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Transforming Factory Data into Actionable Business Insights

IIoT in Manufacturing

The discrete manufacturing sector is highly competitive and price sensitive, requiring every machine, production line, and employee to contribute to achieving optimal yields, high operational efficiencies, and cost controls.

Many manufacturing executives view advanced digital transformation technologies as a critical path to competitiveness—especially predictive analytics, Industrial Internet of Things (IIoT), and "smart" products and factories built on Industrial Revolution 4.0 ("Industry 4.0")[1]. As of 2015, a full third of industry executives already rated their company as "advanced" in factory digital transformation, and nearly 70 percent of them expect to be at that level by 2020[2].

Despite this enthusiastic adoption of IIoT-equipped factory equipment, however, only 3 percent[3] of U.S. manufacturers are fully utilizing the invaluable operational data they collect—data that holds the secret to improving output yields and quality, predicting and avoiding plant-stopping failures, managing costs and resource usage, and optimizing production lines in real time.

IIoT technologies such as advanced cloud-based data analytics, machine learning, and predictive reasoning can assist manufacturers in transforming the rich operational data they already collect into meaningful business information that helps them stay productive and competitive.

1 Deloitte, "2016 Global Manufacturing Competitiveness Index (GMCI) Report," p. 1.
2 PwC, "2016 Global Industry 4.0 Survey, "Industry 4.0: Building your digital enterprise," April 2016, p. 4.
3 BGC, "Time to Accelerate in the Race Toward Industry 4.0," May 19, 2016, chapter 2.

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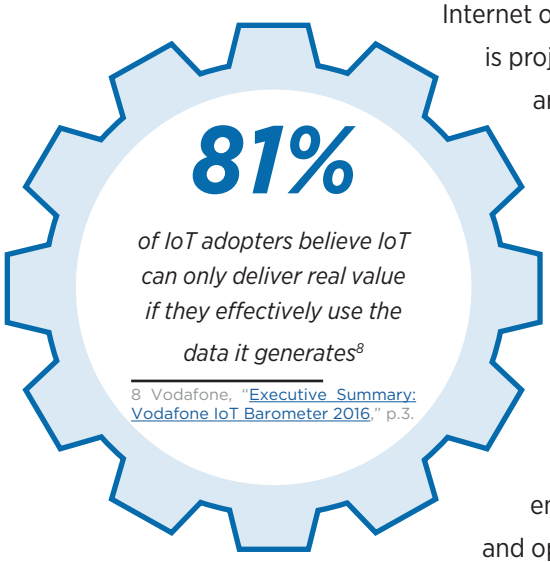
Changes and Challenges for Discrete Manufacturing

The discrete manufacturing sector is undergoing one of the most transformative and challenging business periods in its history—a fourth Industrial Revolution ("Industry 4.0"). This next phase in factory automation is driven by many new forms of digital technology, including machine connectivity and data collection; data analytics and business-intelligence capabilities; touch interfaces and augmented-reality systems; and data-driven automation of complex rules and orchestration.

Companies that build cloud-connected assembly-line equipment, and the manufacturers that use it, already employ a high degree of digital technology in their mechanical, hydraulic, pneumatic, electronic, and computerized devices and systems. Indeed, manufacturing is a leading industry for data collection—gathering an estimated two exabytes of operational data annually[4]. Meanwhile, the price of Internet of Things (IoT) technology, already on the decline since 2015, is projected to drop 50 percent by 2020[5], and embedded sensors are becoming standard features on new equipment. But while 35 percent of U.S. manufacturers are currently collecting equipment data[6], only 3 percent[7] have taken steps to fully exploit that information to improve their operations.



8 Vodafone, "Executive Summary: Vodafone IoT Barometer 2016," p.3.

Advanced as factories have become, manufacturers are still hard-pressed to remain viable and competitive. Operations managers must consistently meet performance, budget, and output forecasts, while also ensuring product consistency, quality, and compliance. Plant engineers must keep production lines operating, maintained, and optimized, while also staying ready to alter production quickly in support of new business priorities and revenue opportunities.

