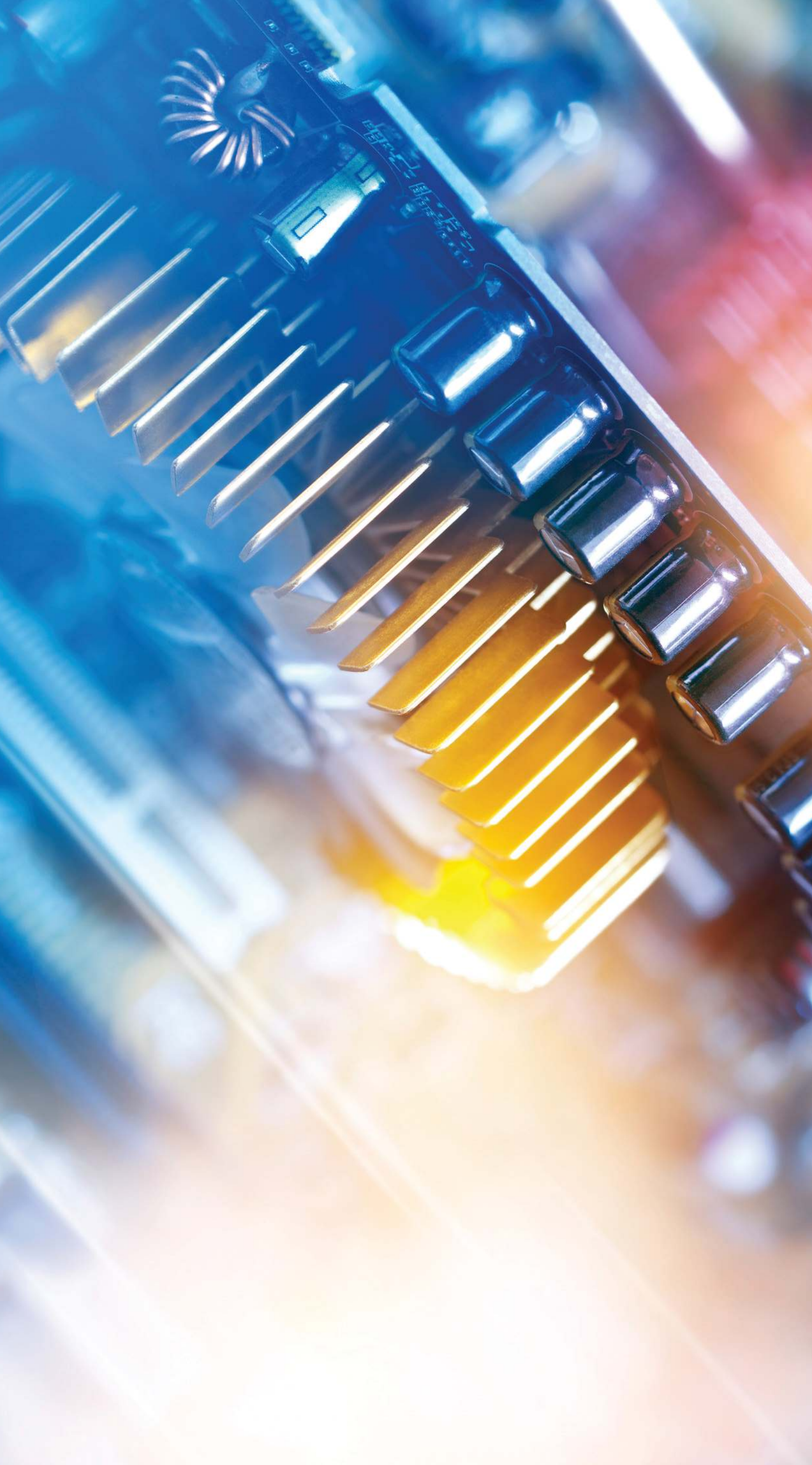


A close-up, angled photograph of a circuit board. The board features several gold-plated connectors and silver components. The background is blurred, showing other parts of the board and some red and blue elements.

Six IoT Use Cases for Edge Analytics

How to acquire manufacturing superpowers in the Internet of Things

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Introduction

How will edge analytics help you acquire manufacturing superpowers in the Internet of Things? In this ebook, we'll show you six ways how.

