Industry 4.0, the Fourth Revolution

Challenges, Benefits, Adoption and How to Begin

A Frost & Sullivan White Paper | In partnership with IBM

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The wave of the fourth industrial revolution, often referred to as Industry 4.0, has brought forth an unprecedented era of information and insights across the manufacturing space. Low-cost sensors and high-tech analytics began coming together a decade ago to give manufacturers the visibility they need to increase production and reduce downtime. Now, with the advancement of artificial intelligence (AI) and cognitive manufacturing, Industry 4.0 is creating a whole new realm of possibilities for improving manufacturing, from suppliers, across the factory floor, and through to customer units in the field.

While the promise of Industry 4.0 is flourishing in some enterprises, the vast majority of manufacturers still find themselves awash with data but with limited actionable insights. According to IBM's landmark study on artificial intelligence in the industrial sphere, The *AI Effect on Industrial Products*:[1] "1 TB of production data is created daily by the average factory, but less than 1% of that data is actually being analyzed by manufacturers"

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This paper will examine how Industry 4.0 can be a game changer for businesses who want to lead in their industries. It will look at the challenges manufacturing is facing and how the inroads being made by the Industrial IoT and AI are addressing these challenges. Finally, it will explore the benefits of Industry 4.0 and why it matters, and how companies can be early movers to capture its promises.

UNDERSTANDING THE POTENTIAL OF THE FOURTH REVOLUTION

It is no understatement to call the transformational changes being seen in manufacturing today as anything short of a "revolution." Industry 4.0 leverages high volumes of data with advanced tools to improve business functions across the enterprise, from predicting failures and prescribing fixes before they occur, to helping generate new innovations and revenue streams.

The benefits to manufacturers are significant. Smarter plant operations mean better efficiency, fewer failures, greater outputs, a more productive workforce and a happier customer. Assets and inventory are optimized, equipment and processes are continuously monitored, managed and dramatically improved as new data continues to feed into the AI-driven solutions. In the new "digital shop floor" the solution in place learns and interprets patterns and related outcomes. Fault prediction, security and productivity all increase over time. Predictive becomes prescriptive: that is, while the benefits of predicting a potential failure or bottleneck is immense, being able to then also prescribe a remedy to mitigate or avert the issue, is what sets successful Industry 4.0 solutions apart from previous systems.

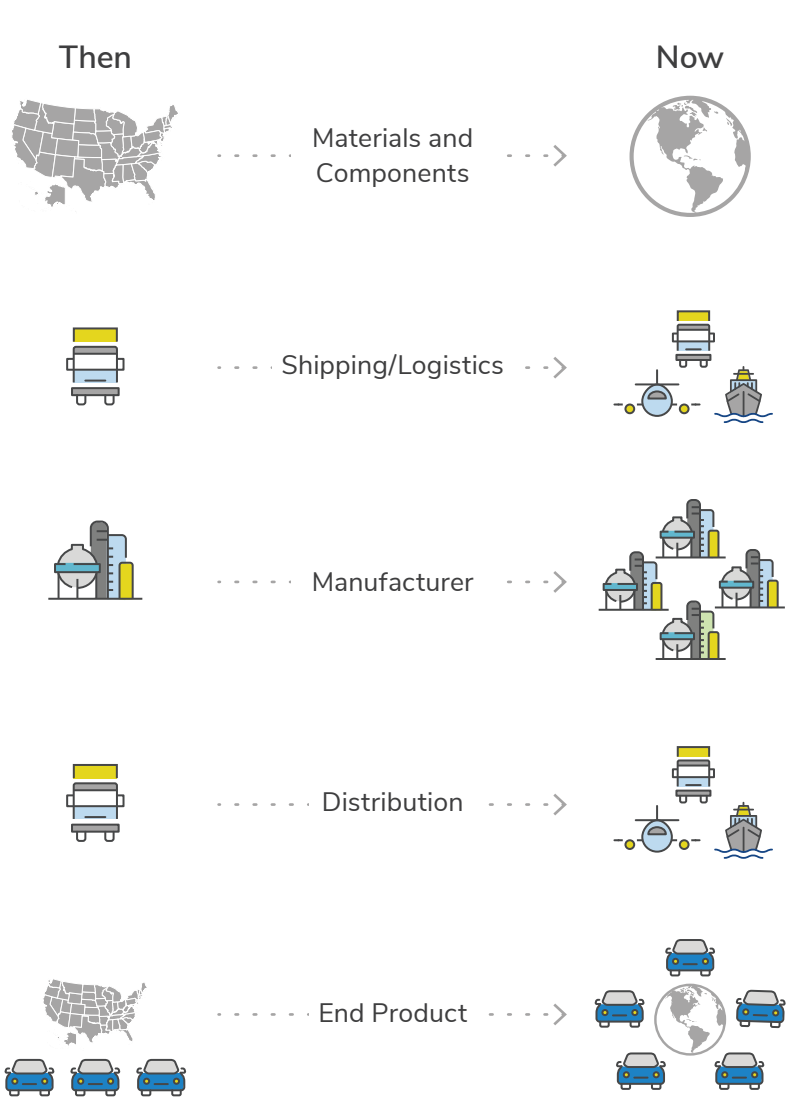
1 **https://www.ibm.com/downloads/cas/QGPNG37Y**

