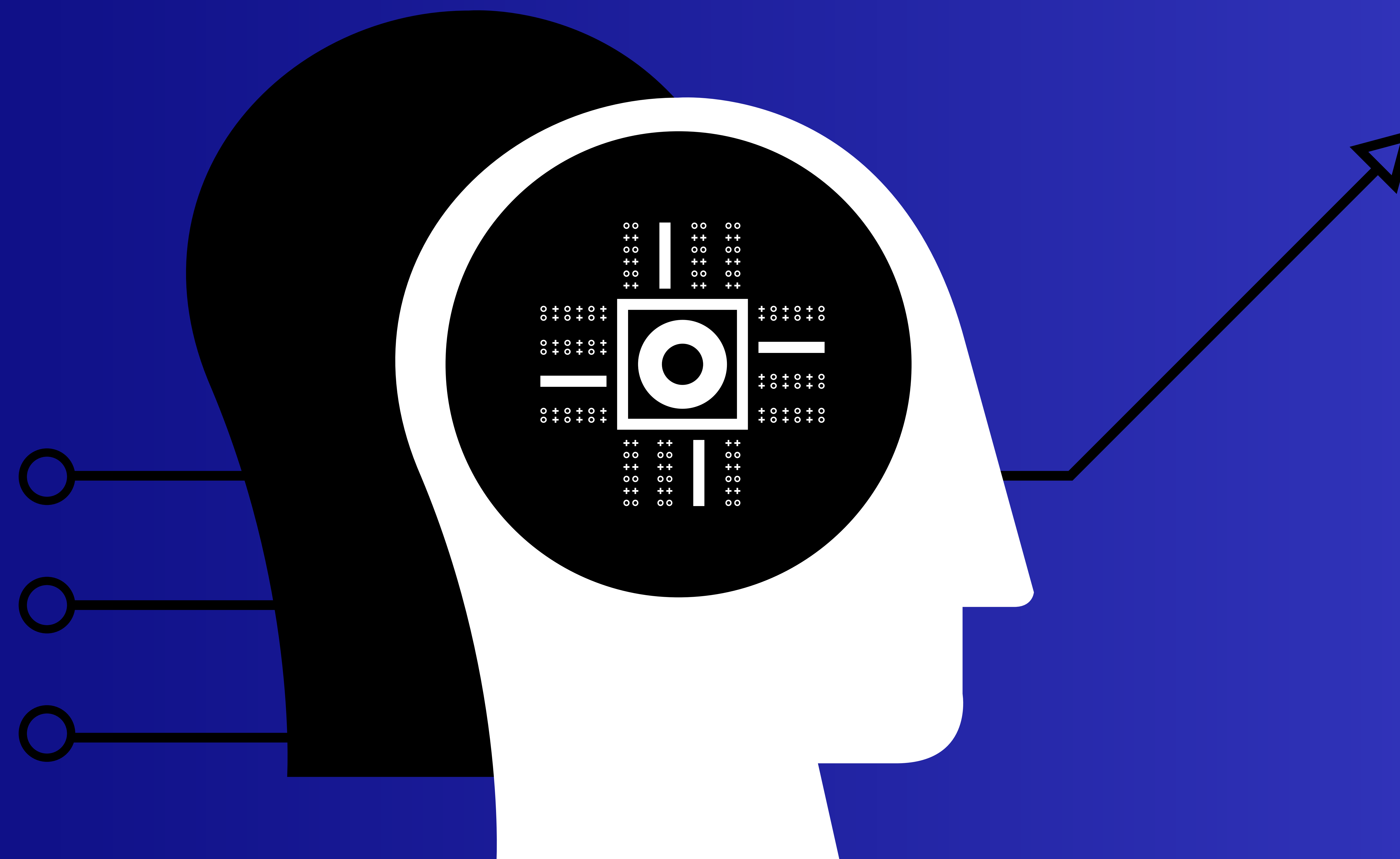
Big Data trends shaping Industry 4.0



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Introduction

Smart manufacturers are embracing the digital revolution – IIoT, machine learning, artificial intelligence, predictive analytics and cloud-based infrastructure.

In today's global, highly competitive economy, industrial companies are under intense pressure to lower manufacturing costs and streamline processes without compromising quality. Production managers are expected to contribute to improved business outcomes through ultra-efficient use of raw materials, near-zero production downtime, streamlined labor costs, and agile workflows — producing competitively priced, quality products that will enhance customer satisfaction and build brand equity.

Smart manufacturers are responding to these challenges by going beyond MES, SCADA and other IT-driven production systems to fully embrace the digital revolution and its underlying foundational technologies — the Industrial Internet of Things (IIoT), machine learning, artificial intelligence, predictive analytics and, of course, cloud-based infrastructure.