Data-intensive companies in manufacturing industries like energy, mining and pharmaceuticals have long collected data from disparate sources and used it to improve operations, eliminate scrap, minimize risk and optimize processes. As one director of analytics commented, "We've been doing IoT for 20 years. We just never called it IoT. [The] IoT will help us reduce the time it takes to act."¹

Is yours a multinational company with 70,000 sensors spread across multiple sites and time zones? Are you collecting data embedded in planes, trains and automobiles? Are you monitoring far-flung solar farms and wind turbines? If so, your data will be messy, fast, complex and voluminous. However, if you can tame, transform and analyze the incoming deluge of data, your organization will acquire superpowers that will make you the envy of your competitors.

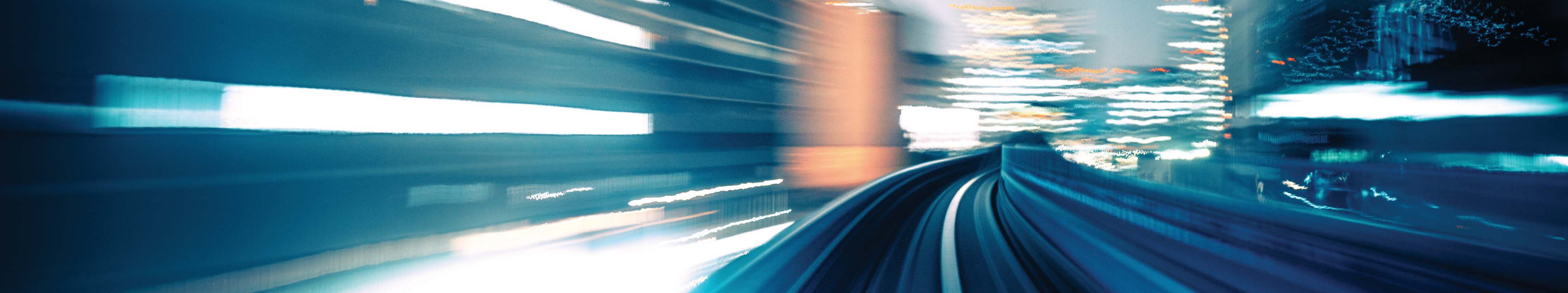
Analytics — especially analytics at the network edge, in industrial settings — is the key to making better, faster, more reliable, data-driven decisions. However, if you begin your project without a clear idea about the decision to be made, then IoT may turn out to be your kryptonite, weakening your business processes even as you try to strengthen them with your superpowers. Before your organization embarks on any IoT project, it should answer three guiding questions:

¹ Gill Press, "IoT Analytics And Dell Statistica Deliver Time Compression," Forbes, April 15, 2016, <http://www.forbes.com/sites/gilpress/2016/04/15/iot-analytics-anddell-statistica-deliver-time-compression>

- Which decision am I trying to make?
- Which data is needed to support that decision?
- After I make that decision, how does my business process change and evolve?

In acquiring those superpowers, you'll need first to understand issues of infrastructure, storage, transport and security, and you'll need to decide among the field of vendors well suited to help you address those issues. To help your organization get started with IoT, we have assembled in this ebook six superpowers you can acquire through IoT uses cases for analytics at the edge of your network.





Superpower #1: Super Speed

Reduced Scrap and Raw Material Waste

Manufacturers have a long tradition of focusing intently on reducing scrap, rework and waste. The usual workflow is to collect data from machines, manufacturing execution systems (MES) and inline inspections, then aggregate and transport it over a web of cables to a central server for analysis. Some of that workflow is automated, but generally it's a matter of engineers, scientists and operators writing queries and reviewing reports. The company may not have standard processes in place for analyzing the resulting data, which slows things down even more.

What if your company had Super Speed to aggregate and analyze all that data in real time at the source?

To acquire Super Speed, smart organizations run data aggregation, data preparation and analytic workflows at the source, where the data is generated. When linked to sensors along the path of production, analytic models running on gateway devices at the network edge evaluate and score manufacturing output by parameters such as size, temperature, pressure, color, vibration and weight. When variances are detected, the embedded sensor, smart device or gateway immediately sends alerts or even stops production to help limit waste.

