data points:

60–80%

of equipment malfunctions are caused by incorrect or insufficient maintenance



Creating unnecessary losses

80%

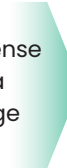
of manufacturers are using reactive maintenance approaches



Leaving operational and financial risks unaddressed

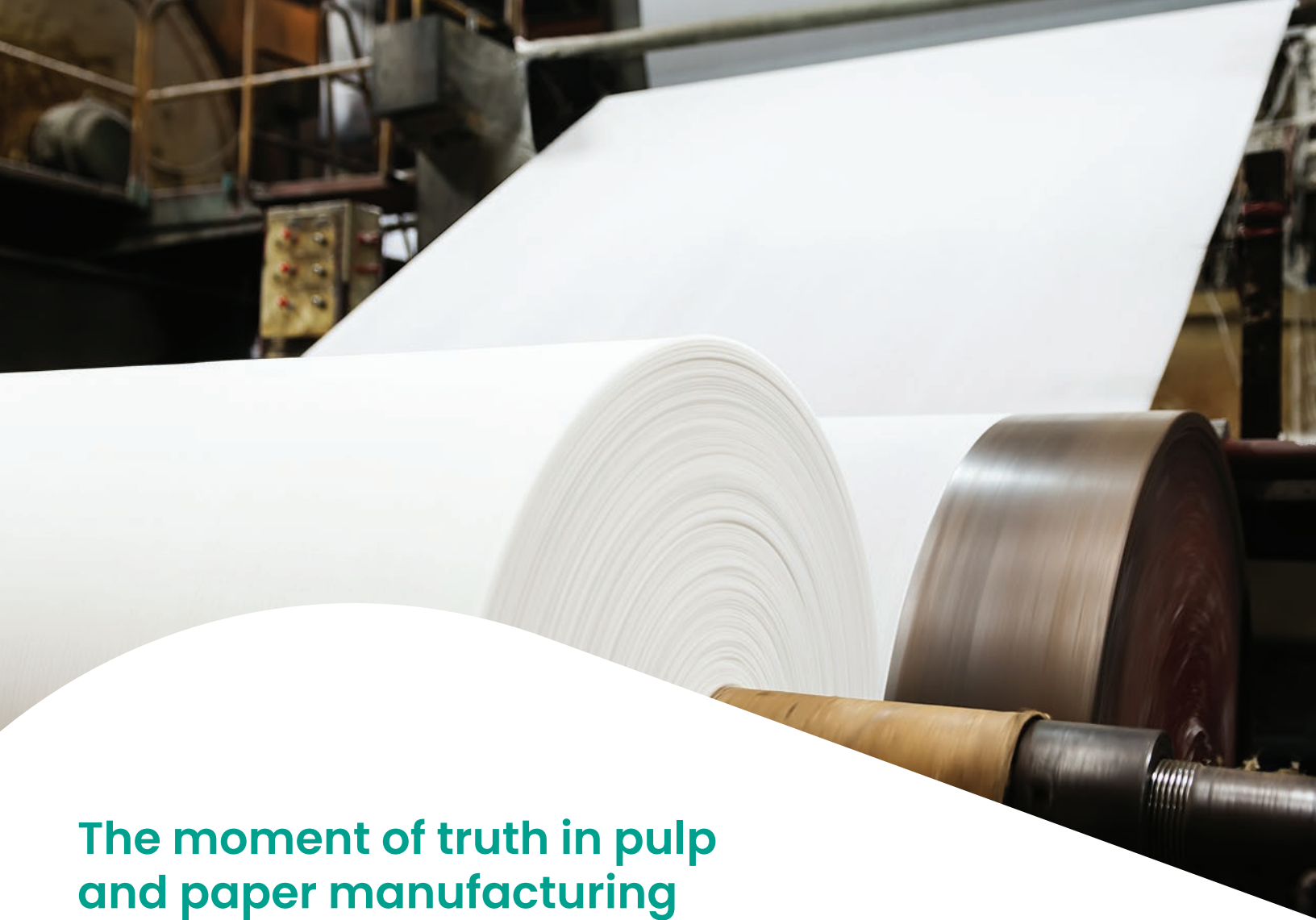
10%

of operating expense is maintenance, a significant overage relative to other industries



Squandering an important path to profit

The solution? Pulp and paper operations must leverage maintenance strategically, and as a continuous improvement process to better optimize manufacturing and improve profits. To do this, leading manufacturers have but one choice: to adopt intelligent, condition monitoring planning capabilities that perpetually—and proactively—optimize operations. This is the next vital step in pulp and paper's evolution—and survival.



