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INDUSTRY 4.0 –The Industry Internet of Things (Computer aided manufacturing)

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ABSTRACT

We are currently living in the era of Industry 4.0, and particularly over the past few years, major developments have been made in the quickly expanding field of Manufacturing Technology due to the extraordinary efforts of both scientists and leaders in business.The regeneration of production and its material and technical base is fundamentally connected with the modernization of the Indian economy and its transition to an innovative development path.In recent years, there has been a trend towards increasing the economic potential of highly developed nations through scientific, technological, and advancements in technology, with the government playing an active role. There is a shift towards a digital industry focusing on Industry 4.0. This results in enormous setup of cyber physical systems in production, the advancement of modern digital technologies such as Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) has been vital, automation of most production processes, the endowment of devices with artificial intelligence, and the introduction of a variety of other advanced technologies in the field by optimizing and streamlining procedures, lowering manufacturing costs, and improving the quality of manufactured parts.

Keywords: CAD/CAM/CAx systems, design and manufacturing features, geometric modelling, tool-paths generation, Industry 4.0, digital-twins, CIM – computer integrated manufacturing (ERM/MRP – CAD/CAM), CAD/CAM for additive manufacturing

I. INTRODUCTION

Industry 4.0 is a concept that encompasses a promise of the flexible technological advancements of the industrial revolution, which linked improved production techniques with the IoT (Internet of Things), CAM (Computer aided manufacturing), CAD (Computer Aided Design). The goal is to develop new and integrated manufacturing systems capable of communicating, utilizing information, and analyzing data to drive intelligent activities in the physical environment. As a result, it is also known as the Fourth Industrial Revolution.

The concepts behind Industry 4.0 followed by the fourth industrial age are getting more popular, and they have turned into more than just words; behind them are trustworthy projects that are making their way into our lives. The fourth industrial revolution is a combination of industry and digital technologies, resulting in the development of digital industries or smart factories and factories in which all devices, machines, merchandise, and people interface with one another via digital technologies and the Internet. In fact, Industry 4.0 is an industrial Internet connection and connecting people or industry with the computer based technology like CAM , CAD, Industry 4.0 allows you to create mass production of individual orders, while the price of products will be lower.

Industry 4.0, which is interchangeably used with the fourth worldwide industrial revolution, signifies another step in the organisation and manages the on-the-ground value chain.

It has the following **characteristics:**

- More automation than the third revolution
- IIoT-enabled cyber-physical systems bridge the gap between the digital and physical worlds.
- A considerable movement from central industrial control to a location where the most

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advanced intelligent products define the manufacturing phases.

- Data models and closed-loop control systems
- Product personalization/customization

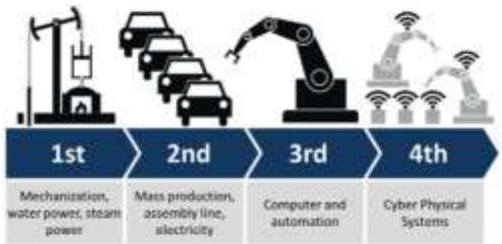
The concept of Industry 4.0 is closely related to the incorporation of advancements in Information Technology into manufacturing technology and systems. As its name implies, it is a revolution in industry, aiming at a higher level of automation and digitization that will lead to the overall improvement of processes, services, and products. Several tools and technologies, such as Internet of Things, cloud computing and CAM ,CAD,CIM, and big data analytics are already used for this purpose. However, the shift from the automated manufacturing concept to intelligent manufacturing is of particular importance. In advanced manufacturing, intelligence is a key element for future development and progress. The aforementioned shift can be accomplished by including algorithms and methods relevant to soft computing or computational methods, for optimization in industrial practice. These methods are capable of providing fast simulation models or resolve industry-related problems efficiently. Especially, in the case of hard engineering problems, it is possible to adopt a rapidly converging optimization method as a part of the decision-making system, which will receive information in real time from the physical processes in the industrial environment and provide reliable results. Computational optimization techniques have proven to be critical for this purpose and a lot of research has already been performed in this field. As a result, many methods and various techniques have been proposed and applied in manufacturing technology problems.

