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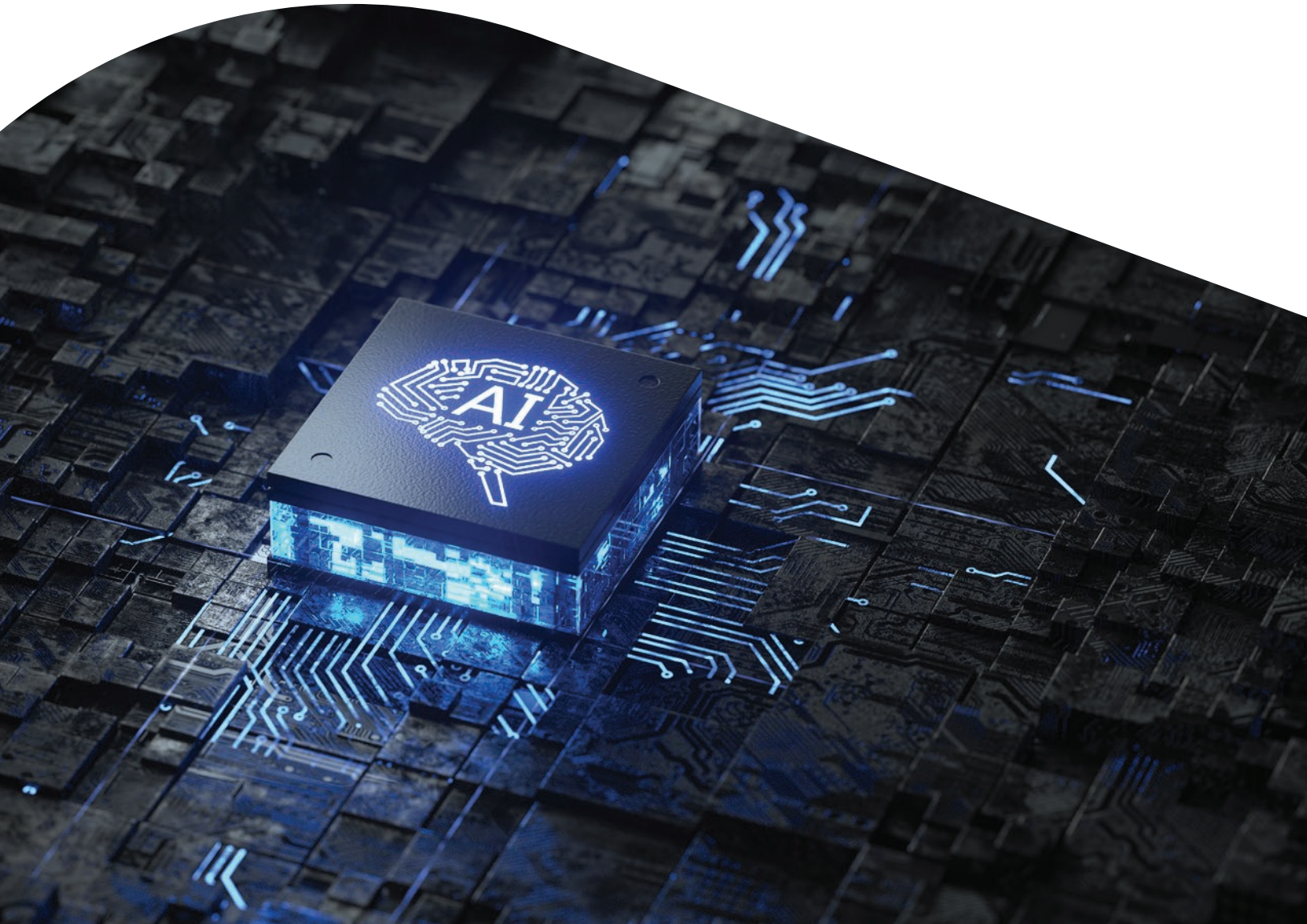
The next decade hinges on APM solutions, AI, and human expertise working together

How to improve asset reliability, boost safety, and reduce costs by integrating human and artificial intelligence



Executive summary

Widespread digital transformations are revolutionizing industrial manufacturing and processing environments. Leading the charge are artificial intelligence (AI) powered applications, which are emerging across industry types and production processes. The intended result? Intelligent and autonomous operations, which reduce costs while boosting asset reliability and safety. In industrial markets—most notably heavy industry, digital transformation is rewriting the future trajectory of manufacturing and creating a compelling mandate for change today.

