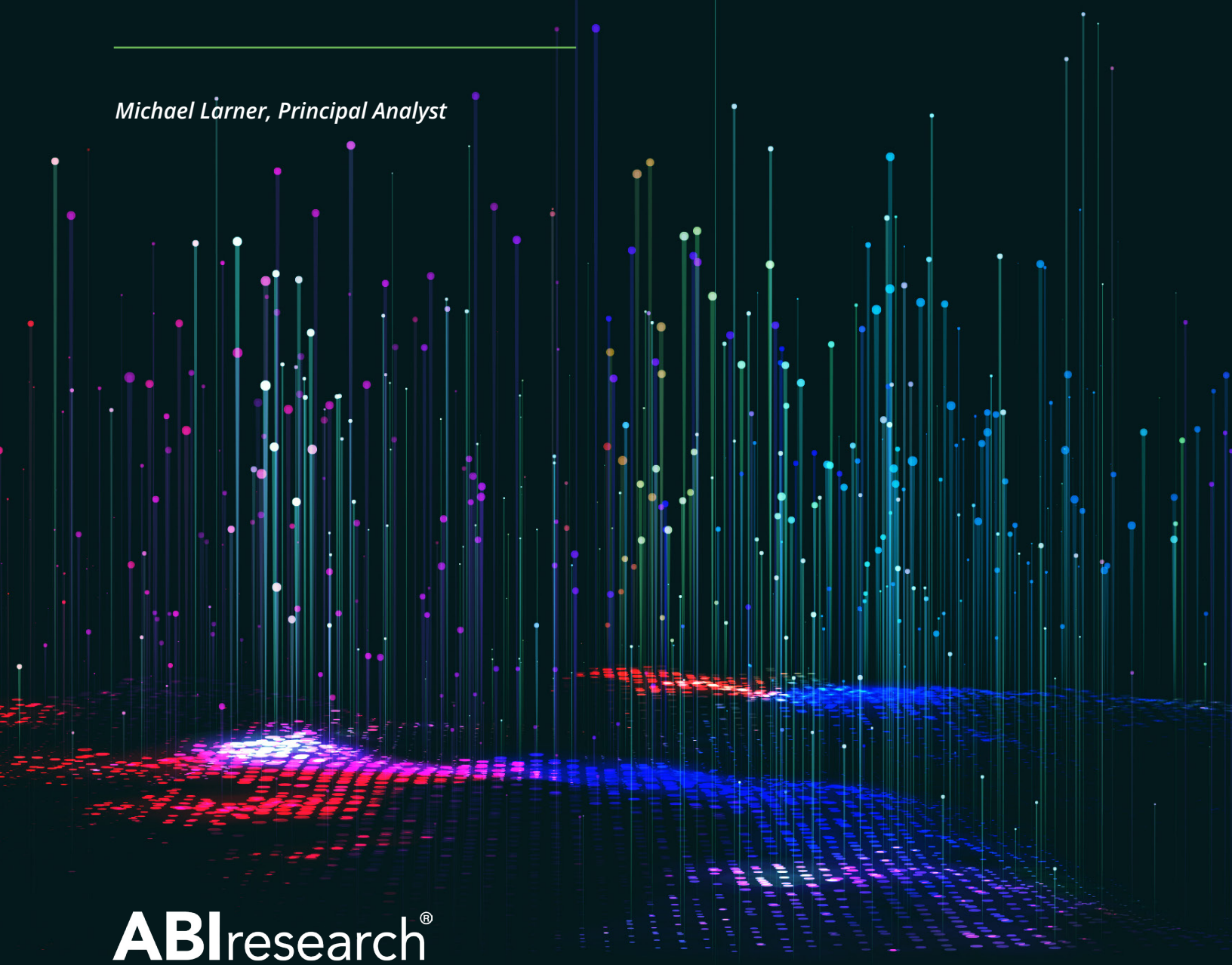
Optimizing Operations With Data Analytics

PTC's ThingWorx Industrial Internet of Things (IIoT) platform can be integral to companies improving their decision-making and overall performance.