By using machine learning, data mining and advanced analytics at the source of the data to examine thousands of steps per process, manufacturers can use Super Speed to catch small, bad batches before they become large, seriously bad batches. One pharmaceutical company discovered that minimizing scrap and wasted resources saved them several hundred thousand dollars. Their Super Speed, combined with a program of statistical process control featuring audit trails and role-based security, allowed them to recover their investment in edge analytics in the first quarter after implementation.

Use Case

A manufacturer of electronic gauges was struggling with expensive rework and recalibration, as intermediate and final product QA led to rejection of more than 30 percent of final output. Besides the waste in time and raw materials, the company also had to deal with the hit to its production volumes. By implementing predictive analytics to its automated processes, the manufacturer was able to identify common failure scenarios and their root causes sooner, then apply corrective action and lower its rework rates by nearly half.

Superpower #2: Shape Shifting

Multivariate Alarms with Tens of Thousands of Parameters

In automated manufacturing, many companies build combinations and correlations of sensor data into models that signify normal operating conditions. They then watch for trends over large data sets and sound alarms when measurements fall outside of compliance limits.

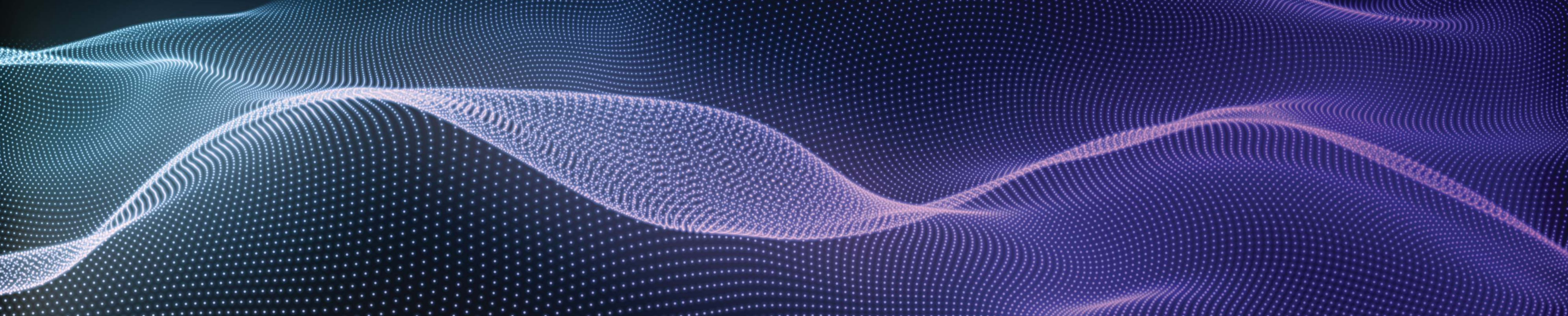
With Shape Shifting, industrial manufacturers create alarms based on multivariate models. When implemented at the network edge, the real-time models monitor more effectively than collections of single-variable monitors, helping to address problems before costly service interruptions and repairs arise.

Consider a process that collects data on 20,000 manufacturing variables at millisecond intervals. With no time to aggregate, prepare and round-trip data to the centralized server at the main office for analysis, operators use the Shape Shifting superpower and rely on machine-local models that react in near-real time. The manufacturing process benefits from the flexibility to monitor and update the model at the point where data is generated and from the network efficiency to send only important information like state changes back to the main office for deeper analysis.



Use Case

A manufacturer of silicon components and solar cells is monitoring thousands of parameters in real time, where “real time” could mean once per second, per hour or per day. There are generally two types of process changes that precede failures or serious quality problems: in the first type, the process summarized by large numbers of parameters slowly drifts away from normal, and the manufacturer must stop the drift before quality problems emerge; and in the second case, something never seen before in one or more parameters — something not captured by multivariate models, is changing, and it is important to identify the changes and evaluate how they may affect quality downstream. Thus, to be effective, predictive quality control — anticipating problems before they occur — requires the combination of multivariate models and one-parameter-at-a-time changes applied to thousands of parameters. The ROI of this approach is practically infinite, because it assures profitability in a very competitive industry.



