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The Future of Automation – A Primer

An outlook on the impact of AI, Edge and Augmented Reality on automation solutions of tomorrow

A Frost & Sullivan White Paper

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SIEMENS

THE FUTURE OF AUTOMATION: KEY ENABLER FOR THE VISION OF FUTURE FACTORIES

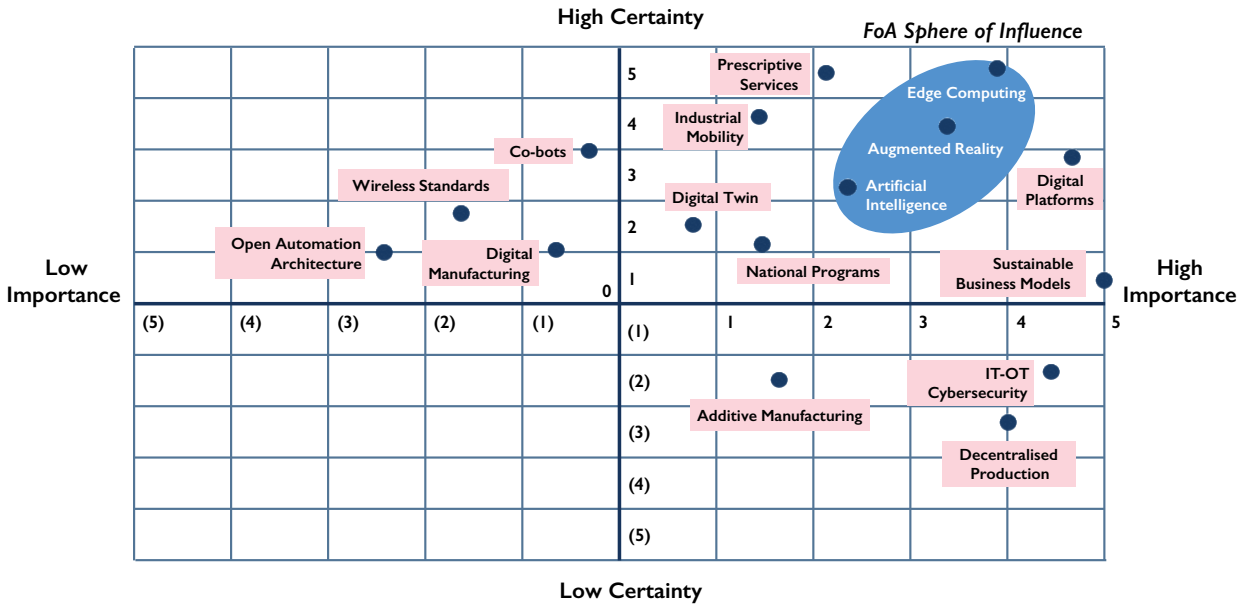
The world of manufacturing and industries has never been as dynamic as it is today. Ever since Platform Industrie 4.0 was launched at the 2013 Hannover Messe, we have seen a surge in interest and call-outs to disrupt manufacturing business models like never before. Despite initial skepticism, the industry has moved forward, and the discourse in the supplier world has moved from new product introduction to new business ideas enabled by digitalisation.

The paradigm of Industrie 4.0 (or any similar initiative) is based on the benefits that manufacturing can accrue from the processing of production data in real time. Aided by full-fledged industrial networks, data from the factories can be acquired, stored, and assessed for insights, which can then be relayed to appropriate value streams for utilisation. This design will create a dynamic factory that can optimise in real time and engage efficiently with the extended value chain. This impending change will involve a gradual evolution—one that begins on the shop floor of industrial automation.

Industrial automation is a domain that developed gradually over time. The technologies surrounding automation and the standards thereof were the outcomes of cautious introduction from suppliers and careful adoption by end customers. The result is thus a highly standardised product market where proprietary approaches run strong and change is hard to come by. Naturally, the boundaries of automation, whether from a programmable logic controller or a human-machine interface, have not changed significantly.

Innovation has played out, but fundamental designs have not witnessed a major overhaul. However, the automation of yesteryear is slowly becoming untenable for realising future needs. This requires reimagining automation across all facets, starting from design, engineering, deployment and operation. Reimagining automation is greatly aided by Mega Trends such as internet of things, big data, and analytic services, which involve sweeping digital changes in the factories of tomorrow. As indicated earlier, envisioning the future of factories must first begin with a vision for the future of automation, an approach that has been relatively less explored in the industry today.

