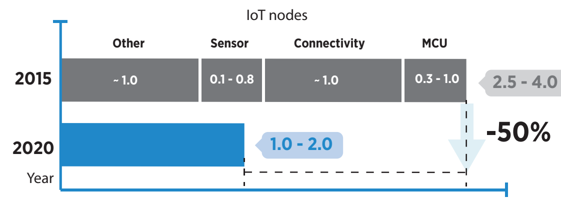
Industrial IoT:
Improving Factory Yield and Productivity

BSQUARE

The business of IoT

01 Improving Results with Industrial Internet of Things (IIoT)

IoT technology costs are free-falling – projected to drop 50% by 2020.[1]



Discrete manufacturing companies have long collected data generated by manufacturing execution systems (MES), enterprise manufacturing intelligence (EMI) software, onsite factory equipment, parts inventories, and other sources. Now, advanced analytics solutions, cloud-based technologies, and the availability of new manufacturing equipment with built-in sensors are on the rise, while IoT technology costs are free-falling – projected to drop 50% by 2020 . More than ever, embracing digital transformation presents a vital competitive advantage with unprecedented insights into all aspects of factory operations.

Yet for many manufacturers, this tremendously valuable data remains locked behind inscrutable datasets, outdated spreadsheets, and static reports, inaccessible to all but trained data scientists.

A well-designed Industrial Internet of Things (IIoT) system helps manufacturers analyze all this raw plant information and convert it into business value, such as improving production yields, optimizing maintenance costs, maximizing line productivity, and tracking resource use in real time to meet business, production, and regulatory objectives.

1 *McKinsey & Company, "Industry 4.0: How to Navigate Digitization of the Manufacturing Sector," 2015, p. 12.*

IIoT systems can tap the entirety of data streaming in from the factory floor, other data sources, and historical datasets, then apply complex analytics to expose business-critical information about each production line's output, quality, and equipment status. Factory owners, managers, and engineers can readily see current operating conditions and production capacity, predict and forestall equipment failures, adjust equipment output, and achieve better quality control, all from the floor or office.

Adding machine learning and rules-based automation can further ensure component-level quality control, adherence to business and operational policies, and that sufficient materials are available to keep production moving.

Ultimately, a well-planned IIoT system can provide data-driven business insights to help manufacturers increase overall production yield, efficiency, quality, and compliance throughout factory operations.

