Industry 4.0 – 4th Rising Industrial Revolution in Manufacturing Industries and its Impact on Employability and Existing Education System

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Abstract

   Industry 4.0 is an emerging revolution that is moving manufacturing industries towards new dimensions. Industry 4.0 is the 4th industrial revolution and vision of tomorrow for manufacturing industries to make it intelligent. To drive mass production in intelligent industries, machines and products are going to be communicated with each other. Intelligent factories will be the next future of existing industries, where raw resources and machines are interconnected through the Internet of Things technology [1].
Skilled man workforce will be required at high demand because when the intelligent machine will replace the man workforce then to monitor and manage the complexities with intelligent machine skilled workers are required. On the other hand, structure of existing education systems will be entirely changed to cope with challenges arisen because of IR 4.0.
The aim of this paper to focus on Industrial 4.0 as 4th revolution and its impact on employability potentials and mass production in manufacturing industries in India. As well as this paper highlights about the Cyber Physical System where all machines and materials will be connected in such way that they can communicate to each other cooperatively through intelligent sensors and communication technology.
It shows how the exiting education will be affected or impact of IR4.0 on existing education systems in India.

Keywords: *Industry 4.0, Internet of Things, Employability, Automation, Artificial Intelligent, Cyber Physical System, Education.*

1. Introduction

A small glance at history of year 1784, when the first industrial revolution (Industry 1.0) came after invention of first steam engine. In the year of 1870, the 2nd revolution (Industry 2.0) was raised, when first time moving belt conveyor was used to drive through electrical power.

In the 1970, it was the year of digital revolution in industries, when electronics and information technology came at a rapid pace and turned the technologies to a new direction. In the mid of 1970s , Electronics & Information Technology as a 3rd Industrial Revolution (Industry 3.0) began to expand rapidly into industries. Over the next few years, in the history of Industries, Industry 4.0 technology will be revolution that will build the industry's structure so vibrant and efficient as far as we all have not imagined. Germany, world's leading manufacturing country, where this industry 4.0 future is experienced at the German Research centre.
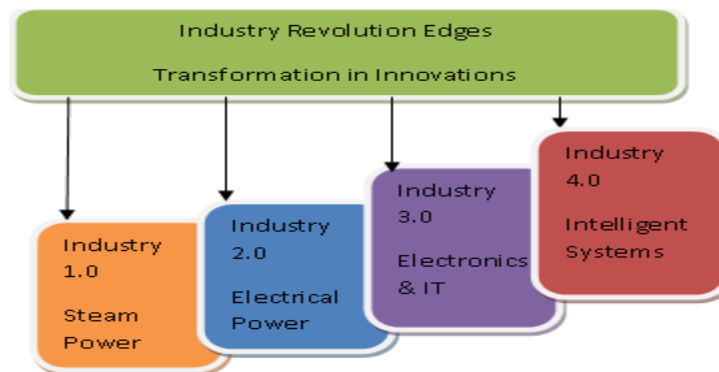
Figure 1. Industrial Revolutions

Industry 4.0 is the 4th Industrial Revolution it uses Automation and data exchange in manufacturing technologies. It includes Cyber-Physical system, Internet of Things and Cloud Computing .As we know India's strength is information technology and it has large workforce of IT professional. Also the "Smart Cities Mission" is going to build 100 smart cities across the India that will create the right industry environment for Industry 4.0.IISc (Indian Institute of Science, Bengaluru) is already building the first smart factory in Bengaluru with the help of Boeing and also Bosch will start its smart manufacturing at 15 centers across India by 2018. GE has intelligent Ecosystem multi-model factory in India already, which is digitally interlinked supply chains distribution networks and service units. So Industry 4.0 is the fourth industrial revolution and its aim is to completely digitize the manufacturing sectors [2].

Since 2011, Industry 4.0 has began as a government projects in Germany and the purpose was to bring automation like well the robots and other automation systems are used to enhance the productivity and reduce the cost. Now internet has also come. To bring this automation and data exchange amongst machines and machines as well as machines and people basically in order to reduce the risk and other beneficial factors to be targeted. Reduce the risk and other beneficial factors costs are formidable things foreign investment. Are they going to come down? If is adopted in appropriate manner, initially there would be some investment certainly but then it matures certainly it is going to come down but when you talk about economics the cost coming down. You have to talk in longer period now if may be in

one period or two years of period, the investment would be high. But if you talk about 10 years then it will come down and economic will benefit it out of it [14].

