Reimagining Factory Automation: The Winds of Change

A brief outlook on the core building blocks of factory automation in the future

A Frost & Sullivan White Paper

Karthik Sundaram
Nandini Natarajan
The Need for a Cognitive Shift ................................................................................................................................................. 3
The 6 Levers of Change .......................................................................................................................................................... 3
Generating Value................................................................................................................................................................. 6
  From Automation to Autonomy ........................................................................................................................................ 6
  Blockchain: The Opportunity for Decentralized Transaction Platforms ............................................................... 7
  Cognitive Engineering: The Move toward Zero Design Engineering ................................................................. 9
Approaching the Future ..................................................................................................................................................... 10
THE NEED FOR A COGNITIVE SHIFT

Factory automation has played a pivotal role in the evolution of manufacturing from the early days of manual control through relays and switches to the advanced digital platforms that are seen today. Increasing productivity, achieving mass production, and improving efficiencies have been a perennial quest for manufacturers and have been catalysts for advancements in automation. We are at a crossroads once again as a new and vastly different era of automation dawns. In the 20th century, the principal driver of factory automation was mass production; in the 21st century, the driver will be manufacturers’ need to manage rapid innovation cycles, complex personalization requirements, and intensifying cost pressures in a global landscape with stiff competition.

Many manufacturers that have enjoyed leading market positions with their legacy machines and production processes will soon find their value proposition either rendered obsolete or, at the very least, challenged by new competitors with innovative ideas. This demands a reimagining of factory automation: a new architecture that can meet the complexities and demands of the future.

For the industry at large, it is imperative to realize that this will be an immediate, tectonic shift rather than the gradual evolution seen in decades past. It will require a dramatic change in the way we perceive factory automation. Many of the rules are likely to be rewritten.

THE 6 LEVERS OF CHANGE

Frost & Sullivan has identified six levers of change that will redraw the approach to factory automation, as shown in Exhibit 1. Foremost is the ubiquitous use of artificial intelligence (AI), which is a collective term that refers to technologies including machine learning, deep learning, neural networks, and natural language processing. AI’s role in automation could vary from supporting design teams to empowering control systems via machine learning algorithms that facilitate continuous process learning and improvements. AI primarily will deliver value in factory automation through machine learning that harnesses the vast amounts of product and process data that remains largely underutilized today.
The worker of the future will not only have access to key performance indicators (KPIs) of production processes but will also be fed visual, immersive contexts in real time. Augmented reality (AR), the second lever, is poised to become a third eye for factory workers, providing greater visibility and guidance on the shop floor.

**AR ON THE SHOP FLOOR**

In a case example from Siemens AG, line managers can identify process anomalies (e.g., faulty machines) through an AR device that can virtually overlay KPI details on any machine in the production process. Information about KPIs that demand further action can be relayed to service technicians, who can then attend to the problem using instructions displayed as an overlay. The AR device also can connect to a remote expert who can guide the on-site technician with remedial steps in real time.

The next lever, edge computing, is a relatively mature concept that has already found its way into many factories. The idea of edge analytics is to expand the functional capacity of automation systems (e.g., programmable logic controllers or PLCs) without having to push all critical data to an external cloud. Besides saving time and effort, it also ensures localized data analytics, high processing speed, and robust cybersecurity.
PROCESS OPTIMIZATION THROUGH AI AND EDGE ANALYTICS
Siemens’ Amberg factory, which produces 6 million SIMATIC products annually, employs a combination of AI, edge computing, and predictive analytics to improve the efficiency of its production lines. The factory previously used X-ray end-of-line testing, which resulted in longer lead times and higher remedial costs for defects. Through the new analytic method, the company was able to gather process information to predict the likelihood of manufacturing defects and qualify the need for quality testing. This helped to minimize the number of X-ray tests, thereby improving process efficiency and eliminating costly bottlenecks.

The next lever is blockchain. Traditionally referred to in the context of digital cryptocurrencies, blockchain is expected to expand its influence beyond financial services and into the manufacturing ecosystem, predominantly in the area of supply chain logistics. This lever is still in the nascent phase; however, its ability to automate processes, enable secure transactions or records, and bring transparency in the network offers many promising opportunities in factories of tomorrow.