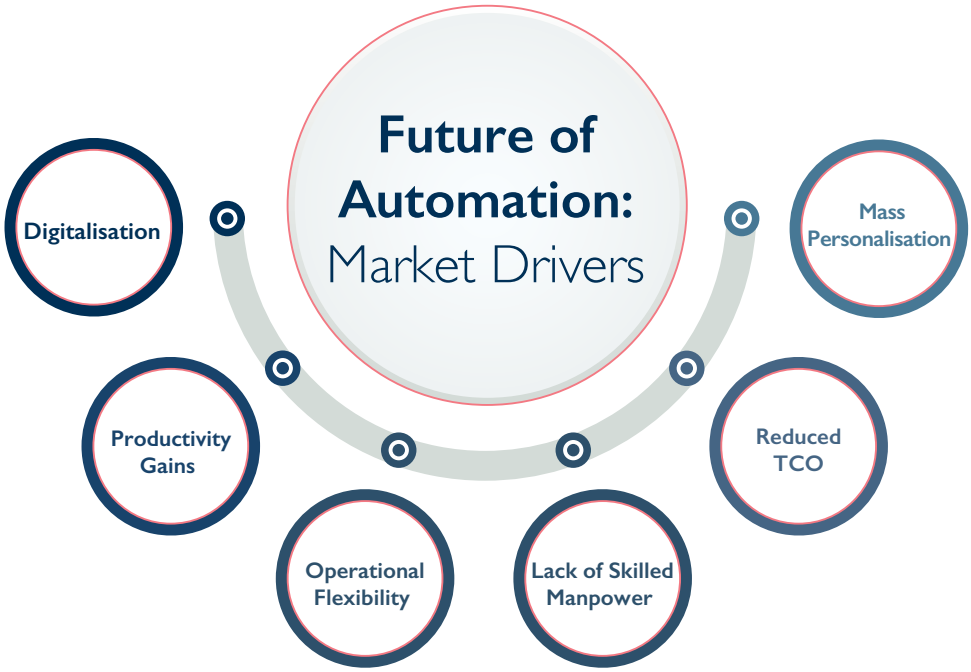
Exhibit 1: Future of Manufacturing: Key Influencers in the Future of Automation



Note: Certainty indicates probability of impact. Importance denotes market significance/need. Source: Frost & Sullivan

It is important for this discussion to be mainstream as there are new companies from the information technology space entering into the manufacturing space. On the one hand, IT firms with long-standing digital know-how are essential to support manufacturing evolution. On the other hand, it is imperative to realize that without proper domain expertise, especially in automation, it is highly unlikely that we will see any major development with regards to end-user adoption.

Exhibit 2 : Future of Automation: Market Drivers



Source: Frost & Sullivan

We have identified a set of key influencers that will redefine manufacturing on the shop floor. The influencers include a combination of technology trends, broad-based industry trends, and new business models, spread across degrees of importance and certainty of impact. These factors have varying levels of impact on manufacturing production, but our interest has been in trying to carve out 'spheres of influence', specifically with regard to industrial automation.

In particular, the three trends of artificial intelligence, edge computing, and augmented reality have been identified as factors that can strongly influence automation in the following ways:

1. **Artificial intelligence has the potential to transform human-centered engineering models into automated systems, facilitating continuous operational learning and resulting in productivity gains that can exceed existing human-led approaches.**
2. **Edge computing or computing at the edge can help expand PLC functionalities with additional computing power and personalised operational needs without sweeping changes to production architecture.**
3. **Augmented reality will be the HMI of the future, enabling operators with high transparency and superior insights into controllers, machines, and production processes.**

The subsequent portion of this white paper will outline how the future of automation can be redesigned using the three technology themes mentioned above.