DISRUPTION AS MANUFACTURING'S GREATEST MODERN CHALLENGE

Most of the main challenges facing manufacturers today can be broadly categorized as disruptions. The basis of this disruption is the move from a relatively aligned value chain, wherein manufactures relied on relatively fewer suppliers and customers in a more restricted geographical space, to one that has become global, fragmented, dynamic and uncertain.

As can be noted in Chart 1, manufacturers are being assaulted on all fronts by disruptions across all aspects of their business. Successful manufactures themselves also become disruptors in the industry.

CHART 1



External Influences

GLOBAL CHALLENGES

- Geopolitcal struggles
- Privatization of industries
- Wage discrepancies
- Environmental legislation
- Customs/Tariffs
- Climate change and weather

TALENT

- Global wage differences
- Becoming tech-savvy
- Experienced talent aging out

PERSONALIZATION

- Customer demand for customization
- X-as-a-service

Disruption from Globalization

Globalization provides manufacturers with more options, and more challenges, than ever before. Competitors, customers and suppliers can come from anywhere in the world. Hence, political disruptions in distant regions can have a much stronger impact on a manufacturer than just a decade ago. Political issues can manifest themselves as rapid currency fluctuations, which can quickly increase costs or decrease profits. Major industries within countries can become privatized, or, conversely, can come under stronger government control, leading to instability in global markets. Trade barriers can change, as can their more pragmatic outcomes such as the efficiency of ports and varying standards and enforcement of customs. Material costs, wages, quality standards and numerous other variables across the world complicate the purchase, lead times, shipping, and even manufacturing and sales of products.

Another global challenge comes from climate change. For example, changing environmental legislation can lead to different product and manufacturing standards in different countries – even in different provinces, states or cities. Weather patterns become more erratic, more difficult to predict, and weather events can become fiercer. In an industry with growing global competition and improving methods leading to downward pressures on prices and margins, delays from any of these global conditions can wreak havoc on the bottom line and a company's competitive positioning.

Personalization

Finding new prospects and servicing existing customers at a global level is challenging enough. However, new customer dynamics are further providing challenges, as well as opportunities, for today's manufacturers. Customers increasingly want a personalized experience, rather than a standardized product, which, at least on the surface, seems to disrupt the strides that manufacturers have made for decades in improving efficiency and productivity.

Earlier industrial revolutions capitalized on standardization as the text-book method to create a successful business. The assembly line reduced production time and standardized quality, automation helped reduce the need for specialization in the workforce and economies of scale helped bring down prices for goods across the board. Now, especially as new and tech-savvy generations find they can have almost anything in their day to day lives customized and "-as-a-service", manufacturers need to find a way to balance efficiency and client demand. Successful manufacturers will leverage Industry 4.0's tools such as AI to bring forth better efficiency and productivity, while still enabling increased customization, improved quality and faster delivery.

L'Oreal , for example, is the world's largest cosmetics company. It's breadth of products, geographic reach and customer base are immense. However, in the last five years, the industry has been flooded with small, boutique cosmetics providers who promise to create 'customized' cosmetics and other products for skin and hair. L'Oreal has had to figure out a way that its products can provide the same level of customization, without losing its cost advantages and commitment to industry-leading R&D.