In manufacturing, a foremost AI-powered application area is integrated asset performance management (APM), including proactive condition monitoring approaches. Estimates indicate the return on investment (ROI) is significant, as much as 50% savings in maintenance costs. For manufacturers and operators, this is a game-changer, as many are challenged with the directive to improve the bottom line on under-optimized operations.

Simultaneously, key misperceptions about AI-based technologies are hindering its proper and effective implementation in industrial environments. This has serious implications since industrial AI-powered applications manage critical assets and issues related to safety, reliability, and productivity; there is no room for improperly designed AI or AI-based predictive errors.

Proper AI applications hinge on one key, counterintuitive component: human intelligence. AI-powered applications require subject matter expertise and the on-going integration of human and 'artificial' intelligence working together, collaboratively. That's because domain knowledge, about assets, processes, and the industry, is extremely vital to proper AI design and on-going implementation and improvement. And deep domain knowledge is, by definition, a narrower field of expertise and in some industries, takes many decades of hands-on experience to fully develop. Regardless, subject matter experts are essential in the design, set-up, and continual optimization of AI-powered applications.

The term AI itself can often get misapplied when considering digital platforms that simply enable autonomous insights rather than true use of artificial intelligence. In heavy industry, the primary focus is to leverage computational digital tools that are codified with expert knowledge in order to automate the activities of searching for and identifying anomalies at the enterprise data scale. Then, the detected data anomaly is connected to a potentially known failure mode before failure occurs. Additionally, the same autonomous tool interprets operational modalities and prescribes mitigating actions.

True AI-powered and Machine Learning (ML) solutions come into play, albeit infrequently, when operators are looking for unknown failure modes that require an all-encompassing assessment of enterprise master data sets. The term AI is also often misapplied where the problem is Big Data—when massive amounts of data have to be processed through various algorithms in a short span of time and often continuously. In this instance, artificial intelligence is not necessarily needed, but rather the application of various data science methods and tools powered by cutting edge computational hardware and software. Hence, AI tools are not here to 'replace' or render humans 'irrelevant'. They are created by humans to assist and cover ground so that human intelligence and cognitive abilities can be applied to more consequential decision making.

This article discusses how to get the most from AI-powered industrial asset health management tools. It dispels prevalent misconceptions and outlines a path forward for heavy industry. Bently Nevada has extensive and proven experience in asset condition monitoring and asset strategy management, and stands ready to help heavy industrial companies achieve next-level, fit for purpose AI-powered operational performance.

Contents

4 Heavy industry's manufacturing imperative

6 Obstacles to effective integrated APM adoption

8 Key levers: Asset performance and maintenance

10 A multi-layer, three-part solution

12 Why services are the linchpin to AI-powered solution success

14 Wrap-up

Heavy industry's manufacturing imperative

Few, if any, industrial sectors are exempt from the sweeping digital transformations known holistically as Industry 4.0. Digital Transformation (DT) has been accelerated by market volatility, need for remote work, increasing price pressures, and rising costs, experienced across many industrial sectors. As a result, agility and integrated asset performance management are the new key enablers to global competitiveness. They are developed as manufacturers address under-optimized areas that are eroding industrial profitability.

Today's challenges, however, cannot be solved with yesterday's solutions. As a result, many heavy industry manufacturers are moving full speed ahead to embrace artificial (AI)-powered digital transformations, recognizing that these new competencies, and the outcomes they enable, have become an operational imperative.

Fortunately, first mover companies are proving the value of AI-powered technology. According to McKinsey, in industrial markets, early adopters of digital transformation are ahead of their peers, earning a total return to shareholders of 47 percent compared to 27 percent for peers.

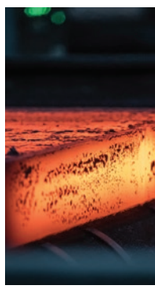
As AI-powered tools and capabilities move to the forefront of industrial optimization, they hold great promise to produce next-level operational optimization. However, the key determinant of success is "how" the tools are used. AI-powered tools require the integration of subject matter experts to help implement, train, adjust, analyze, interpret, and continuously improve. AI amplifies human intelligence and capacity; it does not replace it. It is collaborative intelligence, the inextricable integration of human and artificial intelligence, that is the cornerstone of AI-powered, industrial digital transformation.

