INDUSTRY 4.0 AND ITS Execution IN ASIA

Hemendra Verma
Research, Symbiosis Skill Open University,

ABSTRACT

The fourth modern upset is going through in India, yet numerous industrialists are as yet not recognizing it. Throughout the present modern upheaval, numerous advances like man-made consciousness (artificial intelligence), Web of Things (IoT), 3D printing, mechanical technology and neuroscience are being taken on by organization pioneers, business people and new companies. The Indian business is furrowing its direction forward in leaving an imprint among the universe of moderate countries. The fourth modern transformation will carry Kranti to the modern world by giving numerous useful learning experiences and furthermore would have the option to foster a country's economy at a lot quicker rate. The advancement of mechanical technology will increment efficiency; computer based intelligence gives exact and precise answers for issues; IoT would serve the clients and providers with quick and continuous data. Accordingly, this large number of troublesome advances could change the worldwide business towards the way of Industry 4.0.

KEYWORDS: cyber-physical system; Internet of Things; Internet of Service; Industry 4.0; Smart factory

INTRODUCTION

The German federal initiative called 'High-Tech Strategy 2020 for Germany' aligns with the global challenges in the areas of climate/energy, health/nutrition, communication, mobility and security. Several key technologies were being promoted by an association of German federal agencies, research centres and business organizations to realize the goals and visions of 'Industry 4.0'.

In this collaborative model of Industry 4.0 (refer Figure 1), it is suggested that research institutions would develop methodologies and define the functionality of the model; process standardization is adopted to ensure stability and security; and the industrial support system plays the part of verifying the practicality and relevance of the model to the target audience.

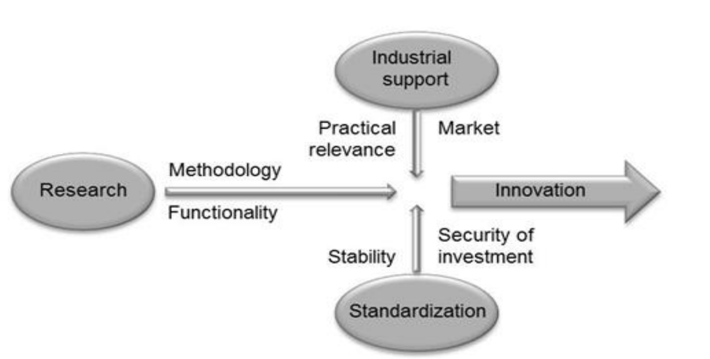


Figure 1: Driving forces for Industry 4.0

Many industries are interested in the concept of Industry 4.0 for basically two reasons. First, never before was an industrial revolution announced a priori. That gives research centres and organizations a chance to actively participate in this revolution. The second reason for a fascination with Industry 4.0 is the forecast of a vast economic impact. The new technology has a potential to grow new scenarios in businesses, products and services as well as considerably increase operational efficiency. A recent study has estimated that the German GDP would increase by 78 billion Euros by 2025 after the realization of the agenda of Industry 4.0.

The production technology in the era of Industry 4.0 is based wholly on computers. Each factory gets converted into a smart factory, ensuring optimum utilization of resources and attuning the workplace to scientific principles of ergonomics. Moreover, customers become integral to decisions regarding the value-added activities of the system. A smart factory shows a deep level of intelligence by way of adopting process automation, rapid product development and an efficient customer service system. Now a valid point is how quickly our legacy system can be transformed to make our industry ready for the future and fast-changing technological world.