The moment of truth in pulp and paper manufacturing

Few inventions have had a more profound impact on humankind than paper. Heralded as the foundation of knowledge sharing, the invention of paper has captured and preserved society's knowledge throughout the ages. Following the development of the printing press in the 15th century, paper rapidly spurred intellectual advancements by sharing that knowledge far and wide, greatly catalyzing man's innovation and progression.

Today, paper and the manufacture of pulp and paper is still a wonder. Manufacturing combines the art of papermaking with the science of highly sophisticated process production, generating a range of paper options that provide a multitude of possibilities for creativity and communication.

As a mature manufacturing process and industry, however, pulp and paper manufacturing is now facing its' "moment of truth", an inflection point of paramount importance and long-lasting impact. With increased competitiveness, skilled workers retiring en masse, emerging regulatory requirements, the rising costs of raw materials, process chemicals and energy and the adoption of the

Fourth Industrial Revolution (4IR) upon it, pulp and paper manufacturers must adapt and do so quickly.

Yesterday's solutions will not address today's or tomorrow's challenges. Pulp and paper companies must become pioneers of change. Most capital-intensive pulp and paper operations have not fully embraced proactive maintenance as a path to profit. Now, under intense competitive pressures, simply reducing costs will not suffice. Operations must leverage maintenance as a plant-wide, continuous improvement process to optimize operations and improve profits.

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One thing is clear for pulp and paper manufacturers: optimized manufacturing is essential to survival and its key strategic component is proactive, data-driven maintenance.

OEE: A vital metric in pulp and paper manufacturing

In pulp and paper manufacturing, plant configurations vary in three primary ways: pulp manufacturing, paper production, and integrated mills that make both pulp and paper. While there are important differences in each of these environments, there is also much common ground. Let's explore both.

What's important across pulp and paper manufacturing environments? Pulp and paper operations are sophisticated and complex. Plants utilize hundreds of assets—boilers, motors, compressors, presses, pumps, gearboxes, turbine generators, paper machines, refiners, etc.—that must perform reliably, on demand, and at their best in terms of quality and productivity. While the specific equipment used in pulp vs. paper manufacturing differs, the principles and practices surrounding successful outcomes via metrics such as Key Performance Indicators (KPIs) are similar.