Collaborative intelligence, the inextricable integration of human and artificial intelligence, that is the cornerstone of AI-powered, industrial digital transformation

Shareholder return

Early digital transformation adopters

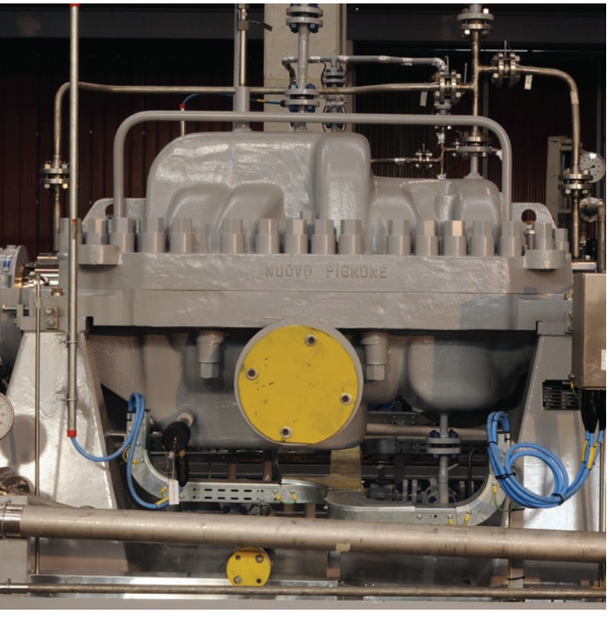
Peers



Obstacles to effective integrated APM adoption

Given the positive potential of AI-powered industrial solutions, why do asset health management approaches (via Integrated APM) remain slower in adoption rate? The answer lies in three primary areas:

- **Lack of domain expertise integrated with AI-powered approaches**
- **Time-based, reactive maintenance approaches are still widely-used**
- **Limited use of AI-powered technology**



Lack of domain expertise integrated with AI-powered approaches

Today, there is a shortage of in-house skilled manufacturing expertise, especially in narrow-but-deep areas of knowledge, such as machine condition monitoring and asset strategy management. This gap impacts AI-technology implementations, which depend on the integration of human intelligence and expertise. The best outcomes occur when there is collaborative intelligence, the blending of human and artificial intelligence.

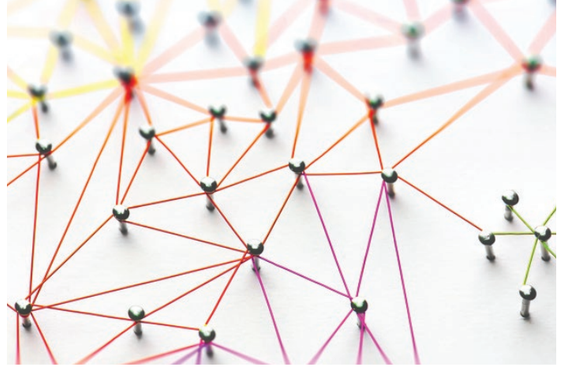
Underscoring this gap in expertise is the growing challenge of workforce retention and skilled labor shortage. In 2020, 62% of companies struggled to fill skilled labor positions. Further exacerbating this dearth of expertise is the mass retirement rate of skilled workers as baby boomers retire and cannot be replaced at the same rate by younger talent. During the next 5-10 years, an estimated 50% of the experienced workforce will be retiring, taking their knowledge and expertise with them unless codified in a capable digital platform.

The clear solution to these trends is to augment inhouse expertise with an experienced services and support partner that has deep domain expertise. Especially in the area of Integrated APM and condition-based asset management solutions, where niche skills (i.e., machine-specific, process-specific, industry-based expertise) are needed to properly enable AI-applications. External services and support personnel with deep domain knowledge are becoming the linchpin of success in heavy industry digital transformation.

