

Industry 4.0

Saurabh A. Diwe¹, Deepali J. Wagh²

^{1,2} Student, Mechanical Engineering Department, G H Rasoni Polytechnic, Nagpur, India (M.S.)

Abstract – Industry 4.0 is a strategic initiative recently introduced by the German government. The goal of the initiative is transformation of industrial manufacturing through digitalization and exploitation of potentials of new technologies. An Industry 4.0 production system is thus flexible and enables individualized and customized products. The aim of this paper is to present and facilitate an understanding of Industry 4.0 concepts, its drivers, enablers, goals and limitations. Building blocks are described and smart factory concept is presented. The current status of Industry 4.0 readiness of the German companies is presented and commented. Finally it is discussed if Industry 4.0 is really a disruptive concept or simply a natural incremental development of industrial production systems

Keywords- Industry, evolution, robotics, autonomous robots, additive manufacturing, IIOT.

INTRODUCTION

Industry 4.0 refers to a new phase in the Industrial Revolution that focuses heavily on interconnectivity, automation, machine learning, and real-time data. Industry 4.0, also sometimes referred to as IIoT or smart manufacturing, marries physical production and operations with smart digital technology, machine learning, and big data to create a more holistic and better connected ecosystem for companies that focus on manufacturing and supply chain management. that's where Industry 4.0 comes into play.

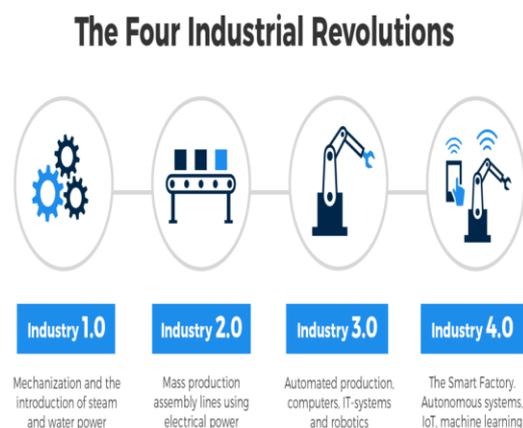
Industry 4.0 isn't just about investing in new technology and tools to improve manufacturing efficiency—it's about revolutionizing the way your entire business operates and grows. This resource will provide you with an in-depth overview on the topic of Industry 4.0 and IIoT, including information on the following:

Who started Industry 4.0?

A German government memo released way back in 2013 was one of the first times that 'Industrie'4.0' was mentioned. The high-tech strategy document outlined a plan to almost fully computerise the manufacturing industry without the need for human involvement.

The Evolution of Industry from 1.0 to 4.0

Before digging too much deeper into the what, why, and how of Industry 4.0, it's beneficial to first understand how exactly manufacturing has evolved since the 1800s. There are four distinct industrial revolutions that the world either has experienced or continues to experience today.



The First Industrial Revolution

The first industrial revolution happened between the late 1700s and early 1800s. During this period of time, manufacturing evolved from focusing on manual labour performed by people and aided by work animals to a more optimized form of labour performed by people through the use of water and steam-powered engines and other types of machine tools.

The Second Industrial Revolution

In the early part of the 20th century, the world entered a second industrial revolution with the introduction of steel and use of electricity in factories. The introduction of electricity enabled manufacturers to increase efficiency and helped make factory machinery more mobile. It was during this phase that mass production concepts like the assembly line were introduced as a way to boost productivity.

The Third Industrial Revolution

Starting in the late 1950s, a third industrial revolution slowly began to emerge, as manufacturers began incorporating more electronic—and eventually computer—technology into their factories. During this period, manufacturers began experiencing a shift that put less emphasis on analogue and mechanical technology and more on digital technology and automation software.

