Industry 5.0: Employing The Human Age To Industry 4.0

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Abstract

industrial operations were unpredictable and challenging in the prior ten years. Without a doubt, the present COVID-19 pandemic is a graphic example. The virus has affected society as well as disturbed the established industrial functioning procedures. If the sector wishes to continue operating a viable company, it must act rapidly to address the issues.

"Industry 4.0" has been well-known worldwide for the past decade. Many companies have started working on Industry 4.0 initiatives, and a lot of research has gone into developing and putting Industry 4.0 to use. As a result of greater competition throughout the market, output, and efficiency have grown. But in addition to focusing on having a factory completely automated by artificial intelligence and other technology, it's vital to take other issues into account as well.

Ten years after the introduction of Industry 4.0, the European Commission introduced Industry

5.0. Industry 4.0 is regarded to be technology-driven, whereas Industry 5.0 is believed to be value-driven. Industry 5.0 adopts a more cooperative posture than Industry 4.0 and involves greater cooperation between humans and machines.

Key Words: Humans and robots, Industry 4.0 and Industry 5.0, and artificial intelligence.

INDUSTRY 5.0: IMPLEMENTING THE HUMAN AGE TO INDUSTRY 4.0

1. Introduction

The **"Fourth Industrial Revolution"** or **"Industry 4.0"** is a leading-edge technological development in the twenty-first century. *Klaus Schwab*, the founder and executive chairman ofthe World Economic Forum, popularized the

phrase "Industry 4.0" in 2016. The fusion of technologies such as artificial intelligence, gene editing, advanced robotics, etc. is known as Industry 4.0. The next definitions of the first three Industrial Revolutions serve as the foundation for Industry 4.0. The switch from manual to steam- or water-powered industrial equipment characterized the First Industrial Revolution. The Second Industrial Revolution was made possible by electricity, which transformed factories into cutting-edge production lines, resulting in great productivity and substantial economic expansion. With the advent of communication technologies and field-level computers like Programmable Logic Controllers (PLC) during the Third Industrial Revolution, production became increasingly automated. "In the era of Industry 4.0, production systems, such as CPPS, can make intelligent decisions through real-time communication and cooperation between manufacturing things, enabling flexible production of high-quality customized products at scale."

Through ongoing automation of conventional manufacturing and industrial practices, using modern smart technology, extensive ***machine-to-machine communication (M2M)***, and the ***Internet of Things (IoT)***, fundamental changes are occurring in how the global production and supply network functions. Increasing automation, better communication and self-monitoring, and the deployment of intelligent technologies that can analyze and diagnose problems without human involvement are all outcomes of this integration. One of the major Industry 4.0-relatedefforts is the Smart Factory.

The Fifth Industrial Revolution (Industry 5.0) emerged as firms started to encirclement Industry 4.0. By ensuring that production respects the limits of our planet and places the welfareof industry workers at the center of the production process. Industry 5.0 is understood to acknowledge the power of industry to achieve societal goals beyond jobs and growth and to become a resilient provider of prosperity. The emergence of Industry 5.0 is predicated on the observation or belief that Industry 4.0 places more of an emphasis on digitalization and AI- driven technologies for enhancing production flexibility and efficiency than it does on the basic principles of social justice and

sustainability. In order to sustain the industry's long-term contribution to humanity within the bounds of the planet, research and innovation are crucial. This is why the concept of Industry 5.0 offers a different focus and point of view.

2. Understanding Industry 4.0

The Fourth Industrial Revolution, or Industry 4.0, is said to be altering how businesses operate and, consequently, the stakes at which they are required to compete. Companies must choose where and how to invest in these new technologies and which would best suit their requirements. Industry 4.0 is often used to refer to "smart manufacturing," which is the culmination of the industrial sector's digital transition and offers real-time decision-making, increased productivity, flexibility, and speed. It is transforming how businesses produce, enhance, and distribute their goods. The Internet of Things (IoT), cloud computing, analytics, artificial intelligence (AI), and machine learning are among the cutting-edge technologies that manufacturers are incorporating into their manufacturing processes. These digital technologies lead to increased automation, predictive maintenance, self-optimization of process improvements, and, above all, a new level of efficiency and responsiveness to customers not previously possible.

