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Review on industrial mathematics and materials at Industry 1.0 to Industry 4.0

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ABSTRACT

Industrial Evolution is a most important part of the development of the World. From the 18th Century itself, Industrial evolution growth has to be increased. But yet now Industries faces a lot of challenges. Facing Challenges on Production-Distribution Planning in Supply Chain Management, uncertain business environment. An industrial mathematics tool helps to improve the efficiency of the industry operation. So here paper review on Industrial revolution with Impact of Industrial mathematics and Materials and How Industrial mathematics and materials develop Smart industries to meet customer need for an uncertain business environment future.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanotechnology: Ideas, Innovation and Industries.

1. Introduction

In worldwide industrial growth started from 18th century. Industries are classified in different sectors as A primary industry sector, Secondary, and tertiary industry sectors. The primary sector is working with natural resources as Farming, fishing, forestry, and mining, mineral extraction [15]. Farming is an important element is a time and money. Farming using Mathematics as integers, Estimates the uncertainties, linear programming, linear equations, linear inequalities, mathematical organization and geometry. Integers are used in many tasks as represent sample land location SE 33 – 15 – 8 – W3 section 33, township 14, range 7, North of the 2nd place. Estimates the Crop irrigation depends upon time and climate with respect to some constraints as cost of seed, time, labor and fertilizer. Finding uncertain situations are handled by linear programming, linear equations. Geometry is used for spraying fertilizer to the place, the place represents acres. Depends on acres and seed passing spray count will vary. It's solved by geometry. Nowadays, much new equipment comes for a farming industry yet now it has uncertainties is not provided efficient output. In mining, the sector Statistical analysis mathematical tool is used for data analytics. Statistical analysis the collection of data and scrutinizing data of samples. In forestry, foresters, and forest scientist do more than measure trees. Calculate estimates of tress before to harvest. Primary sectors consume less energy compared to the two main sectors. It consumes 1% [16,17]. Secondary sectors are focusing on Manufacturing things or construction sectors. Applied mathematics is used in Secondary sectors are used in applied mathematics. In Construction, tradespeople use mathematical concepts such as geometry, trigonometry, and measurement for building roofs or houses, plasterers use ratios for mixing compounds, plumbers use hydraulics for heating systems. Secondary sector consumes less energy compared to Territory sectors. It consumes 15% of the power. Territory sectors are Services as shops and other services it consumes more energy compared other two sectors. It consumes 84% of the power.

2. Industry revolution

2.1. First industrial revolution (Industry 1.0)

First Industrial Revolution period from about 1760 to sometime between 1820 and 1840 over the use of steam power and mechanization of production [8–11]. Due to mechanized version to achieve the eight times of the production for conventional mehtods. What before produced threads on simple spinning wheels, the mechanized version achieved eight times the volume at the same time. Steam power was already known. The use of it for industrial purposes was the greatest breakthrough for increasing human productivity. The first revolution from hand production methods to machines, Steam power and water power is a vital role

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in the industrial revolution growth. Firstly, industrial revolution developed sectors as Textile manufacture, Iron industry, steam power, machine tools, chemicals, cement, gaslighting, glassmaking, agriculture, paper machine, transportation, mining, (canals and improved waterways, railways, roads, railways) and other developments.

2.2. Second industrial revolution (Industry 2.0)

The second phase of the industrial revolution is industrialization form the late 19th a century into the early 20th century [12,13]. The main focus of revolution is manufacturing mass production with the help of the development of machine tools. The second revolution adopts new technologies such as electrical power, telephones, The internal Combustion engine, railroad networks, gas, telegraph, sewage and water supply. Industry and technology are developed in different sector as Iron, electrification, steel, rail, machine tools, paper making, chemical, petroleum, rubber, maritime technology, bicycles, automobile, applied science, fertilizer, telecommunications, engines, turbines, telecommunications and modern business management.

2.3. Third industrial revolution (Industry 3.0)

The third industrial revolution started in the 1970 s through partial automation using computers, and automation industries [14]. In this revolution the industry entering the automation industry in the production sector. Production sector got amazing growth in the field engineering field. Industries are automating the entire production process without human assistance. Automation is run by the electronics and computer-controlled devices. Automation increases the reliability and efficiency of the industrial system. It can work on those fields in the industry as manufacturing, transportation, facility operations, and utilities. But Automation replaces labour. It causes new technology to push up unemployment rates significantly. An industrial robot is a new technology; make more transition in the industry field. The industrial robot will work in the different axis at a very accurate manner. It produces more effective similar products. Industrial robots are designed by The Programmable integrated circuits. Applications in industrial robot such as welding, painting assembly, labelling and testing. According to the International federation Robotics estimate 1.64 million industrial robots in worldwide.