The Fourth Industrial Revolution, or Industry 4.0

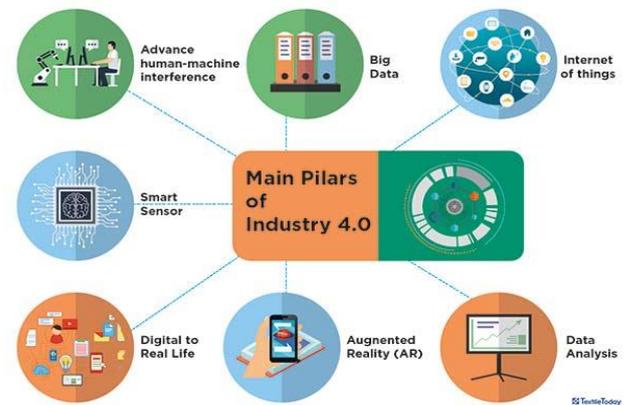
In the past few decades, a fourth industrial revolution has emerged, known as Industry 4.0. Industry 4.0 takes the emphasis on digital technology from recent decades to a whole new level with the help of interconnectivity through the Internet of Things (IoT), access to real-time data, and the introduction of cyber-physical systems. Industry 4.0 offers a more comprehensive, interlinked, and holistic approach to manufacturing. It connects physical with digital, and allows for better collaboration and access across departments, partners, vendors, product, and people. Industry 4.0 empowers business owners to better control and understand every aspect of their operation, and allows them to leverage instant data to boost productivity, improve processes, and drive growth.

What is industry 4.0 ?

When computers were introduced in Industry 3.0, it was disruptive thanks to the addition of an entirely new technology. Now, and into the future as Industry 4.0 unfolds, computers are connected and communicate with one another to ultimately make decisions without human involvement. A combination of cyber-physical systems, the Internet of Things and the Internet of Systems make Industry 4.0 possible and the smart factory a reality. As a result of the support of smart machines that keep getting smarter as they get access to more data, our factories will become more efficient and productive and less wasteful. Ultimately, it's the network of these machines that are digitally connected with one another and create and

share information that results in the true power of Industry 4.0.

Nine Technologies Transforming Industrial Production



BIG DATA AND ANALYTICS

In an Industry 4.0 context, the collection and comprehensive evaluation of data from many different sources—production equipment and systems as well as enterprises- and customer-management systems—will become standard to support real-time decision making.

AUTONOMOUS ROBOTS

Robots will eventually interact with one another and work safely side by side with humans and learn from them. These robots will cost less and have a greater range of capabilities than those used in manufacturing today.

SIMULATION

Simulations will be used more extensively in plant operations to leverage real-time data and mirror the physical world in a virtual model, which can include machines, products, and humans. This will allow operators to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover, thereby driving down machine setup times and increasing quality.

HORIZONTAL AND VERTICAL SYSTEM INTEGRATION

With Industry 4.0, companies, departments, functions, and capabilities will become much more cohesive, as cross-company, universal data-integration networks evolve and enable truly automated value chains.

THE INDUSTRIAL INTERNET OF THINGS (IIOT)

Industry 4.0 means that more devices sometimes including unfinished products will be enriched with embedded computing. This will allow field devices to communicate and interact both with one another and with more centralized controllers, as necessary. It will also decentralize analytics and decision making, enabling real-time responses.

CYBER SECURITY

With the increased connectivity and use of standard communications protocols that come with Industry 4.0, the need to protect critical industrial systems and manufacturing lines from cyber security threats increases dramatically. As a result, secure, reliable communications as well as sophisticated identity and access management of machines and users are essential.

THE CLOUD

More production-related undertakings will require increased data sharing across sites and company boundaries. At the same time, the performance of cloud technologies will improve, achieving reaction times of just several milliseconds. As a result, machine data and functionality will increasingly be deployed to the cloud, enabling more data-driven services for production systems.

ADDITIVE MANUFACTURING

Companies have just begun to adopt additive manufacturing, such as 3-D printing, which they use mostly to prototype and produce individual components. With Industry 4.0, these additive-manufacturing methods will be widely used to produce small batches of customized products that offer construction advantages, such as complex, lightweight design. Augmented-reality-based systems support a variety of services, such as selecting parts in a warehouse and sending repair instructions over mobile devices.