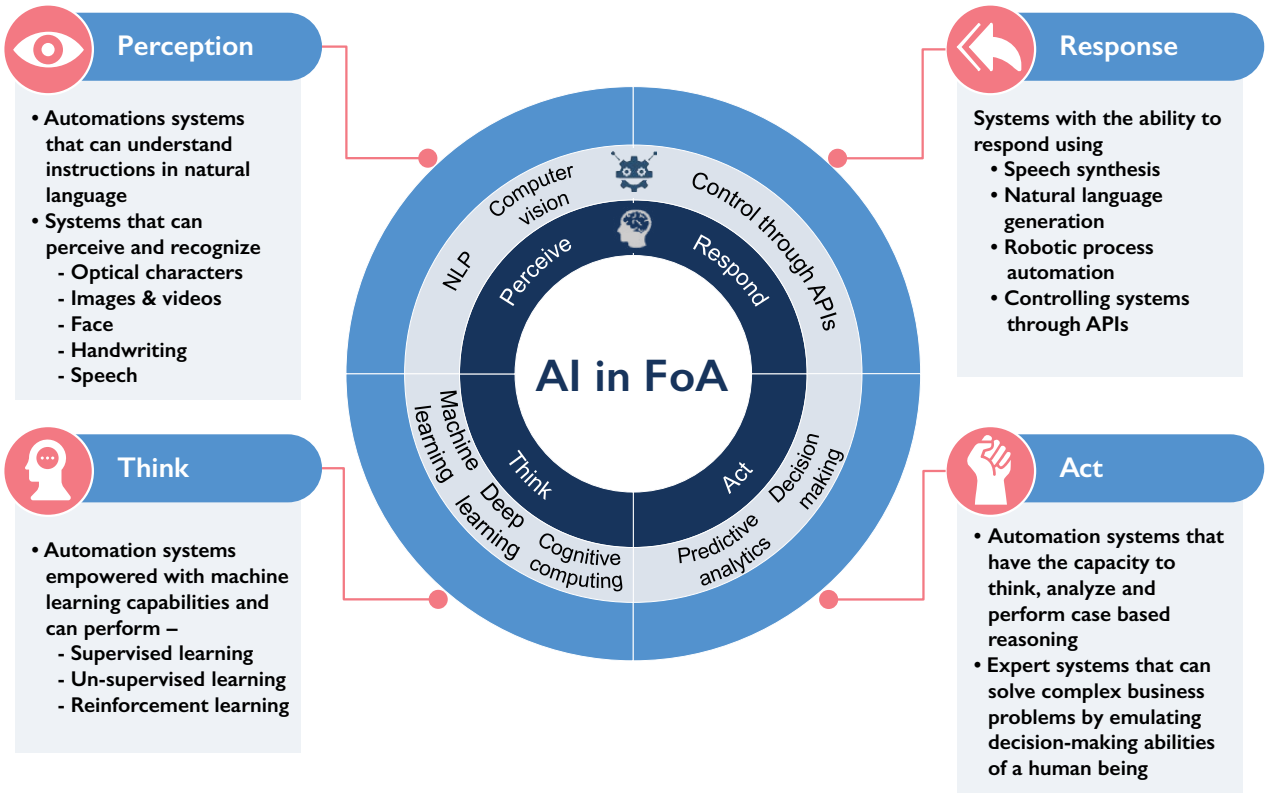
ENVISIONING AI FOR INDUSTRIAL AUTOMATION

The rise of AI for manufacturing is a natural offshoot of the fourth industrial revolution. AI has varying definitions, from the simplest forms that are characteristic of human intelligence to the most complex ones that possess supernormal capacities. To simplify, AI is the endeavor to create machines that can sense, process and act like humans, including natural language processing, planning, image, object and sound recognition, and problem-solving.

In this context, we also have to focus on machine learning (ML), which provides the means to achieve artificial intelligence. AI without machine learning is akin to programming without advanced languages; i.e., machine learning makes it easier to achieve AI compared to conventional means. It conveys the ability of a system (or a machine) to learn without being programmed explicitly. ML deals with training algorithms to learn about specific contexts using massive troves of data. ML can be further achieved through deep learning (DL), decision tree learning, inductive logic programming, etc., with each approach designed and suitable for specific situations.

The field of AI, despite being highly contentious, is well-developed technologically and now beginning to be exploited for various landscapes, most notably in the consumer space. Our aim, however, is to identify how AI can help manufacturing and, in particular, automation. How could AI be deployed to benefit industrial automation?