The challenge is two-fold: understanding the demand, and then fulfilling it. L'Oreal partnered with IBM Services to identify and incorporate customer purchasing behavior. Using IBM's Watson IoT platform

to drive advanced manufacturing sensors, laser measurements, cameras and advanced conveyor belts, L'Oreal can now respond nimbly and quickly to changes in customer needs. This is an unprecedented advantage for such a large organization.

Talent Evolution

As the world moves forward in leaps and bounds towards a digitalized, global and customized world, manufacturing talent needs to evolve as well. All industries are facing a shortage of IT-trained individuals. For example, 67% of IT decision-makers in a 2019 Frost & Sullivan Global Survey stated that their digital transformation has been hampered by a lack of in-house technical expertise; another 59% said that "hiring/retaining qualified IT staff" was a top challenge. Finding IT professionals who can understand the complexities of heavy industry are fewer still.

Many industries will face the need to digitize and adopt new dashboards and devices. However, the manufacturing industry is also facing the challenge of a retiring workforce without the same volume of new talent coming into the space. As noted above, global pressures with lower wages in some countries further make it critical that workers can achieve high productivity and efficiency. Past industrial revolutions came with concerns that modernization would replace human power. Conversely, in Industry 4.0, AI is not a replacement but a necessary enhancement to improve existing workers and rapidly onboard new ones. AI will drive the collaboration of technology and people, elevating the most junior employee to the level of the most skilled.

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The oil and gas industry is one of the hardest hit by the retirement of an experienced workforce, and one of the slowest to attract new talent. According to the US Department of Labor, the average age of employees in the industry is over 50, and up to half of the workforce may retire in the next five to 10 years. Meanwhile, the Bureau of Labor Statistics estimates that petroleum engineer jobs will increase 15% from 2016 to 2026, which is considered "much faster" than the average job category. Forbes has estimated that for every two retiring oil and gas workers, only one is being hired as a replacement.[2]

Woodside, the largest independent oil and gas company in Australia and a veteran of the global market, is using AI to address many of these challenges. The company has more than 30 years of experience in operating the world's most complex and largest offshore oil and gas platforms. Many of its employees have been with the company since its foray into the industry, and hence Woodside needed a way to transfer all this institutional knowledge to new projects and, just as critically, new employees.

2 **https://www.forbes.com/sites/drillinginfo/2015/05/04/the-great-crew-change-why-its-even-more-complicated-now/#3eee857311de**

Woodside turned to IBM's Watson technology solutions to gather, calculate, make sense of and communicate 30 years of data and the knowledge of thousands of engineers to enable fact-driven decision making on complex projects. Watson had to incorporate over 600,000 pages of documentation, including 33,000 technical documents – well more than any veteran industry expert could ever hope to engage. However, this was not a static, one-time data dump: Watson continues to gather and integrate more data, and the users continue to "test" the system's analysis and recommendations. This continuous feedback loop helps Watson learn and improve with every interaction.

Along with synthesizing and communicating information, IBM created a customized user interface for Woodside, in a collaborative method that engaged the users throughout the process. As any company who has ever rolled out a new system can attest to, employee engagement is a critical, if somewhat elusive, metric by which to measure success. From the start, IBM's program with Woodside had over 80% of its workforce using the solution in their daily activities. Woodside saved $10 million AUD in time savings and employee safety. When an issue comes up, employees now spend 75% less time researching it and can more quickly resolve it. Junior employees can be ramped up much more quickly, and veteran employees have great new tools that help them focus more on their highly skilled work rather than on data-gathering exercises.

THE PROMISE OF INDUSTRY 4.0

What many of these challenges have in common is a need to gather increasingly large amounts of data, interpret it, and then apply it to the challenges in real time as well as the outcomes that reverberate from them. For example, having large amounts of real time data on the shipment for a critical component can help a manufacturer better estimate its delivery date. These results can feed into the factory's overall schedule, and AI can automatically suggest changes to the related, as well as adjacent, production lines, and can also alert customers downstream of any changes in the delivery of the final product. Embedding intelligence in process workflows allows insights to be acted upon immediately and processes to become self-healing.