The manufacturing sector has a fantastic potential to join the fourth industrial revolution by developing smart factories. Real-time visibility of manufacturing assets is ensured by analyzing the massive amounts of big data gathered from sensors on the factory floor. This analysis can also provide tools for doing predictive maintenance to reduce equipment downtime. Advanced sensors, embedded software, and robotics are features of smart factories that collect and analyze data to help in decision-making. When operational data from ERP, supply chain, customer service, and other business systems is integrated with data from production operations, even greater value is produced, opening up previously isolated data to entirely newlevels of visibility and insight.

Smart factories with IoT technology have higher production and better quality. Manufacturing errors are decreased, and money and time are saved when manual inspection business models are replaced with AI-powered visual insights. A smartphone connected to the cloud can be easily set up by quality control workers to enable remote monitoring of manufacturing processes. Manufacturers can identify mistakes earlier rather than later, when repair work is more expensive, by using machine learning algorithms.

2.1. Industry 4.0 and Forces of Change:

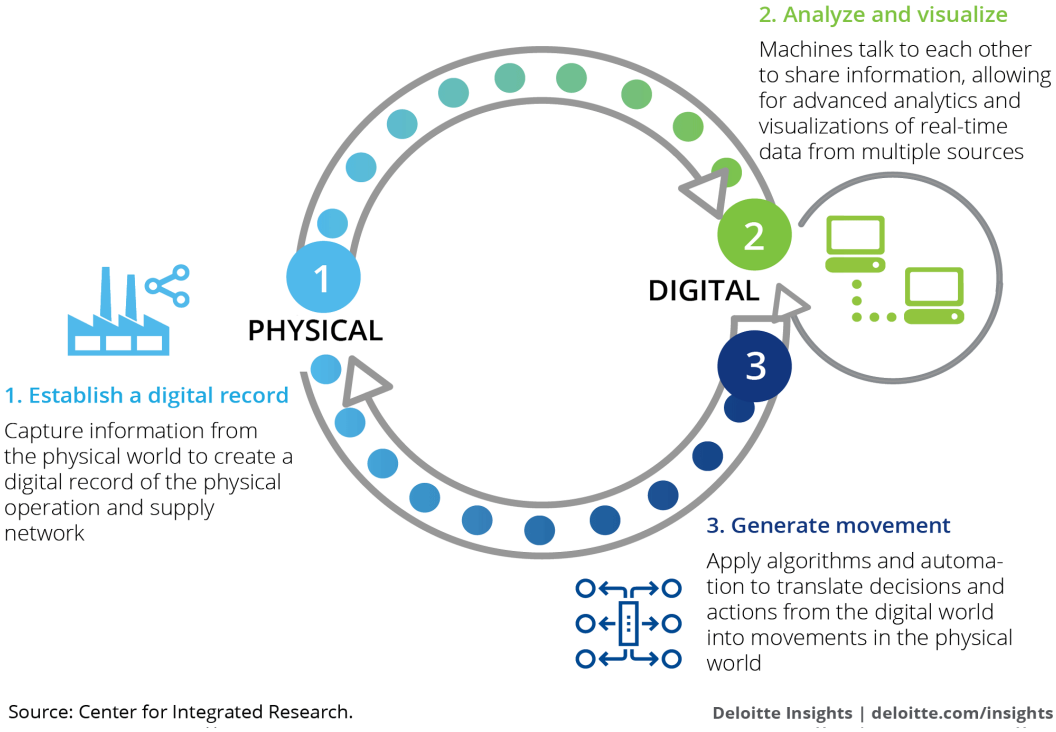
Right now, the fourth industrial revolution is only beginning. Smart manufacturing, which integrates computers into the manufacturing process, is what distinguishes this. We observed the adoption of critical technologies during this phase, including **Artificial Intelligence (AI)** for intelligent decision-making, **Machine Learning (ML) Algorithms** for identifying patterns in data, **Robotic Process Automation (RPA)** for back-office high-volume repetitive tasks, **Digital Twins** for equipment/facility insights throughout their lifecycle, **Collaborative Robot (Cobots)** for assembly line automation and heavy lifting, **Connectivity Evaluation** from 2G-5G for faster communications.

The transition to real-time access to data and information made possible by Industry 4.0 wouldradically alter how company leaders who are accustomed to traditional linear data and communications do business. The physical act of conducting business can be continuously driven by the fusion of digital data from numerous sources and locations.

