Bently Nevada
a Baker Hughes business

How leading metal manufacturers are adapting to meet increasing cost pressures

Maintenance costs and unplanned downtime need to be reduced and proactively managed

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Executive summary

Innovation and productivity are at the heart of metal manufacturing, and their output, metal products, are at the heart of the world's infrastructure. Metal products enable a multitude of essential applications, such as construction, railways, ships, and appliances.

Today, metal manufacturers face escalating price pressures, driven by the simultaneous forces of global competition, carbon emission reductions, and workforce transitions. From steel to zinc, aluminum, and copper, metal manufacturing must innovate anew and further optimize productivity. The significant innovation and transformational promise of Industry 4.0 aims to do just that. As metal manufacturers journey into Industry 4.0, many are starting with one key and often under-optimized area: maintenance.

Why maintenance? Because in metal manufacturing, maintenance is a significant lever to cost reduction. It is estimated that a 10% reduction in maintenance can generate a 30% increase in profitability. Through the automated and data-driven capabilities of proactive maintenance via condition monitoring systems, a 15 to 25% savings in maintenance can be generated. In large metals manufacturers, that translates into millions of dollars saved per year.

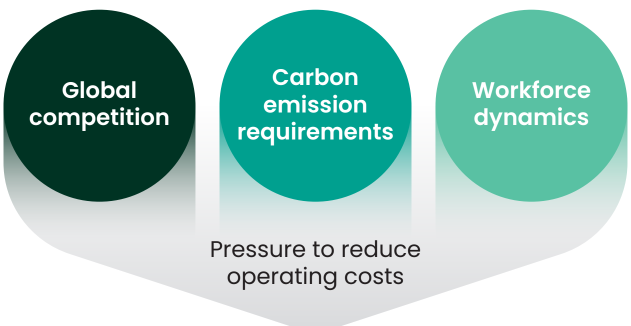
Across all types and sizes of metal manufacturing, proactive condition monitoring systems are the gateway to strategically leverage maintenance and reduce costs while increasing asset reliability. The time to adopt this innovation is now. Condition monitoring is also a step forward in the adoption of Industry 4.0 capabilities, providing immediate and ongoing results along the way to help justify further expansion and innovation.

Metal manufacturing and maintenance

Metals, such as zinc, aluminum, copper, and steel, are essential components in a host of industries. Crucial to engineering and construction, metal products fuel the creation of railways, roads, ships, buildings, appliances, and tools. To fulfill these engineering and infrastructure needs, the worldsteel association estimates that 1,868.8 million tons of steel—the primary segment in metal manufacturing—is produced every year.

Increasing global competition and resulting price compression in the metal industry have created escalating pressure to reduce operating costs. Further, ESG (Environmental, Social, and Governance) indices and resulting metrics highlight the ongoing reductions needed in carbon emissions, placing additional pressures—and costs—on metal manufacturers.

Concurrently, skilled workers are retiring en masse, causing a knowledge gap in metal manufacturing. A significant 50% of the skilled workforce is expected to retire over the next 5 to 10 years. This loss of expertise is exacerbated by the ongoing and urgent challenge of optimizing operations in metal manufacturing.



Metal manufacturers

These competitive forces, regulatory requirements, and workforce dynamics require balance and action. Left unaddressed, they will increasingly hinder metal manufacturers' viability. And, no metal producer is exempt. Per The Globe and Mail, "cost issues do not discriminate by the metal produced or size of the company."

To stay competitive, manufacturers must further reduce costs while decreasing carbon emissions, enabling skill transfer, and optimizing production. Adoption of Industry 4.0 technologies and competencies will help, starting with the most crucial area: maintenance.

Maintenance as a strategic lever

Maintenance is a significant, and under-optimized, lever to cost reduction. For metal manufacturers, a 10% reduction in maintenance can generate a 30% increase in profitability while simultaneously enhancing worker safety. Thus, maintenance is the area where strategic and ongoing optimization can deliver outcomes to meet the concurrent challenges faced by metal manufacturers. Let's quantify the potential impact more granularly with an example:

- **In metal manufacturing, maintenance comprises 10 to 15% of total production costs**

  For medium to large steel producers, maintenance budgets can range from $10,000,000 USD to $4,000,000,000 USD a year

- **On average, metal manufacturers spend 20 to 25% of maintenance costs on unplanned downtime**