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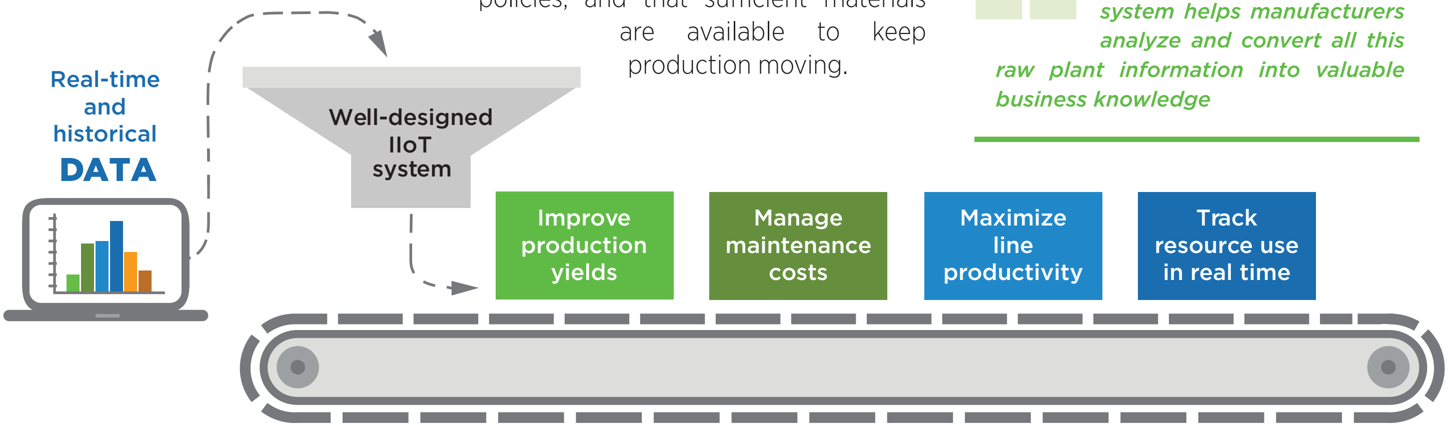
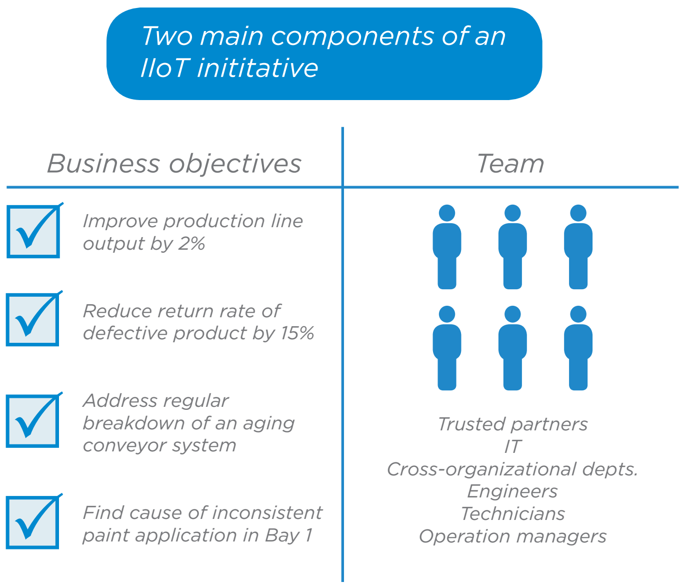