Meeting these objectives requires continuous visibility into the behavior and condition of thousands of critical points across the factory floor. And such visibility is already waiting within the raw operational data streaming from equipment, collected from various systems, and stored throughout the business. The biggest challenge is that most datasets are so massive and complex, they defy human analysis. Companies simply lack the in-house expertise to dig through and extract the right kind of knowledge to help them make smart, data-informed decisions the moment they are needed.

4 Martin Baily and James Manyika, "Is Manufacturing 'Cool' Again?," January 21, 2013.
5 McKinsey & Company, "Industry 4.0: How to Navigate Digitization of the Manufacturing Sector," 2015, p. 12.
6 PwC and Zpryme survey and analysis, "2014 Disruptive Manufacturing Innovations Survey," conducted February 2014, cited by PwC
7 BGC, "Time to Accelerate in the Race Toward Industry 4.0," May 19, 2016, chapter 2.

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Rather than leave this extraordinary opportunity for business improvement on the factory floor, companies can use the power of Industrial IoT (IIoT) solutions to convert their real-time, historical, and other systems data into meaningful business knowledge to increase factory output, improve efficiency, and stay competitive.

Benefits of IIoT and Factory Data Analytics

Of organizations that use smart manufacturing (Industry 4.0/IIoT)

82% *increased efficiency*

49% *experienced fewer product defects*

45% *increased customer satisfaction*[10]

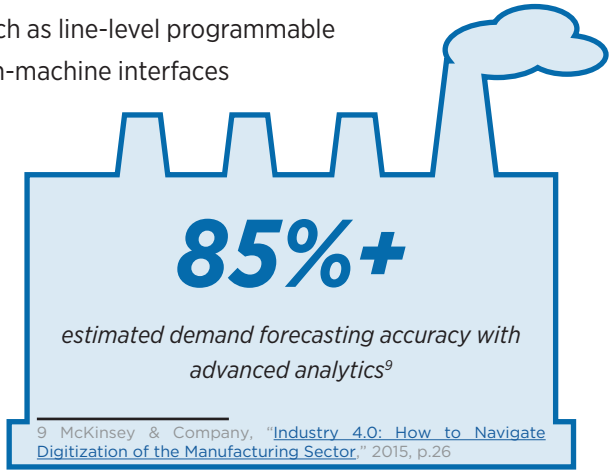
10 American Society for Quality, "Manufacturing Outlook Survey 2014," December 17, 2013, p. 2.

Manufacturers regularly collect vast amounts of data from thousands of sensors built into motors, conveyor systems, 5-axis machines, and other physical assets throughout their factories. This data is typically used for equipment monitoring and alerts, but that only scratches the surface of IIoT's potential to enhance production yield, quality, costs, and compliance.

IIoT solutions can aggregate a company's full repository of real-time and historical data and apply advanced analytics, predictive reasoning, and machine learning. This sophisticated, automatic process unlocks previously unknown operational insights to help manufacturers achieve the "smart" digital manufacturing that Industry 4.0 is all about.

Data analytics can, for example, help operators adjust real-time production variables for greater yield and product quality; monitor and maintain equipment health to avoid failures and lower servicing costs; and optimize production lines as operational conditions change.

Opportunities to gain factory-wide insight and automate resource management are available by incorporating historical operational data, as well as data from other related systems, such as line-level programmable logic controllers (PLCs), human-machine interfaces (HMIs), manufacturing execution systems (MESs), enterprise manufacturing intelligence (EMI) software, parts inventories, and enterprise resource planning (ERP) systems.