2.4. Fourth industrial revolution (Industry 4.0)

Industry 4.0 started in the 21st century. Industry 4.0 develops Cyber-physical system as Industry all systems are connected, communicated and processed through machine learning and cloud computing technology [1–7]. Industry 4.0 connects with the Internet of things (IoT) which help in manufacturing and services. In modern technologies have artificial intelligence, High end robotics and augment reality.

2.4.1. Internet of things (IoT)

Internet of Things is the connection of two words as Internet and things. Internet as the network of the networks like things to things, human to things, human to human and things to human. Things as the industry Physical subsystems. IoT has four operating layers such as sensing layer, network layer, service layer and interface layer. Sensing layer is used to sense the data then actuate data. The network layer is used to connect from one node to another node as things. The service layer is used the process the date then it will transfer to another node by interfacing layer.

2.4.2. Cloud computing

Cloud computing all the industrial data are in the field of cloud. So all the subsystem can access and analyse the data very effective manner for high productivity and reliable operations. Cloud Computing for small and Medium Enterprises (SMEs) as a resource pooling with on-demand self-service, rapid measured service and broad network access.

2.4.3. Big data

Big data technology is a way to analyse systematically extract information from large complex data sets. It includes to process the capturing, analysis, storage, transfer, search, visualization, updating querying of data. Big data can describe the structured, semi-structured and unstructured huge data in one place, All the data are analysed and processing with the linking more physical device by with the internet and brought to analyse by the internet.

2.4.4. Simulation

The simulation tool is used to before implementation it produces the effective output for the system, normally simulation tool is used for mathematical Simulink tool.

2.4.5. Augmented reality

Augmented Reality is a communicating practice of a actual world environment where the things that exist in the actual world are heightened by virtual perceptual information, occasionally across manifold sensory modalities, including graphic and acoustic. Augmented Reality is used in different sectors as Entertainment, tourism, marketing, surgery, logistics, manufacturing and maintenance etc. AR applied in training, design, manufacturing, operations, service and sales & marketing.AM

2.4.6. Autonomous robots

Artificial intelligence is the key to Autonomous robots. Normally robots are designed by motion mechanism with Programmable processor. But this type of robot will operate depends upon the coding. But The autonomous robot will work for any uncertain situations. Autonomous robot have the major blocks are Environment conditional, operating environment and locomotion and Environment classification and application field.

2.4.7. Cyber security

Cyber security helps to avoid hacking industry system data and malfunction of the industrial device. Due to cloud computing and I all the device controlled and operated by the Internet. So Hacker could be Miss-lead Industry operations. It will be secured by Cyber security. The cyber-attack happen internal source and / or external source. Internal attack sources such as an operator that physical access to a data port or an external source such as an outside communication channel Table 1.

3. Materials impact on industrial revolution

Materials usefulness in the major impact of the Industrial revolution. In Industry 1.0 transfer from handhold device to a mechanical device will form based on iron materials. Iron is the Fe (Ferrite materials) [18]. Iron from rocky ores in earth's crust, it's formed by supernovas. Iron mines are available in Canada, Australia, France, India and South Africa and the United States. Iron is obtained by melting the ores. Properties of iron are a transition metal. Iron has an atomic mass of 56 and its density. Iron materials are used to manufacturing hard machine tools. In Industry 1.0 Iron materials bring transition. Iron material and atomic structure are shown in Fig. 1. Textile industries are ruled in industry 1.0. In Textile industries, cotton material makes a transition. Cotton is a natural

Table 1
Factors are Industry 1.0 to Industry 4.0.