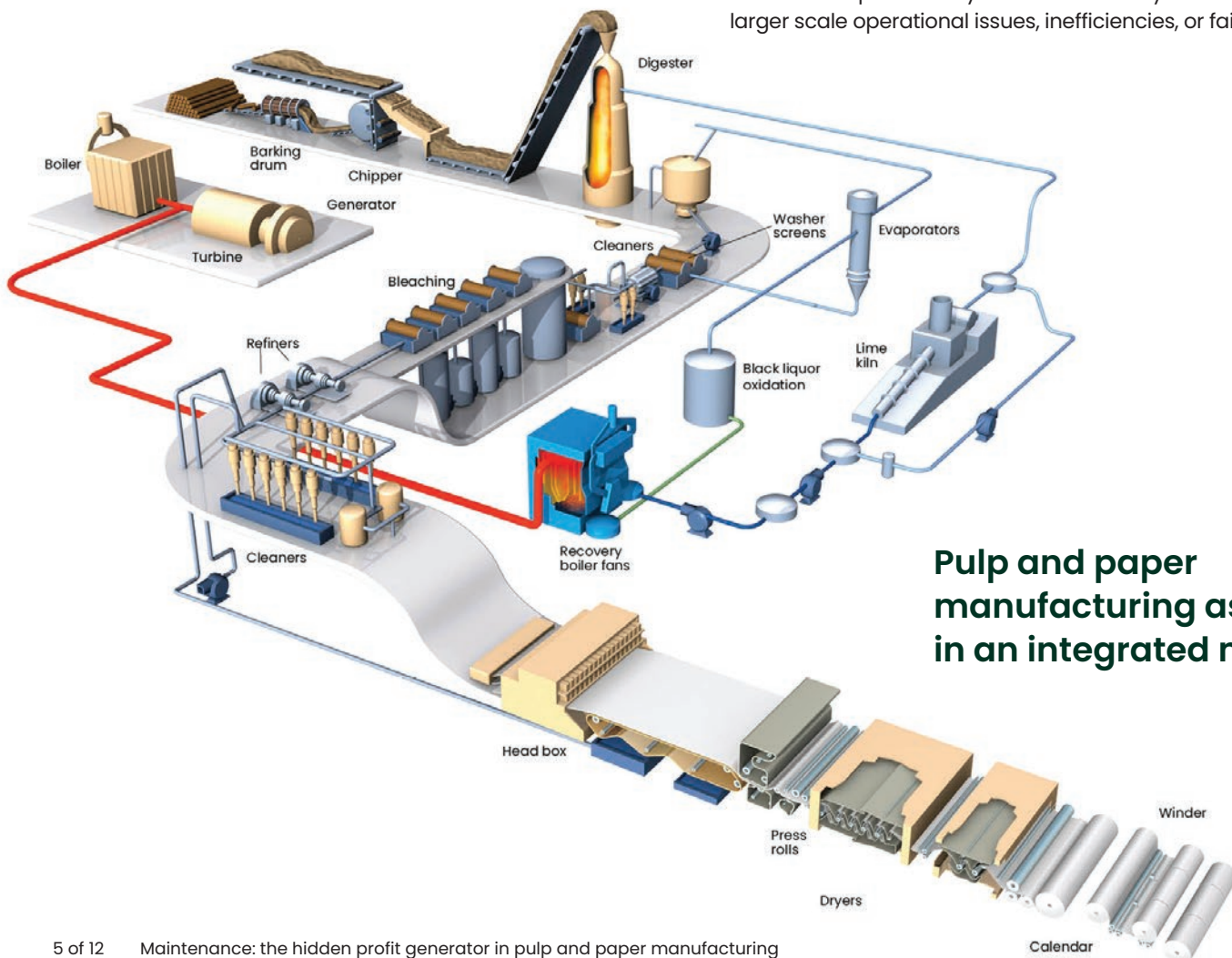
Functional failure is a process, not an event.

One important KPI that spans pulp and paper manufacturing environments is Operating Equipment Effectiveness or OEE, used as a measure of productivity. For example,

- In pulp operations, plant managers improve OEE by minimizing fiber loss and decreasing water usage via wastewater reductions
- In paper manufacturing, OEE is optimized by achieving continuous, uninterrupted paper production to maximize tonnage output from the paper machine and also by increasing quality on the front end in order to minimize waste or mill broke

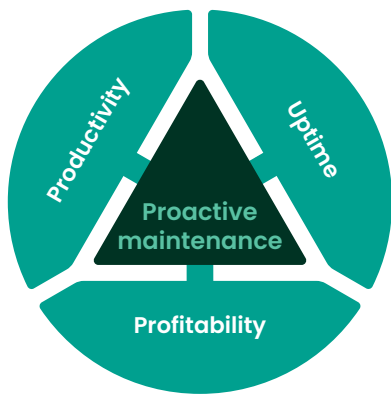
The key to increasing OEE across pulp and paper manufacturing is to avoid functional failure, by preventing equipment issues before they occur and, ultimately, to mitigate the risks of full failure. Functional failure is when equipment is unable to adequately perform a specific function. Full failure is equipment shutdown from, for example, a bearing stop. Functional failure can be proactively managed because it is a process, not an event.

Additional OEE improvements come from the identification and resolution of productivity concerns in the system and avert larger scale operational issues, inefficiencies, or failures.