Why It Matters

Information has a direct and correlated effect on efficiency. Unless a supervisor or manager has visibility into the process, he or she cannot manage and improve upon the overall process. IoT provides this information, but additional insights are required to interpret it. The human brain is simply unable to absorb, process and create the best actionable strategies from the massive volumes of data streaming in. For example, considering the immense amount of information being gathered, how can we determine which data are most critical? How does some data correlate to other data and other conditions? What is the time scale and cause-and-effect relating different data to each other? However, by analyzing, correlating and consistently updating the insights from data, AI can provide that operator up to date insights into what is happening and how to improve it.

KEY BENEFITS OF INDUSTRY 4.0	
Gathering, interpreting and sharing information	Being made aware of equipment failure before it happens reduces downtime and idle production lines
Efficient use of worker time	Plant floor workers having the right information at their fingertips, when needed, makes for more timely and accurate decision making. Predictive fault detection and maintenance further helps by reducing the amount of time needed for root cause analysis and in prescribing the right corrective actions
Improved operational metrics	Improving numerous operation metrics such as overall equipment effectiveness (OEE), which can include equipment availability, performance, efficiency, productivity and quality
Self-managed benefits	Leveraging cost savings and revenue creation from earlier steps in the process can help fund future improvements. Manufacturers who can leverage this self-funding model will move forward with leaps and bounds ahead of the competition

As much as these challenges are front and center in the discussion of Information Technology/Operational Technology (IT/OT), it is important to note two very critical things:

1. These two spheres can work together for a significantly better outcome than if they remain in silos
2. Successful companies are, as with other challenges, making IT/OT convergence a strength rather than a hindrance

THE IT/OT CONVERGENCE

By now, much of the manufacturing world has become familiar with "IT/OT convergence." Put succinctly, this is when IT is used to improve OT. However the situation is much more nuanced than this: Challenges persist between these two once separate realms, as IT strives to understand the deep and longstanding intricacies of the operations space, and OT shifts toward digitalized solutions and a different culture in how to address challenges.

For a smart factory's processes to be optimized, it's critical that IT and OT have converged across the factory floor: Industry 4.0 is only feasible when these aspects are working in conjunction by converging OT's physical production assets with IT's digital technologies, the new, smarter factory floor can realize self-managed and self-optimized production.

This is how a successful business addresses the challenge of increased personalization. It also reduces the amount of time needed to hunt, find, analyze and interpret data on everything from failures to routine operations. Digitization of the factory floor also means that security becomes top of mind for the operations. All solution providers are aware of this, but those with an understanding of manufacturing as well as the IT solution are positioned to avoid pitfalls possible with solution providers that only understand one half of the IT/OT convergence.

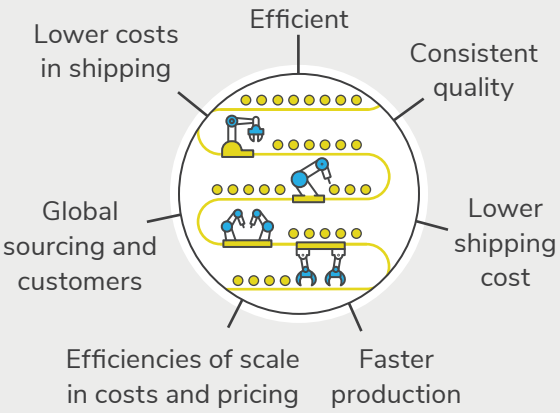
Digital automation leveraging AI moves the model as noted in Chart 2.