  In one large steel operation, a 24-hour shutdown incurs a 115,000 tonne/126,766 ton loss in steel production. At $189 USD/ton, that equals $23.9 million USD lost per day. For medium and large steel producers spending $10,000,000 to $4,000,000,000 USD per year on maintenance, a 22.5% spend on unplanned downtime equates to $2,250,000 to $900,000,000 USD

- **Based on these numbers, the impact is steep, irreversible, and often is an avoidable situation**

  Just one unplanned shutdown—conservatively estimated at a 24-hour duration—can deplete almost a quarter of the annual maintenance budget and a significant amount of expense dollars "wasted" and non-recoverable

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A general definition of Industry 4.0

Industry 4.0 or 4IR is a period of rapid technological growth in which disruptive technologies and trends are changing the way we live and work. Technologies such as Internet of Things (IoT), virtual reality (VR), artificial intelligence (AI), and machine learning (ML) are integrating into manufacturing processes. The adoption and integration of these technologies and the capabilities they bring are called Industry 4.0 or 4IR (the 4th industrial revolution).

Cost reductions in maintenance can be achieved via proactive maintenance using condition monitoring solutions. These solutions, while historically employed in a piece-meal fashion in metal manufacturing, create maximum impact and ROI (Return On Investment) when leveraged strategically and holistically. Outcomes include improved asset reliability and productivity while costs decrease and risks are mitigated.

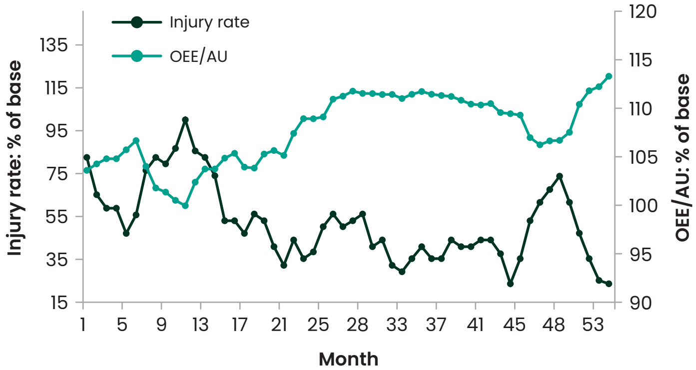
Proactive maintenance also enhances worker safety and enables the automation of expertise, helping to soften the impact of shifts in skilled workers. While worker safety is always of paramount importance, it requires special focus in harsh operating environments such as metal manufacturing. Studies show that a more reliable plant is a safer plant. Specifically, an increase in OEE (Overall Equipment Effectiveness) can deliver enhanced worker safety. In one example, an OEE (or uptime as a percentage of AU, or Available Uptime) increase of 52% delivered a 69% safety improvement over a ten-year period as shown in the graph below. OEE is calculated as per the formula shown below and has a best possible value of 100. Thus, an increase of 52% represents an OEE improvement from 62.5 to 95.

An OEE increase of 52% delivered a 69% safety improvement over a ten-year period.

Note: OEE = Uptime x Rate x Quality and AU = Availability x Rate x Quality

A reliable plant is safer

Production capability (OEE) vs. injury rate



Source: large industrial manufacturer A

Industry 4.0 adoption is built on the principles of automation and connected, data-driven operations, making condition monitoring a key application area—and early step—in the implementation of Industry 4.0 capabilities.

Proactive maintenance tenets and benefits

Because of its inherent proactive capabilities, condition monitoring systems can deliver substantial manufacturing outcomes. In metal and steel manufacturing, leading companies cite a 15 to 25% reduction in maintenance costs as a result of asset-based condition monitoring systems.

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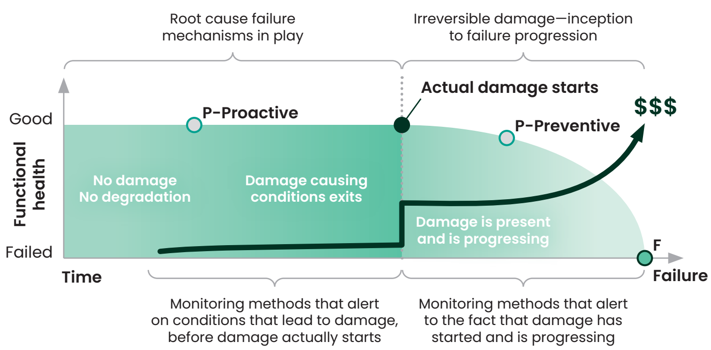
Outcomes of this magnitude are possible due to the foundational tenets of proactive maintenance. The underlying tenet is that **failure is a process not an event**. This, in turn, enables the opportunity to mitigate full failures—and at the very least more serious failures—at the lowest possible cost and with the least operational impact. By contrast, time-based maintenance systems, although still in use today, are poor predictors of potential failure. Time-based systems can exacerbate costly, and avoidable, unplanned downtime, while also incurring incremental and preventable costs and downtime with unnecessary routine maintenance tasks, which are based on time vs. actual asset condition.