Conventional automation systems enable low-level processes to run with little human intervention. Manufacturers could soon find themselves in a scenario where humans will not merely delegate tasks but work alongside another lever of change: autonomous systems that can also think and act. AI also will play a role in cognitive engineering, the final lever of change. It is likely that in the factory of the future, cognitive systems that combine human principles of knowledge, contextual awareness, and situational intelligence will allow for the automation of many engineering tasks. A cognitive engineering system will be able to perform analysis faster than a human, without fatigue, distraction, or forgetfulness.

Exhibit 2 shows how the six levers of change could effectively address today’s limitations in factory automation.

**Exhibit 2: Effects of the 6 Levers of Change on Automation**

|----------------------------------|-------------------|--------------------------------------------------------------------------------------|------------------------|
| Machines have a low level of intelligence | AI                | + Process optimization  
+ Intelligent automation  
+ Heightened productivity | Nascent Evolving  
Well developed |
| Restricted environment for quality inspection and collaboration | AR                | + Streamlined manufacturing processes  
+ Better collaboration  
+ Enhanced simulation and visualization | Evolving  
Well developed |
| Low flexibility with high latency in data processing | Edge Computing   | + Data immediacy  
+ Network security  
+ IT simplification | Evolving  
Well developed |
| Manual and software-based management systems | Blockchain        | + Enhanced contract management  
+ Quality control and accountability  
+ Transparency and traceability | Evolving  
Well developed |
| Machines have limited mobility | Autonomous Systems | + Collaborative working  
+ Sensor and sensing integration  
+ Learning and decision-making | Evolving  
Well developed |
| Machines have a limited ability to learn | Cognitive Engineering | + Data integration and compliance  
+ Cognitively capable machines  
+ Improved competency | Evolving  
Well developed |

The six levers of change will result in new factory automation architecture, supplanting conventional industrial hardware and software. That said, legacy machines will not become obsolete, though their value will be greatly diminished.
GENERATING VALUE

A discussion about the future of automation is not complete without evidence of the value it will bring, as shown in Exhibit 3.

Exhibit 3: Automation Value Drivers

- **Self-Optimising Factories**: Production process that corrects itself pre-emptively with little or no human intervention.
- **Self-Healing Assets**: Factory assets that have the ability to self-diagnose and self-manage their health autonomously.
- **Lot-Size 1**: Creating a unique product experience for a given customer.
- **Negative Latency Manufacturing**: A factory that operates “in tomorrow,” today.

FROM AUTOMATION TO AUTONOMY

Autonomy gives each asset on the factory floor the decision-making and self-controlling abilities to take action independently in the event of a problem. Autonomous systems that are armed with a greater field of view and high degrees of mobility and operational flexibility are not entirely new. However, the scale of autonomous systems in the industrial environment is expected to grow manifold. Their use in factories presents the opportunity to increase productivity, flexibility, and reliability; to add value in a competitive arena; and to compensate for an aging workforce. Although the words sound similar, there is a substantial difference between automation and autonomy: while the former is more about executing a predefined task, the latter is more about how to execute a task by mimicking human behavior in a dynamic environment. For example, an automated robot is trained to perform a single, repetitive task, such as positioning a car panel in exactly the same place on each vehicle; an autonomous robot does this and carries out other independent tasks, such as moving the car panels from one place to another without the need for programming. The use cases of autonomous systems in a factory will vary. In some, the need may be to remove human involvement; in others, it may be just to augment a worker's physical and intellectual abilities.
Exhibit 4: The Evolution from Automation to Autonomy

Exhibit 4 illustrates the evolution of autonomous systems. Undoubtedly, it conjures up an image of a factory filled with self-moving, self-thinking, and self-governing machines. Industrial communication, e.g., Industrial 5G, is crucial for these applications. It provides ultra-reliable, ultra-low-latency communication for mobile real-time applications like automated guided vehicles (AGVs).