Superpower #3: Reality Warping

Virtual Sensors at the Edge

Sensors embedded in machines and equipment generate a constant flow of data. In general, many sensors are designed to measure conditions such as humidity, temperature, proximity, vibration, pressure and torque. When these sensors are active, they can generate data at very high frequencies, sometimes even sub-second.

Collecting data from each sensor is not difficult, but analyzing all of the data is time-consuming. While many organizations have automated processes for indicating exceptions, even analyzing just those exceptions can be an overwhelming task. What if there were a better way to analyze the data? Does the single-parameter data stream tell the complete story, or is the whole more than the sum of its parts?

To acquire Reality Warping, organizations need to measure otherwise invisible variables in a larger context. For example, a mechanical engineer wants to know when a machine is operating out of compliance, as measured by multiple performance criteria (power, torque, pressure) and constraints (temperature, vibration). Multiple sensors measure all of this data at the point where it is generated. However, the operator may have to look at several different graphs to ensure that things are behaving correctly.

What if it were possible to summarize reality in such a way that the engineer could verify the performance and health of the machine across all criteria with a single metric or graph? By creating a virtual sensor at the network edge, the engineer acquires the Reality Warping superpower of easily implemented, industrial-strength analytics for tracking health and ensuring compliance across all equipment and processes.

Use Case

To extract precious metals from ore, a mining company first crushes and grinds the ore, then uses chemical and other methods to enrich the resulting material over many processing steps. The company measures quality in this multistage process through lab analysis of the platinum remaining in the tailings, or residue. The more platinum in the tailings, the less efficient the process. To anticipate such problems, the company summarized its complex, well-instrumented crushing and extraction processes in multivariate models and compared them to time periods known for greater efficiency (less platinum in the tailings). The models helped the company quickly identify problems in the grinding process, such as unusual combinations of particle sizes in a given step, before incurring significant losses.



Superpower #4: Control of Gravity

Edge Filtering of Outliers, Alarms, and Relevant History

In analytics, data has mass.

The more data there is, the more gravity seems to affect it and the more difficult it becomes to send the data to a centralized server for analysis. To comply with policies and regulations, many organizations continually invest in more hardware and network bandwidth to transmit data from remote sites back to the mothership, scan it for outlying data points and send an alarm or corrective action back out to the manufacturing floor.

Obviously, that practice is time-consuming, expensive and unsustainable. What is the alternative to constantly transporting, visualizing and analyzing ever-growing streams of IoT data in search of outliers? How can you control gravity and handle alarms closer to the point of decision?

To acquire Control of Gravity in end-to-end manufacturing and regulated industries, edge-based analytic models are the best way to monitor and filter the thousands of bits of data that sensors send out every minute. Control of Gravity complements Super Speed, Reality Warping and Shape Shifting superpowers, allowing organizations to monitor relevant data out where it is generated and send alarms to other systems or people. The edge filters send only the most interesting events back to the mothership, including operating conditions immediately before and after the alarm.

Use Case

Like many utility companies, a midwestern operator of coal-burning power plants struggles with the transition from fossil fuels to renewable energy sources. While coal remains the largest single source of energy in the U.S., its share is declining. Utilities are converting coal-burning plants to deliver power on demand and supplement renewable sources when needed, but meeting emission standards poses new engineering and operational hurdles. The operator has implemented machine learning models directly into the automated control systems at its plants to manage unstable combustion processes and emission spikes. This has led to significant reductions not only in emissions, but also in unscheduled outages and equipment failures, saving the operator tens of millions of dollars.

