



Future of Business: From Industry 4.0 to Industry 5.0

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Plagiarism: 7%

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Keywords: Industry 4.0, Industry 5.0, Industrial Revolution, Big Data Analytics, Internet of Things, Robots.

Classification-JEL : J24, O14, O33, Q55.

How to Cite: Agarwal, Pulkit (2025). Future of Business: From Industry 4.0 to Industry 5.0. *Journal of Commerce and Trade* (H. Agarwal, Ed.) 20 (1), 36-43. doi:10.26703/JCT.v20i1-5

ABSTRACT

The time has come for Industry 5.0. Industry 4.0 is limited because smart factories increase business productivity. This paper discusses the opportunities and limitations of industry 5.0, as well as future research perspectives. The paradigm shift brought by Industry 5.0 will bring resolution, as it reduces the emphasis on technology. It also assumes that progress can be achieved through collaboration between humans and machines. The Industrial Revolution is increasing customer satisfaction through personalized products. Industry 5.0, with its paid-for technological advancements in modern business, is essential for competitive advantage and economic growth of the factory. This paper will analyze potential business applications for industry 5.0. The first part of this paper is an introduction to industry 5.0, and the advanced technologies that are required for it. The applications of industry 5.0 are also discussed, such as healthcare, supply chains, manufacturing production, cloud manufacturing etc. This paper discusses big data analytics and Internet of Things. It also includes Block chain, digital twins, Block chain technology, collaborative robots and future systems 6G. This paper also examined the difficulties and issues that were caused by the organization of robots in an assembly line.

1. INTRODUCTION

The first Industrial Revolution (Industry 1.0), which took place in the 18th century, saw a major change. Items were produced using machines and methods that had been invented. The first industrial revolution began in England around 1760, and by the 18th century it had reached the United States. The shift to Industry 1.0 was a transition from artisan economy towards a machine-dominated one. It affected industries like mining, textiles, agriculture, glasses, etc. Industry 2.0 is the next step in manufacturing between 1871 and 1914 which saw a faster exchange of people and ideas. The Industrial Revolution is an era of rapid economic growth and increased productivity, which led to a rise in unemployment. (Amr, 2022)

The digital revolution began in the 1970s of the 20th century with the automation and

computerization of memory-programmable control systems. This phase focuses on mass production, the integration of integrated circuits, digital logic and computers. Innovations in technology have transformed traditional business practices and products. Digital revolution converts technology to digital form. (Hashmicro, 2022)

The industry 4.0 concept is the union of physical assets with advanced technologies, such as robots, IoT (Internet of Things), 3D printing and cloud computing. Organizations that have adopted Industry 4.0 tend to be flexible and ready for data-driven decision making. Industry 5.0 refers to the next generation of technology designed for intelligent and efficient machines.

1.1 Industry 5.0 and Its Progress

Humans and machines work together to improve the productivity of manufacturing. The