The constant and circular flow of data and activities between the physical and digital worlds drives real-time access to data and insight across this cycle. The physical-to-digital-to-physical (PDP) loop, which is an iterative sequence of **three phases**, creates this flow (see **Figure 1).** Industry 4.0 brings together pertinent physical and digital technologies, including analytics, additive manufacturing, robotics, high-performance computing, natural language processing, artificial intelligence and cognitive technologies, advanced materials, and augmented reality, to achieve this process.

- **Physical to digital:** Gather data from the real world and turn it into a digital file.
- **Digital to digital:** Information sharing and significant insight discovery through the use of artificial intelligence, advanced analytics, and scenario analysis.
- **Digital to physical:** Apply algorithms to transform judgments made in the digital realm into useful facts that will inspire action and change in the physical world.

Figure 1. Physical-to-digital-to-physical loop and related technologies



Source: Center for Integrated Research.

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3. Understanding Industry 5.0

Industry 5.0 is predicted to leader in the next stage of transition, bringing in human- robot co-working dynamics, which means maximum automation and minimal human engagement. This partnership will be crucial in transforming smart factories into lights-out factories, where the facility may function without any human involvement on site and with only the barest minimum

requirements for human activity. This will result in reduced energy use and electricity downsizing.

Industry 5.0, the following stage of transition, is anticipated to leader in a dynamic of human-robot co-working that maximizes automation while minimizing human involvement. This partnership will be crucial in transforming smart factories into lights-out factories, where the facility may function without any human involvement on site and with only the barest minimum requirements for human activity. This will result indecreased electricity use and saved energy.

The European Commission (EC) developed the idea of "Industry 5.0" to address the need for changing industrial standards to enable innovation for societal wellness as wellas economic growth and sustainability. Industry 5.0, in the opinion of the European Union, "provides a vision of an industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and contribution of industry to society." and "It respects the planet's production limits while putting the welfare of the worker at the center of the production process and using new technologies to provide prosperity beyond jobs and growth."

3.1. Core principles

Human-centricity, sustainability, and resilience are the **three interconnected core values** at the heart of Industry 5.0 (Fig. 2). The change from technology-driven progressto a wholly human-centric and society-centric approach is made possible by the human- centric approach, which places fundamental human wants and interests at the center ofthe manufacturing process. As a result of the shift in value from viewing employees as "cost" to "investment," industrial personnel will acquire new roles. The technology employed in manufacturing is adaptable to the demands and diversity of industry workers because it is designed to serve people and society. To prioritize physical, mental, and overall well-being, as well as to protect workers' fundamental rights, such as autonomy, human dignity, and privacy, a safe and inclusive work environment

must be established. Industrial workers need to keep upskilling and re-skilling themselves for better career opportunities and work-life balance.

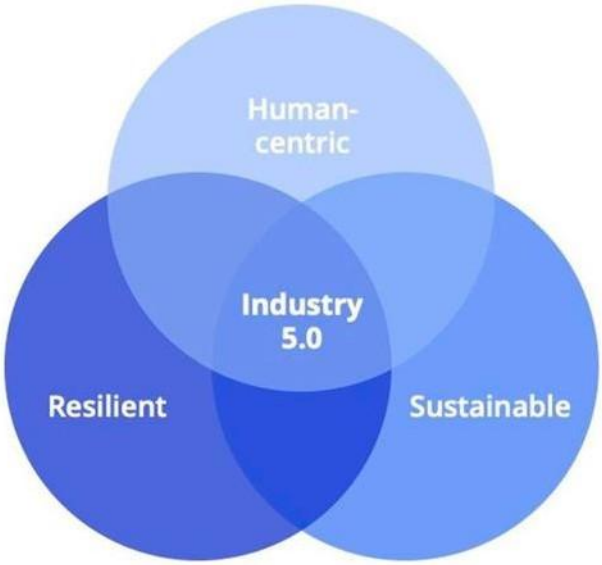

Fig. 2

3.1 Human-Centric Strategy

According to the infographic, a human-centric strategy "promotes talents, diversity, and empowerment." The most significant change this implies is moving away from using people as means (such as in the case of human resources) and toward using themas ends. Or, to put it another way, a change in viewpoint from individuals serving organizations to those individuals serving organizations. Finding, serving, and retaining talent has become a considerably bigger task than finding, serving, and retaining customers in many businesses and nations. If this trend continues, the business plan must find a home for it, and that's what Industry 5.0 aims to do.