One of the big fears already is that, automation is taking away jobs. India is labor intensive country; sense that India can produce so much labor. What is going to happen now? When we reach Industries 4.0, all the work is being by Robots. In 1980 when computer has just started coming and the Banks computerized in those day, at that time there were a lot of agitation in India. But today if you are travelling abroad and those days if you traveled abroad, the difference you can see in different airport, the person may not be taking English but if we say you are from India means you are IT giant. How do you adopt it and how you replenish people who did not know computers so probably you have to chain to some extent, but to some extent there might be some loss of jobs if you don't train them properly? Next generation is going to benefit and today if our economy is very strong it's because of IT [3].

2. Structure of Industry 4.0 System

Industry 4.0 technology is basically Cyber Physical Systems which integrates embedded network, Internet of Things, Electronics and Mechanical Assemblies. Cyber –Physical Systems are the technological systems in which computer network and robots are connected with physical worlds. In next 30 years, these systems might be driving on roads and living and working with Human. Cyber physical system is commuter algorithms based monitoring and controlling systems [6].

Few examples of CPS are Smart Grid, Autonomous Automobile System, Medical Monitoring system, Process Control Systems, Robotics Systems and Automatic pilot avionics. Apart from that, in many areas like chemical process, transportation, entertainment, consumer appliances can be seen and rapidly growing in manufacturing industries nowadays [10].

Cyber –Physical Systems began with the so called embedded systems. Embedded systems are the information processing systems that are embedded into large of products like machine and devices. In safety systems like antilock braking system, abs of automotive application, embedded systems can be found. ABS is air bag system where sensors sense the crash and actuate the trigger the release of air bag. Embedded Systems are used for hardware and software system which is connected with outside world through sensors and actuators to manage different tasks. Embedded systems are followed by networked embedded systems, where numbers of embedded systems are connected with each other and integrated into a wider context. Example of Car where information, ABS unit, speed control, climate controls and Gear Box systems are connected with system through intelligent sensors. Another example of network embedded system would be autonomous aviation when the pilot switched on the autopilot then Engine, Position and Speed of the plane needs to be controlled. Here actuators trigger adjustment to meet the setting of the autopilot [9].

Cyber-Physical Systems are Networked embedded connected with each other through the internet .In Cyber-Physicals Systems, physical world and virtual world merging. Example a CAR in city which can be found as embedded systems share physical data like distance or speed with other CARs through the internet. This data cane used to make road transports much more intelligent. It would be possible for instance to improve traffic flow or to reduce accidents. CPS is going to be helpful for shaping the future of industry by connecting the real with virtual world of production as well as for optimizing the production process in manufacturing to enter entirely new dimensions in quality efficiency, and flexibility [11].
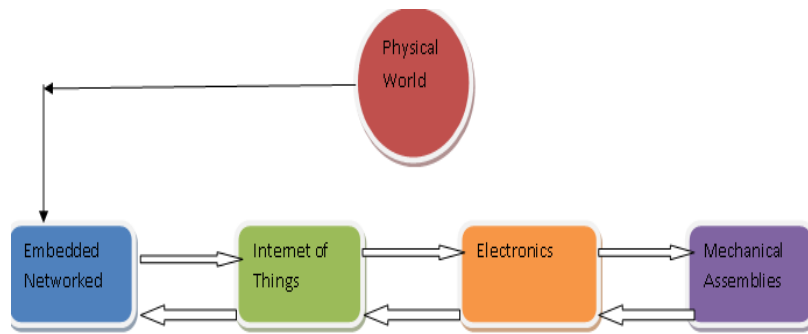
Figure 2. Cyber Physical System