The P-F curve

Condition monitoring's unique value is shown in the P-F curve, which depicts "failure as a process" by delineating the span of time between potential failure and functional failure. During this span of time, as early indicators of asset health are monitored, they are used to warn of potential failure prior to more costly damage or degradation. In this way, condition monitoring averts failures, unplanned downtime, and the consequential higher-order costs. Using the asset-specific monitoring data generated then allows fact-based decisions to be made and repairs scheduled at the most advantageous times and minimum costs.



The P-F curve[1]

Benefits of condition monitoring

Across industrial environments, condition monitoring systems are proven to elevate manufacturing outcomes. Because maintenance is a core function to productivity and downtime, its optimization can have far-reaching and multi-dimensional impact. The major benefits of proactive maintenance, enabled by condition monitoring systems, include:

- Prevent failures/breakdowns/unplanned downtime
- Improve efficiency
- Reduce energy consumption
- Enhance worker safety
- Meet environmental requirements

Need more proof? Read more in this German steel manufacturer customer case study.

Case study

A German steel manufacturer avoids catastrophic event

A steel plant in Germany operates several axial air compressors that provide air for the blast furnaces. After a major overhaul of one of the units in 2015, the customer encountered two catastrophic failures of the compressor rotor. After these events, the steel manufacturer used Bently Nevada Machinery Diagnostic Services (MDS) for startup assistance, monitoring, and testing over the course of several months.

During a scheduled shutdown in 2020, the vibration levels at the compressor bearings reached the danger limit. Remote analysis of the data indicated that the vibration was caused by a surge event or process-related issues vs. mechanical damage. This data helped inform and ensure a path to safe recovery.

The result? The unit was restarted without issue. The properly defined condition monitoring solution with remote access allowed immediate support during a critical situation. An answer was generated within 3 hours of the customer request, enabling a safe, informed decision and the ability to startup operations as planned. After this event and the value provided, the German steel plant immediately moved to expand their condition monitoring implementations.

1. John Moubray (1992). *Reliability-Centered Maintenance*.

How does condition monitoring work?

A proper condition monitoring system requires unique and customized setup and site-specific parameters. There are, however, similarities across condition monitoring solutions and how they work to sense and identify potential failures.

How condition monitoring detects potential failures

Condition monitoring systems predict impending failures before they occur by monitoring and assessing an asset's mechanical characteristics, such as:

- Vibration
- Temperature
- Efficiency
- Oil chemistry/particulates

By monitoring these variables, adapted for each asset, pattern changes or anomalies can be identified. Together with tailored algorithms and customized configurations and set points, operators are then alerted to developing issues that need to be addressed, along with the data that helps to clarify the root cause issues and paths to proper, safe resolution.

Different assets, different strategies

In condition monitoring systems, different machines require different strategies. As shown below, factors such as consequence of failure, availability of replacement parts, and criticality/process, all impact condition monitoring specifics.

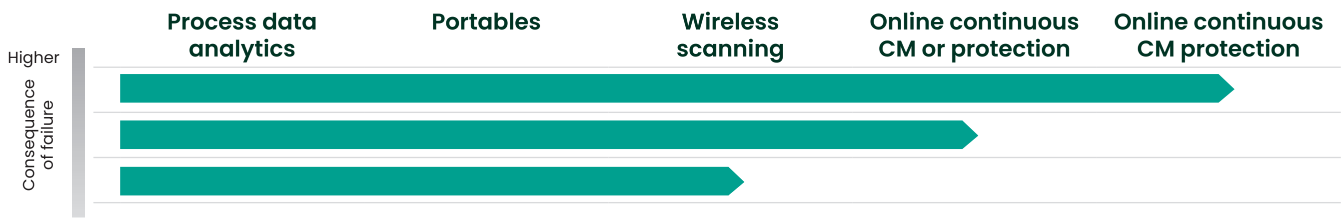
Additional asset-specific customization is done upon implementation to collect the proper data and configure the solution and diagnostics. From a strategic perspective, data-driven insights provide a clear roadmap to help metal manufacturers prioritize maintenance activities, establish focus, and incorporate knowledge-based experience "automatically", thereby reducing dependence on the inherent variability in workforce experience while boosting employee safety.