CHART 2

Pre-Industry 4.0

Manufacturing production

BENEFITS



DRAWBACKS

Not considered high quality

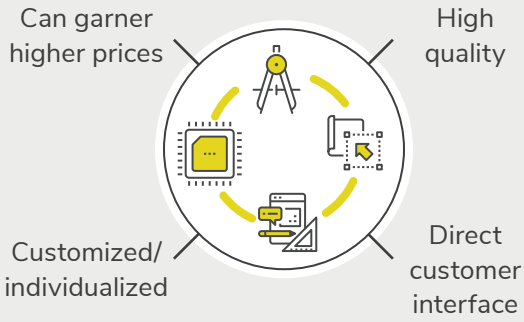
Not customizable

Difficult to change to market demands

Less customer interaction

Customized production

BENEFITS



DRAWBACKS

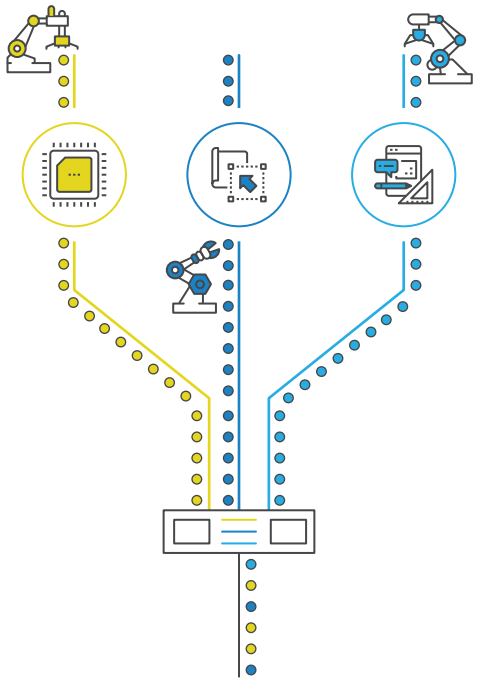
High costs

No efficiencies of scale

Vulnerable to cheap mass produced items

Limited to local suppliers and customers

Production with Industry 4.0



RETAIN BENEFITS OF SCALE

Lower costs for bulk materials

Negotiate better shipping rates

Global suppliers and customers

Consistent quality

Fast production

ADD IN BENEFITS OF CUSTOMIZATION

Integrate end user trends and demand with IoT feedback loops and social media analytics

Customize on-the-spot without bottlenecks

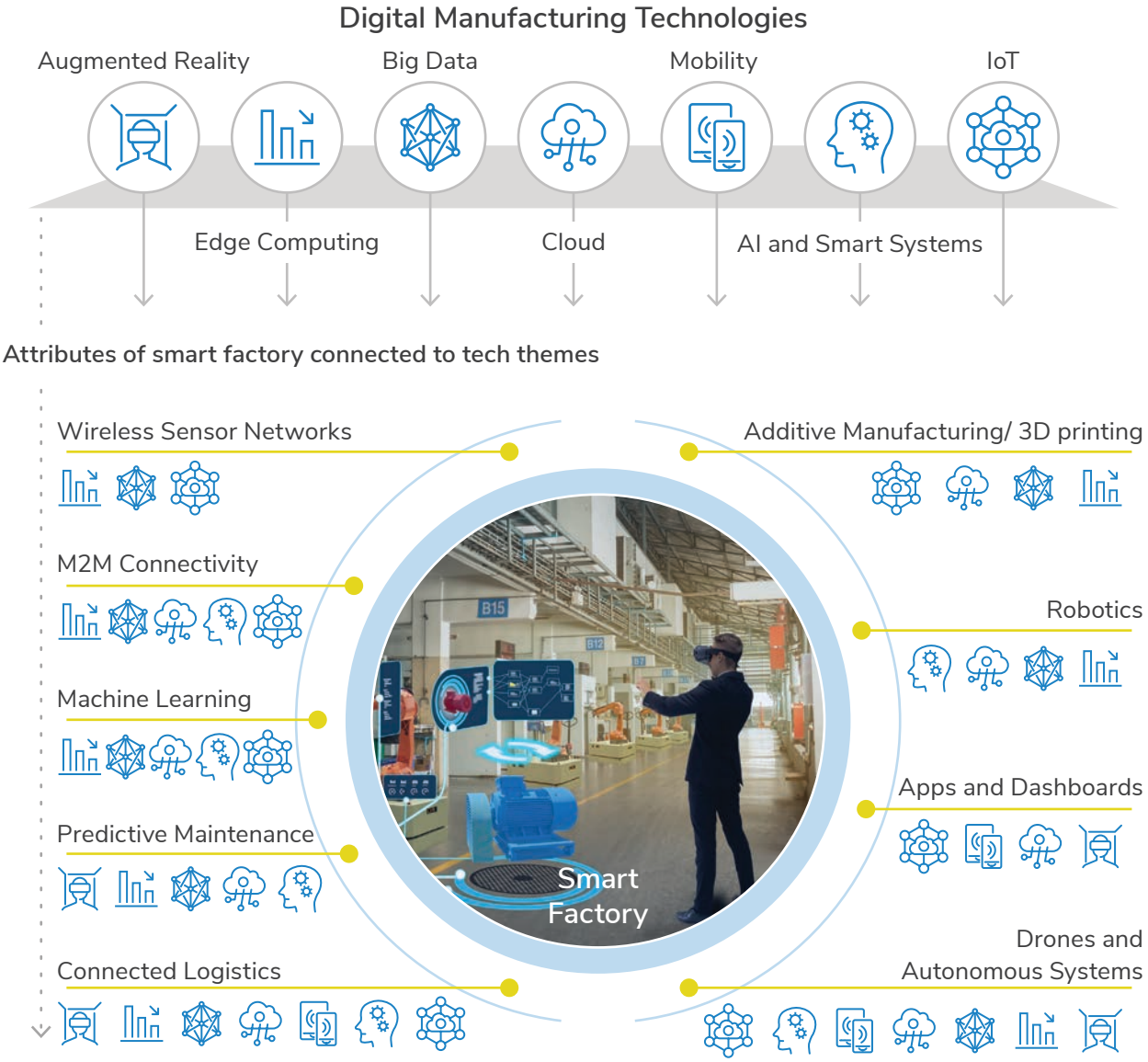
Provide enhanced customer experience through AI-driven interfaces