Physical system consists of physical components and cyber components, that's why we call them cyber physical systems. All cyber physical systems are based on an information basis computer system which is embedded into product like in Car or Plane or Other devices. These computer subsystems are used to handle specific task so for example in Car embedded system would be ABS system to control the brake for us. These computer systems interact with the physical environment via sensors and via actuators. This whole system is embedded system. In cyber physical system these embedded systems do not stand alone anymore they share their data by a communication network like the internet with cloud computing and that way data from many embedded systems can be collected and processed. We can create a system of systems. Connected embedded systems can be controlled decentralized via run computational unit. In computational unit, data can be processed automatically or by human computer interface.
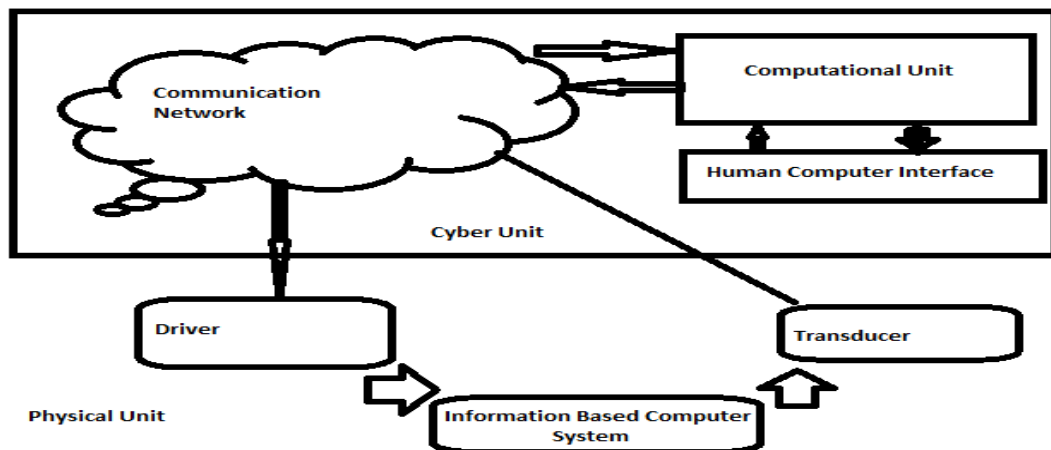

Figure 3. Cyber Physical System's Components

3. Impact of Industry 4.0 on Employability

The question is what will be the effect of the work of the fourth revolution. What kind of jobs will be in the future or will not survive the job. What knowledge and skills are required for employability? Take a look at all these issues. Vending Machine, ATM, Kiosk Machine at

airport, Self service payments in shops, car on road without drivers etc. are the first step of industry 4.0 to lead the revolution in industries. Will technology kill the jobs? Drawn operator, EA sports commentator, Social Media reporter, 3D-fabricator, content curator, Virtual reality designer, Big Data analyser, Block chain auditor , Internet of Things experts, Robot repair artisan , Bit coin Businessman, Space touring guide etc are the new innovation in the field of technology . Will this new innovation create many new and creative jobs?

   Imagine that the apple foil is heating up and a little baby is watching the thermometer kept in the water. As the water gets hot, the thermometer's mercury increases as well, from 30 degrees to 80 degrees. You ask that little girl what will happen next. For the first time, watching the water become hot, as an observer, it is natural that she will say the water will keep becoming hotter. She cannot predict that water will become steam at 100 degree Celsius. Which is called phase change, when the substance and liquid will turn into steam? In the context of the upcoming future, we are like a little girl who cannot even imagine what is going to happen next. No doubt, upcoming future will be Volatile, Uncertain, Complex and Ambiguous, which is called as VUCA. Will the rise of robot and artificial intelligence machines and the result will be the same thing in India as in technically advanced countries in other advanced countries [18]. New study says, robot will destroy jobs and lower wages. Over 90% of India's population is either self employed or works in unorganized sectors. According to the collected data in 2010, in India of the 460 million employed, 50% are in agriculture, 11% in manufacturing and 25% in service sectors [15].
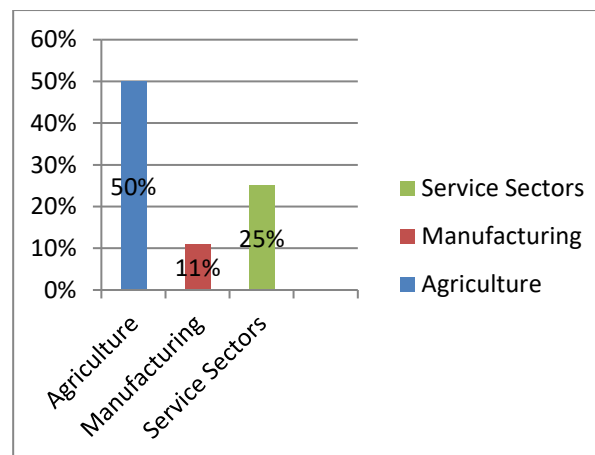
Figure 4. Employment in Different Sectors

