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Industrial Revolution; a continuous advancement in manufacturing technologies: A review

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Abstract - *An industrial revolution is nothing but it is development from creating goods by hands into machine. Industrial revolution started in 18th Century i.e. Industry 1.0 .This revolution continued and now we are in the fourth era of industrial revolution i.e. Industry 4.0.. In each industrial revolution we observe various technology changes , various innovations take place in manufacturing processes. Industry 4.0 introduced by German government .In industry 4.0 the automation and data exchange take place. The various advanced techniques like IoT, Cloud computing ,Big data ,Artificial intelligence ,cyber physical system etc are used to have smart factory to increase productivity and efficiency .This paper represent the transformation takes place in manufacturing technologies in each industrial revolution.*

***Key Words*: Industry 1.0, Industry 4.0 , IoT, Cloud computing ,Big data ,Artificial intelligence ,cyber physical system etc.**

1. INTRODUCTION

The first industrial revolution i.e Industry 1.0 was started in 18th century in Britan. In this revolution manual production work replaced by machines that uses steam or water as source of power. James Hargreaves invented yarn spinning machine i.e spinning jenny to make textile manufacture easier. James Watt had done improvement in steam engine while repairing Newcomen steam engine . Samuel Crompton invented multiple spindle spinning machine to manufacture high quality threads and yarns for textile industry. Industry 1.0 leads to revolution in first railway ,coal mining etc.

In second industrial revolution i.e Industry 2.0 introduction of electricity leads to steam engine replaced by machined powered by electricity which was useful to assembly line work and factory floors to produce goods in time. Henry Ford developed assembly line production in automobile industry. This industrial revolution is well known for era of mass production. In this revolution automatic signals, air brakes and knuckle couples on railroads ,Bessemer and open hearth process in steel mills ,telephone ,electric light and typewriter were invented. In this manufacturing and production methods also improved.

In third industrial revolution Industry 3.0., the automation process started by using logic processor .Many inventions in electronic devices like transistor ,integrated circuits automated machine ,programmable logic controllers were invented which result in reduced effort , greater accuracy and increased speed .This is well known for era of computer .The invention of internet and discovery of nuclear energy was take place in this revolution.

Today, we are the Fourth industrial revolution i.e. Industry 4.0 .It is era of smart machines. In 2021 German government brought this revolution. Application of cyber physical system (CPS),Machine learning ,Cloud computing and Internet of things (IoT), Artificial intelligence ,cyber physical system etc are key technologies in Industry 4.0 . The important points of this revolution is development of customer product , automatic data transfer , making machine interactive and easy to use.

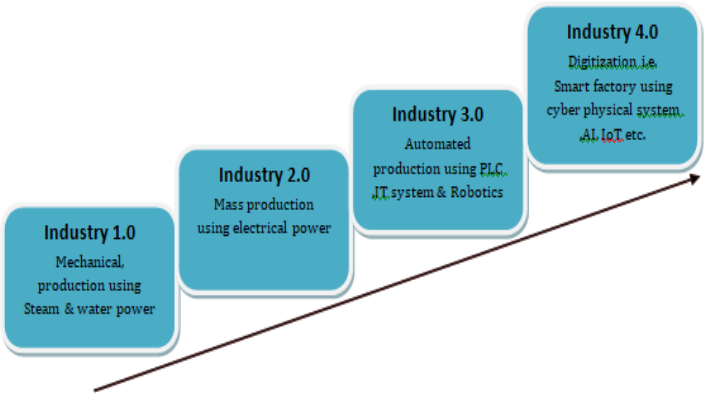

Fig.1 : Industrial revolution Industry 1.0 to Industry 4.0

2. KEY COMPONENTS OF INDUSTRY 4.0

Following are the important components

2.1. Internet of Things (IoT) & Industrial Internet of Things (IIOT) :- IoT related to connection Between sensors or machines and internet while IIOT related to connection between people ,data and machine related to manufacturing. The use of smart robotics helpful in real time identification of issue i.e it will detect cause of issue without sending an engineer to detect that cause, reduce downtime thus increasing efficiency. The recent IOT & IIOT application is APAS-Automatic production assistant, Fully autonomous tractor ,Application of telematics in telecommunication

,wireless connectivity ,electrical engineering ,IT and road transport ,remote vehicle location using GPS ,remote vehicle speed limit control etc. Through IoT cars are connected over IoT network called CV2X (Cellular vehicle to everything) that connect vehicles and smart transport system to each other. IoT automotive maintenance system prevent car parts from sudden breakdown by providing alert about malfunction.