9 McKinsey & Company, "Industry 4.0: How to Navigate Digitization of the Manufacturing Sector," 2015, p.26

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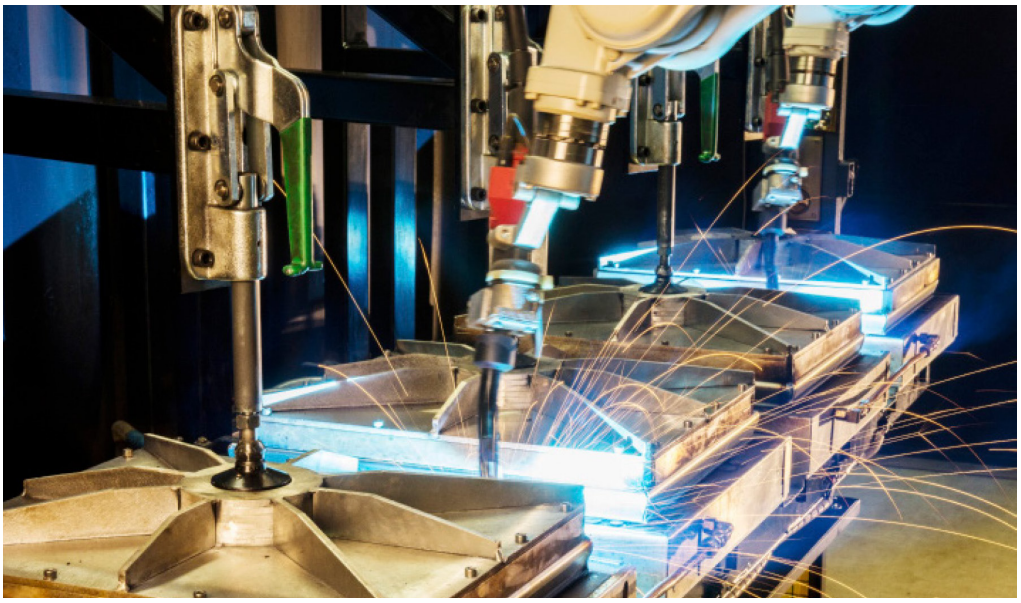

Once appropriately analyzed and acted upon, a company's streaming and stored data become vital business assets in their own right—enabling production improvements, cost savings, and smarter resource allocation. For instance, manufacturers can use IIoT-based data analysis to:

- Establish condition-based maintenance schedules to reduce unplanned equipment downtime, better manage servicing costs, optimize production, and extend the useful life of equipment
- Use rules-based automation and remote control access to maximize yield while also maintaining quality, prolonging equipment lifespans, and remaining compliant
- Automate and connect every corner of the factory floor to optimize processes and material flow for more precise planning, just-in-time manufacturing, and workplace safety
- Make machines more autonomous, such as automated guided vehicles (AGVs) and industrial/collaborative robots, to reduce the workload of IT, operations, and engineering staff
- Find the core determinants of production and workflow performance, then take action to continually improve them

And these are not the only applications of IIoT that can significantly improve financial outcomes. A PWC survey of industrial sectors, for example, projects that 10 percent of all companies that digitally transform their factories, and 27 percent of "first movers" that do so, will simultaneously achieve more than 30% increased revenue and more than 30 percent reduced costs by 2020[11].

11 PwC, 2016 Global Industry 4.0 Survey, "Industry 4.0: Building your digital enterprise," April 2016, p. 12.

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Three Key Uses of Factory Data

IIoT technology delivers direct benefits in three critical areas for discrete manufacturing companies: condition-based maintenance, asset optimization, and smart asset utilization.

Condition-Based Maintenance

IIoT-based predictive asset maintenance leads to

up to **12%** *savings in scheduled repair costs*

up to **30%** *reduction in overall maintenance costs*

up to **70%** *fewer breakdowns*[12]

12 Accenture, "Smart Production, Finding a Way Forward: How Manufacturers Can Make the Most of the Industrial Internet of Things," 2015, pg. 7.