Exhibit 3: AI in Future of Automation



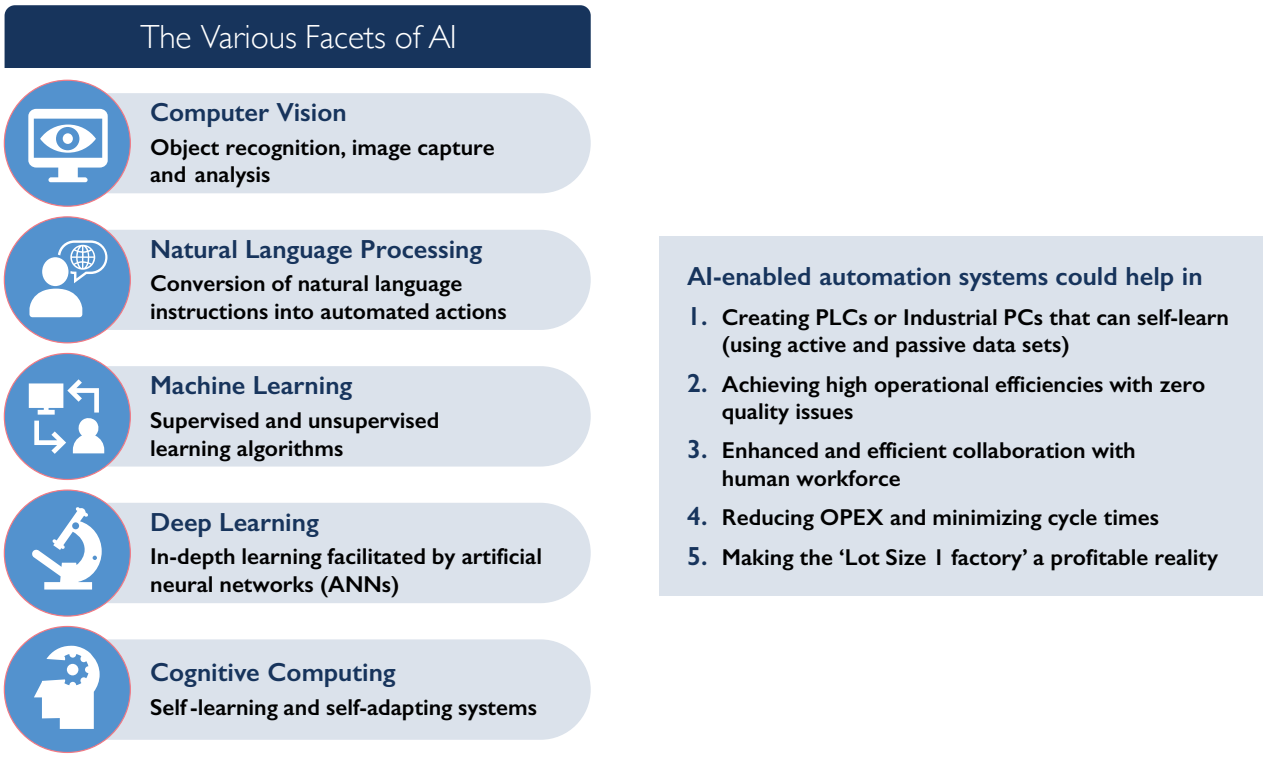
Source: Frost & Sullivan

One major pre-requisite for AI is the need to have massive amounts of data for training algorithms to achieve high accuracy. The production environment driven by automation systems, like PLC, is replete with information and data that is scarcely put to use. The question then is whether we can find a way to use AI and concepts such as ML and DL to help automation engineers with systems that can perceive, respond, think and act using AI-based learning algorithms. It is possible to imagine a PLC or an industrial PC armed with AI and capable of learning from production data sets to emerge with operational programs that are robust, flexible and highly accurate. In a way, an AI-enabled PLC would break free from the conventional definition and

transform into a hyper-intelligent system with eternal learning capabilities. In the exhibit, we have provided an outline of AI's potential in the future of automation (FoA).

There are five major aspects of AI that could be adopted within industrial automation, ranging from the most basic forms of AI, like computer vision, to advanced models like cognitive computing.

