# The intersection of artificial intelligence and manufacturing: industrial AI

**Analysts - Ian Hughes, Haley Brown**

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## Introduction

Artificial intelligence (AI) and machine learning (ML) have continued to garner vast amounts of attention as their impact resounds across multiple industries, manufacturing being no exception. Nearly 31% of enterprise respondents within the manufacturing sector from 451 Research's Voice of the Enterprise: Internet of Things, Workloads and Key Projects survey claim that AI/ML technologies are a critical enabler to the success of their organization-wide IoT initiatives. Although AI/ML is currently being used to drive IoT initiatives for a mere third of manufacturing respondents, its influence is continuously growing, with the magnitude of its impact significant at both the industry and the organizational level and driving adoption.

As per 451 Research's Voice of the Enterprise: AI & Machine Learning, Adoption and Use Cases survey, 90% of manufacturing respondents believe AI will have at least a slight impact on the industry over the next two years, while 75% believe the same about their own organization. Adoption of AI/ML is increasingly born of a need to remain competitive within the space, driven more strongly by industry-wide shifts in sentiment compared with organizational pressures. However, sentiments surrounding AI are positive, demonstrating a positive outlook and driver of adoption that will increasingly lead to greater overlap and co-deployments of IoT and AI/ML technologies over the next few years.

## The 451 Take

AI/ML is rising in importance as a critical enabling technology in manufacturing environments for the adoption and success of IoT deployments. As data generated by sensors and distributed systems becomes increasingly complex and continues to increase in volume, AI/ML is essential to make sense of it, allowing for the generation of critical insights from IoT deployments, driving key value for various manufacturing applications. The concepts of AI/ML and the technology used is similar across all verticals, but industrial use is an edge first use case that has driven changes in how models are

orchestrated and distributed. Machine optimization is a prime example where constant time series data needs to be evaluated on the fly, such as preventative maintenance and automation. That is not to say cloud or other compute venues in the IoT continuum do not have a place, as clearly comparing the Overall Equipment Effectiveness (OEE) of multiple factories globally located is not a pure edge computing use case. Despite pervasive inhibitors, deployment of industrial AI applications within manufacturing environments is anticipated to grow significantly over the next two to three years, driving demand for AI/ML applications at the edge, ultimately paving the way for advances in industrial robotics and broader use cases into the future.

## Current state of industrial AI

According to 451 Research's Voice of the Enterprise: IoT, The OT Perspective 2H 2018 survey, nearly 42% of manufacturing respondents have actively deployed AI/ML technology as a part of a current organizational IoT initiative.

Within manufacturing, IoT use cases span the entire continuum of operations from plant design and commissioning to production monitoring to connected worker and can be built upon and optimized by employing AI/ML technology. However, in addition to AI/ML applications used in tandem with manufacturing specific IoT use cases to augment functionality, certain use cases have specifically emerged as a result of the intersection of IoT and AI/ML technologies, including the likes of intelligent logistics and smart robotics. These use cases resulting from the marriage between AI/ML and IoT technologies are showing traction, with steady growth in adoption catapulting them to become key use cases within IIoT following the adoption of inventory and/or production monitoring and management, and predictive maintenance applications.

As per 451 Research's 2H 2018 OT survey, intelligent logistics is growing steadily, with 41% having deployed such initiatives today, with an additional 44% planning to implement them over the next two years. Smart robotics is also experiencing significant growth within the manufacturing sector, anticipated to rise from a quarter of respondents currently deploying today to include an additional 35% in two years' time, more than doubling its footprint. This growth in uptake of AI/ML and IoT specific use cases is largely being driven by desire for optimization, quality improvements and automation.

## Drivers for adoption

IoT applications are driven by business needs; within manufacturing environments, more targeted benefits are being sought as a response to an overarching desire to make better use of IoT data being collected. AI/ML's greatest point of value contribution within an IoT-specific context is its ability to efficiently process and make use of the vast amounts of generated sensor and system data. Increasingly, these large collections are described as digital twins representing an 'as-is' state for a system. Largely, adoption of AI/ML is driven by manufacturers' goal to use their collected IoT data (digital twins) ultimately to optimize operations, improve quality of products/systems and automate key processes.

### Optimization

The most significant driver on adoption for AI/ML among manufacturing constituents stems from a desire to optimize operations using generated IoT data (nearly three in five respondents claim this). The aim of operations is to improve the OEE, a measurement of how quickly and to what quality parts are manufactured against the downtime of the line. Traditionally, this includes applications along the lines of preventative maintenance to attempt to reduce downtime, alongside logistics, as well as inventory and/or production monitoring/management to manage costs and provide process visibility. When leveraged in this context, AI/ML models are able to efficiently identify anomalous

behavior from equipment sensor data and, once identified, the trained models can offer and convert it into meaningful, actionable insights for proactive asset maintenance, ultimately preventing downtime or accidents.