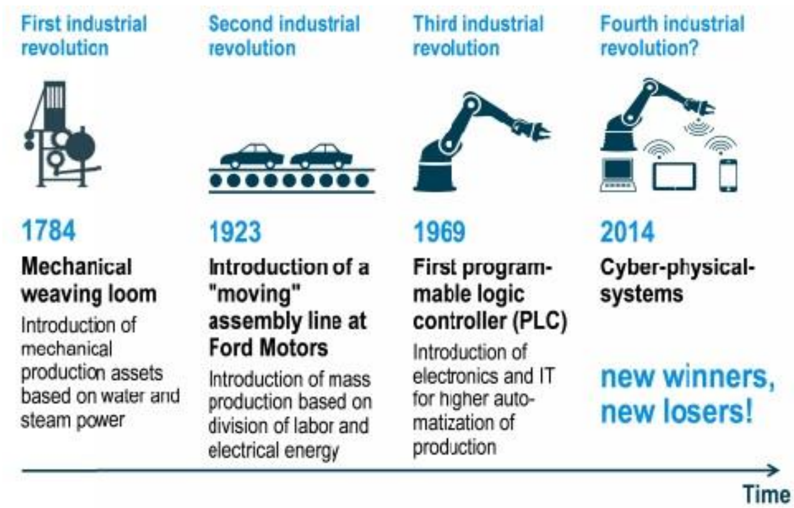
Thus, adopting strategic methods to integrate the four trends, namely the cyber-physical system (CPS), Internet of Things (IoT), Internet of Services (IoS) and smart factory, characterizes a nation's march towards Industry 4.0.

BACKGROUND
In 2011, at the Hannover Fair, the term Industry 4.0 was described by an association of representatives from politics, academia and businesses as an approach to strengthening the competitiveness of the German manufacturing industry. 'Industry 4.0' refers to the fourth industrial revolution. The first industrial revolution arrived with the introduction of mechanical production systems in the latter half of the eighteenth century. The second revolution was based on the division of labour and the introduction of mass production (using electric power) by Taylor. In the third industrial revolution, production processes incorporated the facets of advanced electronics and information technologies. This was also called the 'digital revolution', which occurred in the 1970s.

The German federal government supported the idea of Industry 4.0 and subsequently formed the 'Industry 4.0 Working Group', which published a set of recommendations in October 2012 and published its final report in April 2013.

Around the time of tabulating the final report by Industry 4.0 Working Group, 'Platform Industry 4.0' was formed out of industry associations including Bitkom, VDMA and ZVEI. Their aim was to coordinate the future activities of Industry 4.0 and develop a reference model to structure the basic ideas of the project.

LITERATURE REVIEW



(Source: Torben Juul Andersen, 2015)

Figure 2: The Industrial Revolutions

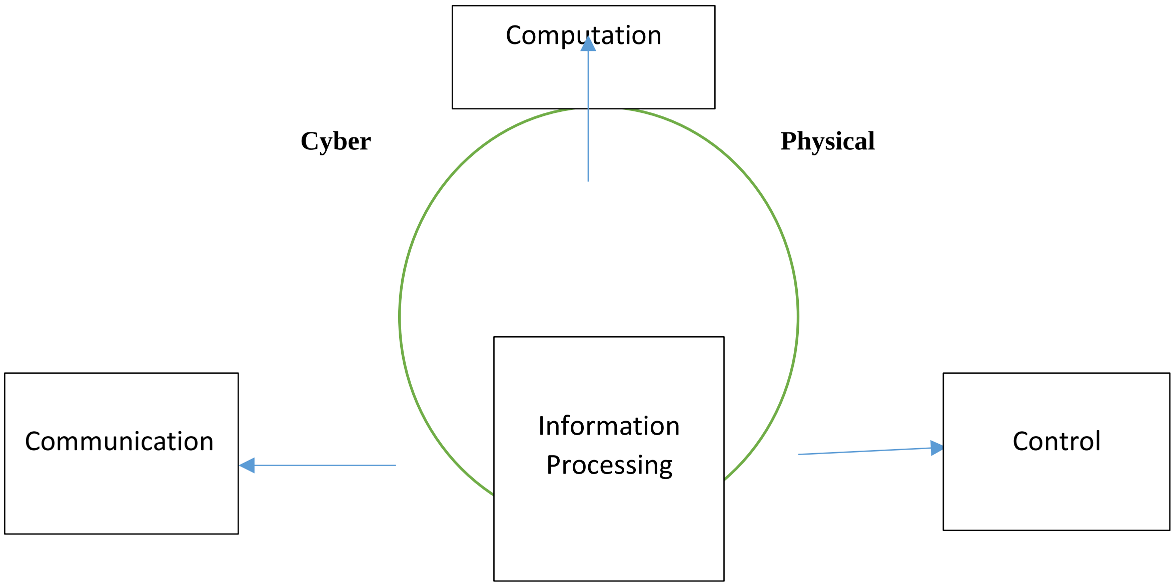
During the late eighteenth century, the first industrial revolution began when James Watt incorporated improvements in steam engine. The second industrial revolution emerged around the invention of electrical power, during the late nineteenth century. Henry Ford, who founded Ford Motors, introduced the technique of assembly line manufacturing in automotive industry, with many manufacturing industries following suit.