Michael Larner, Principal Analyst



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Executive Summary

If 2020 has shown manufacturing and industrial firms anything it's that they need insights in order to build and maintain operational resilience. ABI Research forecasts that spend on data analytics will surpass US$6 billion in 2026, up from $1.3 billion in 2019. Total spend comes to US$19.8 billion in 2026 when also including data management and professional services, a rise of US$16 billion in seven years.

Manufacturers and industrial firms have the tools at their disposal to collect, analyse, and present insights that were unimaginable at the turn of the century thanks to the cost of sensors plummeting, the availability of Industrial Internet of Things (IIoT) platforms such as the ThingWorx Industrial IoT Solutions Platform, creation of edge computing solutions, the cost effectiveness of cloud infrastructure, plus innovations in analytics and visualization software. The sophistication of machine learning technologies means that in addition to running reports, decision makers can now readily conduct root cause analysis or scenario planning and have the software make recommendations.

Analytics can deliver results in real-time, or as needed, depending on context. Applications that trigger alarms to protect staff and the facility need to operate in real time, while simple production related reports can be carried out daily and more strategic analysis performed by data scientists can take weeks or months. The ThingWorx Industrial IoT Solutions platform provides customers with an end to end solution supporting many different use cases including reporting on asset condition and advising operating staff.

A single technology architecture won't necessarily optimize all use cases for data analytics. Edge deployments favor use cases that require quick decision making and a high impact on the firm's operations, while cloud technologies favor those that are less time sensitive but still of high importance.

Manufacturers are of varying degrees of readiness to get the maxium benefit from data analytics, with some still collecting data on paper or using Excel for analysis. Companies need to ensure that the creation and assimilation of data insights are not just the domain of data scientists, but that they are actionable insights available to the people who need to take the actions. Many will need to invest in upskilling staff and developing a data sharing culture whereby critical knowledge does not remain only with a small number of staff (often referred to as "tribal knowledge").

As data feeds decisions across the organization it becomes a critical asset – essential to optimizing manufacturers' operations.

Challenges That Data Analytics Can Tackle

Staff don't have to be data scientists to appreciate data insights, but they do need to be cognizant of what the data is telling them.

Thanks to innovations in data collection and analytics, staff in various roles can incorporate analytics in their work.

ROLE	CHALLENGE(S)	ANALYTICAL INPUT
Plant Manager	Avoiding unplanned downtime, which can cost thousands of dollars per hour.	Perform predictive maintenance so that fixes can be scheduled. Looking to deliver Overall Equipment Effectiveness (OEE).
Plant Manager	Inventory control—having enough raw materials and components, but not too much that cannot be easily stored.	Deploy predictive analytics to forecast customer demand, the impact on the supply chain, and what it means for the facility.
Plant Manager	The production line is delivering goods to the required standards—lowering rates of scrap, rework, and warranty claims.	Deploy smart cameras to automate quality control functions, whereby machine learning understands tolerance levels and identifies items that do not meet the standards.
Machine Technicians	Whether the piece of equipment is performing optimally or needs servicing.	Conduct condition-based monitoring to perform diagnostics, including by machine vision software, analyzing data historians, and/or the acoustics emanating from the piece of machinery.
Warehouse Manager	Is the facility configured so that items can be sent to distribution as quickly as possible?	Use analytics to optimize the scheduling of items for distribution.
Facilities Manager/ Plant Manager	Need to operate more sustainably by reducing electricity and water usage.	Having a holistic view of the facility, staff can analyze cause of waste.
Facilities Manager/ Human Resources (HR)	Ensuring social distancing inside the facility.	Real-time data analytics to identify hot spots in the facility where staff congregate and devise new ways to manage the flow of individuals.
Engineering and Manufacturing Teams	Understanding the effects of potential changes to product design or mix of ingredients.	Using simulation software to understand the downstream impact of changes.
Marketing and Product Managers	Anticipating customer needs and ensuring a profitable product portfolio.	By capturing structured and unstructured data, staff can forecast the demand on the plant.