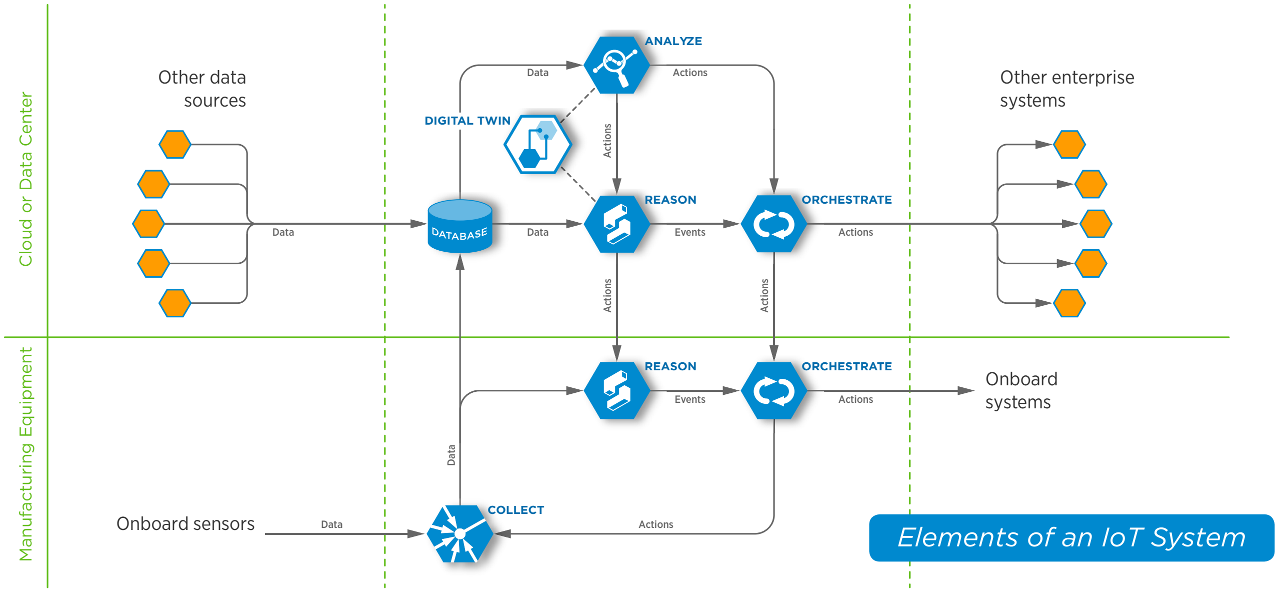
02 Starting with Business Goals



Most equipment and machines used in discrete manufacturing already have sensors pre-installed. In order to harness the business benefit from the vast amounts of data they collect, each IIoT initiative should focus on two primary components: the business objectives the company wishes to achieve, and the team required to make them happen.

Leveraging equipment data to create business value, whether it's production improvements or cost savings, takes a concerted effort among trusted partners, IT, cross-organizational departments, and those who work with the equipment every day: engineers, technicians, operations managers, and others.

The best approach is to start with small, measurable, and outcomes-focused business goals. Typical examples are to improve a particular production line's output by 2%, to reduce the return rate of defective product by 15%, to address the regular breakdown of an aging conveyor system, or to find out why paint application in Bay 1 is inconsistent.



Once these have proven successful, expand into IIoT solutions that address broader, higher-level business goals. These might be to optimize all 5-axis machines in the factory, to make sure the right amount of raw materials is always in stock, or to validate adherence to operational standards and industry regulations.

Establishing IIoT solutions around short-range business goals can reveal the relevance of the data already being collected, and expose what other IIoT data points or sensors need to be installed or activated to understand and resolve a production problem. Once all the missing information is in place, teams will have an increasingly full picture of the factory's inner workings. The most successful IIoT solutions can then be scaled to include more machines, more production lines, and a broader base of input sources.

03

The Five Stages of IoT Maturity

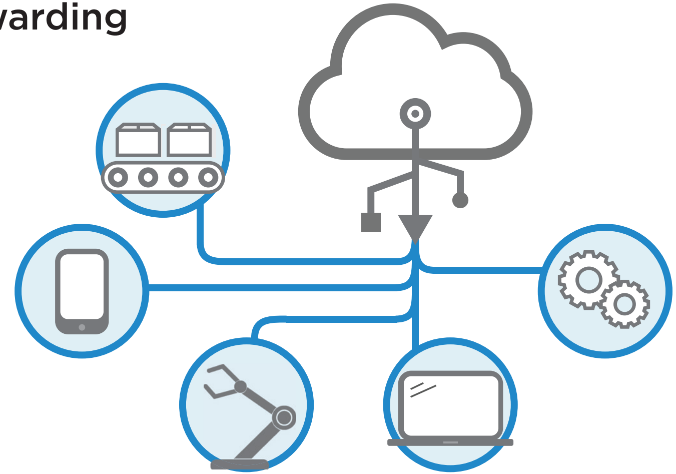
IIoT can help discrete manufacturing companies increase yield and productivity by reducing unplanned downtime, maximizing line efficiency and output, and tracking and automating real-time resource usage. However, it's not a single technology or solution. Rather, it should fuse with existing technologies and systems to enable an organization to achieve its business goals.

IIoT deployments typically progress through five maturity phases. Each yields ROI, but it's the later stages that add the most significant value. That's because early IIoT adoption reflects behavioral changes a company must embrace, while advanced implementation emphasizes a shift in technological perception. As such, a full-scale IIoT solution can represent a stark departure from a company's current operating model.

Furthermore, new IIoT initiatives don't have to start at Stage 1. The ubiquity of sensors, data collection, and monitoring in discrete manufacturing, companies may already have everything in place to start at Stage 3 for a particular IIoT-based factory enhancement.