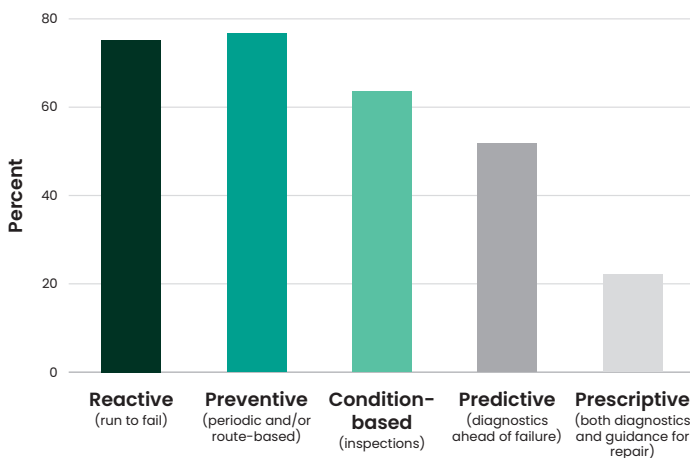
Maintenance drives uptime, productivity, and profitability

Optimized OEE in pulp and paper operations via uptime, productivity and profitability relies on one key, and oft-overlooked enabler: **proactive maintenance**, the central hub of all other metrics. Maintenance should be a strategic business priority, tied to profitability. The financial benefits, however, are difficult to quantify as they are based on prevention of possible (and costly) scenarios. Thus, the full potential of maintenance is often obscured and/or underestimated. Let's quantify the would-be impact and look at some of the unexpected ways that maintenance can deliver improved profitability.



Condition monitoring solutions have been leveraged throughout pulp and paper operations for several decades. It is how these solutions are being used—to reactively manage maintenance—that must change. Per a survey of pulp and paper manufacturers, almost 80% are using reactive or preventative/time-based maintenance modes.

Types of maintenance approaches deployed at plant
(based on pulp and paper research conducted by MarketsandMarkets, 2020)



To make the shift from reactive to proactive maintenance, manufacturers must embrace condition monitoring as a strategic planning tool, moving from disparate and/or underleveraged data sources (i.e., data per machine asset) to connected data. Together with on-going data analysis, this provides a more holistic, "eagles-eye" view of operations and enables the right and best decisions to be made. Herein lies the opportunity for capturing more profit from the unlikely and obscured source: maintenance. Let's look at some numbers.

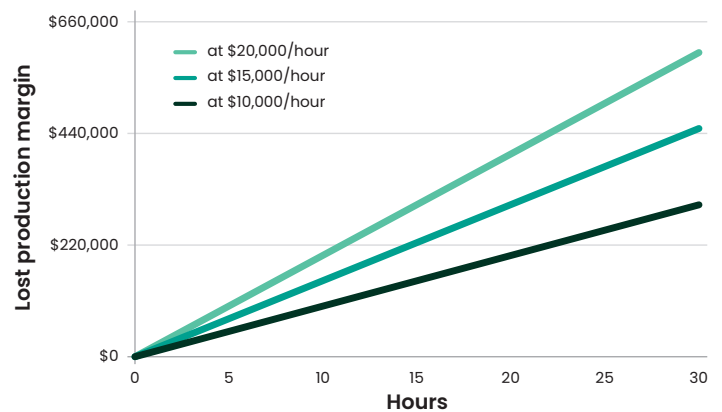
Maintenance

In pulp and paper plants, maintenance comprises an estimated 10% of operating expense (OPEX). This is a hefty percentage relative to other industrial manufacturing processes such as automotive manufacturing, chemical industries, and engine production. As a rule of thumb, world class manufacturers strive for maintenance costs at 2% of OPEX.

Maintenance comprises an estimated 10% of OPEX cost in pulp and paper plants.

Consider this example. When condition monitoring is used strategically—as a planning tool to proactively manage maintenance—the impacts and costs of lost productivity are at the lowest possible point. An estimation of lost production margin by hour is shown below using three different cost scenarios: \$10,000/hour, \$15,000/hour and \$20,000/hour. The losses are estimated for a roll bearing replacement with no ancillary damage. This graph shows how lost margin escalates quickly, with the possibility to reach millions of dollars.

Lost production margin by hour



In manufacturing, there is no "reverse" button for blind spots that go unresolved. Financial impacts include cost recovery, brand reputation, customer experience, and costly penalties.