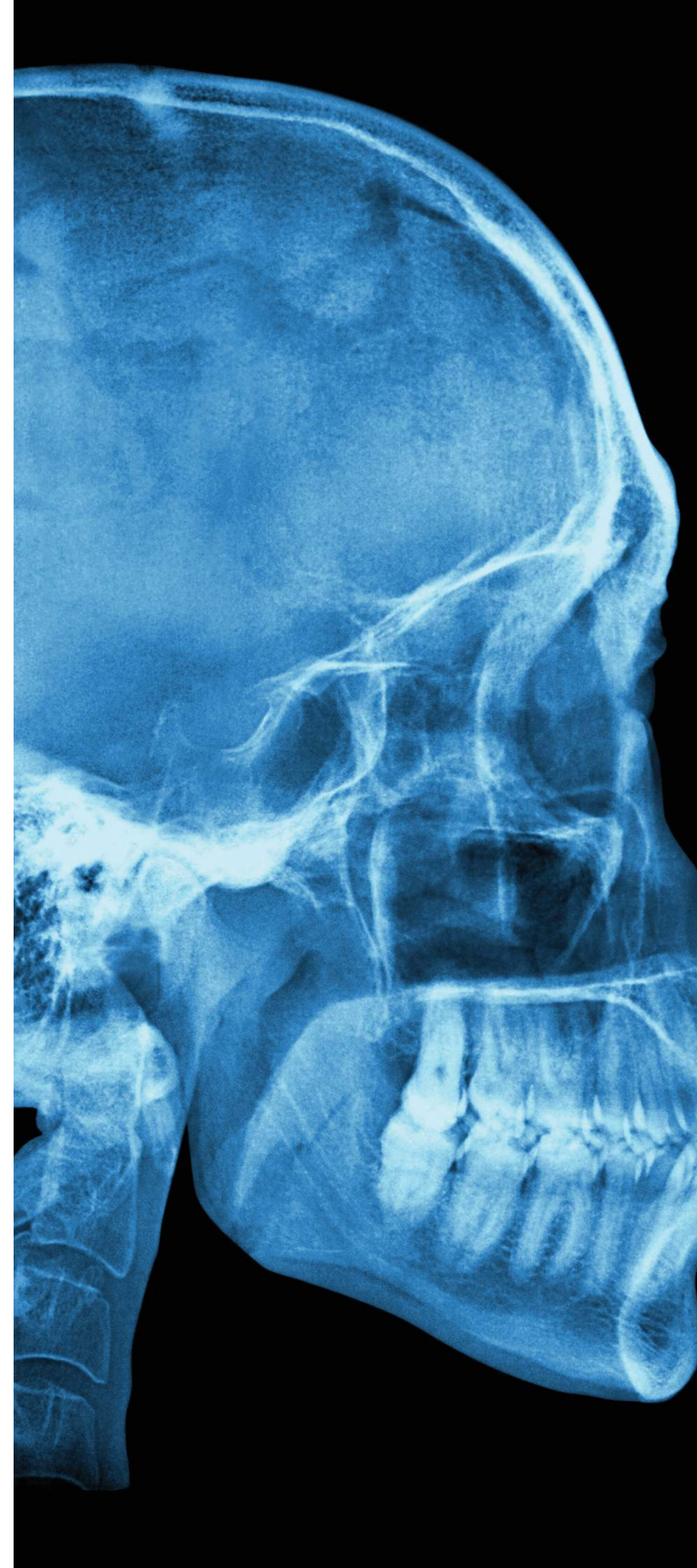
Superpower #5: Super Hearing and X-Ray Vision

Pattern Recognition and Machinery

Engines, turbines, furnaces, pumps and other machines emit signatures that indicate levels of friction, vibration and running noise. If engineers can detect and recognize these signatures, they can diagnose equipment health and predict mechanical failure before it occurs.

Wind turbines, for example, are equipped with embedded sensors for monitoring vibrations, and from the data generated by the sensors gradually comes a unique, discernable signature — how the turbines feel, sound and look, for each set of operating conditions. To acquire the Super Hearing and X-Ray Vision superpowers, an operator can create an analytical model that runs at the turbine, where sensors generate vibration data. The model is designed to compare vibrations emitted by the turbine to historical signatures that indicate everything from normal operations to imminent failure.

The Super Hearing and X-Ray Vision superpowers depend on pattern recognition algorithms to recognize and classify sound or visual patterns, and to provide useful insights at the network edge.