Figure 1: Industry 5.0: Potential Opportunities and Adoption Challenges

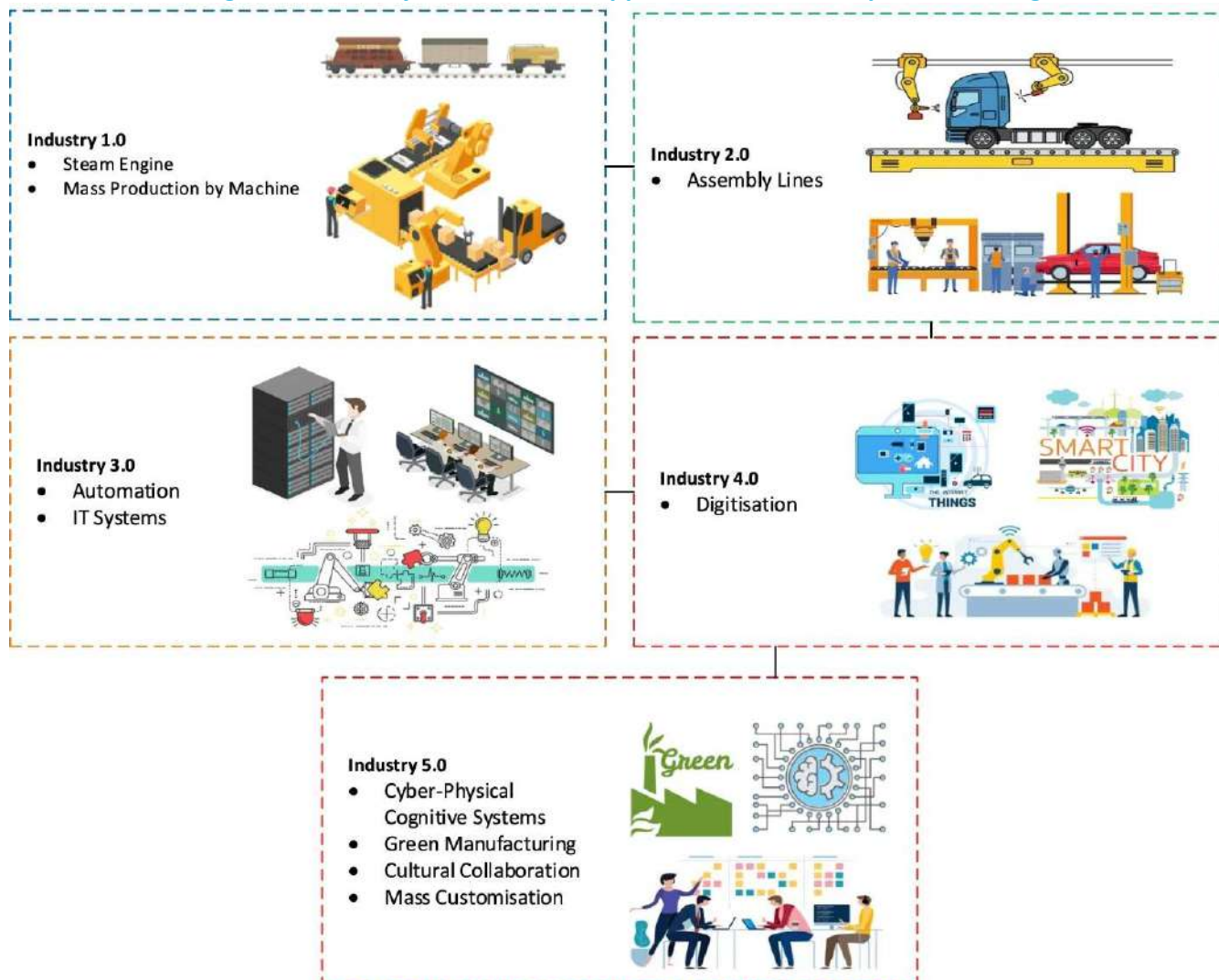


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manufacturing industry is boosted by the combination of human workers and universal robotics. The executive team of each manufacturing company must define the production lines, follow key performance indicators, and make sure that processes run smoothly. Industry 5.0 will focus on the production of industrial robots and robots. (Univeral R, 2022)

Artificial intelligence (AI) and cognitive computing are accelerating the pace of manufacturing and improving business efficiency. Industry 5.0 is not only beneficial for the manufacturing industry, but also in terms of sustainability. It aims to create a system which runs on renewable energies.

To adopt Industry 5.0, companies must have the right personnel to ensure proper interactivity between machines and operators. Knowledge in fields such as robotics and artificial intelligence is required. Business organizations are responsible for making business decisions based on advanced factors. Virtual education is needed to train employees to reduce the costs for businesses. This is because it does not require production to be stopped to provide training. The virtual education provides workers with safe training, preventing them from being exposed to unnecessary issues.

Interactive knowledge environments boost communication and motivation of employees. These positions involve

communication with robotic systems and artificial intelligence.(DoE, 2022)

In order to create intuitive interactions with humans, collaborative robots will be designed. In order to achieve Industry 5.0, it is necessary that digital twins be expanded. Visual models for products, production processes and generations will improve understanding and test. Nexus Integra is the platform required for the industry 5.0 transformation. This integrated system allows companies to make a leap into digital transformation. The previous generations adjusted their lifestyles according to the capabilities of machines. Industry 5.0 is different from previous versions, because humans now play a central role in the production process.