Uptime and productivity (availability, reliability)

Once production capacity is lost, it cannot be regained. In pulp and paper operations, manufacturing speeds can peak at 60 to 74 miles per hour or 96 to 119 kilometers per hour. At these speeds, lost productivity has serious consequences that escalate quickly, further underscoring the significance of maintaining and maximizing uptime.

In manufacturing environments, operational uptime is the “holy grail”. However, optimal uptime is much more beneficial and requires two components to exist simultaneously:

1. Increased, ideal machine performance (at speed, on demand, at quality standards)
2. Reduced downtime (especially unplanned downtime)

An estimated 60 to 80% of equipment malfunctions in pulp and paper production are caused by incorrect or insufficient maintenance. Functional or full failures on a single machine impact both machine performance and downtime, resulting in delays throughout the entire production process, which in turn incur significant costs.

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Avoiding unplanned downtime and events in pulp and paper manufacturing is financially prudent. While the cost of unplanned downtime in mills varies, estimates range from \$10,600/hour to \$50,000/hour USD, establishing strong justification for mitigation, regardless of the exact number. In one example, a European pulp mill experienced

four days of unplanned downtime, losing 10,000 tonnes of pulp with estimated losses of €2.7 million Euro or \$3.2 million USD. In another example, one paper mill took a twelve-day shutdown and lost a staggering 100,000 tonnes of paper production.

Poorly functioning equipment also introduces quality risks. Paper is produced with stringent quality standards, which must be met consistently throughout the production process. Further, increasing uptime helps ensure production capacity is available, on demand, at quality and production speed, to safely and reliably meet customer promises.

As a result, pulp and paper manufacturers strive for world class key metrics, such as:

- >95% uptime
- <2% unscheduled paper breaks and clothing failures
- <2% scheduled maintenance
- <1% unscheduled equipment failures

Workforce and regulatory trends

The key metrics above are challenging, further elevated by two major trends.

Workforce

According to sources such as the United Nations¹ and US Department of Labor and Statistics, 50% of the workforce is forecasted to retire in the next 5-10 years. In the wake of these retirements, enormous experience gaps are emerging. Globally, manufacturers are scrambling to hire skilled talent while concurrently bolstering education and knowledge transfer to retain expertise and productivity.

Insight-driven manufacturing, enabled via condition monitoring helps pulp and paper plants manage workforce transitions by automating the creation of fact-based, actionable insights to proactively manage operations. This takes pressure off of skilled workers while providing deeper insights into plant health to catalyze proactive prevention.

Case study

Costly unplanned downtime at European pulp mill

For one European pulp mill, technical issues caused four days of unplanned downtime. An estimated production loss of 10,000 tonnes of pulp cost the manufacturer approximately €2.7 million Euro or \$3.2 million USD. After an earlier repair to a conveyor belt, the mill hoped to maintain production until the next scheduled maintenance shutdown. However, that was not possible and the belt failed, forcing a 4-day shutdown for in-depth repairs.

Reactive maintenance is costly because it escalates issues, causes unplanned downtime and utilizes higher-cost “emergency” resources to resolve issues. The financial implications and customer experience impacts are steep and often indelible.



**Unplanned maintenance =
6x cost of planned maintenance**

1. https://www.un.org/en/development/desa/population/events/pdf/expert/28/EGM_David_Baxter.pdf

Move data, not people

Condition monitoring is also a remote capability, creating safer operating environments for workers. Moving data and the instantaneous insights it provides, is much smarter than moving people to monitor and optimize operational health.

Regulatory

Increasingly, regulatory demands are being placed on pulp and paper manufacturers. Regulatory compliance further challenges the achievement of the key productivity metrics that ensure profitable operations. Employing data-driven manufacturing helps improve operational consistency and thus aids in maintaining regulatory compliance.

Profit

Achieving proactive manufacturing maintenance improvements leads to one, all-important metric: **improved profitability**. Profitability enables on-going business viability. To increase profitability, pulp and paper manufacturers must first invest in digital competencies to collect and then connect stranded data. Condition monitoring of asset health, integrated via a plant-wide software platform, creates this crucial data-driven foundation. Using connected data in sophisticated, industry-specific algorithms can then proactively diagnose and analyze in real-time to improve operational profits.

An essential path to profit is the connected monitoring of asset health. Then, optimized maintenance can become an essential strategic lever.