Stage 1: Device Connectivity & Data Forwarding

Today, most factory equipment comes outfitted with myriad sensors to transmit a wide array of data. They also have a variety of connectivity options, from plug-in diagnostic reader ports to wireless modules, for delivering data to cloud-based devices. As a result, the average factory streams terabytes of production-relevant each month – ranging from motor operating temperatures to unit counts, product weights to conveyor speeds, motion-tolerance detection to raw materials usage, and much more.



Beyond Stage 1:

Although IIoT-connected equipment provides the foundational first stage of such data collection and forwarding, merely gathering and storing data delivers little to no business benefit. At a minimum, monitoring and error alerts are required to begin to achieve value from the data.

Stage 2: Real-time Monitoring

Monitoring connected plant data begins to provide just-in-time awareness of machine and production line conditions. Real-time operating parameters and fault codes can be visualized as graphics, charts, color-coded alerts, etc., on dashboards that are viewable on any cloud-enabled device. So factory owners at headquarters, operators in plant offices, and engineers on the floor can receive notifications when faults are detected, equipment failure is likely, inventory is low, or operating limits are exceeded. Teams can then take appropriate steps to adjust and remediate.

Beyond Stage 2:

While these basic dashboard and monitoring solutions benefit human operators, they lack the sophisticated logic to detect the complex conditions and events frequently found in factory environments. They do, however, provide a starting point for manufacturers to examine and refine the business processes necessary to achieve their desired outcomes.

Stage 3: Adaptive Data Analytics

Analysis of intricate, multifaceted events, using multiple sources of data for context, is where IIoT really begins adding measurable business value. The best solutions use data discovery, machine learning, cluster analysis, and digital modeling to apply complex event processing and adaptive analytics to real-time and historical data from factory and complementary sources – providing detailed visibility across the manufacturing infrastructure. These insights allow plant operators, engineers, and technicians to proactively manage equipment health and optimize production. This reduces the likelihood of unexpected failures and related problems, like production delays and expensive repairs.

Factory Data Use Cases

Root cause analysis:
Identify problems faster, with greater accuracy

Optimized repair workflows:
Guide technicians to improve first-time repair rates

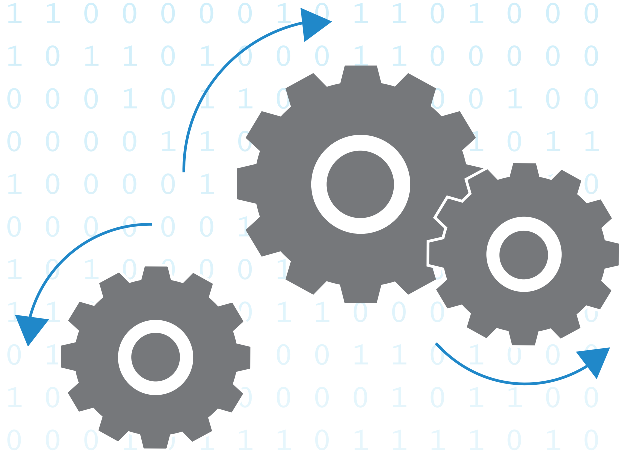
Condition-based maintenance:
Service equipment based on actual usage, conditions, and performance

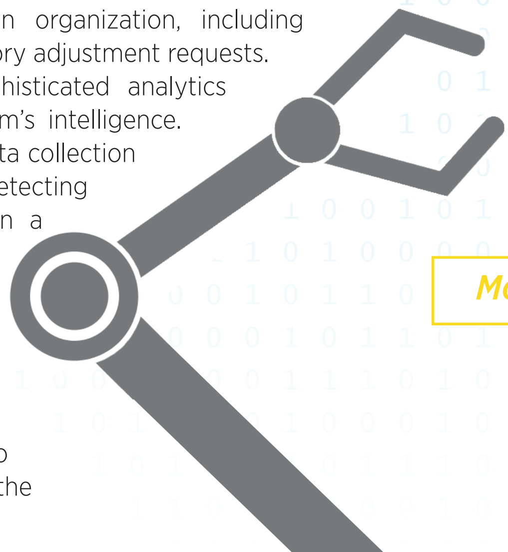
Moving Beyond Stage 3:

This ability to detect, alert, and guide equipment maintenance provides high value to any manufacturer seeking to optimize production output. However, the sheer amount of data produced by multiple sources and across entire plants may overwhelm human operators and dashboard systems, limiting the scope of where analytics can provide business benefit. Some form of automation is also needed to help teams respond quickly and appropriately to fluctuating factory conditions.