Due to the sheer scale of mass manufacturing, the impact on quality and/or profitability of each "small" issue becomes significant — each inefficient use of raw materials, each machine that is not operating optimally, each amount of time it takes to identify root causes and rectify malfunctions, each finished product or product-in-process that has to be discarded or is discarded mistakenly, and so on.

What is sometimes referred to as Industry 4.0 addresses these issues by gathering real-time data from machines and then analyzing the huge volumes of diverse data in order to identify inefficiencies or malfunctions, or even predict them before they occur.

Industry 4.0 reduces costs while improving quality through big data analytics that quickly identifies and even predicts malfunctions to trigger corrective or preemptive measures.

Corrective or pre-emptive actions can be triggered automatically according to each organization's requirements and workflows. Enterprise systems (such as production, finance, ERP, CRM) that are typically siloed now become integrated so that actionable insights can be achieved across all business processes, all manufacturing sites, and the entire upstream & downstream supply chain.

These challenges and solutions have become particularly critical in the automotive sector, which is undergoing a major structural change as vehicles become increasingly connected and autonomous. More and more consumers are perceiving their car as a smartphone on wheels, with strong expectations that it will be plugged into a wide range of online services and easily upgradable as its software-based technologies evolve.

Automaker OEMs are scrambling to meet these expectations without compromising safety and quality — and without increasing end-user car prices They know that their manufacturing processes must become more agile and flexible, and their already complex supply chain must be extended to include a new class of software and platform vendors.

In this ebook we explore how Operations and Manufacturing executives in all industrial sectors — and in the automotive sector in particular — are applying core mega trends in order to achieve better outcomes for their organizations.

Mega trend 1:
Artificial intelligence & machine learning to streamline processes

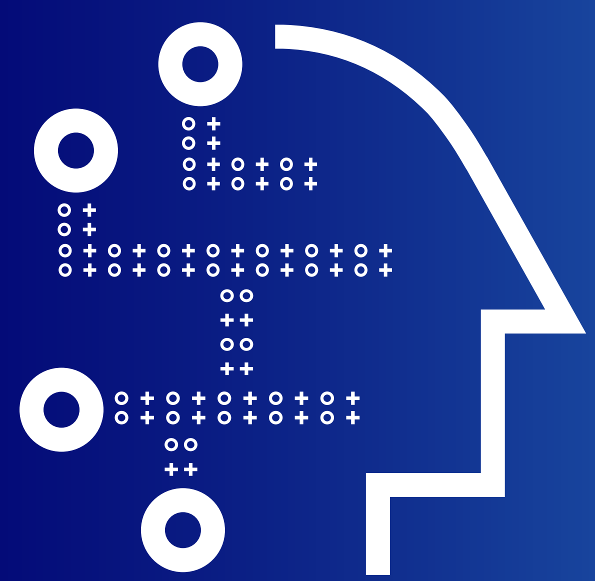
> Industry 4.0 … in the automotive sector had lowered conversion costs by 10-20%, with total productivity gains of 6-9%.
>
> – BCG 2015

The Industrial Internet of Things (IIoT) and its related technologies — M2M (machine-to-machine) communications, ML (machine learning), AI (artificial intelligence) — are transforming the factory floor into a smart, self-learning network of connected devices. Business Insider predicts that the installed base of manufacturing IoT devices will grow from 237 million in 2015 to 923 million in 2020, with manufacturers spending ~$267 billion on IoT solutions in that year.

In the IIoT scenario, manufacturing equipment, raw materials and the works-in-progress are all equipped with sensors that allow production control systems to track the condition of these assets in real-time. The varied streams of big data are fed into carefully trained ML and AI algorithms that can automatically identify and alert to performance gaps at many levels, from individual machines to production lines, inventory management, and so on.

The OptimalPlus IIoT-based manufacturing intelligence platform, for example, collects and analyzes data over many phases of the production process. It then applies AI algorithms to make decisions per unit/batch, support adaptive testing/manufacturing processes, and increase quality.

A 2015 study carried out by BCG in Germany found that Industry 4.0 implementations such as IIoT, AI and ML in the automotive sector had lowered conversion costs (i.e., manufacturing cost excluding materials) by 10-20%, with total productivity gains (including materials) of 6-9%.



IIoT-based intelligent manufacturing applies machine learning & artificial intelligence to equipment, material and process data for increased yields, agility & quality at lower costs.

Here are some real-life examples of how AI and ML are being harnessed to optimize production processes:

Overall Equipment Effectiveness (OEE): An automotive OEM was experiencing low OEE in a particular production line. They began collecting integrated sensor data on 15 operating parameters (such as oil pressure, oil temperature, oil viscosity, and air pressure) — for every machine, every 15 seconds, for 12 months. AI and ML technologies were then applied to the big data in order to better understand and manage the bottlenecks at the individual equipment level — and raised the OEE performance across the entire plant for that type of equipment from 65% to 85%.

