EXECUTIVE BRIEF

Manufacturing & Industrial
Connected Manufacturing

Fast forward or fast fail: where will your manufacturing enterprise be in five years?

Harness the industrial Internet of Things and advanced analytics for connected, agile and competitive manufacturing

This executive brief describes how to solve business challenges through investment in innovative technologies.

If you are responsible for...

- **Business strategy:** You will better understand how connected manufacturing will enable you to successfully meet your business outcomes.
- **Technology decisions:** You will learn how a predictive maintenance solution works to deliver IT and business value.

Executive Summary

Industry 4.0 is completely disrupting manufacturing – an already fiercely competitive sector where aggressive innovation separates the winners from the losers and only the fittest survive. IDC predicts that by 2018 one-third of the top 20 manufacturing companies (and companies from every other industry) will be disrupted by digital transformation[1].

Success will come to those who can respond quickest to changes in consumer demand and leftfield disruptions. This may come as bad news to many, whose existing plant floor systems struggle to provide the necessary agility. Others will welcome the challenge, recognizing this as a unique period during which winners can truly take all. Investing in Industry 4.0, or IOT enabled enterprise, is crucial for transforming from rigid to agile manufacturing, from push to pull customer relationships, and for creating entirely new revenue streams.

Figure 1. Investing in digital technologies is key to creating a demand-driven and responsive manufacturing model

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The first critical element of connected manufacturing uses the Internet of Things (IoT) to connect 'dark data' (operational data that is not being used) to the IT systems that can turn this data into information. Once data becomes available, advanced analytics and machine-learning techniques enable manufacturers to draw valuable insight from their data which they can then use to increase the efficiency of their operations, improve productivity, and boost agility.

Predictive maintenance is one example of how connected assets are transforming the factory floor. This approach can boost the performance of equipment, minimize unplanned downtime, and reduce operational costs. It is more effective than traditional preventative techniques since it relies on real-life data to analyze the condition of equipment rather than average or expected life statistics to predict when maintenance is required.

OEMs who manufacture equipment used by consumers or businesses are finding the path to deeper relationships and customer loyalty requires visibility of asset conditions. This concept of condition-informed serviceability was first introduced to consumers by the automotive industry. Simply said, if you are not already thinking about how to delight customers with improved reliability, it's likely you're already falling behind your competitors.

Succeeding in a challenging sector

Increasing customer expectations offer opportunities for substantial new revenue streams for global manufacturers but the environment will be challenging. In some low-cost-labor countries, wage rates are rising rapidly. Volatile resource prices, a looming shortage of highly skilled talent, and heightened supply-chain and regulatory risks create an environment that is far more uncertain than it was before the Great Recession, warns consulting firm McKinsey[2].

In addition, competition in the manufacturing sector is fierce, particularly within and from Asia. "Anyone waiting for a slow-down in the level of competition coming from Asia will be disappointed," says Doug Gates, Global Sector Chair, Industrial Manufacturing and Head of Aerospace and Defense, KPMG[3]. Manufacturers must remain highly focused on achieving new growth to remain competitive.

To realize these ambitions, manufacturers need to dramatically transform their existing operations. The factory floor systems they have in place tend to be decades old and proprietary, largely inflexible and expensive to run. Relics from the dawn of mass production, this equipment struggles to respond quickly to consumer demand and sometimes unpredictable disruptions. Investing in digital technologies will be crucial for creating demand-driven and responsive business models.

Towards agile manufacturing

This latest phase in the digitization of the manufacturing sector, or Industry 4.0, is creating new ways for manufacturers to deliver value. McKinsey says this phase has been driven by four disruptions: the astonishing rise in data volumes; the emergence of analytics capabilities; new forms of human-machine interaction; and improvements in transferring digital instructions to the physical world, such as 3D printing[4].

The rise of the IoT, among other things, enables manufacturers to derive value from the first of these disruptions. Connected manufacturing has been evolving for years in the semiconductor industry and leading organizations in other industries are starting to take steps to implement it across the factory floor. Where they go, the rest of the sector will inevitably follow.

Connected manufacturing harnesses the power of the IoT to link sensors, machines, computers, and humans so they can monitor, collect, process, and analyze data. From this data, it is then possible for manufacturers to derive insight to improve operational efficiency and productivity, and increase flexibility and agility. Manufacturers need not invest heavily in new equipment to generate this data. In most instances, the data already exists. The trick is mastering how to tap into it.

Since most existing equipment predates the IoT, it lacks built-in connectivity, making it difficult for manufacturers to access data. The first step towards a more agile manufacturing model is to connect these systems across the factory floor. A lack of common communication standards to enable interoperability between legacy equipment and the IoT makes this initial transition to Industry 4.0 seem difficult to some. However, the situation is improving quickly as groups like the Open Connectivity Foundation* (OCF), Open Process Automation Forum* (OPAF), Industrial Internet Consortium* (IIC), and ecosystem players like Intel work towards accelerating open standards for the IoT. Ecosystem solutions to connect legacy equipment with middleware on open platforms are already available, and can be updated to work with new protocols as needed in the future.