Analytics is increasingly more than tracking data points over a time period:

- Descriptive analytics looks to determine the causality and correlations between data points
- Predictive analytics looks to provide users with the tools to perform scenario planning
- Prescriptive analytics enables users to convert what-if analysis to scenarios

Manufacturers and industrial firms will increasingly prioritize spending on proactive analytics (predictive or prescriptive), as opposed to reactive tasks (descriptive analytics). In 2019, spending on predictive analytics overtook descriptive analytics and is forecast to reach US$3.4 billion in 2026. Meanwhile, prescriptive analytics is forecast to increase from just over US$150 million in 2019 to US$1.4 billion in 2026.

Investments in data analytics must deliver on tangible results (such as increased productivity, reduced downtime, improved preparedness to handle unforeseen events) and be understood both inside the plant and the boardroom. Almost as important as the analytics is that the data insights need to be readily understood.

However, data analytics is not an out of the box solution. Users need to ensure:

- The data collected is accurate and consistent over time
- Data are securely stored both inside the facility and after being transferred to a cloud service provider

Furthermore, managers need to articulate the objectives and demonstrate commitment to the projects to ensure all staff contribute to the project's success.

ThingWorx: An Industrial IoT Solutions Platform

The PTC ThingWorx IIoT platform provides a "one-stop shop" that can take data from devices, helping clients get data to the cloud, and work like an operating system with an app store to provide end users with the data they need. ThingWorx was built to specfically help with the challenges around volume, velocity, and variety of IIoT data. Its capabilities provide various value-driven benefits, such as minimizing time-to-resolution by detecting anomalies in real-time, enhancing decision-making with operational insights, improving forensic data investigations, and more.

Some examples of ThingWorx engagements include:

- Braking system manufacturer Brembo wanted to better understand its production line. The company utilized PTC's connectivity solution Kepware to integrate data from plant equipment (lathes, mills, robots etc.), PLCs, Quality Systems, ERP, and Maintenance Systems. By using the ThingWorx platform three different groups of Brembo staff now have actionable data including:
  - Plant Managers who now know the OEE of their equipment in real-time
  - Line Operators receive alerts that production metrics are not being met
  - Operations Teams can troubleshoot events

(For additional information see here)

- Logistics and energy management firm China International Marine Containers (Group) Ltd. (CIMC) experienced machine downtime but couldn't diagnose the issues because production data resided in siloes. PTC partnered with Microsoft to integrate IoT with their Manufacturing Execution System (MES). The ThingWorx platform was able to provide CIMC with a view of their operations and in so doing have the ability to perform predictive maintenance, manage energy consumption, and trace quality. (For additional information click here)

Architecting for Delivering Data Insights

The biggest consideration for practitioners is to decide whether to process and analyze the data at the edge of their networks or let cloud service providers do the heavy lifting. The following are two different ways to architect for data analytics to support manufacturing operations.