Time-based, reactive maintenance approaches

Time-based, reactive maintenance is a long-standing pillar in heavy industrial operations. Its usefulness, however, has now been outpaced by proactive technology solutions. Yet, an estimated 76% of industrial operators describe their current maintenance as reactive or time-based. This results in two vulnerabilities, both of which can be of significant magnitude:

- Maintenance dollars are spent on unnecessary maintenance
- Increased risk and frequency of unplanned downtime, creating significant exposures (financial, safety, operational)



Limited use of AI-powered technology

The proper use and adoption of AI is hindered by three myths:

Myth one

When it comes to AI, anybody with a platform can do it

Any autonomous tool must analyze raw data and turn it into intelligent insights. Since industrial AI is applied to critical processes, accurate predictions are vital to safety, reliability, and productivity. Prediction failures or errors can cause a snowball-effect of costly problems. Subject matter expertise that extends beyond AI technology and includes domain expertise (asset knowledge, process expertise, operational experience) is a must-have competency. In other words, embracing the myth that "anybody can do AI" may incur serious—and costly—consequences.

This myth is further supported by a McKinsey study stating that only 16% of those investing in digital transformation were able to reap its benefits. The study alludes to the fact that; throwing technology at a problem is not a solution. The key enabler to being a part of the 16% is an understanding of how purpose built AI, APM solutions and human expertise fit together to intentionally solve challenges.

Specifically, human intelligence and subject matter expertise is needed on the front end in setting up AI configurations, modeling processes, thresholds, and analytics to fit the environment and asset. Once in-place, human intelligence remains crucial for on-going AI improvements to workflow process integration, vetting causal analysis claims, and continuous collaboration.

Myth two

AI is the "total answer"

AI is a great tool for many situations. However, it is not a panacea for all industrial problems. A preemptive reliance on AI's ability to solve "all problems" without a fit-for-purpose approach will lead to misapplications. The result? Investment without sufficient returns; or a worst-case scenario of inaccurate AI-based predictions, spiraling into higher-order issues.

Historically, over-adoption of newfound capabilities without the necessary due diligence and specific expertise has resulted in misconceptions. One example is when the medicinal purposes of tobacco were first discovered. Tobacco was thought to be a panacea; if it could solve multiple ailments, it might solve them all. Initially, it was believed that nineteen conditions and diseases were treatable with tobacco. Oddly (in hindsight), tobacco was thought to be a cure for all cancers. Similarly, AI is not a cure-all for everything that ails manufacturing. It is a valuable tool in the toolbox for a solution provider but care must be taken to establish fit-for-purpose need. This is done during discovery stage of any engagement intending to identify the problem(s) and design a sustainable solution that encompasses the right mix of technology, human expertise and culture of better work process adoption.

Myth three

AI is too costly

While AI does require investment, that investment needs to be put into context. The ROI of AI-powered applications is months, not years and in some cases, days or weeks if existing enterprise performance problems were previously unresolved but sufficient and quality historical data is available. Most importantly, the cost of not implementing AI-powered solutions is much greater than doing nothing at all.

Further, the cost of AI is a point-in-time data point. As the technology moves from early stages, the investment costs are higher, however, it is expected that the technology will rationalize quickly and those that have not planned it's use will be behind from a competitive standpoint. Thus, it is best to start now and focus on validated use cases and scale from there.

For example, through the automated and data-driven capabilities of condition monitoring systems, an up to 50% savings in maintenance can be generated. In heavy manufacturing, that can translate into millions of dollars saved per year, which far outpaces the investments needed to fund AI-powered solutions—including access to the external subject-matter experts needed to facilitate the successful use of AI-powered applications.

Key levers: Asset performance and maintenance

In manufacturing environments, optimization must begin where the biggest vulnerabilities exists: asset reliability and maintenance cost and effectiveness. In a globally competitive market of rising costs, increasing price pressures and fluctuating demand, downtime is more expensive and uptime is more valuable. Thus, reacting to operational issues carries steep costs, especially without the safety net of subject matter experts to expedite and facilitate resolution.

Current asset health/maintenance approaches require substantial investment and are typically well-funded across industrial sectors. Paradoxically, despite sizable investment, maintenance approaches are often ineffective at minimizing downtime and maximizing uptime. Maintenance costs are significant (see examples below) and just one unplanned shutdown can deplete 25% of the annual maintenance budget.

The bottom line is that maintenance costs must go down while maintenance effectiveness and asset health goes up, delivering enhanced asset reliability, productivity, and safety. To accomplish this, heavy industry operators must embrace AI-powered digital transformation—together with domain-specific human discernment, intelligence, and subject matter expertise—to gain the must-have improvements required to remain competitive.