Once systems are connected the next step for manufacturers is to apply advanced analytics to unlock the value of the data. Here lies another challenge. Most existing equipment generates huge volumes of data, far too much to be sent back to a data center for speedy analysis. Instead, it requires high-performance computing at the edge, close to the source of the data stream to distil the most important information.

IoT platforms based on Intel architecture are designed to connect the unconnected, allowing data from billions of devices, sensors, and databases to be securely gathered, exchanged, stored, and analyzed.

Before investing in IoT, however, it is best to begin with the end in mind. Job one is to determine what data is most valuable to collect, as well as gauge the efficacy of the analytical structures that will be used to assess the data. Mary Bunzel, Vertical Sales Director of Manufacturing & Industrial, Intel Group, says: "Most enterprises have already established goals for how they wish to use data streaming from equipment to improve machine learning and Artificial Intelligence models. And they realize fundamental platforms to collect and analyze this data are

a prerequisite to this transformation. Each implementation exposes weaknesses in the infrastructure which must be overcome before moving to the next phase. Fortunately, with our work on customers in various points in this journey, we learn these pitfalls and can help address these roadblocks with technology tools which in turn support progress to the next iteration. Transforming your enterprise into the Factory of the Future is a vortex of continuous improvement."

Predictive Maintenance

Predictive maintenance is just one example of how connected manufacturing can transform the factory floor. Traditional approaches to maintenance are based on imperfect inspection judgements to detect and correct problems that might cause failure before it happens. Non-inspection preventive maintenance routines almost always require machine or line downtime, incurring cost and lost productivity and introducing potential for other types of failure.

Rather than following a set schedule, predictive maintenance analyzes data to help determine the condition of equipment to predict when maintenance should be performed. It monitors performance across connected assets for insight on dependencies and correlations that cause failure. Edge analytics or Fog Computing are strategies whereby algorithms are installed at the point of streamed data collection, at a gate way level, at the cloud level or any point in between, to make evaluations on needed vs unneeded data. These tools improve delivery of accurate condition data which in turn indicates prediction of failure. Predictive maintenance improves the reliability of equipment and reduces unscheduled maintenance and downtime. More effective than preventative maintenance, it can reduce operating costs and delivers much greater efficiency.

A study of common failure patterns by ARC Advisory Group found that a full 82 percent of failure types are random, only 18 percent are predictable and preventable with traditional maintenance methods, and only 23 percent of the data streaming from equipment ever reaches the technicians who could use it to prevent failure[5]. The IoT and computing power at the edge is enabling manufacturers to change this trajectory.

Ted Connell, Director Solution Architect, Intel Group, says: "The part most people struggle with is how to make sense of analytics, how to turn their raw data into insight. One way to achieve this is to apply machine-learning techniques." Modern techniques of modeling production line performance through a digital twin (a computerized companion of a physical asset) provide a baseline of expected performance for manufacturing lines based on optimal performance. A form of artificial intelligence, machine learning automates analytical model building, enabling computers to learn iteratively from data and refine algorithms.

Once 'normal' operating parameters are learned and modeled in these digital twins, data streaming from collection points on the manufacturing line and pace of change can be used to identify anomalies that indicate trends toward failures. Most manufacturers have enjoyed the expertise of workers who have intimate knowledge of equipment – they were the 'intelligence' the plant relied on. As these workers retire, machine learning and artificial intelligence tools will help new workers close this knowledge gap.

Greater visibility into asset health means workers and factories are safer, and reduced downtime can improve performance against that of the competition – see figure 2.

Manufacturers already using predictive maintenance have seen a dramatic return on investment. One of the world's