Stage 4: Automation

Automating the wealth of insight and awareness provided by the adaptive data analytics in Stage 3 allows a manufacturer's IIoT system to become progressively more intelligent, and capable of delivering greater business benefit. Dynamic rules-based logic can orchestrate complex actions across an organization, including service ticketing and inventory adjustment requests. Machine learning and sophisticated analytics also enhance an IIoT system's intelligence. For example, it increases data collection and transmission upon detecting an anomalous condition on a production line. The system can then execute a series of automated steps to correct the error, or automatically adjust operating parameters to minimize damage while also notifying a technician of the issue and repair urgency.





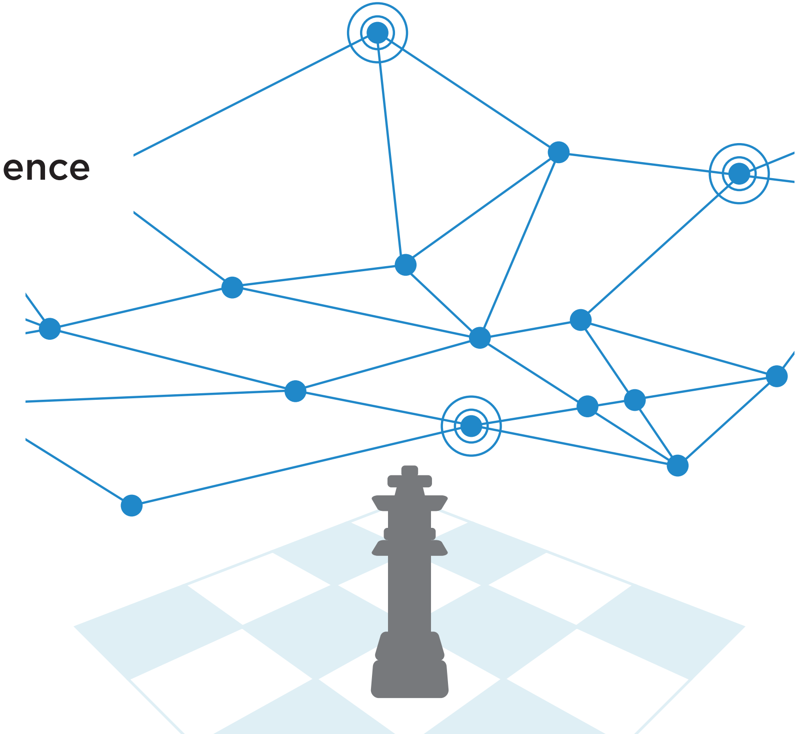
Moving Beyond Stage 4:

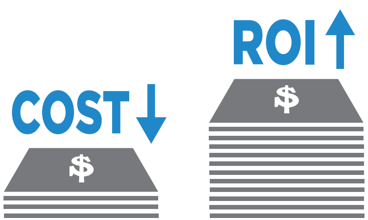
In Stage 4, all IIoT processing activities are done over a separate cloud location that is accessible from any mobile or desktop device. Even greater automation can be achieved by moving these automated processing tasks onto the units themselves.

Stage 5: Enhancing On-Board Intelligence

By embedding the same intelligence and processing capabilities from Stage 4 directly into plant equipment, analytics and actions can be performed right at the network edge, rather than in a separate cloud location.