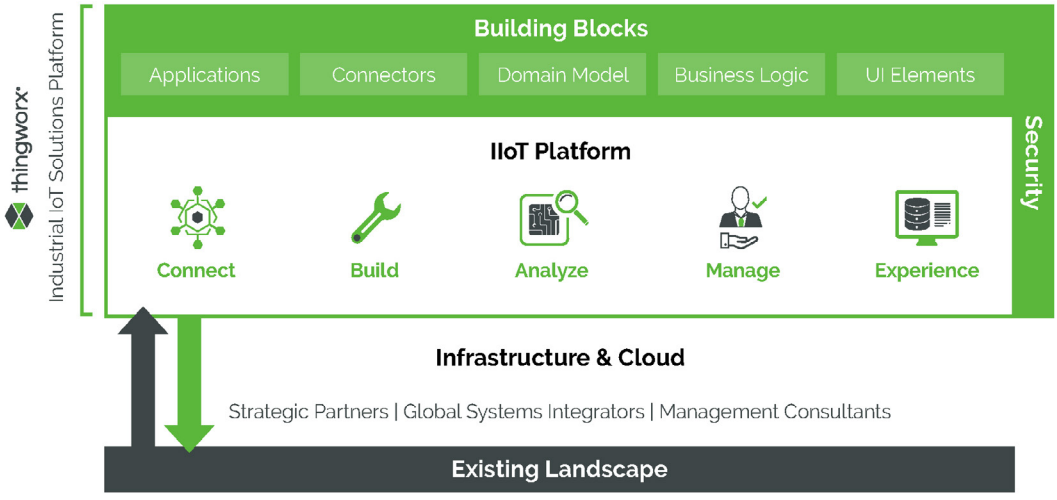
DATA ANALYTICS IN THE CLOUD

The data is collected via sensors or IoT Gateways which transfer from the sensors, Programmable Logic Controls (PLCs), Supervisory Control and Data Acquisition (SCADA) systems, and/or historians to an IIoT platform such as ThingWorx. The ThingWorx platform can also connect with other operational technologies such as PTC's PLM solution Windchill or Rockwell's MES or ThingWorx Operator Advisor. The ThingWorx platform can, for example, analyze downtime, apply KPIs or statistical process control, and then feed individual apps.

The end to end solution illustrates the benefits of partnership between PTC, Rockwell, and Microsoft. The Factory Insights as a Service enables customers to fully monitor assets and have more control over production line performance.

Figure 1: ThingWorx Solution Platform

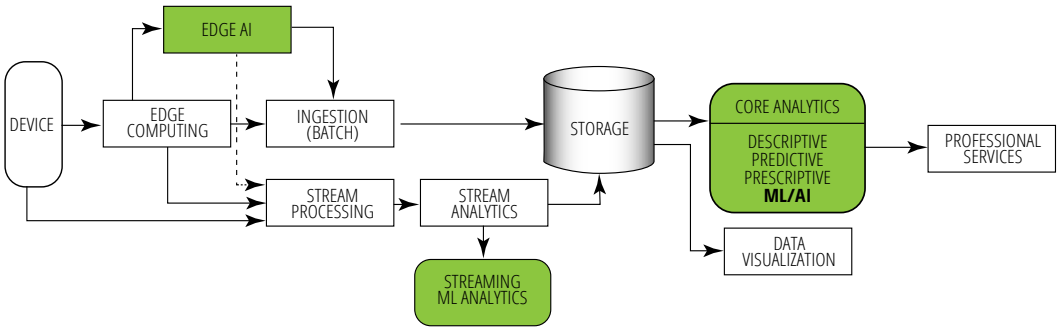
(Source: PTC)



Alternatively, the data need not be transported to the cloud and instead be analyzed at the edge of the network.

Figure 2:
IoT Data-as-a-Service Value Chain

(Source: ABI Research)



The data collection process is similar; however, with edge or fog computing architectures, analytics can be incorporated in edge devices and, in the case of fog computing infrastructure, analytics can take place simultaneously across multiple devices on the network via a single IoT gateway or router. With data ingestion, the data are enriched (labeled/tagged, and cleaned for corrupt or inaccurate records) before it is stored. Accelerating the data analytics process is stream processing and stream analytics during which the software gets to work on the data in real time. In data management, the software configures, models, trains, and tunes the data.

Key considerations when deciding upon the architecture include the following:

- **Cost:** The costs for transporting and processing large data volumes in the cloud can become prohibitive, for example monitoring a machine's vibrations to identify the development of faults. Manufacturers need to prioritize the workloads that need to go to the cloud.

- **Scale:** Cloud architecture should be considered when analysis projects are looking to assimilate and analyze numerous different types of information in order to synchronize the supply of parts to the plant or when a manufacturer is looking to create a digital twin, of the production line or entire facility, and simulate different scenarios.

- **Speed:** In terms of the time it takes to decide time and take action; for example, worker safety at a chemical plant favors edge analytics.

The two different approaches have their merits in different circumstances and use cases. Two key considerations are the impact of the analytics on the company's operations/strategic importance and the speed with which the decision needs to made, such as sub-second or of a strategic nature requiring more longer-term thinking.