The same concept is used in security across systems providing warning of unexpected behavior. IIoT and providing real-time visibility/information into production line operations and systems both up and downstream (supply chain) can also aid overall decision-making. Additionally, AI/ML models leveraged for inventory management purposes free employees to focus on other tasks, reducing human error in such complex, distributed environments and boosting combined productivity, not replacing human jobs. ML also finds a home in augmented reality (AR) systems for connected workers, where it is increasingly used to identify specific objects and pieces of machinery in order to provide the correct data to a service engineer through smart glasses or a headset. AR is the user interface for IoT and is greatly enhanced by AI technology both in understanding the world around a device as well as offering guided work instructions to the engineer in context or improving any human-centric process for safety or efficiency.

### Improve quality of products and/or systems

Second to optimizing operations, another key driver on AI/ML adoption, according to 59% of IoT manufacturing respondents, is to improve the resulting quality of products and/or systems. AI/ML models using computer vision technology can more effectively and efficiently aid in visual inspection processes. This ultimately drives benefits in the form of improved output by means of reduced defects and reduced materials waste, positively influencing manufacturers' bottom lines.

Increasingly, AI techniques are used in design processes across computer-aided design (CAD) and product life cycle management (PLM) with algorithms offering a curated set of design tradeoffs (e.g., weight, strength, complexity, cost) for selection by the design engineer.

### Automation

By collecting the vast amounts of data being generated at the source (edge) and then also employing AI/ML models to not only process but act upon that data locally improves the efficacy of systems while reducing complexity. Automating key business processes – although many would attempt to attribute this strictly to robotic process automation (RPA) – encompasses a broader desire for smart physical autonomous robotics to achieve automation of more sophisticated manufacturing processes. Within an industrial manufacturing environment, robots are really edge computing devices that are required to make smart decisions locally and quickly, requiring the utilization of AI/ML models running at the edge vs. solely in the cloud. We recently published an overview of a nine-level autonomy classification of robots to help understand this space.

## Barriers to adoption

As with any new technology, the intersection of AI/ML and IoT has resulted in various key challenges, hindering adoption and success of deployments.

### Skills gaps

Historically, AI/ML model deployments' greatest inhibitor has been a lack of available skilled resources. Within distributed industrial manufacturing environments, this skills gap becomes more prevalent because deployments require specialized knowledge sets encompassing both AI/ML model training as well as knowledge of IoT and, more importantly, industrial environments. Due to this complexity, it remains difficult for many to find the appropriate expertise to enable successful deployments.

### Budget constraints

Thirty-six percent of respondents say that limited budget is another major barrier to AI/ML adoption within manufacturing environments. Industrial IoT deployments in manufacturing environments are networks comprising many legacy devices. The intersection of AI/ML and IoT requires models to be run at the network edge on existing data-generating devices, acting essentially as robots, requiring brownfield infrastructure modernization and/or new deployments entirely. This can be costly to get such projects off the ground; however, as AI/ML becomes integrated into machines into the future, this will become less of an issue, tracking with the growth of IoT in general.

### Technology integration challenges

Due the inherent complexity of distributed IoT environments involving many different types of hardware and software, as well as legacy systems, technology integration is a main challenge facing the deployment of AI/ML models. Traditionally, ML models are trained in the cloud and getting them to the network edge highlights the last-mile problem with ML in manufacturing.

However, despite these pervasive inhibitors, AI/ML applications within IoT-dominated manufacturing environments are showing tangible benefits in present operations, positively influencing OEE and operations, ultimately improving manufacturing constituents' bottom lines.

## Outlook

As per 451 Research's 2H18 OT Perspective survey, respondents believe AI/ML will increasingly become a part of their organizations' IoT initiatives in the near term, rising from 42% with AI-enabled IoT deployments today to 72% within the next three years.

Anticipated use cases in the future are diverse, extending beyond intelligent logistics, smart robotics and optimization applications to include maintenance forecasting, reducing materials waste, quality assurance using computer vision, product design and creation, as well as assembly line optimization and an AR-enabled workforce.

The drive on robotics applications can also be anticipated to increase with a rising need for these tools to work collaboratively with humans in an ad hoc way. Smart robotics and connected workers are part of the overall system.

Anything that improves OEE has a bottom-line impact, with thousands to hundreds of thousands of dollars potentially lost even due to short bouts of downtime. AI/ML techniques' ability to improve the understanding of what data is generated complements robotics applications within manufacturing environments, driving its adoption and advancement into the future.

The resulting overlap between AI/ML and IoT technologies is at present generating felt value within industrial manufacturing environments and will only increase in size and scope in the near term.