Juxtaposing logic capabilities with source data aboard the machine (rather than transmitting the data from the machine to the logic tools in the cloud) eliminates any loss of accuracy from wireless transmission and conserves cloud data storage and network bandwidth. It also enables many other ways to work with the data and manipulate equipment directly, such as to apply real-time asset optimization and configuration to achieve greater quality control, or to automatically retool production lines.

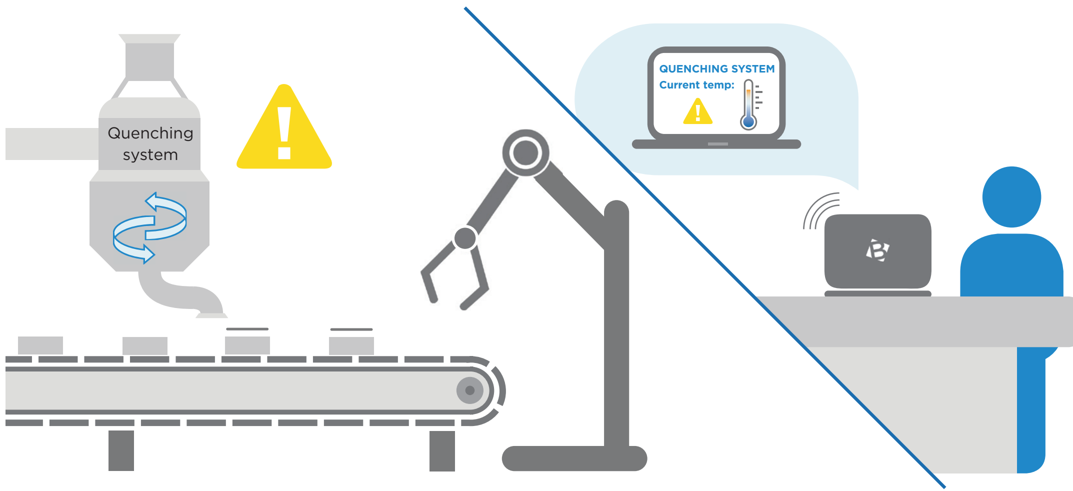




Stage 5 provides maximum ROI and business benefit from predictive failure, data-driven diagnostics, and device optimization.

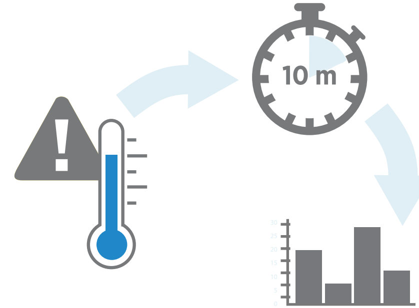
04 An Illustrated Example

Consider a scenario where the water temperature in assembly line #3's quenching system begins rising. If the system exceeds target heat thresholds, the thin-gauge steel that's flash freezing will fail to meet specified material hardness properties and every finished product coming off that line will be defective. By continually monitoring the operating conditions of all assembly line equipment, the IIoT solution identifies the quenching anomaly and initiates a diagnostic and service repair plan.



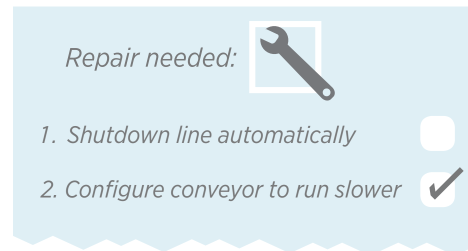
STEP 1

The programmable logic controller (PLC) alerts the IIoT solution that thermal couplers have detected rising water temperatures. The solution increases data transmission to 10-second intervals to update the quenching system's digital model, then applies predictive analytics.



STEP 2

Determines if the situation calls for an automatic line shutdown, or if remotely configuring the conveyor to run slower will safely produce the required steel hardness properties at the higher quenching temperature – while prioritizing a repair need.