   How will 4th Industrial Revolution impact them? Will online shopping and self service automation lead to large –scale unemployment in the retail sectors. If this happens it could lead to big problems. As the Industrial 4.0 is giving a new shape to the business economy, robots and artificial intelligence machines are not ending the jobs, but the form of employment is definitely changing. In the coming time, fewer skills, less salaries and higher skills, higher salary jobs will remain, but existing middle-level jobs are very likely to disappear. The economist named it Job Polarization.
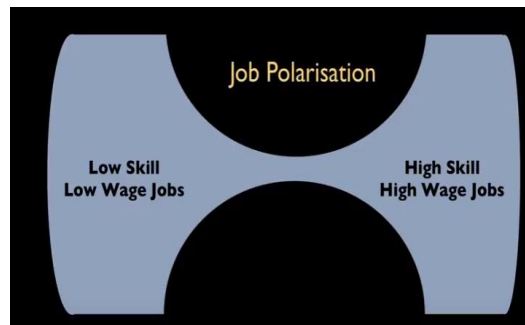
Figure 5. Job Polarization

Polarisation means, things exist at two ends and the middle part becomes hollow. The emerging economy can be somewhat like the "clock of the sand". It has been seen that when the mid-level jobs ends, most of people are unable to learn the complex skills required to do the high-skill high wages jobs. Therefore, they move down towards low-skill-low-wages jobs [17].

4. IR4.0's Impact on Education

No doubt about it, that Industry 4.0 is the big revolution across the world for transforming the structure of companies in terms of productivity and economically but along with this revolution different challenge also has been raised for educational organizations in all over the world. Still we are in the mindset of revolution 2.0, where we are following preset or predefined structure of education. Somewhere we are not ready to accept the changes to avoid the reworking on existing parameters as well as our mind got stuck into fix frame of IR2.0's concept. Due to new IR 4.0, not a single frame of education will be affected but entire structure of education will be affected. If educational organizations do not connect these principles of IR 4.0 and do not incorporate these principles in existing education system, definitely we are not able to produce better students for our country. As we know that in the line with principles of IR 4.0, high quality education is required so that students can be more skilled than educated. All three, Industry 4.0, skills and employability are completely dependent on each other. In this competitive world, to meet the needs of industry 4.0, students must be trained in such way that they must have capable for doing any job independently. They must be equipped with new skills to be better learner and executers individually. Employability is completely proportional to skill parameter. If more numbers of students will be well trained then they will be more skilled and employability rate will be increased. To produce more skilled workers, needs a change the structure of existing traditional education systems where teacher teach the students and at the end of year or semester unit test are conducted. That is because; still we are evolving around the fixed structure and not try to come up from that circle. Now as the technologies are changing at fast rate, at same pace, we have to change our mindset and be ready to adopt the changes .To meet the needs of industry, education organisation has to take big step and has to design or develop the education system where all requirement of industry must be fulfilled. Modern India is moving fast towards digital technologies and in this era of digital, education's aspects must be expanded in order to train the students and teachers individually and not to deliver knowledge to the students through traditional method. Structure of Education system in line with the principles of Industry 4.0 is given below in Figure 6 [20].
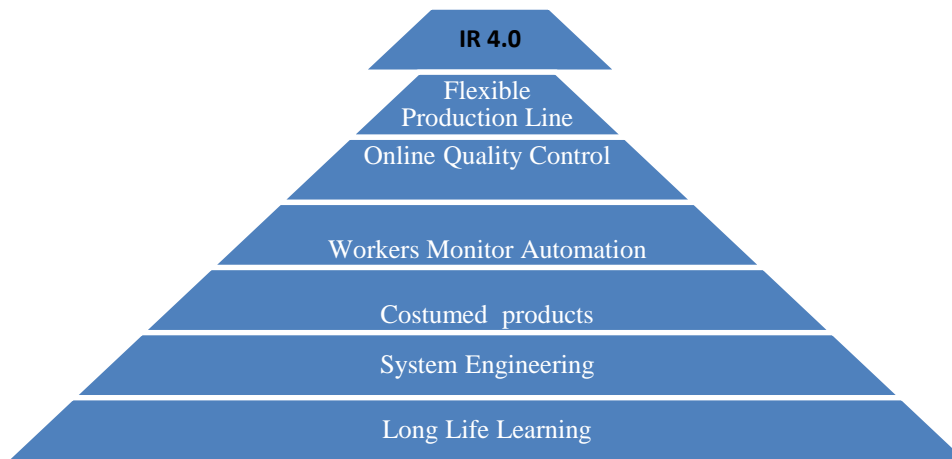
Figure 5. Industry 4.0 Structure
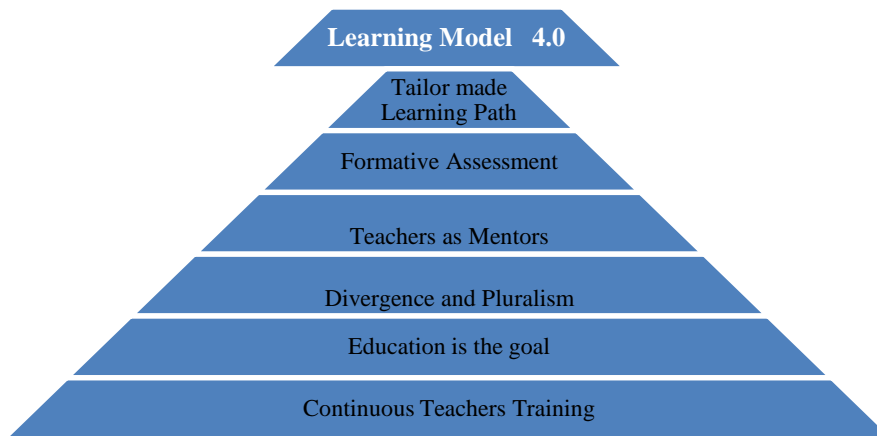
Figure 6. Learning Model 4.0 in Line with Principles with IR 4.0