The third industrial revolution that boomed in the late twentieth century was to be powered by information technology. Computers were introduced for the very first time on the factory floor. With the automation of assembly line, computers began to be seen as a substitute for human beings on the shop floor.

The fourth industrial revolution signified the birth of the concept of Industry 4.0. Industry 4.0 is intertwined by an intelligent network of advanced technological systems, aiming to revolutionize the manufacturing industry to a great extent. By stimulating simultaneous developments in electronics, software technology, networking and mechatronics, Industry 4.0, in fact, had its origin many years ago. This concept will transform all the business models, starting from designing, manufacturing to the final delivery to end customers.

CYBER-PHYSICAL SYSTEMS
CPS is a core computational system in which all physical and engineered parts are operated and monitored, coordinated and controlled by a common device. In this system, an engineer could add or delete capabilities as per the requirements of the physical processes.

Selmar Allenhof (2015) suggests that a substantial element of Industry 4.0 is where the physical and virtual world combines. This fusion is realized by means of CPS. The VDI-GMA technical committees 7.20 ('Cyber-Physical Systems') and 7.21 ('Industry 4.0') describe a CPS as "a system that connects processes related to physical objects vis a vis with virtual objects with the help of an information network, having the open and continuous connectivity with the global world". Alternatively, a CPS uses services spread through external to local services, direct application of crossing point of human-machine, and offers possibility to dynamically adapt the system at runtime.



Source: Author' view point

Figure 3: Cyber Physical System

Figure 3 visualizes the concept of CPS in three layers. In the bottom layer are the physical objects, which are the intelligent, self-exploratory and self-diagnostic assets in the system (compare the real vehicles and traffic lights in the example). In the middle layer are the data and models of the physical objects (virtual traffic lights). In the upper service layer, new products and services are developed (a service evaluating traffic light schedules and the velocities of vehicles to improve fuel consumption).

INTERNET OF THINGS

Selmar Allenhof (2015) suggests that IoT derives from the idea that the computer might progressively disappear as a device and be replaced by 'intelligent objects and things'. These intelligent, ever-smaller embedded objects aim to support human activities quietly in the background, without attracting or demanding any attention. In his article 'The Computer of the Twenty-First Century', Mark Weiser explains the vision that IoT designates the link of clearly identifiable physical objects (things) with a virtual representation in an internet-like structure. In this 'Future Internet', not only humans but also the representations of 'things' act as participants. The technique of automatic identification using RFID is often viewed as the foundation of IoT. However, the unique identification of objects can also be achieved through a barcode or a 2D code. Devices such as sensors and actuators extend the functionality of collection of states and execution of actions. IoT allows for 'things and objects' to interact with each other and with their neighbouring intelligent objects through unique addressing schemas.

An example of IoT is the tracking of an order over the internet. Delivery services today offer the possibility to follow an ordered product through their delivery stages. This is realized by a unique identification using barcodes or 2D codes. Other application examples include 'smart factories', 'smart homes' and 'smart grids'.

INTERNET OF SERVICES

IoS allows service suppliers to provide services over the internet (Allenhof 2015). It comprises an infrastructure for services, certain business models, services themselves and participants requesting a service. The services may combine numerous value-added services and be offered by various vendors and communicated to users through numerous channels. Customized production technologies could be offered through a IoS network, enabling a customer to simply manufacture a specific part or compensate for limited production capacities. The concept of IoS was applied by the German Ministry of Economic Affairs and Energy within the programme titled 'Autonomics for Industry 4.0'.

SMART FACTORY

The Industry 4.0 Working Group considers 'smart factories' a key feature of Industry 4.0 (Alpenhof 2015). The term constitutes the vision of a production environment in which production facilities and logistic systems largely self-organize without human intervention. The 'context-aware' smart factory takes into consideration the position of a product and assists machines and people in the execution of their tasks. Built on the capabilities of CPS, the systems communicate and cooperate with each other and humans with the help of IoT. The vision specifically addresses communication between the product or workpiece and the manufacturing facility. The systems gather information both from the physical and the virtual facilities to determine their next production steps. Physical information in this regard often means the position of a product or tool wear, whereas information from the virtual model is the optimal tool choice or optimal production schedules.