Exhibit 4: The Various Facets of AI



Source: Frost & Sullivan

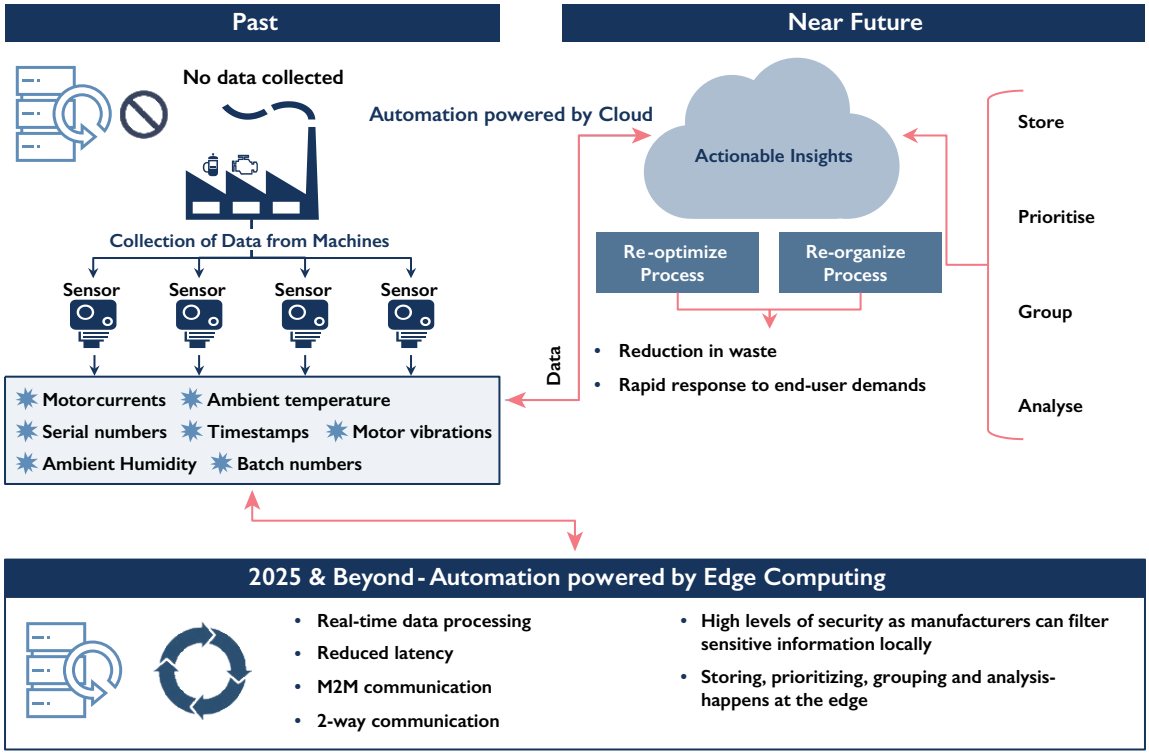
Using AI in industrial automation is possible today, and with increasing AI use cases in the consumer world, this approach should find traction in the future of automation.

MOVING TO THE EDGE

Industrial IoT is transforming how data is being generated, gathered and analysed. Today, the industrial infrastructure is burgeoning with data like never before. This transformation calls for a change in the existing infrastructure to support the changing needs of the industry. One of the primary components of this emerging infrastructure will be the edge devices, including next-gen controllers such as PLC, DCS and PAC. Apart from controlling the different manufacturing processes, these systems will also gather, store and process data at the source of data generation.

In this emerging scenario, key business processes such as analysis, control and decision making may be distributed between the edge and the cloud, as required. With data making a move from the cloud to the edge, not all of the data that is generated by the manufacturing ecosystem would be sent to the cloud. The edge would act as the decisive component that decides what kind of data needs to be sent to the cloud and when. Additionally, the edge will be instrumental in collating all the data that is generated from different domains to ensure speedy analysis in real time. The workload of data processing thus will be shared between the cloud and the edge.