1. **The three pillars that allowed the development of this engineering field are:**

- **Mathematical models:** From the point of view of design (CAD), innovative mathematical solutions have enabled the more precise representation of complex shapes, as well as the development of new tools and technologies, such as virtual reality, geometric design for Additive Manufacturing (3D printing), and new structural design (lattice structure), which ultimately facilitate the designer's work. To optimise production from the standpoint of manufacturing (CAM), new algorithms that improve tool-path computation, as well as new alternatives for tool trajectories, have been developed.
- **New functions**: modern CAD/CAM functionalities have been developed to meet new technical needs and advance the state of the industry. CAD/CAM for Additive Manufacturing (3D printing), CAD/CAM and Virtual Reality, Digital-Twin technology, and reverse engineering are a few examples.

- Industry 4.0 era: real-time data collected during design and manufacturing processes can be used to optimise production and feed into new generations of CAD/CAM.

2. Transition to the fourth industrial revolution: Industry 4.0



- The discovery of a steam engine in the second half of the 17th century in Great Britain triggered the first industrial revolution. However, the revolution occurred between the XVIII and XIX centuries, and it did not occur simultaneously in all countries. Steam engines were first employed in pumps, then in locomotives, steamboats, and in manufacturing. Steam power has had an impact on the advancement of metallurgy, mechanical engineering, transportation, and other industries. There was a shift from manual to machine labour, and productivity increased dramatically.
- Henry Ford's creation of the conveyor belt and in-line production are associated with the second industrial revolution. The time spans the second half of the nineteenth to the beginning of the twentieth centuries. Many other inventions were also created during this time period, including the Bessemer process of steel smelting, which was the first low-cost method of creating high-quality steel, electric energy, widespread use of chemicals, telephone, telegraph, and so on. Electricity allows for the division of labour in the manufacture of bats.

- The third industrial revolution, often known as the "Digital revolution," occurred around the end of the twentieth century (since 1970) and is related with the development of electronics,

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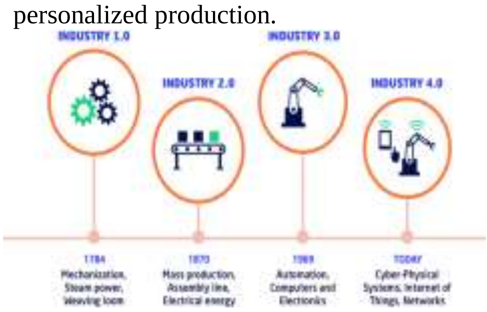
digitalization, computerization, information systems, and the advent of a robot. Industrial production has become more automated as a result of advances in electronics and information technology.

- The fourth industrial revolution originates in 2011 , as the German public-private Industries 4.0 program within which the German companies with assistance of the federal government in the form of grants create digital, clever productions which devices and products interact with each other and provide the personalized production.



3. **Industry 4.0 principles :**

- Compatibility is a feature of all devices and machines to communicate with one another in the same language via the Internet of Things, i.e. they must be compatible.
- Transparency is the construction of a digital duplicate of the product, as well as the collecting of data from microarrays and sensors that allows devices to connect with one another. As a result, the most complete information about all processes that occur with equipment, smart products, production in general, and so on is accumulated.
- Technical support is software that collects, analyses, systematises, visualises sensor data and assists a person in making a decision or makes it automatically, thereby freeing up human resources. This assistance may even include the entire replacement of humans with machines during hazardous or routine procedures.
- Decentralization of management decisions, automation of various solutions by systems, maximum human replacement. Employees are assigned the role of supervisors who can connect in emergency and non-standard situations.

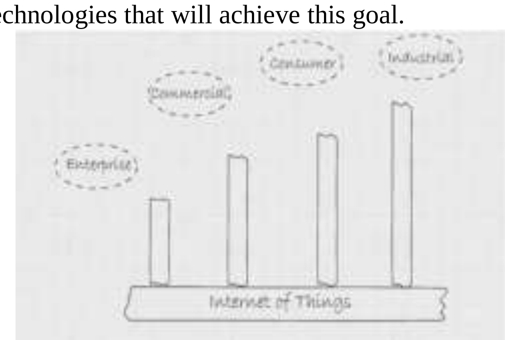
4. **Computer-aided manufacturing and Industry 4.0**

- The kind of intelligent system design will enhance computer-aided manufacturing by providing higher quality assurance more efficiently. However, CAM plays a larger role as part of a larger, integrated product and service delivery process. New design principles will be required, and new technology will have a significant impact on computer-aided manufacturing and its future role.
- In existing Industry 3.0, networks and processes are limited to a single factory. Individual industrial borders will most likely no longer exist in Industry 4.0. Computer-aided manufacturing will grow increasingly networked until everything is interconnected. As a result, the complexity of production and supplier networks will increase.