Process benchmarking: It is not unusual for manufacturers to have multiple production plants and it can be very valuable to benchmark processes across the sites. With an enterprise-wide Industry 4.0 infrastructure, it becomes relatively easy to gather data at each site and then run sophisticated analyses to discover exactly which plants are achieving better process outcomes and why. These insights can then be used to provide consistent operator instructions across all manufacturing sites, and to optimize equipment and process controls in real time.

Big Data analytics provide increased yields, with greater flexibility and agility, at lower costs and higher quality.

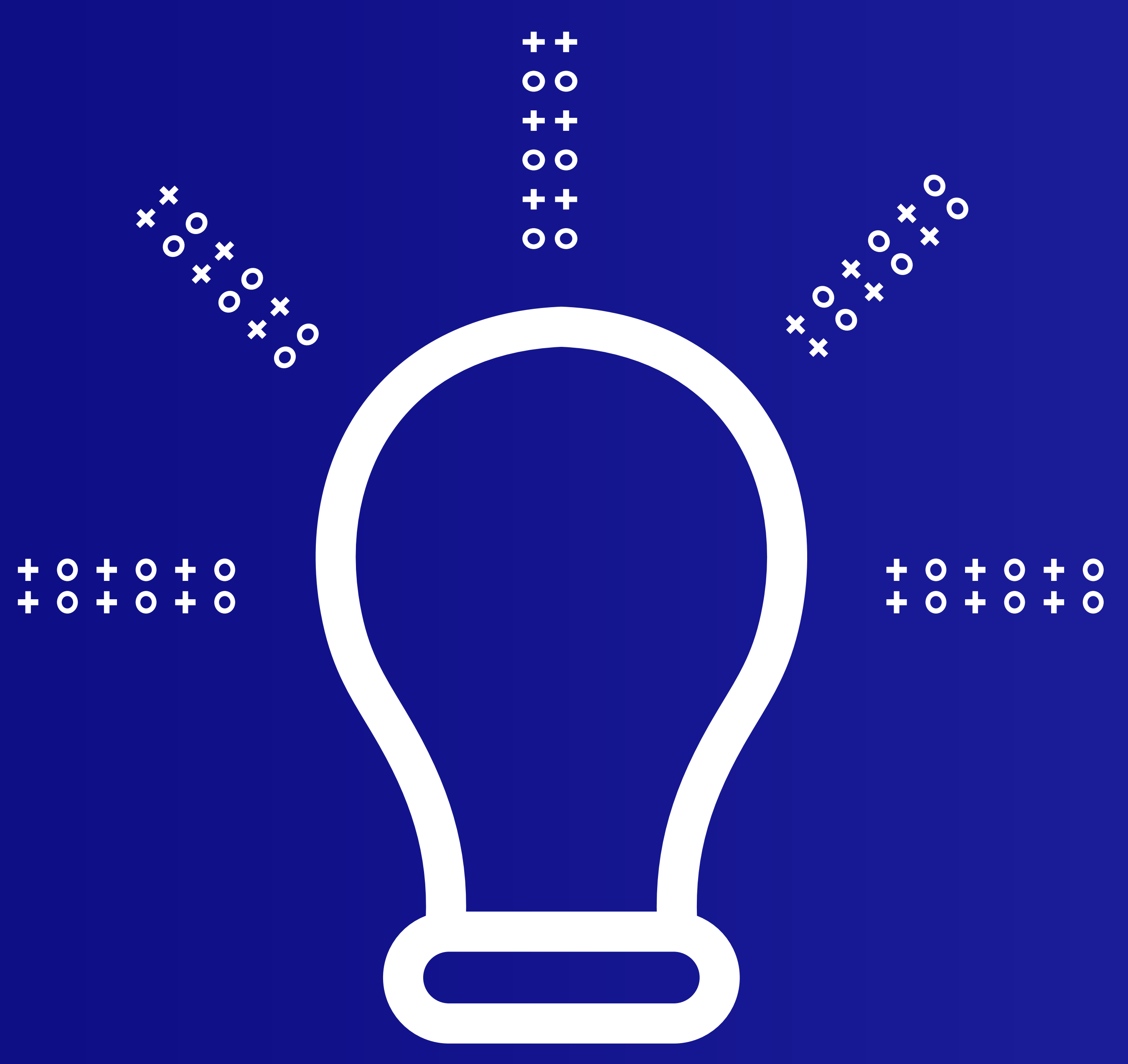
Production flexibility: In order to lower production costs and to make it economically feasible to run smaller, more customized batches, automaker OEMs and their suppliers are using M2M communications and ML-based processes to achieve on-the-fly production flexibility. A good example is a large drive-and-control-system supplier to the automotive sector that turned its valve production line into an adaptive system. Each work-in-process is identified by a unique RF code and the workstations across the production line automatically adjust their tasks to the specific needs of each valve type.