1.2 Structure of the Paper and Its Contribution

The next section reviews the definitions for Industry 5.0, comparing them to previous industrial revolutions. In section 3, this paper also discusses the applications. In section 4 we will discuss the technologies that enable industry 5.0, such as IoT (Internet of Things), cloud computing (6G networks), Block chain, and big data. Highlights of section 5. Section 6 concludes the paperwork with a summary.

2. GREAT FEATURES OF INDUSTRY 5.0

The highest degree of perfection and machine-work reduces human effort and time. Industry 5.0 has taken over past improvements. A few other features, aside from the difficulties of implementing industry 5.0, encourage businesses to do so. In the medical field, for example, professionals are currently working towards creating a synthesized pancreas. The project is not finalized. Patients with Type-1 Diabetes are provided with a monitoring device to check their sugar levels and blood. The device can be connected to another device which is capable of delivering insulin directly into the bloodstream. It is a creative technology that was developed for patients to provide a convenient and reliable control system.

This personalization is taken to a new level with Industry 5.0. It allows doctors to give patients

an app that can be installed on their smart-phones. The application can then be used to track their daily routine and lifestyle, and create a personalized plan for each patient. The technology used is based on artificial-intelligence (AI) systems. This could be life-changing to Type-1 diabetics. The AI systems are able to learn and understand the various reactions in the body, and then act appropriately.

This requires monitoring the devices to ensure they are working properly. A maintenance plan can prevent the machines from breaking down.

a. Sustainability: Industry 5 promises to adapt resources to current manufacturing requirements. Humans and machines working together leads to more flexible business models. To eliminate waste, it is necessary to reduce overproduction and to minimize the amount of wasted material. Local production, along with new initiatives, makes the economy sustainable.

Corporate technologies have changed the industry trend with Industry 5.0. This leads to sustainable policies such as minimal waste generation and effective management. It is designed to be applied by focusing on research and knowledge. The industry 5.0 movement is characterized by an attitude that goes beyond manufacturing products for profit. Sustainability, human-centricity and resilience are the three fundamental principles that define Industry 5.0.

Human efficiency and productivity is boosted by advanced technologies. Robots work together to perform dangerous and repetitive tasks, while humans focus on creative business solutions and efficiency. Skills lead to increased business productivity when people are motivated to work hard and feel they get the result. Human-centered methods emphasize human needs over manufacturing procedures. The producers must recognize the benefits of technology for people, and concentrate on the ways in which technology can be adapted to worker needs instead of vice versa. Technology must address privacy and autonomy issues.(Ghobakhloo, 2023)

b. Environment control: Connected sensors, customized software, and smart and intelligent

sensors provide an overview in real time of climate, temperature and energy consumption. Businesses can use this technology to improve their production and prevent loss. It is important to improve the iterative processes that reuse, recycle, and recover resources in order to maintain the sustainability of manufacturing. The environmental impact must be reduced. Manufacturers can use the technologies developed, such as artificial intelligence, to enhance personalization and minimize waste.

Machine learning, smart and connected machines as well as industrial automation are used to forecast the efficiency of production. This increases the efficiency of the business, as the processes can be adjusted according to the parameters in order to prevent losses. To protect their production from disruptions, manufacturers need to increase the level of production resilience.

c. Creativeness: The technological innovations do not allow for the personalization required to meet customer demands. The human resource is a key component of Industry 5.0. This can help to maximize the technological potential. The company finds new ways to develop products with personalization as a priority.

3. GREAT FUTURE BUSINESS APPLICATIONS WITH THE INDUSTRY 5.0

3.1 Hospital

The goal of Industry 5.0 will be to build a real-time smart hospital. This technology allows for remote monitoring within the healthcare industry. This technology is crucial to improving the lives of doctors. This smart technology can help doctors focus their attention on the infected and give them data that will allow for better treatment. It also assists medical students and students in obtaining the necessary medical training due to the COVID-19 outbreak. Medical imaging, genetic data, and natural language processing are all analyzed using machine learning (ML). The focus is on disease detection and prediction, as well as diagnosis.