Any form of downtime affects manufacturing capacity. Failure of even the smallest factory component can halt production, delay delivery, impact revenue forecasts, and create havoc along a manufacturer's supply chain. Every hour spent redistributing workloads to other lines, diagnosing root causes, and making repairs adds to the financial burden. The immediate and substantial benefits of avoiding such issues are why companies invest in safeguards like preventative maintenance. However, manufacturers have historically employed maintenance procedures based on fixed intervals, like time or usage, which fail to account for a machine's actual condition and operational fitness. Often, this leads to costly over- and under-servicing, which heightens potential risk of early failures, unplanned downtime, expensive emergency repairs, shorter equipment lifespans, and unnecessary maintenance costs.

A fundamental application of IIoT is the ability to harness real-time and historical data from across a manufacturing plant to construct (using machine learning) highly accurate digital models of the plant's physical components. IIoT software then leverages data analytics to detect changes, predict potential problems, send alerts, identify probable causes, and present technicians with likely solutions based on similar previous occurrences.

Operations managers and engineers can intelligently accelerate or delay repairs according to actual asset condition. This can extend the life of harder-working equipment and avoid the unnecessary cost of over-servicing. Using data analytics to prescribe optimal maintenance intervals also contributes to smoother operations and reduces, or even eliminates, unplanned downtime.

Asset Optimization

Actual performance of critical factory equipment can vary from unit to unit, production line to production line, and factory to factory. Similar machines can

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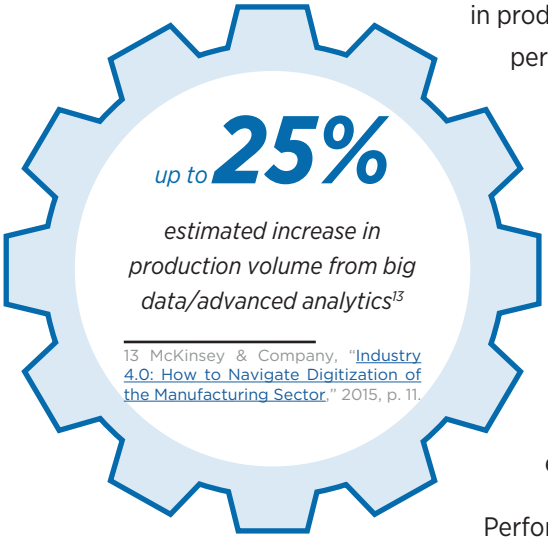
exhibit substantial variance in efficiency, output quality, and yield due to a variety of factors. Continuously streaming data conveys each machine's inner workings in real time, but it is beyond most human capabilities to analyze it quickly and accurately enough to detect equipment inefficiencies, assess variations in production capacity, and adjust to achieve optimal operational performance almost on the fly.



Applying machine learning and more advanced data analytics to digital models, IIoT solutions can define the behavior and operating parameters of optimally performing factory equipment. This characterization includes equipment settings, environmental conditions, calibration, service intervals, configurations, and other variables. The "optimized profile" can then be applied across similar assets to improve underperforming equipment.

Performance adjustments can be made remotely by engineers or automatically by the system—such as to correct for quality anomalies, account for ambient humidity, or temporarily reduce output speeds if a machine's operating temperature exceeds specific thresholds.

This optimization process—which is actually a continuous, ongoing aspect of IIoT—becomes more intelligent over time and helps ensure equipment continues to run as expected and as cost-efficiently as possible.

Smart Asset Utilization

Without full visibility into all factory operations—as well as the ability to adjust systems automatically and remotely—manufacturers cannot easily define and implement production workflows that will lower costs while improving efficiencies and quality. Manual, unit-by-unit examination and reporting of machine status and compliance-related data limits factory-wide view, and has inherent time delays and potential for error. Managers have difficulty projecting inventory needs as well as coordinating parts and materials orders for just-in-time production.

IIoT systems, using rules-based automation and advanced data analytics, can consolidate utilization data from all connected equipment into a single dashboard that is viewable from anywhere. Moreover, they can integrate factory-floor data with that of other sources, such as line-level PLCs, HMI systems, MES, EMI, parts inventories, and ERP systems. Rules-based logic applied to this aggregated data can automate complex, conditional actions (e.g., inventory adjustment requests),

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enforce business policies (e.g., operator hours, safety parameters), and ensure compliance in regulated industries (e.g., emissions, disposal).