Enhanced customer experience

THE FACTORS OF INDUSTRY 4.0 ADOPTION

The Industry 4.0 solutions available to manufacturing today are wide and varied. Companies need to be able to define their specific challenges and need a solution partner to understand how Industry 4.0 can address them. Such a provider can work with manufacturers on the key elements that all manufacturers need to undertake to ensure they have adopted a comprehensive Industry 4.0 process.

CHART 3



Key Performance Indicators include: reduced unplanned downtime, better risk profile, lower maintenance costs, extension of asset life, improved asset utilization, increased production output, and many others

Equipment Level Solutions

Industry-leading solutions will provide some level of enterprise asset management (EAM). This is critical for realizing the benefits noted above – in particular, improving reliability and performance of assets across the operational spectrum. The condition, availability and performance of equipment is paramount to any manufacturing process. A general rule of thumb is that just one hour of downtime can cost a manufacturer an average of $100,000. More specifically, according to a 2017 IBM Institute for Business Value survey,[3] 71% of electronics executives said lower machine downtime was the most important KPI for their production plant with 50% of respondents reporting challenges related to unplanned machine downtime. Hence there is a clear and direct benefit to reducing instances and length of asset down time.

> 71% of electronics executives said lower machine downtime was the most important KPI for their production plant with 50% of respondents reporting challenges related to unplanned machine downtime

No maintenance strategy is complete without an EAM system. It is the backbone of your maintenance technology where all your data and asset records live. Building upon that is Asset Performance Management, or APM, which takes the asset health impacts of EAM and layers upon them lifetime performance and improvement metrics. A solid APM program, built on a foundation of IoT data that is consistently being upgraded and improved with AI, can lead to better predictive maintenance. Such sophisticated insights at this level of equipment can reduce downtime by up to 50% and maintenance costs up to 25%.[4] For example, **KONE Corp.**, a leading elevator and escalator company, uses the IBM Watson IoT platform and its AI capabilities to help predict the condition of the elevators and escalators and suggest resolutions to potential problems. This has helped greatly reduce failures and downtime and provides detailed information for maintenance crews on the performance and usage of equipment. It has improved "people flow" in some of the world's tallest and most-notable structures and provides a better user experience, resulting in less waiting time and fewer delays.

Another example is **Sugar Creek Brewery** in Charlotte, North Carolina. By making equipment-level improvements, the brewery, which operates at a "craft" or microbrewery scale,[5] was able to save $30,000 a month in lost revenues from reducing spillage of their bottling system. The process and savings will continue to improve as they incorporate more aspects of AI and IoT into their brewing process.