Abdelmageed & Zayed stated that Industry 5.0 allows the manufacturing of

personalized smart implants properly according to the changing requirements of customers. Artificial intelligence is being used by medical professionals to monitor problems such as glucose levels. The technology helps mass-personalization, by manufacturing implants according to the matching patents. This was the original need for orthotics. It is capable of updating medical tools and devices, as well as changing the way implants are made. As it helps to carry out surgery with precision, the technologies are being used.

Medical students can benefit from better learning and teaching, as well as research and development procedures. Industry 5.0 in orthopedics requires personalized, high-quality implants that have a long life span. This helps to solve problems such as overproduction, the wrong tool selection and lack of transparency. (Adel, 2022)

3.2 Manufacturing industry

The new model of production, Industry 5.0, is based on the interaction between humans and machines. In order to maximize the collaboration between increasing accuracy machinery and human innovation potential, Industry 5.0 leverages a combination of both. It develops processes to repurpose or recycle resources in order to create a sustainable manufacturing. It is necessary to also reduce environmental impacts within the manufacturing industry.

To maximize resource efficiency and reduce waste, additive manufacturing is needed to personalize. By removing repetitive work from humans, Industry 5.0 revolutionizes manufacturing systems around the world. Brown and Wobst demonstrated that intelligent systems and robots are affecting supply chains and manufacturing shops at a level never before seen. Smart manufacturing is a way for designers to store design files and manufacturing products in the cloud, with access controls that are robust. This allows them to use the resources of different manufacturing locations.

Ghobakhloo et al. The designers can place manufacturing plants near raw materials and