STEP 3

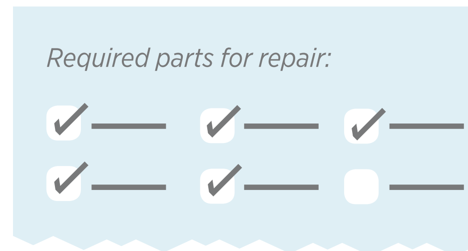
Simultaneously estimates the quenching system's remaining useful life based on its repair history and current operating conditions, compared to historical information from all assembly lines in the factory.

STEP 4

Evaluates real-time conditions and other contextual data against the pattern bank built from all factory equipment to pinpoint a probable root cause. Based on similar past scenarios, it identifies an inadequate supply of cold water flowing through the quenching box, due to a failing high-pressure pump, as the probable source of the temperature deviation.

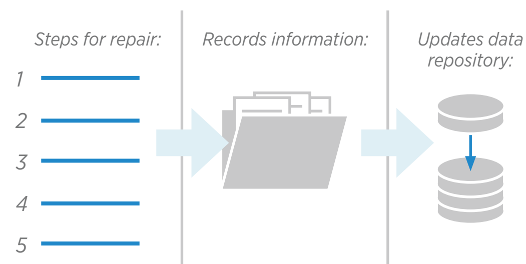
STEP 5

Creates a step-by-step repair plan with a list of required parts; notifies the production manager of the fault and any corrective actions already taken; and prescribes detailed maintenance initiatives to correct the issue.

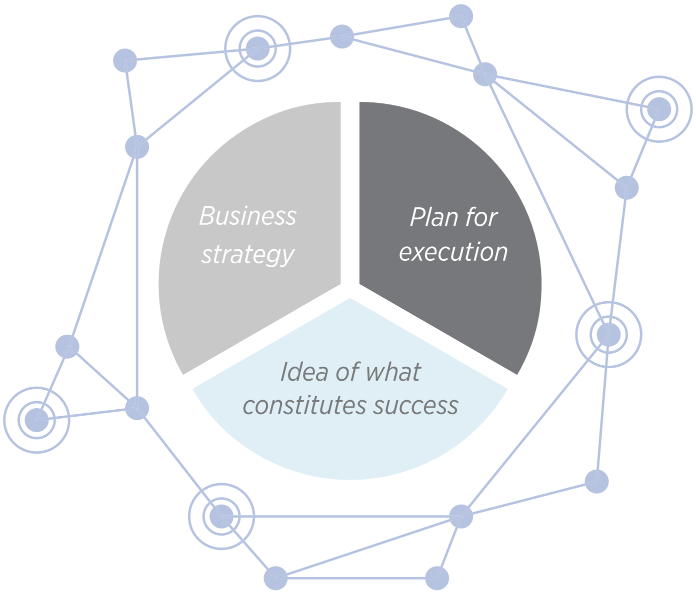


STEP 6

Guides technicians through the optimal steps for replacing the high-pressure pump. At the same time, it records all repair information—including any deviations from the prescribed plan—and updates its data repository to enhance repair processes for any future scenarios matching the characteristics of this fault.



The best IIoT implementation revolves around a clear business strategy, a clear plan for execution, and a clear understanding of what constitutes success.



Summary

IIoT can unequivocally improve manufacturing yield and productivity through lower maintenance and repair costs, maximized quality and output, and full, coordinated use of manufacturing resources. Although technology itself is a crucial element, a successful IIoT initiative is a cross-organizational effort built upon business goals shared among many stakeholders.

The best IIoT implementation revolves around a clear business strategy, a clear plan for execution, and a clear understanding of what constitutes success. It is best undertaken in stages, rather than through an "all or nothing" approach.

Viewed as a maturing process, a company's IIoT system will progress naturally from success to success as the organization's business needs evolve and as personnel gain greater IIoT experience.

About Bsquare

For more than two decades, Bsquare has helped its customers extract business value from a broad array of assets by making these assets intelligent and connected, 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.

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

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