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Specific Directions of the Digital Development of Industrial Production

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ABSTRACT

This article outlines views on the main and specific aspects of the digital development of industrial production. The main directions of the introduction of digital technologies in the production process and the organization of intelligent production were also discussed.

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Introduction

Developed countries rely chiefly on domestic consumption, which makes nontradable sectors important. Across developed economies, digitization improves productivity and has a measurable effect on growth. However, the result can be job losses because lower-skill, lower-valueadded work is sent abroad to emerging markets, where labor is cheaper. By contrast, emerging markets are more export-oriented and driven by tradable sectors. They tend to gain more from digitization's effect on employment than from its influence on growth.

The digital age has impacted every industry, and for the manufacturing sector, in particular, this digital revolution has been labelled "Industry 4.0". Starting with the industry 4.0 definition, we analyse the benefits that digitisation introduces to enterprises in logistics, supply chain, automotive, and beyond.

When looking for an industry 4.0 definition, the title represents the fourth evolution that is currently taking place, and the effects it is having within the manufacturing industry. If individuals first learn to embrace the changes, enterprise businesses can utilise these shifts in processes and see the benefits that digitalisation has on an existing company's infrastructure.[1]

Industry 4.0 is the subset of the fourth industrial revolution that concerns industry. The fourth industrial revolution encompasses areas which are not normally classified as an industry, such as smart cities, for instance.[2]

Although the terms "industry 4.0" and "fourth industrial revolution" are often used interchangeably, "industry 4.0" factories have machines which are augmented with wireless connectivity and sensors, connected to a system that can visualise the entire production line and make decisions on its own.

In essence, industry 4.0 is the trend towards automation and data exchange in manufacturing technologies and processes which include cyber-physical systems (CPS), the internet of things (IoT), industrial internet of things (IIOT), cloud computing, cognitive computing and artificial intelligence.

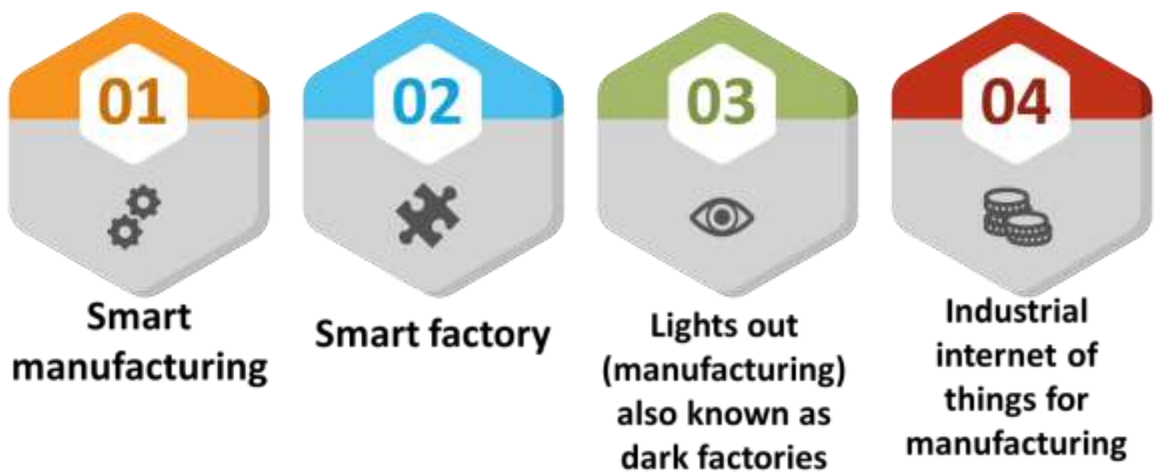

Figure 1. Main directions of Industry 4.0[1]

Industry 4.0 fosters what has been called a "smart factory". Within modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real-time both internally and across organizational services offered and used by participants of the value chain.[3]

Smart manufacturing is a broad category of manufacturing that employs computer-integrated manufacturing, high levels of adaptability and rapid design changes, digital information technology, and more flexible technical workforce training. Other goals sometimes include fast changes in production levels based on demand, optimization of the supply chain, efficient production and recyclability. In this concept, as smart factory has interoperable systems, multi-scale dynamic modelling and simulation, intelligent automation, strong cyber security, and networked sensors.

The broad definition of smart manufacturing covers many different technologies. Some of the key technologies in the smart manufacturing movement include big data processing capabilities, industrial connectivity devices and services, and advanced robotics.[4]

Smart manufacturing utilizes big data analytics, to refine complicated processes[clarification needed] and manage supply chains. Big data analytics refers to a method for gathering and understanding large data sets in terms of what are known as the three V's, velocity, variety and volume. Velocity informs the frequency of data acquisition, which can be concurrent with the application of previous data. Variety describes the different types of data that may be handled. Volume represents the amount of data. Big data analytics allows an enterprise to use smart manufacturing to predict demand and the need for design changes rather than reacting to orders placed.

Some products have embedded sensors, which produce large amounts of data that can be used to understand consumer behavior and improve future versions of the product.