Tailor Made Learning method is a individualized learning knowledge method, where it can help to ensure that learners are the following a pathway that suits their interests and learning style as well as helping to tackle any barriers they face. Formative assessment is perceived as just one more thing that educators must do something to add to never ending to do list. However, formative assessment is not a onetime event, it is a process embedded into everyday instruction to give educators and students' information needed to understand what comes next in learning. Mentoring is applicable to all faculties at any point of their career in future. It can involve of the following: Indentifying developmental needs and interests, strengths, weakness, action planning, reviewing progress etc. Students are not the same and they are also not likely to be the same. The function of the education model is to assist students for identifying the field in which they are well-matched and help them to excel at it [20].

To design a education model system in order to provide full access of technology resources and to give a platform to them in developing reanalyzing, recreating and rethinking strengths individually.   To maintain the quality of education and relationship between mentor and mentee, teachers must go under continuous skill development programs during their career [20].

Conclusions

It is concluded that, industry 4.0 is a rising revolution for manufacturing industries. IR 4.0 is dynamic revolution, which will have different dimensions of technologies in next few years. In next coming over the years, Its impact, we can see directly on employability and education's aspects across the world. With this revolution, as new technologies will knock the door of industries like that new challenges will be also raising .At one end, middle jobs will be killed because of IR4.0, and low skilled and high skilled jobs will be live. Therefore, more skilled people will be in high demand and this will be the wakeup call for the educational organizations across the world to transform education systems from traditional to modern where students will be equipped with skills to meet the needs of industry 4.0. Learning model 4.0 will be used as a strong tool for such educational organizations. This tool will be helpful for the teacher to develop the skills in students as well as to themselves professionally.

References

[1] Harry J. Gray, "The New Technologies: An Industrial Revolution", Journal of Business Strategy, vol. 5, Issue: 2, (1984), pp.83-85.

[2] Almada-Lobo, F. "The Industry 4.0 Revolution and the Future of Manufacturing Execution Systems (MES)", Journal of Innovation Management, vol. 3, Issue. 4, (2016), pp. 16–21.