3 **https://www.ibm.com/downloads/cas/Z1BNYROX**
4 **https://www.ibm.com/blogs/internet-of-things/asset-maintenance-strategy/**
5 Definitions for "microbrewery" typically put this category at production 6,000 to 15,000 barrels or fewer per year, as opposed to the large commercial "macrobreweries" who will produce tens of millions of barrels yearly.

Once key equipment has been upgraded with APM solutions, the next step is to look at the processes that use this equipment. Asset optimization is important but will only bring a company so far: maximizing operational efficiency across processes is the next step to successfully implementing and achieving the benefits from Industry 4.0.

Process Level Solutions

Heavy process industries are complex organizations with suppliers, components and feedstock that can be highly variable. Manufacturers have to readily adapt to constant variations in feedstock for example, whether it be the quality of the metal in a shipment of ore or the quality of components from shifting vendors. Within the plant, different processes and operators will also run systems at different levels of efficiency. All this variability can make it difficult to consistently optimize a factory floor, much less the broader value chain. The *power* of AI is necessary to weed through all of these variations, predict various outcomes and prescribe ongoing performance improvements.

Sandvik, a major global provider of drilling and earth moving equipment, sought to improve field operations for its mining customers who were clamoring for help in better maintenance schedules and improved equipment uptime but unclear as to what type of solutions could achieve this. Sandvik took up the challenge and partnered with IBM to create a solution that applied IoT sensors, Watson AI and EAM to devise a real-time view of mining equipment in action below the surface. The data also offered unexpected visibility into underground mining operations of their customers.

Sandvik then worked with IBM to co-create a mining production optimization dashboard. OptiMine™ leverages vast amounts of data with Watson AI that a human operator would be unable to calculate. With Sandvik's OptimMine solution, mining operators can detect and respond to conditions deep underground, for greater efficiency and better yield. Sandvik customers are also seeing significant savings: in many cases, production downtime has decreased by 30% and cost-per-ton of ore production has been halved.

This new offering represents a transformation of Sandvik's business model, from a provider of physical products to a consultant offering digital services. This increased customer value has positioned Sandvik for long term growth.

HOW BUSINESSES CAN BEGIN THEIR JOURNEY

There is no single path, no silver bullet, to achieve Industry 4.0. It depends on a business' selection of key KPIs to improve against its competitors. It depends on a business' maturity level in innovating and transforming data, processes and culture.

Business leaders want a partner with deep industry expertise, a profound understanding of advanced technologies and the experience of hundreds of industrial implementations that will help them rapidly achieve results, avoid roadblocks and maximize impact on their business. They want a partner with open, innovative technologies that grow with future needs and avoid vendor lock-in. Getting started with Industry 4.0 is different from deploying the packaged applications of the last two decades. It is no longer about tailoring modules to implement a set of fixed processes or waiting one to two years to go live. Industry 4.0 solutions are defined and deployed in small chunks, enabling businesses to begin to

achieve benefits in as little as three to six months. Initial savings are applied to fund further iterations to refine functionality and scale to expand deployment.

> One week of design thinking, seven weeks of standup, and by the eighth week we had the app in the hands of our clients. One of the things I hear often from IBM is about earning the right to continue doing business with its customers. Outcomes like this are what earns it.
>
> Mark Lack, Manager of Strategy, Analytics and Business Intelligence, Mueller, Inc

The **IBM Garage**, for example, partners with manufactures to co-create innovative solutions with diverse, empowered teams. IBM Garage uses a unique methodology that curates the best practices in the industry, layered with a depth of experience only IBM can bring. Combine that with the right people—from across IBM, your team and their ecosystem—useful data, applied technology and intentional spaces, the IBM Garage can drive unprecedented transformational change to Industry 4.0. With an IBM Garage experience, you can move faster, work smarter, ideate more rapidly and fundamentally change the way you work.

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Another way to get started quickly, is with maintenance, repair and operations (MRO) inventory optimization. Using predictive and prescriptive analytics, MRO Inventory Optimization helps asset-intensive companies maintain the ideal mix of critical spares and materials to ensure the right parts are available at the right time and the right cost. IBM clients experience up to USD 60 million in inventory savings and an ROI of 149% or more-savings[6] that can then be applied to the company's next Industry 4.0 project.

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6 **https://www.ibm.com/downloads/cas/AOYWNPZE**

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