**BLOCKCHAIN: THE OPPORTUNITY FOR DECENTRALIZED TRANSACTION PLATFORMS**

The blockchain is an incorruptible, distributed digital ledger that can be programmed to record any digital transaction or information. The technology allows for the distribution of information from one party to another without the risk of being copied or manipulated and for both parties to arrive at a consensus on a common digital history without involving an intermediary. Frost & Sullivan identified the possible scope of blockchain applications in manufacturing, as shown in Exhibit 5.
Industrial enterprises exchange information related to designs, raw materials, manufacturing, delivery, and services with multiple stakeholders in locations around the world. The production of even one small component of a single product involves several levels of transactions in the form of material quotes, purchase orders, and design change requests; each requires a financial, regulatory, contractual, and trust-based relationship between two parties at any given point of time. Blockchain has the potential to resolve trust issues in the supply chain and enable various stakeholders to instantly begin trading without the need for a middleman or regulatory authority. From an automation standpoint, manufacturers can use blockchain technology to boost their innovative capabilities, slash inventory costs and turnaround times, distribute overcapacity, automate terms and pricing, and eliminate bottlenecks to meet global demand.
**COGNITIVE ENGINEERING: THE MOVE TOWARD ZERO DESIGN ENGINEERING**

Cognitive engineering is the application of cognitive psychology to the function of automation systems, bearing in mind process objectives to continuously optimize the way products are designed, processes are orchestrated, and production assets are managed. Exhibit 6 outlines the influence of cognitive applications on design engineering.

**Exhibit 6: Cognitive Engineering System Evolution**

The cognitive systems of tomorrow will include if-then algorithms that allow machines to learn from their own experiences. In effect, the function of design engineering could eventually become obsolete. Zero design engineering would be a key development that would alter the status quo across many manufacturing ecosystems.

*Source: Frost & Sullivan*
APPROACHING THE FUTURE

Factory automation has always been a contentious topic. Our outline in this paper is to introduce the beginning of a new journey of factory automation in manufacturing—a disruptive change that will find its way due to the demands emerging in the consumer (B2C) landscape. Automation—a term that took hold in the middle of the 20th century—was meant to indicate a production process that made use of integrated machines. The wider adoption of industrial automation after the Second World War that led to an era of increased prosperity initially mired the workforce in economic anxiety related to fears that machines would replace people. The story today is unlikely to be any different. As a new automation paradigm takes root, the same sense of apprehension will re-emerge. The onus will be on industrial automation suppliers to define the paradigm with clarity and articulate the value that it can bring to a manufacturer. Exhibit 7 provides a chronology of expected developments at different stages of the automation journey.

Exhibit 7: The Journey towards Automation

1. Tech Disruptions
   The nascent phase where ideas/technologies/processes from B2C make their way into automation—the stage of betas, prototypes, and new application introductions.

2. Proofs of Concept → Operational Implementations
   Proofs of concept of new automation applications infused with AI, AR, edge, blockchain, cognitive engineering, and autonomous systems make their way into operational implementations.

3. New-Age Automation
   Conventional automation is replaced by new-age systems.

4. The Future → The Present
   Automation innovation grows exponentially with limitless possibilities.

Future of Automation: Foresights

- New automation strategies will be the linchpin for digital transformation of manufacturing.
- Automation designs in future will vary depending on end-user contexts and customer (B2C) requirements.

Although much of the topics discussed herein are still a work in progress, there is reasonable certainty that in the next three to five years, factory automation would have changed in its form and shape, significantly. While it is certain to cause a short-term jolt to legacy infrastructures in place, it will be a change that none can choose to ignore.
DISCLAIMER

The following materials were prepared by Frost & Sullivan. Frost & Sullivan does not make any representations or warranties to any third party with respect to the information contained in this report. While reasonable steps have been taken to ensure that the information in this report is correct, Frost & Sullivan does not give any warranty or make any representation as to its accuracy and does not accept any liability for any errors or omissions. The study should not be used or relied upon by anyone without independent investigation and analysis, and Frost & Sullivan will not assume any liability for any such use or reliance by third parties. Any trademarks and other service marks contained in this document are the property of respective owners and may not be used without their prior written permission.
Frost & Sullivan, the Growth Partnership Company, works in collaboration with clients to leverage visionary innovation that addresses the global challenges and related growth opportunities that will make or break today’s market participants. For more than 50 years, we have been developing growth strategies for the Global 1000, emerging businesses, the public sector and the investment community. Is your organization prepared for the next profound wave of industry convergence, disruptive technologies, increasing competitive intensity, Mega Trends, breakthrough best practices, changing customer dynamics and emerging economies?

For information regarding permission, write:
Frost & Sullivan
321 I Scott Blvd
Santa Clara CA, 95054

Siemens AG
Digital Factory Division
Factory Automation
Gleiwitzer Str. 555
90475 Nürnberg, Deutschland

To discover more about the ‘Future of Automation’, please visit: www.siemens.com/futureofautomation