Industry examples

Power industry

In the power industry, every minute of unplanned downtime counts. Here's why:

Impact on power companies

- Estimates indicate one day of unplanned downtime can cost a power company over **$20 million USD**
- Reactive maintenance costs **2-10 times** more than planned maintenance
- **Remote expertise from a trusted ally** that understands the value of each minute is a must-have and scarce resource during unplanned downtime emergencies (see customer case study)

Impact on power customers: communities and companies

- Continuous, reliable power is **essential for communities** around the world
- For the business world, power outages can escalate into **millions of dollars per hour** of downtime. In one example, outages cost the U.S. economy **$150 billion** per year as estimated by the Department of Energy

Metals industry

In metal manufacturing (steel, aluminum, etc.), a 10% reduction in maintenance costs can generate a 30% increase in profitability. Consider this example:

In metals manufacturing, maintenance comprises 10-15% of total production costs

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

On average, metal manufacturers spend 20-25% 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 and many times, avoidable

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

Assumptions

- One 24-hour shutdown incurs production losses of 126,766 tons of steel
- Steel cost = $189 USD/ton
- Medium-large steel producers spend $10,000,000 to $4,000,000,000 USD per year on maintenance
- Steel manufacturers spend 22.5% of maintenance spend on unplanned downtime

Calculations

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 $189 USD/ton X 126,766 tons = $23,958,774 USD lost per day
- For medium-large steel producers, spending $10,0000 to $4,000,000,000 USD per year on maintenance → a 22.5% spend on unplanned downtime equates to $2,240,000 to $900,000,000 USD

Maintenance cost for unplanned downtime

$10,000,000 to $4,000,000,000 USD X 22.5% = $2,250,000 to $900,000,000 USD

Mining industry

Mining operations currently run at 70% operating efficiency due to breakdowns, stalled production and other operating issues. An operating efficiency of 85% is the benchmark standard of world class manufacturing. Concurrently, in mining operations, maintaining plant, fleet, and equipment comprises 30-50% of operating costs.

Thus, the sizable spend on maintenance is still not delivering the outcome needed for mining operations.

Case study

Subject matter expertise quickly resolves issues in Ireland power plant

A power plant in Ireland experienced an unexpected trip on a main power generation unit, comprised of a gas turbine, generator, and clutch and steam turbine. The power plant operator immediately requested assistance from Bently Nevada services and support staff to review the data and expedite resolution.

The data was analyzed, which indicated high vibration from a rub in the clutch. The shaft centerline plots suggested misalignment of the clutch as the root cause. Correcting the clutch alignment resulted in improved stability of the vibration levels that same day. The support staff and their collective expertise turned an imminent unplanned outage into an expeditious intervention, minimizing downtime and mitigating the risk of further machine trips.

The result? An estimated savings of 2 days of downtime, translating into millions of dollars savings for the power operator.

A multi-layer, three-part solution

Three interdependent components comprise the ideal AI-powered, Integrated APM solution to optimize operations. Manufacturers using a proactive, data-driven/insight-based approach have 36% less unplanned downtime than those with a reactive approach, according to a GE study. On average, this results in a $17 million increase to the bottom line.

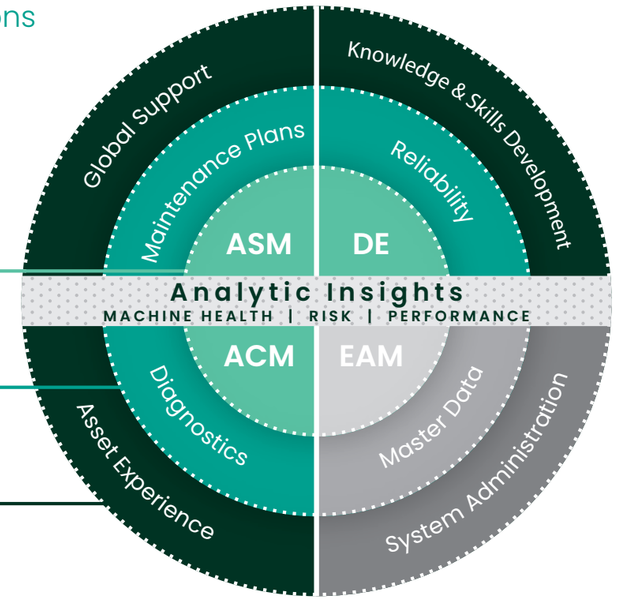
An Integrated APM solution is comprised of capability layers that work together as follows:

- **Connected technology** comprised of
  - ACM = Asset Condition Monitoring
  - DE = Defect Elimination
  - ASM = Asset Strategy Management
  - EAM = Enterprise Asset Management
- **Content and knowledge** comprised of
  - Maintenance Plans
  - Reliability Strategies
  - Diagnostics & Failure Mode Libraries
  - Master Data
- **Support and expertise**
  - Human intelligence/subject matter expertise via managed services support

The results? Optimized operations that reduce costs, increase profitability, and boost safety.