What's data got to do with it?

The power of proactive

Condition monitoring solutions help remove blind spots around asset and plant health to transition from costly reactive events to informed, proactive maintenance. This matters because unplanned maintenance costs six times more than planned maintenance.

As shown in the graphs below, monitoring asset health allows for proactive identification of root cause issues well before failure occurs and when preventative repairs are at the lowest cost. Specifically, this allows preventive repair events to be scheduled more effectively. By grouping proactive repairs to coincide with planned maintenance, for example, the number of paper machine start-ups (estimated to take 4-12 hours per start-up) can be reduced.

Over time, hidden and impending asset failures, when undetected, increase in both severity and cost while decreasing in repair-ability. Condition monitoring enables manufacturers to “get ahead of the curve” and run smarter and thus more profitable operations.

The steep and far-reaching costs of reactive maintenance

As shown, reactive maintenance incurs excessive costs, much of which is straightforward to quantify, such as lost productivity, decreased revenue and increased maintenance costs. However, intangible penalties, more difficult to quantify and often obscured, are the most far-reaching and indelible costs, such as negative customer experiences, customer defection, brand reputation, and environmental impact. Looking at the entire financial snapshot yields the most accurate and comprehensive view of reactive maintenance’s true costs.

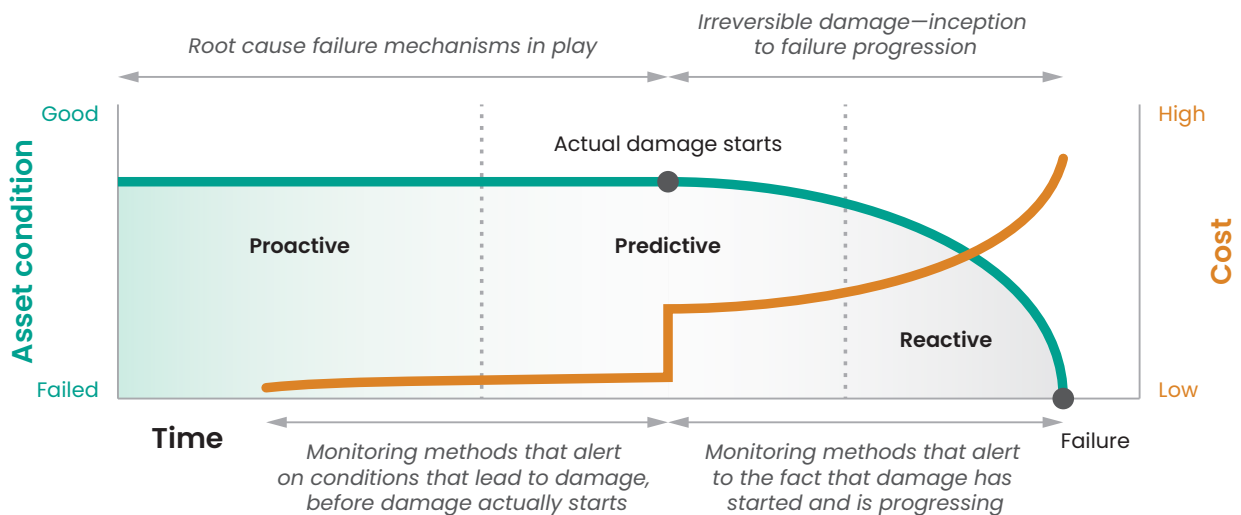
Tangible costs	Intangible costs
<ul style="list-style-type: none"> • Lost productivity • Decreased revenue • Unplanned maintenance costs (6X more than planned) • Fixed costs (labor and overhead) • Equipment repair/ replacement • Legal penalties 	<ul style="list-style-type: none"> • Customer experience • Customer defection • Brand reputation/damage • Environmental impact

Data is nothing without actionable insights

To mitigate the potential of these steep costs, manufacturers must rely on information and insight. Raw data is a powerful foundation and enables a significant number of higher order benefits. But data on it’s own or siloed is somewhat worthless. It is industrial-based algorithms, translating data into actionable insights via customized pulp and paper intelligence and analysis, which create real value.