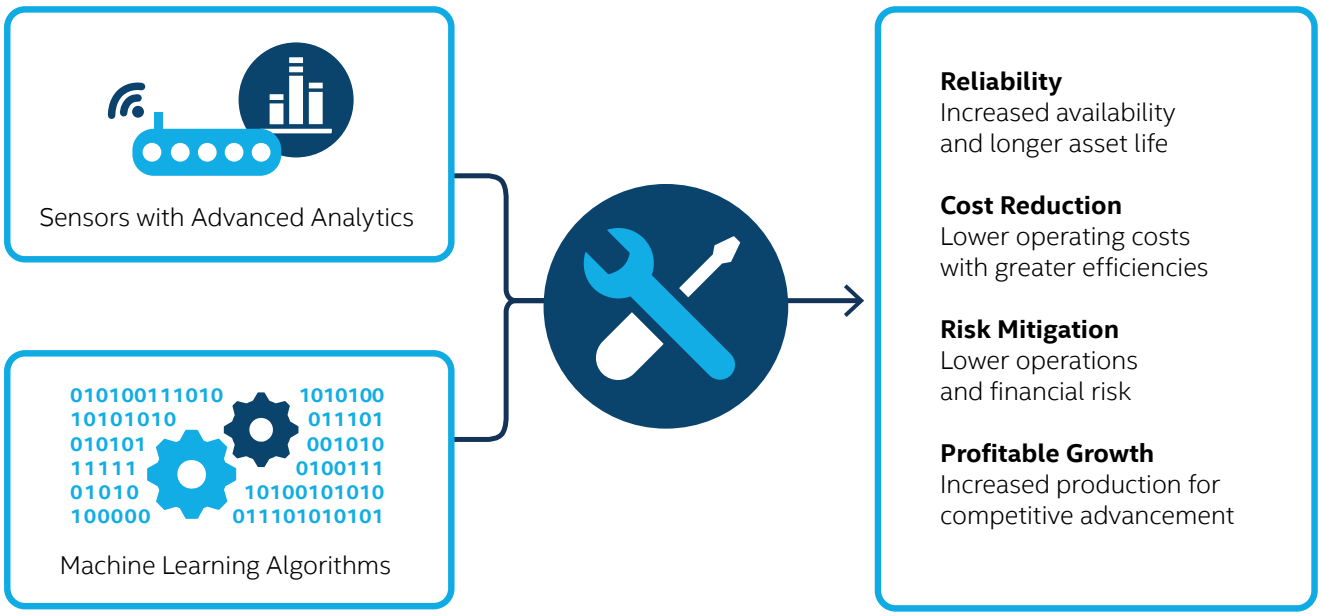

Figure 2. Sensor data combined with advanced analytics and machine learning improves visibility of asset health

largest automotive manufacturers found new patterns in its data which give it greater insight into the key factors influencing the quality of cylinder head production. Using this information, it increased productivity of its cylinder head production line by 25 percent, reduced ramp up time by 50 percent to achieve target production levels, and enabled faster adjustments in production by analyzing data in near real time[6].

More generally, research by Aberdeen Group shows manufacturers with comprehensive predictive maintenance plans average a 25 percent return on assets versus a 10 percent return for companies with older, less efficient maintenance practices[7]. Data from the U.S. Department of Energy and the Federal Energy Management Program shows that upgrading from a run-to-failure system to a preventive maintenance plan saves 12-18 percent on maintenance costs, and taking the final step to a predictive approach shaves another 8-12 percent from the budget[8].

Predictive maintenance is particularly beneficial for disparate and remote sites, since it removes the time and costs associated with sending technicians out to make manual checks and repairs.

Conclusion

To derive maximum benefit from the IoT, manufacturers must push powerful computing with as much analytical capability as possible to the edge of the network. This enables them to start the transition to a more agile manufacturing model with greater operational efficiency and improved productivity. Predictive maintenance is just one example of how connected manufacturing can deliver significant benefits on the factory floor.

Looking to the future, the next step is to extend connected manufacturing across the entire supply chain. And beyond that, to achieve true manufacturing nirvana, the final step is to introduce autonomous software-defined machines (SDMs) for a truly agile, on-demand Factory as-a-Service (FaaS) manufacturing model. By abstracting the software layer from the machine hardware, the 'brain' and 'body of the machine become separate. The machine's intelligence then runs in the cloud helping manufacturers to prolong the life of machinery so it doesn't quickly become obsolete.

Find the solution that is right for your organization. Contact your Intel representative or visit **www-ssl.intel.com/content/www/uk/en/industrial-automation/overview.html**

Solutions Proven By Your Peers

Intel Solutions Architects are technology experts who work with the world's largest and most successful companies to design business solutions that solve pressing business challenges. These solutions are based on real-world experience gathered from customers who have successfully tested, piloted, and/or deployed these solutions in specific business use cases. Solutions architects and technology experts for this executive brief are listed on the front cover.

Learn More

You may also find the following resources useful:

- **Boosting uptime and revenue with predictive maintenance:** www-ssl.intel.com/content/www/us/en/industrial-automation/boost-uptime-revenue-predictive-maintenance-brief.html
- **Digital disruption reinvents business rules:** www.intel.co.uk/content/www/uk/en/it-managers/industrial-revolution-vortex-of-change.html
- **Industry solutions for smart manufacturing:** www.intel.com/content/www/us/en/internet-of-things/infographics/iot-industry-solutions-smart-manufacturing-infographic.html

Solution Provided By:

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[3] https://home.kpmg.com/content/dam/kpmg/pdf/2016/05/global-manufacturing-outlook-competing-for-growth.pdf
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