Items	Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0
Period	18th century	19th century	20th century	21th century
Focus Sector	Textile manufacture, steam power, Iron industry, machine tools, cement, chemicals, gas lighting, glass making, paper machine, mining, agriculture, transportation (canals and improved water ways, roads, railways)	Iron, steel, rail, electrification, machine tools, paper making, petroleum, chemical, maritime technology, rubber, bicycles, automobile, applied science, fertilizer, engines and turbines, telecommunications and modern business management.	Semiconductor industry, Digital circuits, Programmable Integrated circuit, Telecommunication, wireless communication, Renewable energy sector, Automate the all production industries.	All type of Industries, such as Primary, secondary and territory sectors with intelligent system.
Technologies	Machine tools, Steam power and Water power	Electrical power, telephones, Internal Combustion engine, railroad networks, gas, telegraph, sewage and water supply	Programmable Integrated circuit, Robot, Industry Automation. Internet,	Internet of ThingsBig dataAugment realitySimulationCloud computing,Cyber securityAutonomous robots.
Achievements	Transportation, employability, sustained growth, Agriculture development.	Electrical power grid, telephones, telegraph, Internal Combustion engines	Telecommunication, Renewable energy, Automated industries, Robots.	Fully Automated System, Aritificial intelligent system in industry application to work in uncertain situations.
Drawbacks	Pollution, Takes maximum time	Maximum cost to consume electrical power.	Automated system would not work in uncertain situations.	All the data are in the cloud computing may be some data's will up protectable. Fully Expert systems are not yet developed for industries.
Mathematics tool	Linear programming, Geometry.	Differential equation, Linear equation, Geometry	Integral equation, Linear programming, Logical controller.	Optimization techniques, Network theory,
Impact on Materials	Iron, Steal	Copper, Aluminium	Semiconductor (Germanium, silicon)	Germaniums, Silicon, Nano Materials.

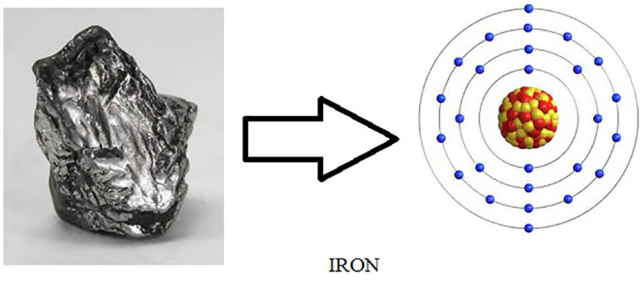

Fig. 1. Iron and Iron atomic structure.

fibre and it is one of the most used fibres together with wool. Also, it is one of the little non-edible cultivation that humankind has sewn for centuries. Cotton is 95% cellulose and is a light, soft material with high absorption capabilities. Cotton Cellulose is shown in Fig. 2. In Industry 2.0 transition impact by Electrical Power Generation. Electrical Power Generation, Transmission and consumption are copper and Aluminium is important material on Industry 2.0 revolution. Copper atomic structure is shown in Fig. 2. Copper is a transition metal. Copper atomic weight is 63.56, melting point is 108.62 °C, 1357.77 K, boiling point is 2560 °C, the number of electrons and protons is 29 and neutrons are 34 [17]. Copper is a reddish-orange, soft metal that takes on a bright metallic lustre. Copper characteristics are ductile, and an excellent conductor of heat and electricity – only silver has a higher electrical conductivity than copper. In Industry 3.0 transition technology is Programmable Integrated Circuit. The integrated circuit is manufacture by Semiconductor material [19]. The semiconductor material is a partial conductor. Silicon and germanium is an example of semiconductor material. Silicon is a metalloid, silicon atomic

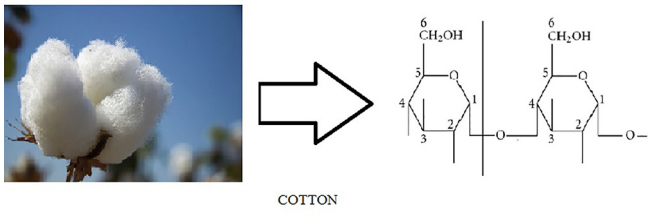

Fig. 2. Cotton and atomic structure.

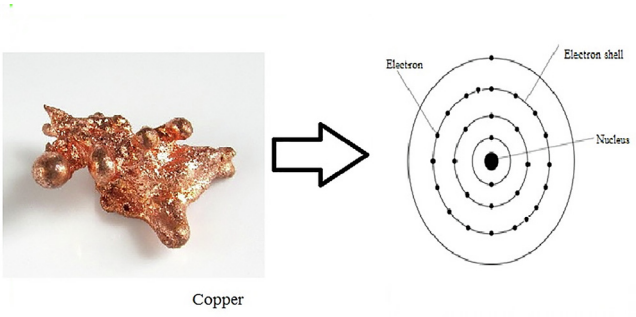

Fig. 3. Copper and atomic structure.