Exhibit 5 : Moving to the Edge – 2025 & Beyond



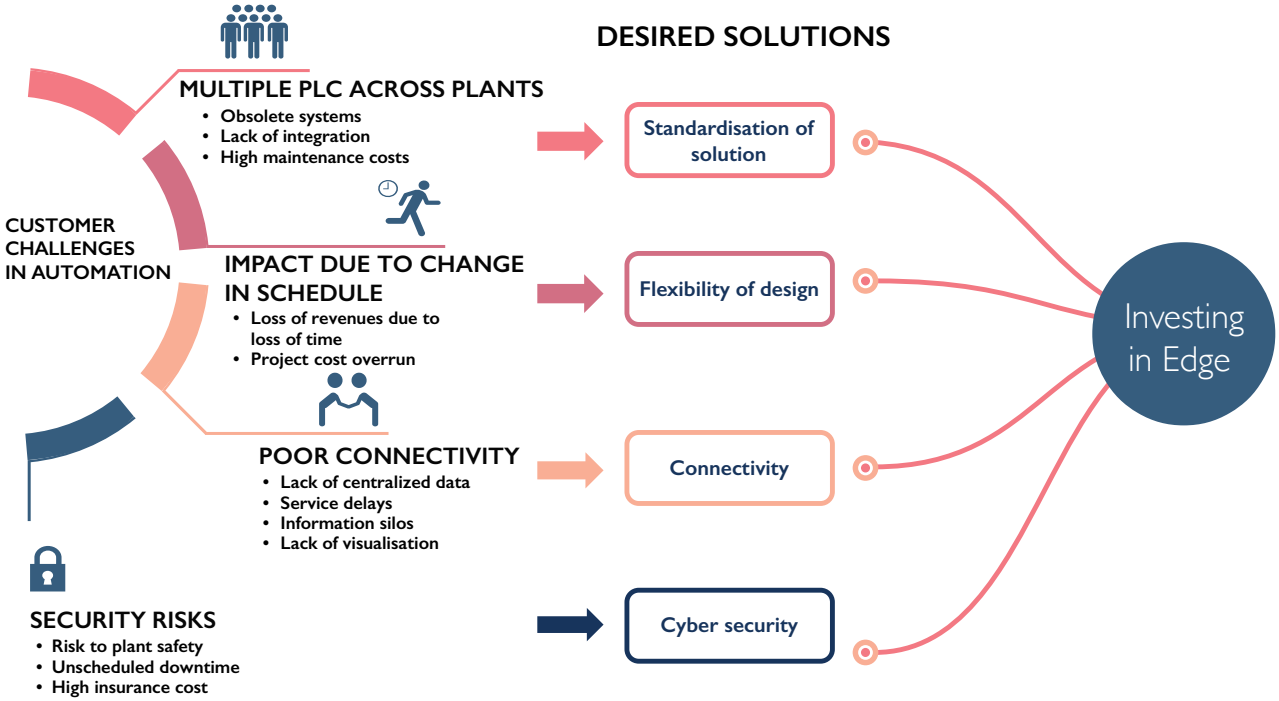
Source: Frost & Sullivan

The edge will have a prominent role in addressing some of the major challenges in the industry while on its path to shaping the future of industrial automation. Some of the key factors that will drive adoption of edge over cloud will be cybersecurity, standardisation of solutions, design flexibility and low latency. With market competition getting stiff, there will be a dire need to maintain confidentiality of all data that is being generated.

With the introduction of the edge, there will be growing emphasis on encrypted communication and protection of IP, along with system integrity. Generation of data at the edge would thus imply ensuring maximum levels of data security at all levels of the plant infrastructure. With different types of data generated at different levels, security measures will also need to be as varied as the potential risks. Companies will be encouraged to follow an end-to-end approach to industrial security combined

with several complex levels of integrated security mechanisms. Further, conducting all data processing at the edge will help ensure low latency and save the time, effort and bandwidth required to move data from the edge to the cloud. Companies will begin to see value through investments made in edge technologies.

Exhibit 6: Investing in Edge – Challenges vs. Solutions



Source: Frost & Sullivan

Innovations are expected to be built on the basis of real-time data availability on the edge devices. Increased collaboration of operations with the aid of advanced tools and analytics will further help improve productivity. Edge computing will thus come a long way in disrupting existing limitations in data processing and solving some of the biggest challenges in the industry. Edge computing is likely to evolve as the next natural step from cloud computing and will lead to sophisticated end-computing. Edge intelligence will become an important technology that will support the decentralized and intelligent processing of unparalleled data volumes generated by IIoT devices.