The use of data to observe, understand, and automate equipment and resource utilization enables companies to oversee all manufacturing and assembly activities with the aim of optimizing production, ensuring workplace safety, and maintaining compliance.

Key Uses of IIoT in Discrete Manufacturing

Connect physical assets for:

- Data collection and transmission to the network, cloud-based databases, and applications
- Filtering, prioritization, and pre-processing of data
- Local business rules and actions of assets

Monitor asset data to:

- Apply logic to real-time data streams from physical assets both locally and remotely
- Run complex event detection in real-time
- Establish a distributed rules engine for anomalous conditions

Predict conditions to:

- Best identify circumstances that frequently precede failures and orchestrate complex actions
- Integrate into enterprise systems to prevent predictable failures
- Schedule preventative maintenance at optimal intervals to eliminate costly unplanned downtime

Automate operations with:

- Machine learning that optimizes equipment efficiency and lowers the cost of failures
- Predictive modeling that plans for anomalous conditions detected by the monitor function
- Automatic rules generation to perform actions such as adjusting heat treatment time and temperature to prevent product defects or improve yield

Optimize equipment performance through:

- Digital asset modeling that can benchmark operational parameters of high performing equipment
- Performance optimization that applies the parameters used for the best performing equipment
- Prescriptive remediation that can improve abilities of less than optimal assets

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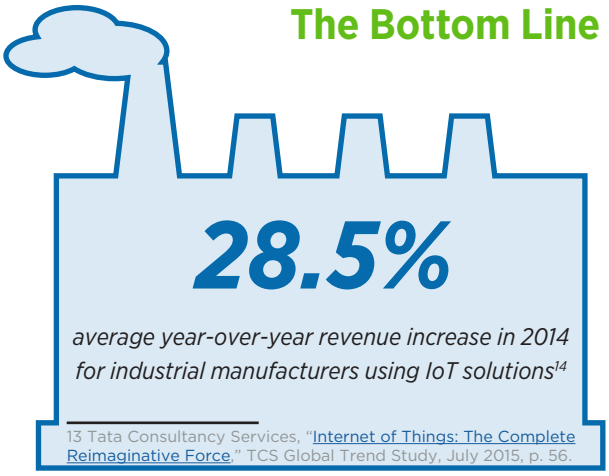

13 Tata Consultancy Services, "Internet of Things: The Complete Reimaginative Force," TCS Global Trend Study, July 2015, p. 56.

The Bottom Line for Discrete Manufacturers

The emergence of Industry 4.0 and IIoT is transforming manufacturing yields and operational efficiency around the world. IIoT, in particular, holds the key to helping manufacturers transform the data they already collect into the business knowledge they need to increase output, manage costs, and improve productivity.

Benefits of enhanced visibility into all operational and mechanical data include the ability to:

- Ensure the execution of manufacturing strategy
- Develop consulting solutions, optimize workflows, and drive improvement initiatives
- Manage capital investments and high-level planning
- Consistently meet KPIs (e.g., performance, budget, forecasts)
- Promote and deploy continuous improvement initiatives, techniques, and practices
- Analyze operational data and make real-time adjustments as needed

To find out more about how your organization can best embrace IIoT for maximum impact, please email sales@bsquare.com or call 425-519-5900.

About Bsquare

For over two decades, Bsquare has helped its customers extract business value from a broad array of assets by making them intelligent, connecting them, and using data collected from them to improve business outcomes. Bsquare software solutions have been deployed by a wide variety of enterprises to create business-focused Internet of Things (IoT) systems that can more effectively monitor assets, analyze data, predict events, automate processes and, in general, optimize business outcomes. Bsquare couples innovative software with advanced professional services that can help organizations of all types make IoT a business reality.

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