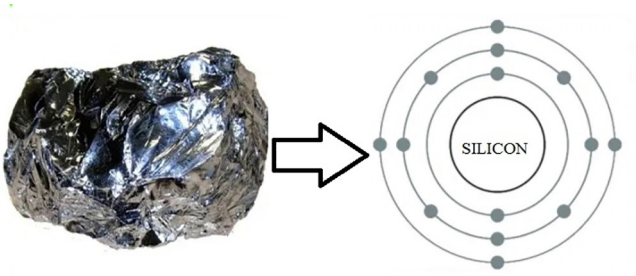

Fig. 4. Silicon and atomic structure.

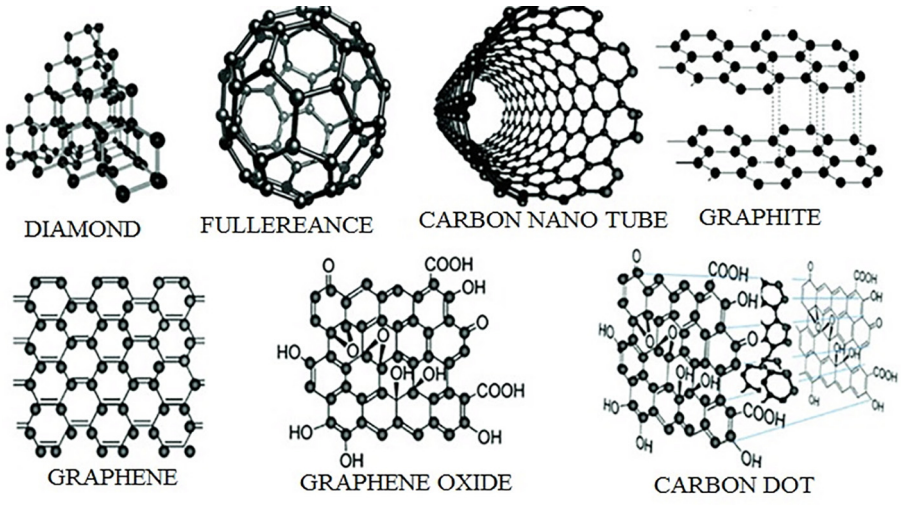

Fig. 5. Type of Nano materials.

weight is 28.08555, melting point is 1414 °C, 1687 K, boiling point is 3265 °C, a number of electrons and protons is 14 and neutrons is 14. In Next transition in the material is Nanomaterial's. Nanomaterials have an extremely small size which has at least one dimension 100 nm or less. Nanomaterial's can be Nanoscale in one dimension, two dimensions, or three dimensions. They can exist in single, fused, aggregated or agglomerated forms with spherical, tubular, and irregular shapes [19]. Nanomaterial's application are Next generation computer chips, Kinetic energy penetrators with improved lethality, better insulation materials, Phosphors for high-definition TV, Low-cost Flat panel displays, Tougher and Harder cutting tools, Elimination of pollutants, High Energy Density Batteries, High-Power Magnets, High-Sensitivity Sensors and Automobiles with greater efficiency, Better and Future Weapons platforms and Longer-Lasting satellites. Nanomaterial's structures are shown in Figs. 3–5.

4. Industry 5.0 (In Future)

Personalization system is design to meet customized requirements. So it provides different type of production for meat customer needs at uncertain situations. Industrial block chain gathers the data between the each industry. So industries are work with integrated manner depends the uncertain situation it produce the reliable output. So all industries are works in the integrated manner. Mixed reality are new research content it combination argument reality and virtual reality, it will provides the new impact in industry. Drones are used to auto pilot transportation with very effective manner. Human robot –co working future technology integrated human and robot Co-working.

5. Conclusion

In Industrial revolution are Materials and Mathematics is the key factor of Industrial growth. In each new material and new mathematical tool are used to satisfy the customer needs and profit in production side. In future mathematics are soft computing and genetic algorithm, Artificial intelligence are developing Expert industrial systems are explored all industrial challenges. In future Materials are carbon nanotubes, quantum dots, aluminium oxide, cellulose, titanium dioxide and nanocrystaline material to provide the magnificent result in next industrial revolution.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further Reading

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