ARCHITECTING FOR DIFFERENT USE CASES

COMMERCIAL IMPACT	HIGH-SPEED ANALYSIS AT THE EDGE	LOWER SPEED ANALYSIS IN THE CLOUD
High impact on the operations	Quality inspection, process adherence, worker safety, worker health	Supply chain analysis, predictive maintenance, OEE, condition-based monitoring
Lower impact on operations	Measuring output, measuring energy usage	Inventory optimization, customer analysis

Embedding Data Analytics

Different verticals and companies within them are at different stages of sophistication when it comes to data analytics. Automobile plants with just-in-time delivery of components and automation on assembly lines are more attuned to data analytics. Fueling the adoption of data analytics is the need to assemble tens of thousands of components and personalize each vehicle to the customer's preferences often via a single production line.

At the other end of scale, there are manufacturers that collect data on paper and rely on the expertise of individual machine technicians. In these environments the merits of changing working practices is key before discussing data analytics.

ABI Research has created a five-stage continuum whereby manufacturers can identify the challenges they face in making data a first-class citizen, and some investments they need to make to improve their operations.

FIVE STAGES OF DATA ANALYTICS PROGRESS

STAGE	OPERATING ENVIRONMENT	TRIGGERS THAT SHIFT THINKING TOWARD THE NEXT STAGE
Stage 1: Operating in the Dark	Data collected on paper and not necessarily accurately transcribed into a database.	• Adverse events (equipment failure, missed orders) mean that the firm realizes operations insufficient. • Staff retire reducing operational capability.
Stage 2: Data Discovery	Original Equipment Manufacturers (OEMs) help clients glean insights from the machinery to perform tasks like predictive maintenance and condition-based monitoring. However, manufacturers need to add more data sources to round out their analysis of operational performance.	• Manufacturers can run basic reporting in Excel, but realize that Excel is not designed for the manufacturing environment; specialist applications are required. • Original Equipment Manufacturers (OEMs) help clients glean insights from the machinery to perform tasks like predictive maintenance and condition-based monitoring. • But different communication protocols and application designs mean that data remain in silos.
Stage 3: Data Deluge	IIoT platform transfers data from sensors, historians, PLCs, and SCADA systems to a cloud provider. Operational data now reside in data lakes.	• Information overload. • Data not always complete or clean. • Challenging to understand what data are critical. • Need to employ data scientists. • Many staff members not convinced of the benefits.
Stage 4: Data Makes Sense	Investments in data management to clean and stream the data. Analytics not just looking for correlations, but predicting outcomes based on machine learning.	• Confidence that the data are accurate. • The desire to use predictive analytics and include unstructured data. • Data still not shared throughout the facility.
Stage 5: Running on Data	Democratization of data with staff members able to access and make decisions based on all the relevant data. Operational Technology (OT) and Information Technology (IT) integrations enabling a closed-loop, whereby data automatically are captured by corporate applications (MESs, ERP systems, QMSs, etc.)	• Data analytics provides staff with findings (machine performance, production, and quality performance) and suggested actions via dashboards. • Data can be manipulated via low-code platforms. • IT and OT teams collaborate to ensure data can be shared across the plant and via cloud service providers.

Companies need to support data analytics endeavors by investing not just in sensors, but network infrastructure, including cloud and wireless networks which enable data transfers. In addition, successfully optimizing operations with data can require a change in culture; data analytics insights is as much about staff members as it is about the technology. Decisions can no longer be made based soley on an individual's experience and some staff may need convincing before they embrace a new decision-making process.

By adopting an analytics strategy, manufacturers will start to evolve from reacting to events on the production line towards proactively planning maintenance and also working with data in real-time. The analytics strategy should not only concern equipment maintenance but also improving quality and the yield of the production line. In the longer term, an analytics strategy can help a manufacturer to optimize their production process by utilizing data collected to run simulations. In parallel to introducing analytics from a technical perspective, manufacturers should develop a data culture where by decisions are made as a result of vigorous analysis rather then gut feel and previous experience.

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ABI Research
249 South Street
Oyster Bay, New York 11771 USA
Tel: +1 516-624-2500
www.abiresearch.com

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