Figure 2: Application of the Industry 5.0

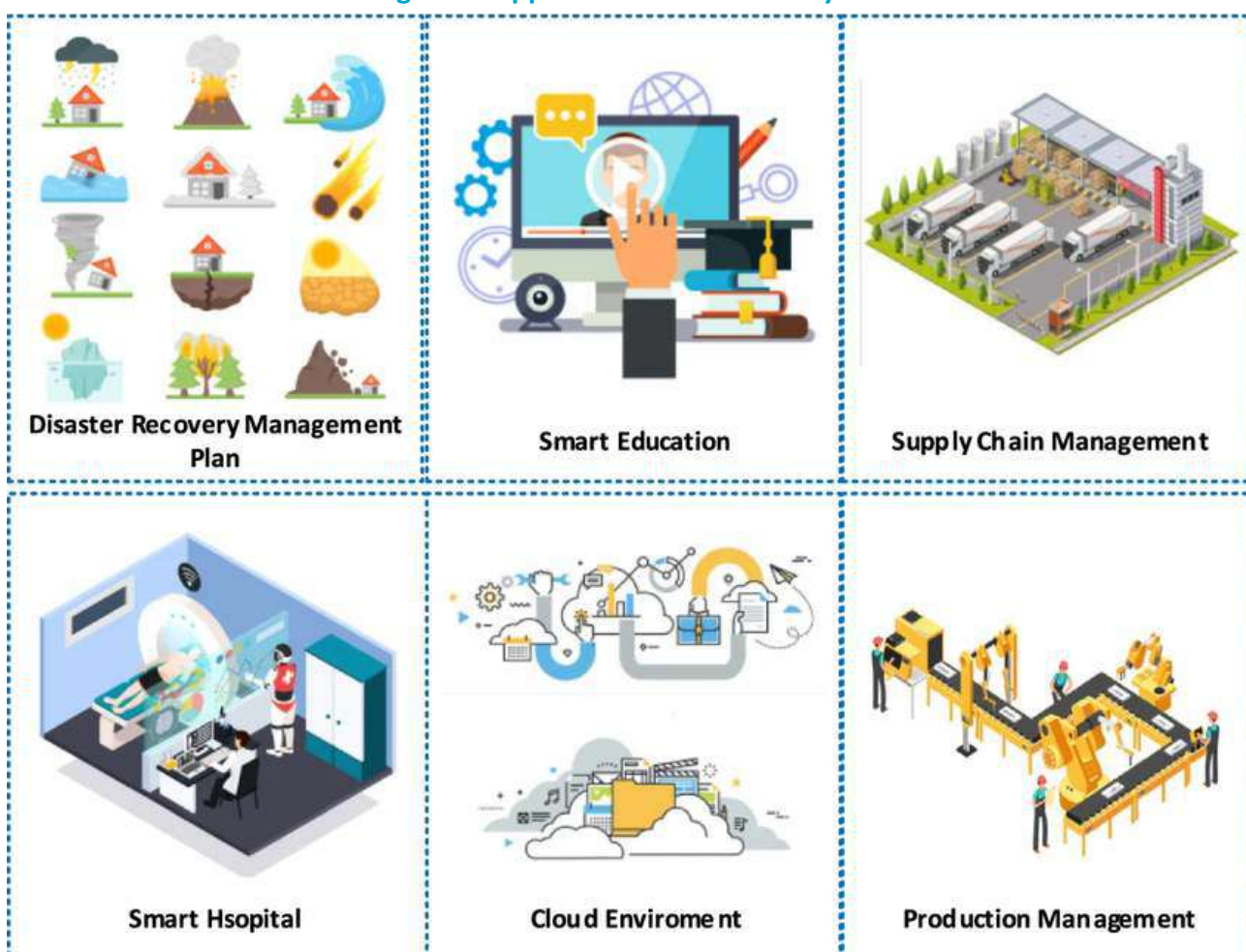


Image Source: https://www.researchgate.net/figure/Applications-of-Industry-50_fig2_363384163

areas where manufacturing costs are low. Cloud manufacturing will be responsible for the control of machines and the operations in the lifecycle of manufacturing. Service-oriented models help manufacturing to integrate their production capabilities with services in order to offer the right solutions for clients. By adding services to the manufacturing process, the aim is to increase production efficiency, the value added, and market share. Cloud-based platforms control manufacturing services and are used to optimize costs. Cloud manufacturing uses a networked system as well as distributed production resources.

3.3 Supply chain management

BabamiriBahari and Salimi stated that a human touch was not necessary to create and personalize products. It also provides seamless

processes from end to end, including selecting raw materials and understanding the customization requirements of individual consumers. The goal of Industry 5.0 is to combine intelligent and automated digital ecosystems with the human element. Human elements are leveraged in a way that helps optimize workflows and customize end-user experience.

ERP systems manage the entire supply chain of a business. This includes raw material delivery, transaction processing, and transportation. Next generation supply chain solutions are able to make and deploy the latest technology in order to power the digital supply chains. This means that the next generation of supply chain solutions will be able to customize the system, improve customer satisfaction as well as manage the efficiency and margins for the

company. Based on existing business information, there is a reduction in the risk of supply chain wastages and risks. Letto et al. concluded that the integration of supply chains for strategic partnerships has improved, allowing supply chains to focus more on experimentation and less time fighting for project execution. (Santhi, 2023)

4. TECHNICAL ADVANCEMENT OF THE 5.0

4.1 Cloud computing

Cloud computing includes databases, software and intelligence analytics. The technology offers efficient innovation as well as economics. The technology stores and manages data remotely on remote servers using the Internet. Data is then accessed through the internet. This technology delivers computing on demand, from storage to applications.

4.2 Collaborative robots

The goal of Industry 5.0 is to bring the human element back into development and production. The robots can be programmed to perform tasks with high precision, and even lift heavy objects. Humans are capable of performing critical tasks. This allows for a higher degree of control, and individualization of production phases. Human inputs are required to extend existing iterations. This is a significant impact of both collaborative robotics and Industry 5.0. Industry 5.0 and collaborative robots are a new age of robotics. Cobots and Industry 5.0 are the core that combine the creativity of people with the consistency and efficiency of robots.

People-centricity is a shift that makes it easier to access customized products and skills. The focus of Industry 4.0 lies on the consistency and collection of data. Industry 5.0, on the other hand, combines highly-skilled people with robots in order to produce individualized consumer products ranging from cars to smart devices. In industry 5.0 the robots start to collaborate. Using collaborative robots, the heavy lifting and consistency are done by the machines while the skilled workers are provided with cognitive skills. Robots will change the relationship between humans and machines within production.

People working with smart machines and robots is what Industry 5.0 means. By leveraging new technologies, such as Internet of Things, robots help humans to work more efficiently. This added human touches to Industry 4.0, allowing for greater automation and business efficiency. This is a system of objects, things, and software embedded in physical things. This is an internet-based way of connecting and exchanging data between devices as well as systems.