Smart Manufacturing Use Cases

One of the best ways to understand the concept of smart manufacturing better is to think about how it could be applied to your business, or a business similar to your business. Here are three use cases that can help to understand the value of Industry 4.0 in a manufacturing operation:

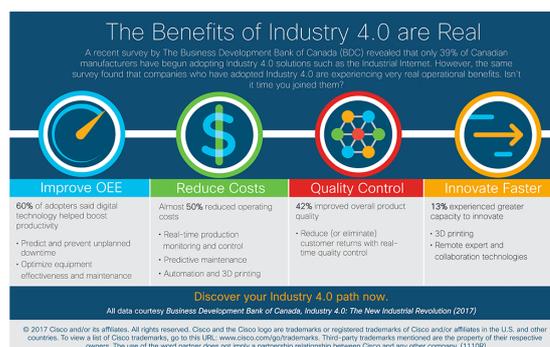
1. Supply chain management and optimization—Industry 4.0 solutions give businesses greater insight, control, and data visibility across their entire supply chain. By leveraging supply chain management

capabilities, companies can deliver products and services to market faster, cheaper, and with better quality to gain an advantage over less-efficient competitors.

2. Predictive maintenance/ analytics Industry 4.0 solutions give manufacturers the ability to predict when potential problems are going to arise before they actually happen. Without IoT systems in place at your factory, preventive maintenance happens based on routine or time.

3. Asset tracking and optimization—Industry 4.0 solutions help manufacturers become more efficient with assets at each stage of the supply chain, allowing them to keep a better pulse on inventory, quality, and optimization opportunities relating to logistics. With IoT in place at a factory, employees can get better visibility into their assets worldwide.

Benefits of Adopting an Industry 4.0 Model



Industry 4.0 spans the entire product life cycle and supply chain— design, sales, inventory, scheduling, quality, engineering, and customer and field service. Everyone shares informed, up-to-date, relevant views of production and business processes—and much richer and more timely analytics.

Benefits of adopting an Industry 4.0

It makes you more competitive, especially against disruptors like Amazon. As companies like Amazon continue to optimize logistics and supply chain management, you need to be investing in technology and solutions that help you improve and optimize your own operation. To stay competitive, you have to have the systems and processes in place to allow you to provide the same level of service (or better) to your customers and clients that they could be getting from a company like Amazon.

It makes you more attractive to the younger workforce Companies that invest in modern, innovative Industry 4.0 technologies are better positioned to attract and retain new workers.

- **It makes your team stronger and more collaborative.** Companies that invest in Industry 4.0 solutions can increase efficiency, boost collaboration between departments, enable predictive and prescriptive analytics, and allow people including operators, managers, and executives to more fully leverage real-time data and intelligence to make better decisions while managing their day-to-day responsibilities.
- **It allows you to address potential issues before they become big problems.** Predictive analytics, real-time data, internet-connected machinery, and automation can all help you be more proactive when it comes to addressing and solving potential maintenance and supply chain management issues.
- **It allows you to trim costs, boost profits, and fuel growth.** Industry 4.0 technology helps you manage and optimize all aspects of your manufacturing processes and supply chain. It gives you access to the real-time data and insights you need to make smarter, faster decisions about your business, which can ultimately boost the efficiency and profitability of your entire operation.
- **Current state of Industry 4.0**
When considering the current state of the Industry 4.0, it is important to understand the preconditions that have to be fulfilled so that a new concept can be introduced in industrial manufacturing system. The following six dimensions were evaluated,
 - Strategy and organization (investments, innovations management),
 - Smart factory (equipment and IT systems, data capturing and usage, digital modelling),
 - Smart operation (integration of value chain, cloud storage),
 - Smart products (physical components, virtual identity),
 - Data-driven services (ICT functionalities, prediction and optimization of business outcomes,,
 - Human resources (employees skills, continuous education). A survey was conducted of 268 companies from Germany with more than 20 employees.

educate themselves on these new technologies and invest in pilot projects will lose their competitive advantage and miss the opportunity to lead the transformation that is currently sweeping across the manufacturing industry.

REFERENCES

- [1] https://www.cgi.fr/sites/default/files/white-papers/manufacturing_industry-4_white-paper.pdf
- [2] https://en.wikipedia.org/wiki/Industry_4.0
- [3] https://en.wikipedia.org/wiki/Industry_4.0
- [4] <https://online-journals.org/index.php/ijim/article/viewFile/7072/4532>

CONCLUSION

Industry 4.0 will change the entire manufacturing system, from the architecture and organizational structure to products, services and business models. The development and deployment of these solutions will be incremental and part of a long-term trend, but the opportunity is already here today. Companies that fail to