In these and many other ways, AI and ML leverage big manufacturing data to optimize the usage of materials, equipment, and personnel at all levels — from discrete production lines, to entire plants, to multi-site production operations. The results: increased yields, with greater flexibility and agility, at lower costs and higher quality.

What's next?

The focus of the industry has been on leveraging artificial intelligence to optimize manufacturing processes but there is much more to be gained by focusing the same capabilities on the products themselves. By using data generating during and after the manufacturing phase of the product, it is possible to gain deep insight into the workings (and failings) of the product and to better tune the process for better performance and higher quality.

Mega trend 2:
Predictive analytics for actionable insights



The greatest benefit of predictive analytics is the ability to predict malfunctions before they occur, and take preemptive actions.

One of the biggest challenges of any complex system — such as a manufacturing plant — is being able to quickly understand the root cause of a malfunction in order to reduce the MTTR (mean time to repair). In the auto industry, for example, Business Insider estimates that each minute of work stoppage costs $22,000 — or $1.32 million per hour.

Predictive analytics aggregates and normalizes huge volumes of diverse, real-time production data streams in order to create root cause analysis (RCA) models that can quickly identify which of many subsystems is the one that has caused a work stoppage. When the root cause is clear, the right corrective workflow can be triggered to deal with the problem and reduce the time to repair.

But perhaps the greatest benefit of predictive analytics for those charged with keeping manufacturing systems up and running is the ability to predict malfunctions before they occur, and take preemptive actions.

In the example described above of the automotive OEM that used AI and ML to enhance OEE, the real-time operational data that was collected over 12 months was also used to create reliable failure probability models and generate an estimated time to failure for each piece of equipment. These predictive analytics became the foundation for optimized Maintenance, Repair, and Overhaul (MRO) practices that reduced costly machine failures.

Mega trend 3:
Optimized quality & reliability – across the entire supply chain

Over 95% of respondents believed that better problem-solving would have a significant impact on quality.

– Deloitte Quality 2020 survey

In Deloitte's Quality 2020 survey for the automotive industry, over 95% of the respondents believed that better problem-solving would have a significant impact on quality. Two key factors that they cited for their problem-solving challenges are inadequate root cause analysis and management/ organizational culture.

These two factors are, indeed, related. Effective root cause analysis is possible only when all relevant data is brought to bear in understanding the problem. However, it is not unusual for an organizational culture to encourage data siloing. Rather than integrating production and quality data, for example, in order to achieve an end-to-end understanding of a failure, each data set is carefully guarded.

The power of OptimalPlus' QPaaS (Quality Platform as a Service) solution is that it breaks down data silos and uses both production and quality data in its root cause analyses and adaptive manufacturing/testing processes.

Quality issues In the automotive sector are exacerbated even further by the fact that the branded automaker OEMs essentially assemble subsystems and components that are provided by a complex network of tiered suppliers. However, OEM visibility into the supply chain has traditionally been limited.

Increased visibility into supply chain data helps OEMs assess the overall performance of their suppliers and optimize their procurement decisions.

A painful example is the Takata airbag recall that took place in 2014. No less than ten automotive OEMs were using the airbags, which were found to explode with too much force. Inadequate quality control records made it unclear which specific makes and models were affected, resulting in a massive recall over months and years of ~42 million vehicles manufactured between 2000 and 2011. The cost of the recall, the largest and most expensive in automotive history, is estimated at $24 billion, much of which will have to be absorbed by the OEMs themselves since Takata has, in the meantime, filed for bankruptcy.

With the advent of advanced data technologies and the maturing of the cloud infrastructure, data-driven quality assurance across the entire global supply chain is gradually becoming the new norm. In addition to the quality benefits, the increased visibility into supply chain data also helps OEMs assess the overall performance of their suppliers and optimize their procurement decisions.

Summary

Advances in IoT, data analytics, machine learning and artificial intelligence are being embraced in the automotive sector, which is undergoing dramatic changes as connected, autonomous vehicles become mainstream.

Automotive OEMs are under pressure to shorten production cycles and fully leverage production capacities, with no compromising of quality and safety.

The advances in IoT, data analytics, machine learning, artificial intelligence and cloud infrastructure are being embraced by smart manufacturers around the globe to enhance yields and quality, while maintaining or even reducing costs. Oceans of production, quality and other business-critical data are now being aggregated from previously siloed repositories in order to streamline and automate processes, with compelling ROIs from lowered costs of materials, resources, capital expenditures, and labor. Less tangible but equally important benefits include more reliable quality outcomes, better supply chain management, and enhanced responsiveness to customer requirements.

These value propositions are even further amplified in the automotive sector, which is undergoing dramatic changes as connected, autonomous vehicles become mainstream.