Integrated APM solutions

ACM = Asset Condition Monitoring
DE = Defect Elimination
ASM = Asset Strategy Management
EAM = Enterprise Asset Management



Why services are the linchpin to AI-powered solution success

Of the three solution components, in the urge to embrace the Digital Transformation, the most often overlooked one is subject matter expertise. When a critical situation occurs in manufacturing, human intervention has proven to be the most important enabler to fast and precise resolution when collaborating with AI-powered technologies, such as condition monitoring and asset performance management overall.

Setting up for success: How to get the best outcomes

Operational optimization requires proactive approaches, to prevent failures and costly unplanned downtime before they occur and at the lowest possible cost. Condition monitoring to improve asset health does just that. Working alongside of technical solutions, a proactive engagement of support expertise is equally important. That importance skyrockets during an operational anomaly, when subject matter expertise and deep domain knowledge can make or break outcomes. Effective and timely resolution of just one potential crisis can more than justify an entire, multi-year services and support contract along with the technology investment already in place. And when not in a crisis mode, the ability to contextualize asset heath, alongside asset maintenance strategy and work execution management, allows to make the best informed decisions to avoid the 'crisis' in the first place. Yet, no amount of proactive solutions will avoid 100% emergent situations, so it is best to be prepared for both.

Existing in-house skills shortages further elevate the need for at-the-ready expertise via services and support. AI-technology can do amazing things and concurrently creates a must-have requirement for human intelligence, specific subject matter expertise, and intervention-ready data access architectures.

There are three levels of services engagement to access subject matter expertise. Top-quartile manufacturers are adopting the "Best" approach to ensure skilled and domain-specific resources are immediately available if needed and used proactively to help avoid critical situations:

Good

Use of expert commissioning services to deploy integrated asset performance management solutions. This is a 'meets minimum approach' as it only covers the front-end implementation of solutions

Better

In addition—use of services to support urgent site issues, reactively.

Best

Use of proactive support to avert reactive events, and mitigate emergencies, unplanned downtime and inflated costs. Capabilities include:

- Asset strategy content creation and continuous improvement to better optimize operations
- Results analysis/interpretation
- Mitigation action support and integrated operability with work execution management systems

Finding the right industrially-minded partner

For integrated asset performance management, all solution and services and support partners are not created equal. Knowing what to look for before engaging a partner helps ensure the right resources are in place to fully optimize operations and to handle any critical situation quickly and effectively.

At a high level, industrially-minded partners who understand operations should provide:

- Robust expertise (breadth and depth)
- Localized presence alongside remote support (anywhere, anytime)
- A proven legacy (trust built on proven results)
- Contemporary technology stack capable of automating 'knowhow'

Here is a brief checklist for finding the right industrially-minded services and support partner:

Does your industrially-minded partner:

- ◯ Have an install base?
- ◯ Have globally diverse and locally present service people?
- ◯ Have built and operated centralized and remote asset monitoring centers?
- ◯ Provide subject matter experts to maximize customer success: on-going, dynamically?
- ◯ Bring AI expertise? And, can integrate AI with people?
- ◯ Provide automated analysis and diagnostic tools?
- ◯ Have industrial experience?
- ◯ Understand system-of-systems integration?
- ◯ Know industrial cybersecurity?

Wrap-up

Every day, under-optimized maintenance incurs additional expense and creates high-risk operational vulnerabilities. The digital transformation underway in industrial manufacturing will help—when purpose built AI is used to augment and collaborate with human intelligence. Integrated APM together with subject matter expert support and advanced AI-powered analytic insights helps to minimize costs and mitigate risk so that productivity, profitability, and safety are fully optimized.

The future will not wait. Manufacturers must embrace the powerful, revolutionary and challenging digital transformation that is underway today—and get it right the first time.

Bently Nevada has deep expertise in AI-powered integrated asset performance management. Please contact us to learn more and discuss your specific needs.

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