AUGMENTED REALITY IN AUTOMATION

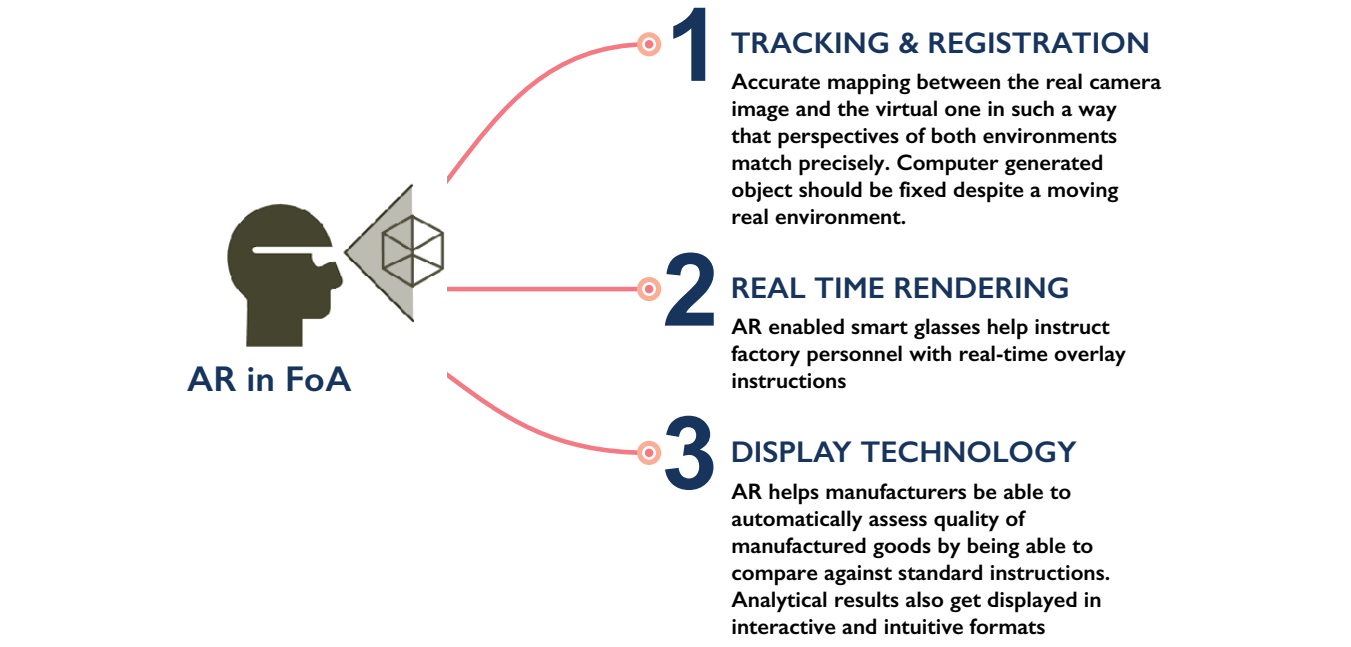
Augmented reality (AR) has been a futuristic trend for many years; more precisely, a trend that belongs in a distant future. In the industrial context, in particular, AR as a topic is mostly assumed to be more of a digital fancy than a utility.

Augmented reality is an amalgamation of the digital world with the real world. Augmenting the real world using insights from the virtual world creates an AR environment. If virtual reality (VR) denotes the visual essence of digital insights, then AR is about bringing this digital essence in the context of reality, helping people see more than what is obvious and, in the process, enabling more informed decision making. In simple terms, AR helps create an enhanced vision of reality.

Naturally, AR, if applied in the right context, can bring about enormous value for automation, including both factory and the process variety. The idea of superimposing digital information on top of physical assets in the real world is extremely powerful in an industrial context.

AR benefits in an industrial context are immense, some of which are listed below:

Exhibit 7: AR in the Future of Automation



Source: Frost & Sullivan

This ability can aid operators and factory personnel access work instructions in real time and visualise process outcomes pre-emptively. AR systems allow industrial users to completely immerse in sandboxes and simultaneously act on data and insights delivered by analytics.

The ultimate goal of any AR implementation should be vested in constructing an intuitive and immersive experience that can augment and amplify the way factory personnel is able to visualise and interact with data. In that, AR can come a long way in shaping the future of industrial automation, especially in the design of human-machine interfaces (HMIs) that form the front end of industrial automation. Besides real-time insights, AR-enabled HMI systems can bring a multi-dimensional process view (up to 4D) as compared to 2D interfaces of conventional HMIs today.

The benefits of AR systems in the future of automation are listed below:

1. Guided Assistance in Maintenance

Using AR systems like Smart Glasses, alongside PLC-HMI product interfaces, operators can be provided with instructions to carry out a desired maintenance task. All secondary information like product manuals, operational instructions, maintenance work logs, etc., can be pulled up digitally without the hassles of manual effort.

2. Pre-empting Process Outcomes

AR systems not only work in real time but possess the ability to generate outcomes based on specific process action. AR-based HMI systems can help operators see the outcome of a specific response, aiding in measuring and improving real-time decision making on the ground. It is likely that in the future, AR will drive all HMI interfaces to the extent that the current HMI systems will go through a complete makeover.