Ghobakhloo et. al. mentioned that IoT was a paradigm shift that would change the way people live their lives in the modern high-tech world. IoT is used to improve advanced technologies. IoT can be used to solve data security and privacy issues. IoT developers are particularly interested in privacy and the secure interaction between social networks. Smart cities, which include smart homes, are considered an important IoT area. (Nižetić, 2020)

Sinclair et al. concluded that IoT authentication and access control were the main issues. These are needed to create solutions with strong security. To reduce the risk of losing sensitive information, a solution must be implemented to confirm communication parties. The key security controls are verified using an authentication scheme. These authentication and control methods help provide end-to-end confidentiality, as well as authenticity in IoT. This is an approach that is dynamic for data-centric platforms. (Chmiel, 2021)

4.3 Big data analytics

Industry 5.0, an innovative technology, allows for 3D symmetry to be used in innovation ecosystems. Matheus and colleagues stated that the big data analysis is a complicated procedure for examining big data in order to discover data such as hidden patterns, market trends, etc. The advanced analytical method is used with diverse data, such as structured and semistructured data. The data is massive and requires traditional tools to process. The data is used in real time to improve the competitive advantage of business industries, with a focus on providing recommendations for predictive discovery. The organization uses big

data analytics to identify discrepancies, while also leveraging the list of root causes. The majority of businesses use analytics to help them make strategic choices. Businesses use factors such as population size, accessibility to locations and other variables in order to determine customer preferences. The customer experience can be improved by monitoring customer feedback and finding solutions for problems to create strong relationships. Industry 5.0 is challenged by big data when there is no detailed information on the manufacturing process.

4.4 Blockchain

This is a decentralized technology that uses blocks as records to store the transaction data. This shared ledger can be used to record transactions and track assets within the network. Information is the lifeblood of any business. Blockchain delivers data through the sharing and completion of information in an immutable ledger, which is accessible to all network members. The blockchain technology assists the customer by keeping track of orders, payments and production. To avoid duplicate efforts, the network participants maintain distributed ledgers of transaction records. To speed up transactions, smart contracts are stored on Blockchain. They will be automatically executed. The smart contract is a set of conditions that the company must adhere to, such as terms and conditions for travel insurance. It is important that the transactions be done in an irreversible chain, which strengthens the verification of previous blocks. The business must have accurate data to verify the recorded transactions. The distributed ledger allows network members to share the time, eliminating waste.

4.5 6G and beyond

In general, flexible organization managers will adopt adaptable, decentralized 6G plans, including nearby authorization, range-sharing, framework-sharing, and intelligent mechanized management, supported by advanced edge processing, AI, short parcel correspondence, and Blockchain advancements. In order to achieve ultra-high reliability, industry 5.0 expects 6G

networks to be able to comply with the standards of an intelligent information society. Mobility predictions are made using artificial intelligence to guarantee network connectivity. Industry 5.0 was challenged by a need for high data rates in various applications. Energy management will be a major issue in industry 5.0, as large devices with smart capabilities are now connected. Energy management can be optimized by analyzing energy usage and using energy harvesting methods.

4.6 Future directions

Cognitive computing is an application that aims at transforming the thinking of a human into computerized models. Self-learning algorithms are used to read the brain of the human using data mining, patterns recognition, natural language and other methods.

The user interface is the means of communication between humans and machines. The use of natural user interfaces such as gestures to attract attention is a way to get people's attention, since they let humans control machines using intuitive and natural behaviors. This is the direction of industry 5.0, as it keeps the human at the center and allows for technologies to be built in. The user interface can help people to understand the behaviour of people and their motivations.

Quantum computations are carried out by the devices, which is what defines a quantum computer. The device performs calculations focusing on the probabilities of an object's states before they are measured.

5. CONCLUSION

The study concludes that the author began the project with definitions for industry 5.0, both from an industrial and business perspective. The author has also discussed the application of Industry 5.0 to help understand its features. This is followed by an analysis of the enabling technologies. The industry 5.0 concept has been designed to improve the efficiency of both humans and machines. ■

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