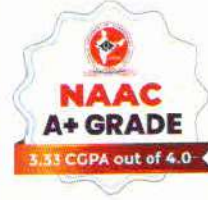




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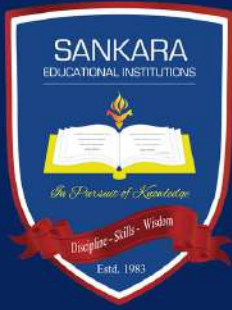
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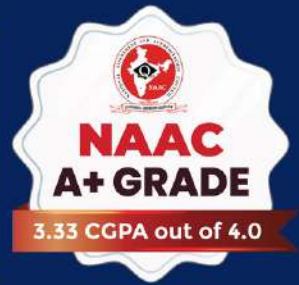
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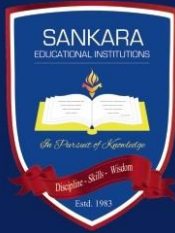
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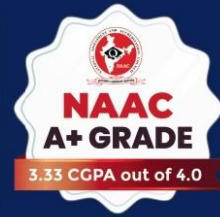
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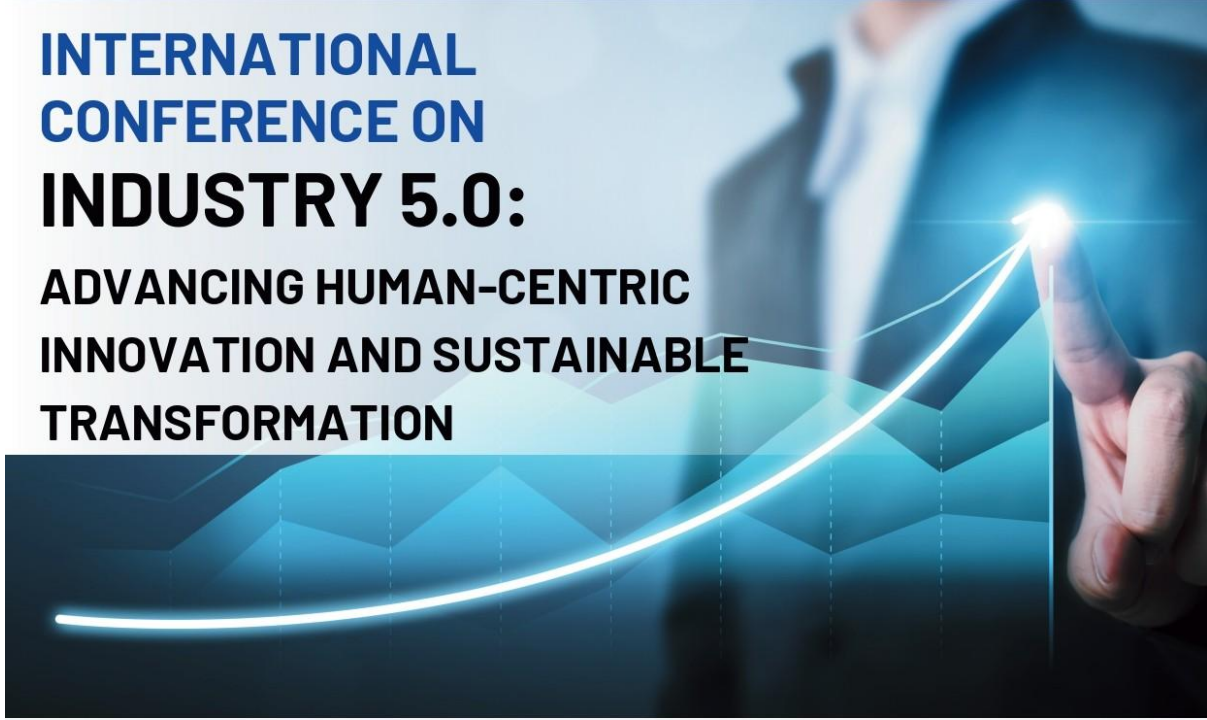
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## **INDUSTRY 5.0 – A HUMAN – CENTRIC SOLUTION**

*Dr. K SURESH BABU, Associate Professor, Department of Commerce with Retail Marketing, PSG College of Arts & Science, Coimbatore – 14.*