Specifically, actionable insights provide a fact-based roadmap that help manufacturers objectively prioritize and plan maintenance activities, achieve crystal clear focus and incorporate knowledge-based experience vs. rely on a dwindling workforce and siloed monitoring techniques.

For example, in kraft pulp mills, the recovery boiler is a vital asset. On average, boilers have an operational life of 40 years with rebuilds every 15 years. Globally, 57 percent of recovery boilers in use today are over 40 years old. This presents a noteworthy risk for pulp manufacturers that should be monitored and managed proactively.



The power of connected condition monitoring

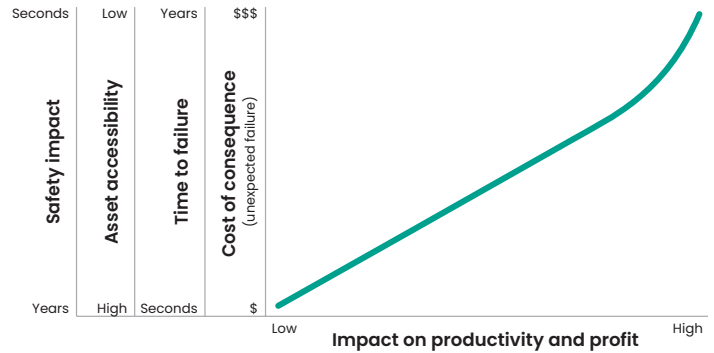
Maintenance as a strategy

As mentioned, a core truth is that functional failure is a process, not an event. In order to adequately monitor health to avert functional failure, different assets require different solutions. Variables such as failure modes and progression rates, the cost consequence of failure, safety, asset accessibility, availability of replacement parts, and the criticality and process impact help determine the appropriate monitoring solutions for each asset.

Clearly, detection of a potential failure is a golden opportunity to correct before consequence. How golden? Data from customer installations around the world indicate that proactive condition monitoring can reduce maintenance costs by 50%. Step one is asset health protection. Step two is integrating multiple sources of mechanical, process and control data across a facility for

proactive planning. This is known as plant-wide condition monitoring, which, when deployed, can translate into significant productivity and profit gains, the magnitude of which is determined by variables such as cost of consequence for unexpected failures, time to failure, asset accessibility, and safety concerns, as shown below.

Maintenance as a strategy
(condition-based planning)



Getting started

Along with other industrial manufacturing markets, pulp and paper manufacturing must adapt and transform. The paper companies of tomorrow will be the ones who embrace the competencies required for this transformation. Front and center requirements are digital capabilities to acquire proactive insights and strategically manage plant operations. Condition monitoring does just that. And, its adoption is a journey.