5. **CAM's Success Factors Are Changing :**

Currently, success in manufacturing is defined as producing a high-quality service or product at the lowest possible cost. Factories strive to do this through optimising performance and volume. More complex variables will be incorporated in the future of CAM. Monitoring and fault diagnosis, components and systems will self-diagnose and self-predict, providing additional insight into the status of the process and delivering self-healing and adaptive solutions.

Computer-aided manufacturing and IoT will necessitate orchestration throughout the entire value chain, from product creation, product management, manufacture and assembly, through digital service provision and service management. The necessity for orchestration will reflect the convergence and interdependence of the emerging technologies that will achieve this goal.



6. **The Negative Effects of Industry 4.0**

- The Industry4.0 medal has a disadvantage. Mass robotization and automation will result in job independence; a huge number of people may be out of work; retraining of specialists to other professions will be required; but many new professions will emerge.

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- The value of low- and middle-skilled labour will be dramatically diminished, perhaps reducing middle-class income and material goods. The move to highly trained labour will be arduous and not available to all. The middle class is a large segment of the country's population, and a drop in middle-class wages can lead to the country's democratic system collapsing.
- There is also a presumption that the population's low purchasing power as a result of Industry 4.0 will lead to poor demand for items, putting the profitability of many firms producing non-vital products in jeopardy.
- It is also a danger that automation will replace the mental and physical activities of people, production workers will only observe robots, and thus people can atrophy memory and other brain functions. It is necessary to involve people in various tasks for universal development.

7. Industry4.0implementation examples

- The leaders in this area are Microsoft, GE, PTC and Siemens. Microsoft is developing solutions for IoT platforms that are closely related to the infrastructure (IaaS + PaaS) that is, operating on the basis of the IaaS server of the cloud provider. The technology is already being used by BJC HealthCare, a health care provider that manages 15 hospitals in Missouri and Illinois. The company uses an IoT platform to save in the supply chain.
- Combining IoT and big data is a that Bosch uses to transform digital technologies at its Bosch Automotive Diesel System plant in Wuxi, China. The company connects its equipment to control the entire production process to a single distribution center of the plant. To do this, sensors are installed on all machines of the factory, which are used to collect data on the state of the machines and their time of operation. The company BoschRexroth equipped equipment for the production of valves (and the valves themselves) with special radio frequency identification (RFID), so that the working equipment "understands" what steps need to be performed and how to adapt each individual operation.
- Along with robotics and intelligent systems, additive manufacturing, or 3D printing, is a key technology that stimulates the development of the 4.0 Industry. One of the World economic forum's best intelligent factories in the world, Fast Radius, uses its own technology platform for 3D printing.
- Siemens has developed and used virtual and augmented reality capabilities to develop a virtual training module for its Comos software. Using a 3D model and augmented reality glasses, the module helps staff cope with emergencies in virtual simulation mode. In this virtual world, operators learn to interact with equipment using a digital presentation, change equipment parameters and display operating indicators and repair instructions.

- An example is Siemens PLM Software's Tecnomatix, a family of software products designed to automate production preparation and optimization tasks.

II. CONCLUSIONS

- The fourth industrial revolution will cause major changes in practically every aspect of human life. The following are the most likely effects of Industry 4.0 development: The fundamental transformation of the economy, the predominant development of sectors of the economy that have access to large amounts of data; the growth of social classification as a result of the disappearance of the importance of a large number of professions, intellectual and creative opportunities will become the main value in the labour market; The removal of routine and standard tasks as a result of the automation of the great majority of such activities; world transparency as a result of the interpenetration of the real and virtual worldsdigital environment, new opportunities for digital control of undesirable social phenomena and events.
- Industry 4.0 is slowly but surely entering our world. Industry 4.0 will make it possible to reach a new level of human development and quality of life. It will change the attitude of people and people themselves.

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