Read our India steel manufacturing example where unplanned downtime was averted at one large manufacturer. Unplanned downtime can have immense negative implications in manufacturing environments as costs can snowball and escalate quickly—including reactive and on-demand maintenance costs, lost revenue, and in some cases catastrophic events.

Different assets, different approaches

Based on the criticality rank of assets, the assets are divided into high critical, critical, medium to low critical ranking.

Note: CM = condition monitoring



Case study

A large steel manufacturer in India averts unplanned downtime

For one large steel manufacturer in India, a high tension (HT) motor bearing began to experience elevated vibration levels shortly after routine maintenance had found the bearings to be in good condition. The high vibration caused repeated machine trips and the Bently Nevada team was asked to diagnose and identify the root cause issue of the abnormal vibration.

An analysis of the monitoring data indicated signs of rubbing in close clearance areas, such as a bearing or seal. The motor was opened to find the precise location of the rub and, upon inspection, the root cause was identified as an improper fitting and insufficient clearance on the bearing seals. The seals were adjusted, the motor re-started and the vibration pattern returned to normal.

The result? By identifying the problem early, the Bently Nevada MDS team saved the customer valuable downtime. Any further damage to the motor bearings would have resulted in unplanned downtime, forcing the customer to stop production and halt downstream processes.

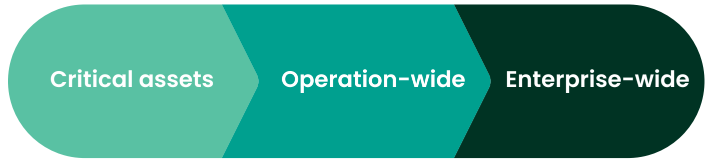
Steel/metal manufacturing application areas

When it comes to metal types, variety is the norm. For example, there are 3500 different grades of steel. Maintenance cost challenges, however, are not unique based on the type of steel, type of metal, type of machinery, or size of operation or enterprise. Therefore, condition monitoring systems can help operations of all types and sizes, and are beneficial across a host of assets and application areas.

Specific condition monitoring application examples in metal manufacturing, as shown in the following diagram, can include:

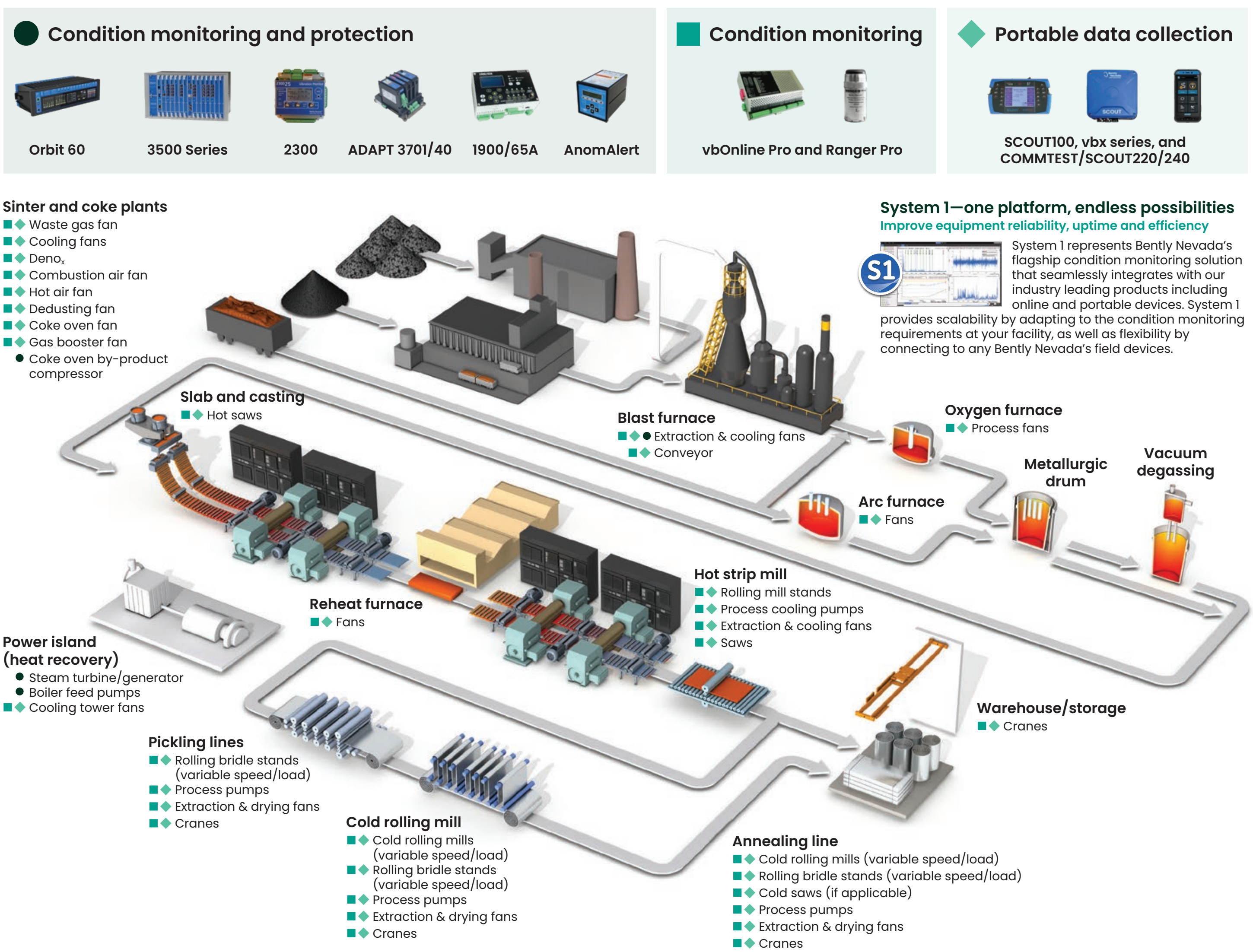
- Rolling mill
- Blast furnace
- Hot strip mill
- Pickling lines
- Conveyor belts
- Compressors
- Gearboxes