### **Abstract**

Staying at the top is getting tougher and more challenging due to the fast-growing and changing digital technologies and AI-based solutions. The world of technology, mass customization, and advanced manufacturing is experiencing a rapid transformation. Robots are becoming even more important as they can now be coupled with the human mind by means of brain-machine interface and advances in artificial intelligence. A strong necessity to increase productivity while not removing human workers from the manufacturing industry is imposing punishing challenges on the global economy. To counter these challenges, this article introduces the concept of Industry 5.0, where robots are intertwined with the human brain and work as collaborator instead of competitor. This article also outlines a number of key features and concerns that every manufacturer may have about Industry 5.0. In addition, it presents several developments achieved by researchers for use in Industry 5.0 applications and environments. Finally, the impact of Industry 5.0 on the manufacturing industry and overall economy is discussed from an economic and productivity point of view, where it is argued that Industry 5.0 will create more jobs than it will take away.

**Keywords:** *Industry 5.0; artificial intelligence; advanced manufacturing*

### **Industrial Revolutions**

Traced back to 1780s, the First Industrial Revolution was born with the generation of mechanical power from water, steam, and fossil fuels. In the second such revolution, electrical energy was favored by manufacturers with assembly lines and mass production in the 1870s. Employing electronics and information technologies (IT), the Third Industrial Revolution familiarized the production industries with the concept of automation in the 1970s. The fourth phase of revolution utilizes the Internet of Things (IoT) and cloud computing for the provision of a real-time interface between the virtual and physical worlds—the so-called cyber-physical systems. Although Industry 4.0 is not yet well grown, many industry pioneers and technology leaders are looking ahead to the Fifth Industrial Revolution: autonomous manufacturing with human intelligence in and on the loop.

### **Background**

Manufacturers are competing to satisfy the ever-changing market demands. This requires production lines to be adaptive, intelligent, and flexible enough to meet the updated requests.

Business leaders and manufacturing managers have concluded that they should achieve an integration of business and industrial production. Such an integration requires considerable advancement in industrial process and strategies. Moreover, it is achievable only by integrating various facets of a company, including suppliers, production lines, and customers. This multi-faceted integration has been termed the Internet of Things (IoT), which is the main asset of Industry 4.0.

### **What is Industry 5.0 and Why is It Required?**

Industry 4.0 is about automating processes and introducing edge computing in a distributed and intelligent manner. Its sole focus is to improve the efficiency of the process, and it thereby inadvertently ignores the human cost resulting from the optimization of processes. This is the biggest problem that will be evident in a few years when the full effect of Industry 4.0 comes into play. Consequently, it will face resistance from labor unions and politicians, which will see some of the benefits of Industry 4.0 neutralized as pressure to improve the employment number increases. However, it is not really necessary to be on the back foot when it comes to introducing process efficiency by means of introducing advanced technologies. It is proposed that Industry 5.0 is the solution we will need to achieve this once the backward push begins.

### **Methodology for the Solution—What is Required for Industry 5.0?**

As mentioned in the previous section, Industry 5.0 will solve the problems associated with the removal of human workers from different processes. However, it will need even more advanced technologies to achieve this, which are discussed below.

### **Networked Sensor Data Interoperability**

Ranging from smart houses to autonomous manufactures, cobots, and other distributed intelligent systems, it makes sense that ubiquitous sensing and collection of big data is an unavoidable asset of the next industrial revolution and it is only possible through networked sensors. This also makes it possible to achieve faster analyses and customization processes. A network of sensors with some low-level intelligence and processing power could reduce the need for a high-bandwidth data transfer mechanism, while also allowing for some local preprocessing of data. This would, in turn, reduce network latency and overload, while also creating a level of “distributed intelligence” in the network. A common framework for information transfer, rather than a simple data transfer mechanism, will be needed to fully benefit from a sensor network. Once implemented, these networked sensors will open the possibility for unprecedented customization in manufacturing processes.

### **Multiscale Dynamic Modelling and Simulation: Digital Twins**

With the intelligence of autonomous systems arises complexities in evaluation monitoring of the manufacturing setups. Visualization and modeling of the production line is a very useful tool for making policies and for managing and personalizing future products and product lines. A digital twin is “A virtual model of a process, product or service”. Bridging the virtual and physical worlds, digital twins provide manufacturing units with the ability to analyze data, monitor the production process, manage risk prior to its occurrence, reduce downtime, and further develop by simulations.