Use Case

Large manufacturers of coke must keep their emissions in check. Coke, a raw material used in making steel, is produced in batteries of ovens, where coal is heated to extreme temperatures in the absence of air. When implemented on an industrial scale, the process involves repeatedly charging (loading coal) and discharging hundreds of ovens across numerous batteries. The manufacturers monitor the surrounding air quality for emissions of very small, solid particles. Sensors generate data throughout the continuous charging, heating and discharging of hundreds of ovens, showing exit-gas opacity as an indicator of particulate emissions. When cracks develop in the walls of particular ovens and the emission level rises, certain signatures become more pronounced in the data linking the charge-discharge cycles to particulate emissions. One large coke manufacturer implemented pattern recognition methods to identify signatures, prioritize maintenance on cracked ovens and avoid excessive emissions.

Superpower #6: Control of All Matter

Quality Control through Edge Analytics

Implementing analytics at the edge of the network, close to the source of production data, has the potential to improve quality control and yields.

Companies in process-centric industries have become accustomed to bringing large volumes of machine data all the way back to the home office for analysis, decision and corrective action. Now, with the Control of All Matter superpower, they can take advantage of the falling cost of sensors to capture more data from more types of equipment, then analyze the data on dedicated hardware near the point of generation. When gateways and edge-based processors identify anomalies in the data, they trigger alarms and initiate corrective action, including direct communication with machines, to reduce waste and restore production to acceptable levels of quality.

In one pharmaceutical manufacturing company, that approach extends to building a validated connection to an advanced analytics platform for importing historical Laboratory Information Management System (LIMS) data for statistical process control (SPC).

Use Case

Manufacturers use quality control and process monitoring techniques to detect shift, drift, trends, trend reversals and exceptions, often in thousands of continuous data streams simultaneously. Automated manufacturing environments prioritize alarms by augmenting their quality and process techniques with meta-learning or rules. Increasingly, manufacturers use machine learning methods to sift through patterns of alarms and automatically convert them into actionable information. For example, semiconductor manufacturers automatically analyze and classify patterns of failures such as scratches or defects around the edges of silicon wafers. They identify possible root causes, and the specific processing steps and respective tools and machines that require inspection or maintenance.



Superpower Bonus: Ability to See the Future

Predictive Analytics and IoT – Next Steps

In short, it will eventually become unsustainable to ingest, transmit, store, query and analyze all of the data generated by your manufacturing process on a central server. Even with unconstrained server resources, the network latency will introduce delays in your detecting and reacting to signals within the data.

Instead of trying to use all of the data that comes back from your manufacturing processes, focus on using only the right data. Extracting value from vast amounts of data involves mining historical data for specific patterns, which in turn requires infrastructure that supports very large data sets and applies machine learning algorithms to them.

The examples and use cases given above are reactive: a condition arises, a sensor sends data about it, an alarm or notification fires and somebody or something takes action. While this is a natural starting point, the ultimate superpower is the Ability to See the Future. Organizations equipped to predict failures, out-of-control situations and sub-optimal operating conditions will outperform those who remain in reactive mode.

But even prediction is not enough. Consider the questions posed in the Introduction:

- Which decision am I trying to make?
- Which data is needed to support that decision?
- After I make that decision, how does my business process change and evolve?

If your organization has carefully thought through the answers to those questions, we can take the predictions from our ultimate superpower and prescribe actions, machine-to-machine, machine-to-human or both. Being able to not only predict the future but also prescribe actions that address the questions above will allow your company to defeat any super villains that may be hiding in your processes.

Summary

“I have lots of streaming data. Now I want to find something interesting.”

The Internet of Things is quickly expanding the potential to collect real-time data from your manufacturing processes and make real-time decisions. Unfortunately, IoT is also quickly expanding the data set, probably faster than you can keep up with it.

Are you making the best use of all the data you’re collecting now? How about next year, or in three years? What will it take to keep pace with your organization’s growing stream of data from all points along your manufacturing chain? Mining such large data sets for insights requires new methods of measurement.

Finding something interesting in your endless streams of IoT data requires the kind of superpowers that come from using edge analytics in your manufacturing processes. TIBCO Statistica™ provides the edge analytics needed to keep up with IoT in manufacturing. It is simple to use and it offers high-speed processing, real-time performance and analytic depth. Statistica complements gateway solutions that enable IoT at the edge of the network, close to where organizations in manufacturing and regulated industries collect data, monitor compliance and make decisions.