3. Remote Monitoring and Collaboration

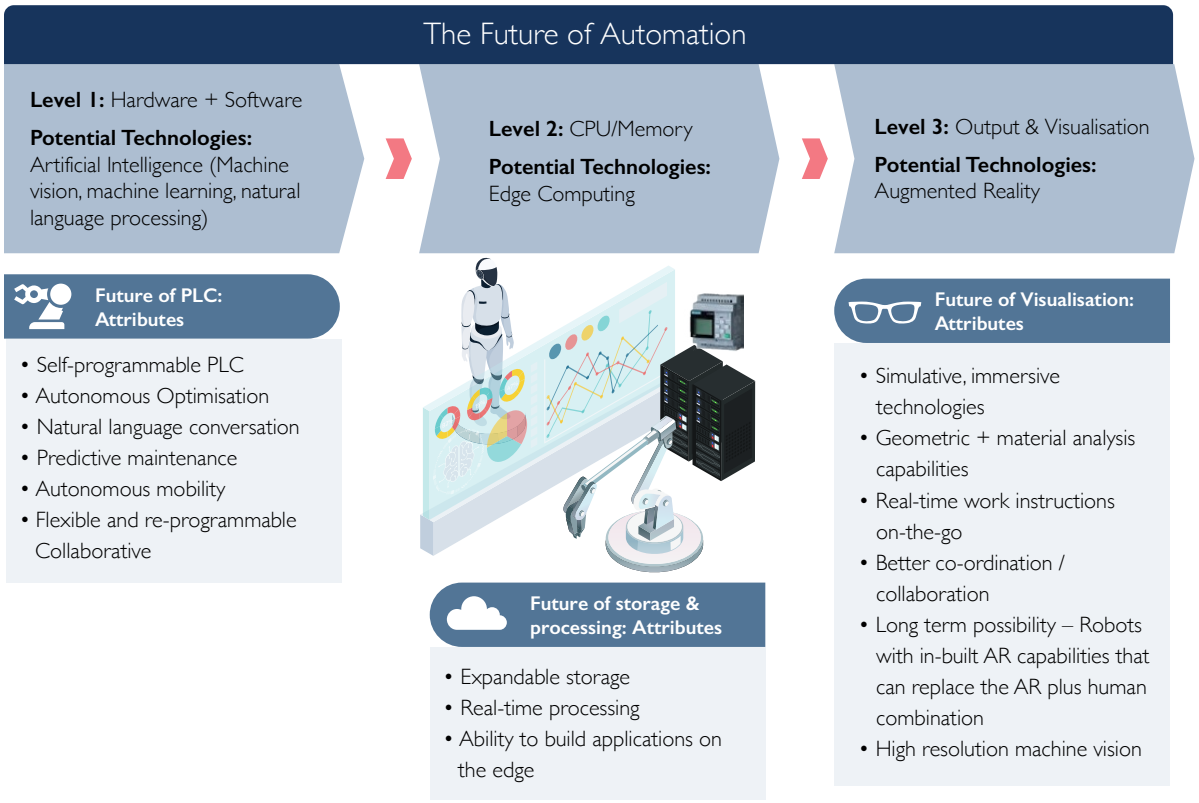
A major challenge facing automation in the future is the arrival of a new workforce possessing attitudes and skillsets that will be vastly different from those of today. It is likely that many end users will adopt a remote operations approach to employ domain experts for daily operational requirements. In such a scenario, AR systems will be the perfect foil, becoming an interface that can bring the intelligence of a remote subject-matter expert to an operator who is on the ground. This is similar to the healthcare industry, where you have specialized doctors guiding intermediates remotely using digital means on even critical issues like surgery.

However, the development of AR within automation needs to proceed with caution. AR applications will have to integrate with and complement existing automation systems. Besides challenging conventional HMIs (a trend that is most likely to happen), AR systems enabled by industrial cloud platforms could also challenge the core of automation systems like PLC. This possibility will pit AR against automation—a trend that will not be desirable for the industry. The idea of AR making its presence in automation is indisputable. With industrial investments taking center stage across global economies and with an anticipated shortage in skilled labor, end users will increasingly require expertise-on-demand. This will make AR an inevitable strategic necessity in the future of automation.

CONCLUSION

With the convergence of advanced technologies, industrial automation is expected to go through a phase of explosive growth in the coming years. Emerging technology paradigms such as AI, AR and edge are poised to drive the evolution of control process automation from the early days of control switches and relays to advanced control systems.

Exhibit 8: The Future of Automation



Source: Frost & Sullivan

AI technologies such as machine vision, NLP and machine learning can significantly transform the way automation is designed and executed. Edge analytics could make legacy PLCs expand in power and functionality without a major process design revamp. Augmented reality could soon replace HMIs and enhance the perception of products, processes and people.

With traditional automation attaining technology saturation, the dawn of these innovation themes will make automation tenable in the digital age.

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