2.2 Big data :- It refers to identification of patterns ,trends ,and preference for companies to make better decision by use of advanced computer technologies .Big data analytics sensor data from production machineries is analyzed to predict when maintenance and repair operations are to be needed. It guide manufacturer by identifying variable that can affect the performance & by identifying problem and also by identifying variable that can affect the performance. Bosch automotive diesel factory system combine IoT and bigdata by connecting machinery to monitor overall production process by embedding sensors in machines to collect data about cycle time and machine condition.

2.3 Cloud computing :- Method to store , manage and process data using network of remote server hosted on internet. This is helpful in manufacturing for improvement of product development and productivity. As this deliver different services on internet which is helpful for small scale company to access high tech manufacturing services. Cloud helpful to avoid and inaccuracies and delays in manufacturing. Through cloud based IoT manufacture receive data in in real time for specific machinery. To grow manufacturing business it allow aggregation of customer data to accelerate engagement with customer in real time. Volkswagen Automotive Cloud enable the next generation of infotainment, vehicle performance, passenger comfort, automated driving. It is helpful in enhancing existing services by providing emergency assistance and re mote vehicle access and also helpful in car navigation by providing charging station location .

2.4 Artificial Intelligence (AI) It is combination of technologies by allowing software and machines to sense, understand, act and learn their own. This enable robot to perform tasks that persons not able to do. This technology enable machine to simulate human behavior. Artificial intelligence impact on manufacturing by Reducing production losses by generating automated recommendation and alerts to prevent losses before they happens , Predictive maintenance by detecting quality defects, Human robot collaboration, Predict failure in design, effective demand and price forecasting of raw materials ,intelligent and self optimizing machines to automate production process, etc. It include learning, reasoning and self correction . Number of leading automobile industries benefited from the real time data and virtual simulations provided by digital twins that provide input to train AI model to improve operational efficiency and reduce time to design.

2.5 Machine learning (ML) It enable computer system to make predictions or take decisions using historical data without programming explicitly. The machine learning learn past data to give accurate outputs. It include learning and self correction when new data is introduced. The applications of ML process driven loss reduction , cost reduction by predictive maintenance , Consumer driven product creation , more efficient inventory management, enhanced quality control etc.

The two models commonly used in manufacturing are

1. Supervised machine learning :- It Can be trained, using predefined criteria, to identify patterns in data This uses one of the two model regression model or classification model

2.Unsupervise machine learning :- It Infers its own patterns from sets of data without any predefined outcomes and, therefore, can't be trained in the same way as supervised learning. Its applications are clustering by creating clusters of different data points linked by certain attributes to identify patterns , anomaly detection identify unusual patterns within a dataset i.e faulty components ,fraud behavior etc, latent variable model used in data processing to reduce number of points in a dataset etc

2.6 Additive Manufacturing (AM) It is production technology to obtain final products through generation and addition of layers of materials. It produce less waste and scraps as it add the material needed to create material instead of subtracting or removing the material. It provide freedom in design for manufacturing complex components .It include new developments such as bioprinting , Three dimensional(3D) printing , Four dimensional(4D) printing, Nanoscale , metamaterial printing etc. The most common materials used in this process are metals ,plastics ,ceramics ,metallic alloy etc. This process used in aerospace for manufacturing aerospace components having complex geometries and also for producing parts having low strength to weight ratio. It is also applicable in medical field to produce medical implants. It is used in automobile industry to manufacture parts having low weight to strength ratio and also used to produce prototyping parts as well as actual parts .

2.7 Cyber physical system (CPS) It is collection of physical and computer components integrated by means of sensors, actuators and network connections to operate process safely and efficiently. As per the research paper [4] It consist of various layers such as

1. Physical layer:-include sensors ,actuators ,tracking device and computing elements

2.Network layer:- include networking protocol such as Wifi ,WiMAX ,GPRS,3G/4G/LTE Technology and communication protocol like Bluetooth ,Satellite , Controller Area Network (CAN). etc.

3. Storage layer:-Data stored in local server or in cloud.

4 Processing and analytical layer:- It process data using simulation model

5. Application layer: - This is user interface for consumers, operators, manufactures, third party suppliers etc.

3. CONCLUSIONS

Industrial revolution is continues process i.e. it is revolution as new innovations and developments takes place from Industry 1.0 to Industry 4.0 . Now we are in the fourth revolution Industry 4.0 but its implementation will require considerable economic investment .So, to achieve this necessary national investment plans has to be developed to encourage the manufacturing companies to implement this in their industry to survive in the global competition in terms of the developing technologies .Also the industry must have plans to arrange the training and information activities to train their operators to know the components of Industry 4.0 as discussed in the paper. Industry 4.0 achieve better process efficiency, less scrap, quality products, reduce delays in manufacturing.

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