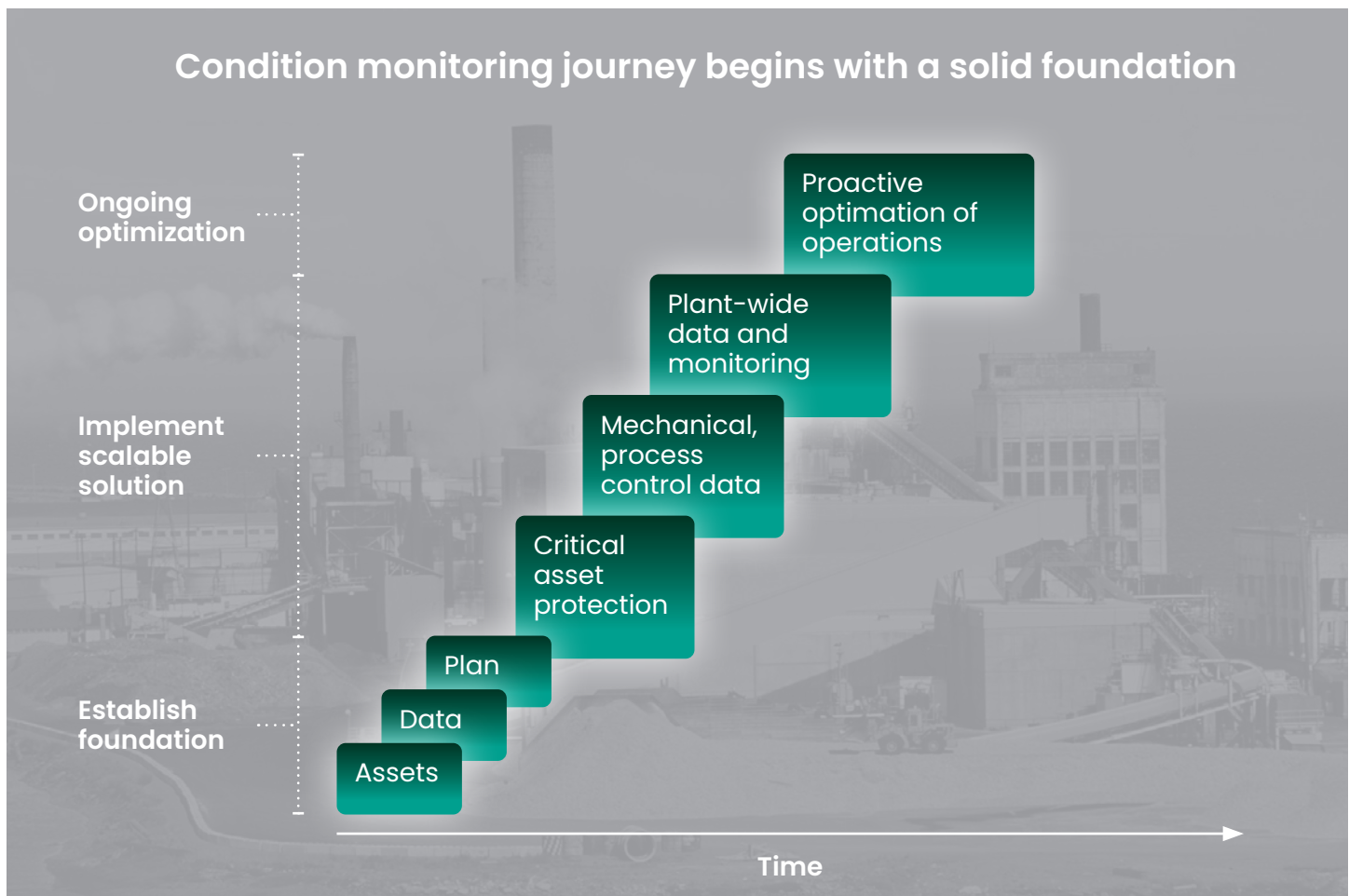
The most vital part of a journey is to start at the beginning. Establishing a solid foundation ensures that gaps are identified and addressed upfront vs. discovered later in the process when they are major issues. In condition monitoring and planning, a rock solid foundation of asset information and data oversights is the first and most important step.

A journey requires a long-term partnership that can flex with emerging needs and innovative developments to craft modular, scalable solutions, including cybersecurity needs. Key decision factors include building in-house expertise (and the option to augment with outsourced expertise)

while providing hardware, software, data and diagnostics. In addition, partners should offer remote monitoring options, train staff, preserve data records, and integrate all the parts together into an effective, holistic, and seamless condition monitoring solution.

Getting started involves finding a partner to work beside you and, first, build the foundation on which to craft a long-term, scalable solution. This journey begins with a thorough analysis of your operations and your goals. From there, a plan can be developed, most often starting with critical equipment and branching out from there to provide proactive, predictive, and actionable insights that better optimize operations.

The ultimate end-state and biggest payoff occurs when plant-wide data from all sources—mechanical, process, and control—are integrated for holistic operational insights. This helps manufacturers prioritize and focus on the most essential areas of operations and achieve new levels of optimization and profit.



More information here: <https://www.bakerhughesds.com/blog/condition-monitoring-single-vendor-advantage>

Summary

Tomorrow's pulp and paper leaders must pivot today. Data-driven, proactive condition monitoring and planning has become a must-have competency to help maximize uptime, optimize productivity, and improve profit. Thus, connected condition monitoring solutions are the gateway to a sustainable business trajectory, leveraging maintenance as a strategic path to profit. Further, these solutions help usher in the adoption of 4IR (The Fourth Industrial Revolution), forging the pulp and paper manufacturers of the future.

For more information,
please contact us at: [bently.com](https://www.bently.com)

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