Advanced industrial robots, also known as smart machines operate autonomously and can communicate directly with manufacturing systems. In some advanced manufacturing contexts, they can work with humans for co-assembly tasks. By evaluating sensory input and distinguishing between different product configurations, these machines are able to solve problems and make decisions independent of people. These robots are able to complete work beyond what they were initially programmed to do and have artificial intelligence that allows them to learn from experience. These machines have the flexibility to be reconfigured and re-purposed. This gives them the ability to respond rapidly to design changes and innovation, which is a competitive advantage over more traditional manufacturing processes. An area of concern surrounding advanced robotics is the safety and well-being of the human workers who interact with robotic systems. Traditionally, measures have been taken to segregate robots from the human workforce, but advances in robotic cognitive ability have opened up opportunities, such as cobots, for robots to work collaboratively with people.

Leveraging the capabilities of the Internet, manufacturers are able to increase integration and data storage. Employing cloud software allows companies access to highly configurable computing resources. This allows for servers, networks and other storage applications to be created and released at a rapid pace. Enterprise integration platforms allow the manufacturer to collect data broadcast from its machines, which can track metrics such as work flow and machine history. Open communication between manufacturing devices and networks can also be achieved through Internet connectivity. This encompasses everything from tablets to machine automation sensors and allows for machines to adjust their processes based on input from external devices.[4]

Smart manufacturing can also be attributed to surveying workplace inefficiencies and assisting in worker safety. Efficiency optimization is a huge focus for adopters of "smart" systems, which is done through data research and intelligent learning automation. For instance operators can be given personal access cards with inbuilt Wi-Fi and Bluetooth, which can connect to the machines and a Cloud platform to determine which operator is working on which machine in real time. An intelligent, interconnected "smart" system can be established to set a performance target, determine if the target is obtainable, and identify inefficiencies through failed or delayed performance targets. In general, automation may alleviate inefficiencies due to human error. And in general, evolving AI eliminates the inefficiencies of its predecessors.

Worker safety can be augmented by safe, innovative design and increasing integrated networks of automation. This is under the notion that Technicians are exposed less to hazardous environments as automation matures. If successful, less human supervision and user instruction for automation will devitalize workplace safety concerns.[5]

As one of the main elements of Industry 4.0, *cyber-physical systems* play a significant role in the future of smart manufacturing systems and have been recognized as one of the 30 visionary concepts that aim in revolutionizing the smart manufacturing. An advanced Cyber-Physical System can be summarized into 5 levels. [6]

Figure 2. Cyber Physical System levels in Smart Manufacturing[2]

Industrial Artificial intelligence (AI) is a systematic discipline to enable engineers to systematically develop and deploy AI algorithms with repeating and consistent successes. Successful implementation of Industrial AI will improve decision making and provide enhanced insight to business users - whether that's reducing asset downtime, improving manufacturing efficiency, automating production, predicting demand, optimizing inventory levels or enhancing risk management. A unified architecture for industrial AI includes four major categories (Figure 3).

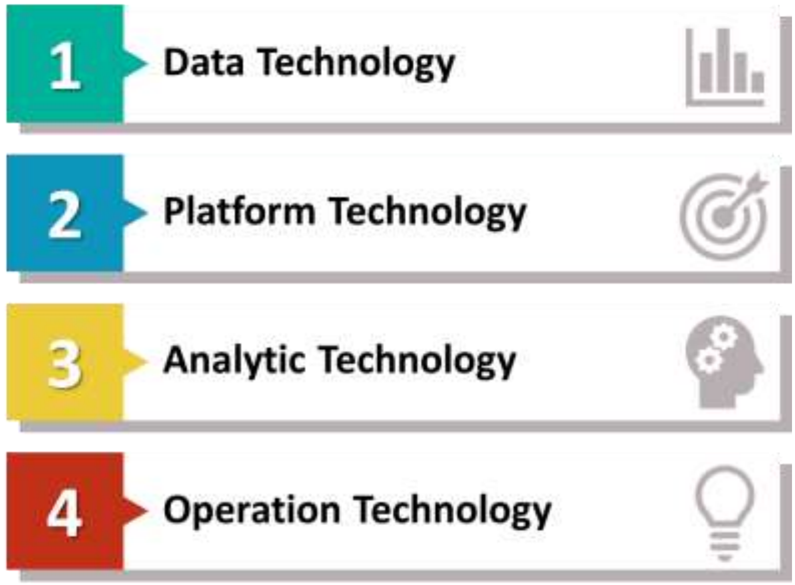

Figure 3. Four major categories of unified architecture for industrial AI includes[3]

Smart Manufacturing is leading to some clearly visible and measurable benefits such as lower costs, more efficiency, easier inventory management, lower payback time and enhanced productivity. All this is done through the deployment of advanced technology in a strategic and intelligent way. Benefits of this industrial revolution can also be felt in developing nations such as India, where previous technology breakthroughs have been skipped. The end result? Shop floor professionals and manufacturing players get to operate in the factories of the future and improve their business and growth while giving consumers exactly what they want.

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