The 'Future Urban Production' facility in Fellbach, Germany, is an example of a smart factory that manufactures gear wheels. In the past, the transport of goods between various delivery and pick-up spaces was done by an electric truck that is driven around the factory every hour. This inflexible procedure was superseded by material supplies on demand in the framework of Industry 4.0. For the implementation of a demand-driven supply, now intelligent workpiece carriers are used. When a workpiece is ready to be picked up, the carrier reports this status to the transportation control unit. This decreased the number of transportation runs and saved superfluous work.

RESEARCH METHODOLOGY

The researcher used a case study approach to justify the implementation of Industry 4.0. Two cases, namely Rexroth–Bosch and Syslogyx Technologies Pvt Ltd, are discussed here to understand the problems faced by the management and how they have fixed those problems. To implement Industry 4.0, six basic design principles are required in actual operations.

1. Interoperability: The CPS components should stay connected and be able to converse with human operators and smart factories through the connectivity of internet (IoT and IoS).
2. Virtualization: A virtual plant framework is linked through the sensor data of physical processes by simulation, and an imitation copy of a smart factory is produced.
3. Decentralization: Decisions are taken by the CPS by working within the periphery of smart factories rather than depending on a centralized body.
4. Real-time capability: Industry 4.0-equipped factories generally fetch and analyse real-time data, and they present the findings instantly.
5. Service orientation: An Industry 4.0-based system comprises CPS, human beings and smart factories that provide a wide range of services with the application of IoS.
6. Modularity: As smart factories are governed by the principles of module concept, they must be able to adapt quickly as per the varying requirements of customers.

INDUSTRY 4.0 AND ITS CHALLENGES

For a seamless data integration, industrial automation goals have to comply with the principles of Industry 4.0. In India, industry giants like Havells, Bosch, LG and Samsung have already pawned their feet in the space of IoT with successful outcomes. The Chinese industry is giving a tough competition to Indian business houses, as several challenges confront India's industrial sector in the form of bureaucratic snag and shortage of power and resources.

INDUSTRY 4.0 IN INDIA

The first and foremost challenge faced by the Indian industrial sector is the lack of a unified protocol to connect all IoT devices. By way of standardization of IoT devices, most practical problems might get resolved, but there is more to travel in this direction.

Another problem is that a lot of data are produced by IoTs, making it very difficult to identify the relevant data out of the big lot of data. Since many controlled systems need to be installed for the automation of manufacturing units, both useful and irrelevant data might be encountered. The point of discussion is how to segregate useful data from the chunk of large databases.

GOVERNMENT POLICIES WITH REFERENCE TO INDUSTRY 4.0 IN INDIA

Interest among the Indian businesses, academia and lawmakers in Industry 4.0 has slowly gained traction. Much of the evolution is happening in the manufacturing platform, but a clear transformation in our legacy system in support of Industry 4.0 is awaited. For a faster realization of Industry 4.0, the Indian government is expected to provide the infrastructure necessary for smoother connectivity between IoT devices, including long-range networks. Financial incentives can be introduced by the government to ensure a faster adoption of IoT and IoS by the manufacturing arena, which will not only boost the economy but also pose a challenge to other competitive economies in terms of technology advancement.

CASE STUDY: THE REXROTH-BOSCH GROUP

The Bosch Company is in the business of making hydraulic valves for tractors and forklift trucks at Homburg, Germany. The company is continuously striving for innovative solutions with the help of global application experience in order to tap the market segments of mobile and machinery applications and factory automation.

Since the customer's demand would fluctuate for hydraulic valves, aligning the demand with the complex system of production was the biggest challenge to Bosch. Bosch was using control technology at the plant to move the machines and systems of varying sizes.

THE PROBLEM

The basic problem was that the company was manufacturing six different types of valves with 250 variants and 2000 individual parts. Along with this, the production line was supposed to be highly flexible as per the demand for each product family. Using the connectivity philosophy of Industry 4.0 with human beings at the centre of it, the Homburg production facility was re-engineered by breaking the full line into nine autonomous workstations connected by RFID chips, which would help in assembling and pooling data from each workstation for decision-making regarding each variant of valves and parts in successive workstations. As a result, all the nine workstations could switch among the various product lines as need arises. The company adopted a new technology called 'Active Assistant', which guides workers in every step and makes it possible to eradicate all errors.