[3] Rabeh Morrar, Husam Arman, and Saeed Mousa, "The Fourth Industrial Revolution (Industry 4.0): A Social Innovation Perspective", Technology Innovation Management Review, vol. 7, Issue:.11, (2017), pp.12-20.

[4] Dragan Vuksanović, Jelena Ugarak, Davor Korčok, "Industry 4.0: The Future Concepts and New Visions of Factory of the Future Development", International Scientific Conference on ICT and E-Business related Research, (October 2017).

[5] Dr. Jay Lee, Behrad Baghery, Hung Ann Kao, Edzel Lapira, "Industry 4.0 and Manufacturing Transformation" ,Manufacturing leadership journal,(February 2015).

[6] Andreja Rojko," Industry 4.0 Concept: Background and Overview", iJIM, vol. 11, Issue. 5, (2017), pp.77-90.

[7] N. G. Nayak, F. Dürr and K. Rothermel, "Software-Defined Environment for Reconfigurable Manufacturing Systems, "Internet of Things (IOT), (2015), pp. 122-129.

[8] <u>Li Da Xu</u>, <u>Eric L. Xu</u> and <u>Ling Li</u>, "Industry 4.0: State of the Art and Future Trends", International Journal of Production Research, vol . 56 , Issue. 8, (2018), pp.2941-2962.

[9] Hong Chen, "Applications of Cyber-Physical System: A Literature Review", Journal of Industrial Integration and Management, vol. 2, no. 3, (2017),pp.1-28.

[10] Jay Lee, Behrad Bagheri and Hung-An Kao, "A Cyber-Physical Systems Architecture for Industry 4.0-based Manufacturing Systems", Elsevier Journal, Science Direct, Manufacturing Letters 3, (2015), pp.18–23.

[11] Vandana Sharma, Ravi Tiwari, "A Review Paper on "IOT" & It"s Smart Application, International Journal of Science, Engineering and Technology Research (IJSETR), vol. 5, Issue. 2, (2016), pp.472-776.

[12] Gubbi, Jayavardhana, et al. "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions." Future Generation Computer Systems 29.7 (2013): 1645-1660.

[13] Marcelo T. Okano," IOT and Industry 4.0: The Industrial New Revolution", International Conference on Management and Information Systems, Research Gate, ISBN 978-1-943295-07-4 ,(2017), pp.75-82.

[14] Sommer, L., "Industrial revolution-industry 4.0: Are German Manufacturing SMEs the first Victims of this Revolution", Journal of Industrial Engineering and Management, 8(5), (2015), 1512.

[15] Joseph Flynn, Steven Dance and Dirk Schaefer, "Industry 4.0 and its Potential Impact on Employment Demographics in the UK", Advances in Manufacturing Technology XXXI, doi:10.3233/978-1-61499-792-4-239, (2017), pp.239-244.

[16] H. Lasi, H.-G. Kemper, P. Fettke, T. Feld, and M. Hoffman, "Industry 4.0," Bus. Inf. Syst. Eng., vol. 6, no. 4,(2014), pp. 239–242.

[17] Beyza Sumer, "Impact of Industry 4.0 on Occupations and Employment in Turkey", European Scientific Journal, edition Vol.14, No.10 ,(2018),ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431.

[18] Mohd Aiman Kamarul Bahrin , Mohd Fauzi Othman, Nor Hayati Nor Azli and Muhamad Farihin Talib," Industry 4.0: A Review on Industrial Automation and Robotic", Jurnal Teknologi, 78: 6-13, (2016) , pp. 137–143, eISSN 2180–3722 .

[19] Ślusarczyk B, "Industry 4.0 – Are We Ready?", Polish Journal of Management Studies, vol.17, no.1, (2018), pp.232-248.

[20] D. Moourtzis,E.Vlacchou, G.Dimitrakopoulos and V.Zogopoulos, "Cyber- Physical Systems and Education 4.0 –The Teaching Factory 4.0 Concept", 8th Conference on Learning Factories - Advanced Engineering Education & Training for Manufacturing Innovation , Science Direct ,Procedia Manufacturing, 23, (2018), pp-129–134.