Leveraging condition monitoring on these assets is step one and a powerful starting point to reduced maintenance costs and optimized productivity and safety. Proactive maintenance through condition monitoring, however, is a journey that progresses as follows:



As metal manufacturers move forward through this journey and increase condition monitoring's breadth, the benefits and ROI of condition monitoring rise in-kind.

Typical integrated steel/metal manufacturing plant process



Getting started

Maintenance costs are under-optimized in many metal manufacturing environments. Thus, condition monitoring systems are often the first step in the adoption of Industry 4.0 competencies, generating outcomes upon implementation. As Industry 4.0, via digital technologies and automation, expands in use across metal manufacturing environments, it becomes increasingly essential to embrace two truths about condition monitoring systems:

1. All condition monitoring solutions are not created equal
2. Proven, comprehensive condition monitoring experience is vital

Since technology investments and condition monitoring solutions must be scalable and connectable, it's essential to start with the proper foundation. Thus, metal manufacturers need industry-tailored solutions via a like-minded partner with deep, proven expertise in full-suite condition monitoring technology and metal operations.

Condition monitoring adoption goes beyond reducing maintenance costs. For metal manufacturers, it also necessitates working differently and working smarter to achieve safer, more reliable operations. This requires a cultural shift and the development of a comprehensive digital data strategy that spans functional siloes and technologies. Data has the latent power to transform operations. There is a big difference, however, between collecting data versus using and analyzing data by extracting actionable and meaningful insights. Without industry-tailored algorithms and actionable insights to drive measurable business outcomes, the full potential of technological innovation, including condition monitoring and Industry 4.0, cannot be realized.

Finding the proper balance point is also key. Data helps drive smarter decisions by balancing the reduction of maintenance costs while simultaneously ensuring improvements in operational efficiency via equipment reliability and availability. Enabling operation-wide optimization mandates change. This change begins when the move from reactive, tactical maintenance to proactive, strategic asset management is underway.

Summary

As an integral component in the world's expanding infrastructure and engineering needs, metals are vital to future progress. To meet these needs, metal manufacturers must navigate the simultaneous pressures of global competition, carbon emissions, and workforce reductions. To maintain price competitiveness, cost reductions are crucial, starting with the rich and currently underleveraged opportunity that is maintenance optimization.

As a result, data-driven, proactive condition monitoring systems have become a must-have competency for metal manufacturers. The journey begins with critical assets and progresses operation-wide and ultimately enterprise-wide, generating positive outcomes along the way. Throughout this journey, metal manufacturers can minimize maintenance costs, enhance safety, and automate expertise while improving plant reliability and productivity. Condition monitoring systems and their outcomes also help to advance and build scalable Industry 4.0 capabilities and as such, are a welcome and needed transformation in metal manufacturing environments.

For more information,
please contact us at: bently.com

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