Another innovation by the Homburg production facility is 'Active Cockpit', an interactive manufacturing system that affords digital connectivity among the operators, products, processes and work stations. With the help of this system, the management is able to take quick and appropriate decisions, because it has the capability to gather and envision manufacturing data endlessly, giving real-time data to both workers and the management.

THE RESULTS

After implementing the technology, logistical and set-up times reduced from 450 seconds in 2014 to zero in 2015. Inventory days during the same period lowered from three days to 1.5 days, with cycle times cut from 474 seconds to 438 seconds.

SYSLOGYX TECHNOLOGIES PVT LTD

Syslogyx is a solutions provider in the field of IoT, process automation, embedded systems, web and mobile development and machine learning. Due to ever-changing customer expectations and demands, the company decided to adopt a fully IoT-based manufacturing environment where machine-to-machine communication would enable automatic exchange of information and initiation of actions. Sensors and microchips can be added to almost every product (tools, machines and even raw material), thus making the products 'smart'. Data would be available from any kind of device and used to better analyse and control processes. The product itself can tell the operator if it is the right product for the current manufacturing order. Production will be highly responsive and organized. By integrating IoT with every equipment, one could detect possible equipment failures and predict when maintenance should be performed.

POLICY IMPLICATION

Any step taken in the reformation of economic policy in view of Industry 4.0 should think about the many things falling into risk during transition. Numerous jobs are at risk due to automation. AI and Industry 4.0 is going to create new skill-intensive job profiles, but the highest risk will be entailed by the cognitive and manual routine tasks. It is also a well-known fact that Industry 4.0 would increase productivity, flexibility, quality and also, most importantly, allow customization of products with new disorderly business models. With smart factories, there would be less deficiency, less wastages and less consumption of energy. Therefore, there will be an estimated 0.5–2.0 per cent per annum of additional value addition. Urban production would be in demand and a manufacturing facility would be located near design and innovation activities as per the emerging trends.

LIMITATIONS

Industrialization and sustainability is interlinked, and so it would be challenging to address the sustainability factor during transition to Industry 4.0. Researchers have analysed the two pillars of sustainability, namely economic and environment. However, there is a scope to extend our attention towards the third pillar of sustainability, that is, social aspects. At present, the shared relationship among the three pillars of sustainability deserves a serious academic scrutiny.

FUTURE RESEARCH

In Industry 4.0 settings, an open innovation process could be a very stimulating topic of study. Since the tools and techniques are the results of open innovation processes, concentrating on this specific facet will be a worthy endeavour of forthcoming research.

In this sphere, value co-creation could be another worthy subject of scientific scrutiny as all the stakeholders will look into ways to recognize the consequences of value co-creation with respect to customer satisfaction and also in the context of all partners operating in the ecosystem.

CONCLUSION

The past three industrial revolutions have created history; the same would be expected of Industry 4.0 in near future. With the passage of time, the industry's demands will continue to grow in unforeseen directions, to counter which the evolution of Industry 4.0 will have a huge promise in store. The speed of this change would be unimaginative because the way information propagates is hard to foresee. The advent of Industry 4.0 would facilitate information to be passed from the producer to the product and from there to the customers. Industry 4.0 would be the direction for the industry to move from the basic mass production to customizable automatic production systems. Industry 4.0 is going to provide remarkable growth opportunities in terms of highly trained and flexible manpower plus the flexibility in expanding the production capacity in infinite, unimaginable ways.

And lastly, a quotation of the famous twentieth-century American philosopher Eric Hoffer (1902–83) would appropriately fit the present scenario: '[i]n times of change, learners inherit the earth; while the learned find themselves beautifully equipped to deal with a world that no longer exists'. No doubt, the above statement holds true both to this day and to the century gone by. Nevertheless, given the rapidity with which the technology is evolving, the statement will turn out to be more and more relevant in the coming times. India will attest itself as an inevitable force to lead on the frontiers of 'Industry 4.0' in the years to come.

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