Today's strategy is mostly focused on acquiring a competitive edge and utilizing it to produce distinctive additional value for clients. The work of Michael Porter, the most well-known strategy professor to date, is fundamentally influenced by this mindset. The first implication for strategy is that it must be about acquiring a competitive edge and exploiting it to produce

distinctive added value to employees if firms are to become truly human-centric.

3.2. A Resilient Strategy

A robust strategy is, in the words of the European Commission, "agile and resilient with flexible and adaptable technologies." Few would deny that resilience is essential both now and in the future in light of COVID-19, global supply constraints, and the Ukraine conflict. This is why many programs to increase a company's agility and flexibility, particularly in its "lean" version, are driven by an emphasis on efficiency. The creationof organizations that are "anti-fragile," or able to anticipate, react to, and learn systematically from any crisis, will be the primary focus of strategy rather than growth,profit, and efficiency if we are to truly understand that resilience will become one of the three pillars of Industry 5.0. This will ensure stable and sustainable performance.

3.3. Sustainable Strategy

The concept of sustainability only needs an introduction given the widespread worrieswe currently have regarding climate change. However, fully integrating sustainability into a company's strategy involves going above and beyond what has already been done. Truly sustainable businesses concentrate on boosting their positive impact as opposed to merely lowering their negative impact. In other terms, the Industry 5.0 strategy entails.

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4. Technologies that facilitate 5.0

The six enabling technologies that Industry 5.0 identified are as follows:

1. Technologies that connect and integrate the talents of humans and machines through human-centric solutions and human-machine interactions.

2. aterials with embedded sensors and improved features that are recyclable and made possible by bio-inspired technology using simulation and real-time digital twins to model entire systems.

3. Technologies for data transmission, storage, and analysis that are cyber-safe and capable of handling system and data interoperability.

4. Artificial intelligence, such as the ability to identify causal relationships in complicated, dynamic systems and provide useful intelligence.

5. Energy-efficient and reliable autonomous technologies are important because the previous methods use a lot of energy.

6. Industry 5.0 is a value-driven effort that pushes technological transformation with a specific focus, not a technology-driven revolution.

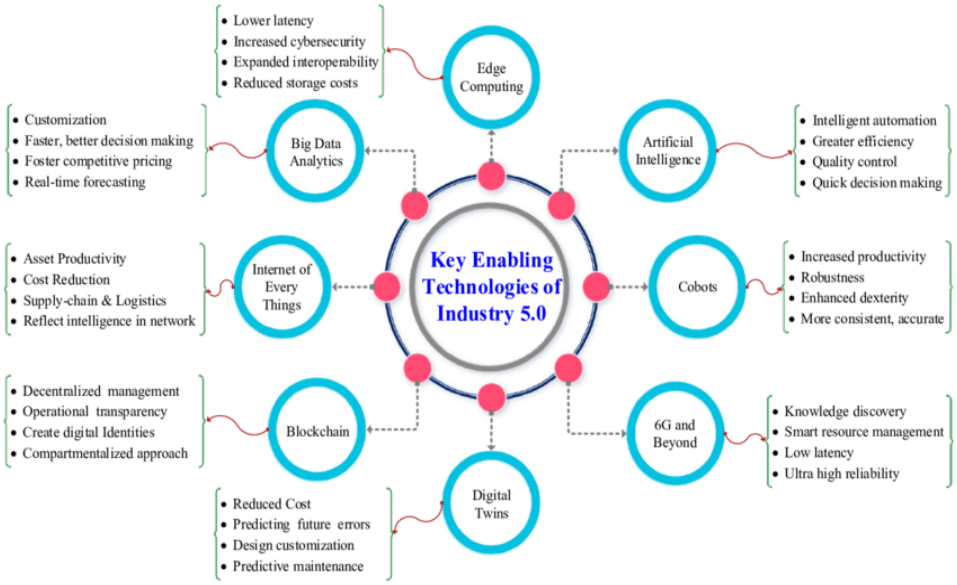

Fig. 3

5. Business Opportunities @ Industry 5.0

The following opportunities are presented by Industry 5.0:

- The adoption of next-generation technologies will have a ***favorable influence on employment*** in several areas as a result of increased automation.
- Manufacturing processes that are highly automated give clients ***more customizationoptions***.
- It increases the opportunity for innovative people to come and work, ***maximizinghuman productivity.***
- Machines can be programmed to ***produce high-level choices based*** on staff demands, and they will aid the client digitally in managing repeat follow-up assignments.
- In Industry 5.0, the production cell's operator is ***more attentive to the planning process*** than to the more or less automated manufacturing process.
- It permits liberty of design to function and allows ***more tailor-made and personal products***.
- ***increased worker safety*** as a result of COBOTs' ability to perform hazardous and dangerous tasks.
- More individualized goods and services ***boost consumer happiness and loyalty*** as well as draw in new clients, which boosts revenue and market share for the businesses.
- If appropriate money and infrastructure are available, it offers ***enormous opportunities for start-ups*** and entrepreneurs in creative and inventive fields to develop new goods and services related to Industry 5.0.
- The field of human-machine interaction is given more weight in Industry 5.0 and has ***a larger platform for research and development*** in this area.
- With the aid of Industry 5.0, ***quality services, particularly in the healthcare***

sector, such as medical procedures in rural areas, can be supplied at remote places.

6. Challenges @ Industry 5.0

Industry 5.0 poses various distinct problems that have never been encountered before,including:

- This trend exacerbates the polarization of the labor market, as middle-skill employment is declining and the workforce is divided into two groups: highly qualified workers who earn high salaries, and unskilled workers who earn low salaries. This might narrow the gap between competent and unskilled people insociety.
- Due to highly automated production processes, it is extremely difficult to increase workers' skills, such as preparing them to embrace cutting-edge technology and changing their behavior when interacting with others.
- Collaborative robotics is an automation technique that, along with human coworkers, nonetheless poses a serious risk on the factory floor.
- As essential components of self-organized systems, smart manufacturing systems demand greater autonomy and sociality capabilities. Due to the current context's lack of autonomy in systems like integrated decision-making, the transition to Industry 5.0 is challenging.
- It is challenging to accommodate different data repositories from industrial systems and to obtain high-quality, accurate data.
- Due to its increased connection and usage of common communications protocols, Industry 5.0 poses a greater threat to the security of vital industrial systems and production lines.
- Industry 5.0 is challenging for businesses, especially SMEs, to adopt because it requires enormous expenditure to properly execute all of its pillars.

- For instance, industry 5.0 has enormous potential for the healthcare sector, butsignificant accuracy and precision are required. This area of research is still in its infancy and requires significant infrastructure and funding.
- Startups and business owners face difficulties since Industry 5.0 involves significant infrastructure investments and the use of cutting-edge technology.
- It is difficult to create regulatory frameworks for Industry 5.0 because of the prevalence of automation. For instance, who will be responsible for failures, and to what extent?
- The current business strategy and business models must be adjusted and tailored to fit the requirements of Industry 5.0 due to greater degrees of automation in the industries.
- The company strategy will place a greater emphasis on customer-centric operations as a result of mass personalization. Customer subjectivity shifts throughout time, making it challenging to alter corporate tactics and businessstructures.
- Industry business strategy Due to various client preferences, version 5.0 requires a higher level of dynamism to maintain competition.

7. The Outcome:

This industrial revolution involves utilizing human-machine interfaces to expedite and simplify tasks. The personalization concept is advanced by Industry 5.0. Industry 5.0 is employed more effectively to create a virtual environment, cutting-edge computers, and information technologies in order to satisfy the highly individualized demand. **Big data**, **artificial intelligence**, the **Internet of Things (IoT)**, **cloud computing**, **COBOTS, innovation**, and creativity are all optimally integrated with Industry 5.0.

Industry 5.0 is anticipated to generate higher-value jobs with more room for innovationand creative thinking. It contributes to raising labor productivity and giving customers more customization options. On the other hand, skill development for the workforce isa massive task as a result of highly automated industrial systems. Due to its increased connection and adoption of common communications protocols, industry 5.0 poses a greater threat to cyber security in important industrial systems and production lines. Even though Industry 5.0 gives machines more autonomy, humans still have the authority to make crucial decisions that are morally sound.

In general, industry 5.0 is anticipated to transform the manufacturing processes and systems by enabling more cooperation between humans and robots in order to providecustomers with customized products. Through programs like **Make in India, Skill India**, and **Start-up India**, India hopes to become a manufacturing hub. The potential for Industry 5.0 to integrate with these initiatives is enormous.

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