### **Shopfloor Trackers**

Shopfloor trackers improve real-time production tracking. They allow the association of sales orders from customers with production orders and supplementary materials. Subsequently, they lead to optimal and efficient resource management, which is a critical objective for manufacturers. Shopfloor trackers also allow for real-time tracking of assets and process flow, which paves the way for online process optimization in the production process. These trackers can be implemented in the form of networked sensors or by utilizing the benefits offered by networked sensors. They could also lead to reductions in material wastage, theft prevention, and prevention of mismanagement of assets when coupled with technologies like IoT and machine learning.

### **Virtual Training**

This started in 1997 and is a kind of training in which the trainee learns a specific task or skill in a virtual or simulated environment. In some cases, the trainer and the trainee are based in different locations. This type of training significantly reduces the costs and time for both parties. It is also flexible enough to be updated and reconfigured for new training courses.

### **Intelligent Autonomous Systems**

Autonomously controlling production lines requires a great deal of artificial intelligence applied in the software agents operating in the factory. Autonomy in Industry 5.0 is considerably different from what was referred to as automation in Industry 3.0. Exercising autonomy that performs useful functions is very difficult if not impossible without artificial intelligence (AI). AI techniques allow machines to learn and therefore autonomously execute a desired task. State-of-the-art classification, regression, and clustering methodologies empowered by deep learning strategies result in intelligent systems and solutions that can make decisions under unforeseen circumstances.

### **Advances in Sensing Technologies and Machine Cognition**

Intelligent autonomous systems will greatly depend on replication of the senses that we, humans, use to cooperate with others and learn in an adaptive manner. Computer vision, combined with deep learning, reinforcement learning, and GPU-based computation, has shown great promise in replicating primitive vision and sensory capabilities. However, for Industry 5.0 cobots, these capabilities must be improved significantly. For example, a human worker will stop working when he/she suspects something unnatural in his/her workspace, even when there is nothing wrong in plain sight but using their emotional intelligence.

### **How Industry 5.0 Will Affect Manufacturing Systems**

Previous industrial revolutions demonstrate that manufacturing systems and strategies have been continuously changing towards greater productivity and efficiency. Although many conferences and symposia are being held with a focus on Industry 5.0, there are still several manufacturers and industry leaders under the belief that it is too soon for a new industrial revolution. On the other hand, accepting the next industrial revolution requires the adoption, standardization, and implementation of new technologies, which needs its own infrastructure and developments.

Furthermore, as a direct impact of Industry 5.0, a large number of start-up companies will build a new ecosystem of providing custom robotic solutions, in terms of both hardware and software, across the globe. This will further boost the global economy and increase cash flow across the globe.

### **Concerns in Industry 5.0**

- In the next industrial revolution, humans are expected to add high-value tasks in manufacturing policies. Standardization and legalization will help to prevent any serious issues between technology, society, and businesses.
- Particularly, senior members of a society and stakeholders will find it much more difficult to adapt with the new industrial revolution.
- Fast and highly efficient manufacturing may result in an overproduction phenomenon. Implementation transparency should also be taken into consideration.
- We must consider how autonomous systems can incorporate ethical principles.
- There should be explainable ethical behavior solutions in autonomous systems.
- Ethical behavior in autonomous systems must be subject to verification and validation.

- Essential skill gaps such as CROs in future management and executive roles must be addressed.

## Conclusions

The Fifth Industrial Revolution will emerge when its three major elements—intelligent devices, intelligent systems, and intelligent automation—fully merge with the physical world in co-operation with human intelligence. The term “automation” describes autonomous robots as intelligent agents collaborating with humans at the same time, in the same workspace. Trust and reliability between these two parties will achieve promising efficiency, flawless production, minimum waste, and customizable manufacturing. In doing so, it will bring more people back to the workplace and improve the process efficiency.

## Finding

This research was supported by the Australian Research Council and iTrust Lab. at the Institute for Intelligent Systems Research and Innovation (IISRI) at Deakin University, Australia.

## Conflicts of Interest

The author declares no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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