Industry 4.0 and its impacts on society

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Abstract

Thanks to constant progress in science, we are living in a rapidly evolving world where new trends and technologies are developed daily. This has an impact on many different areas that impact on society in general, one of which is the whole field of industry and education. Especially in recent years, much progress has been made in this area, leading to some people talking about the fourth industrial revolution. This article discusses this new revolution, also known as Industry 4.0, addressing the introduction of modern communication and computing technologies to maximize interoperability across all the different existing systems. Every day we are more connected and able to communicate and interact in real time between educational and industrial systems. This article will discuss about technologies that support this new industrial revolution and discuss impacts, possibilities, needs and adaptation. These changes are important steps to meet the growing demand for highly customized products and services, improving resource efficiency and higher throughput.

Keywords
Cyber-Physical Systems, Industry 4.0, Internet of Things

1. Introduction

Thanks to constant progress in science we are living in a rapidly evolving world where new trends and technologies are developed daily and incorporated into our everyday lives. This has an impact on many different areas, the real world and virtual reality continue to merge, and allied to this modern information and communication technologies are being combined with traditional industrial processes, thus changing the various production areas. Traditional companies have realized that customers are unwilling to pay large amounts for incremental quality improvements. As a consequence, many companies, especially the industries have to adapt their production with focus on customized products and fast market time, always with lower cost and higher quality. Especially in recent years, with the progress made in this area, it is believed that we are experiencing the fourth industrial revolution. When talking about this new revolution, also known as Industry 4.0, we are often talking about the introduction of modern communication and information control technologies, with increasingly intelligent devices. , In a factory it is sought to maximize the interoperability between all the different existing systems. This interoperability is the backbone to making a factory more flexible and intelligent, as different subsystems are now able to communicate and interact with each other. These changes are important steps to meet most of today's industrial facility needs, such as the increasing demand for highly customized products, improving resource efficiency and higher throughput.
This article aims to describe briefly the history of industrial evolution and to highlight that we live in a silent industrial revolution that is due to advances in several areas, especially ICT, and which areas lead these changes.

HISTORICAL REVIEW

Figure 1 shows a summary of industrial revolutions, where technological advances have driven a dramatic increase in industrial productivity since the beginning of the Industrial Revolution. In the 1st revolution the steam engine fed factories in the nineteenth century, in the second revolution electric power raised mass production at the beginning of the century XX the became automatized with the introduction of computers in 70´s decade.

In the decades that followed, however, industrial technological advances were only incremental, especially compared to the breakthroughs that transformed IT, mobile communications, and e-commerce. Now, however, we are in the midst of a fourth wave of technological advancement: the rise of the new digital industrial technology known as Industry 4.0, a transformation that is fueled by nine fundamental technological advancements and which are mainly based on Internet of Things (IoT) , Cyber physical systems, Big Data, cloud computing, collaboration systems, intelligent robots.

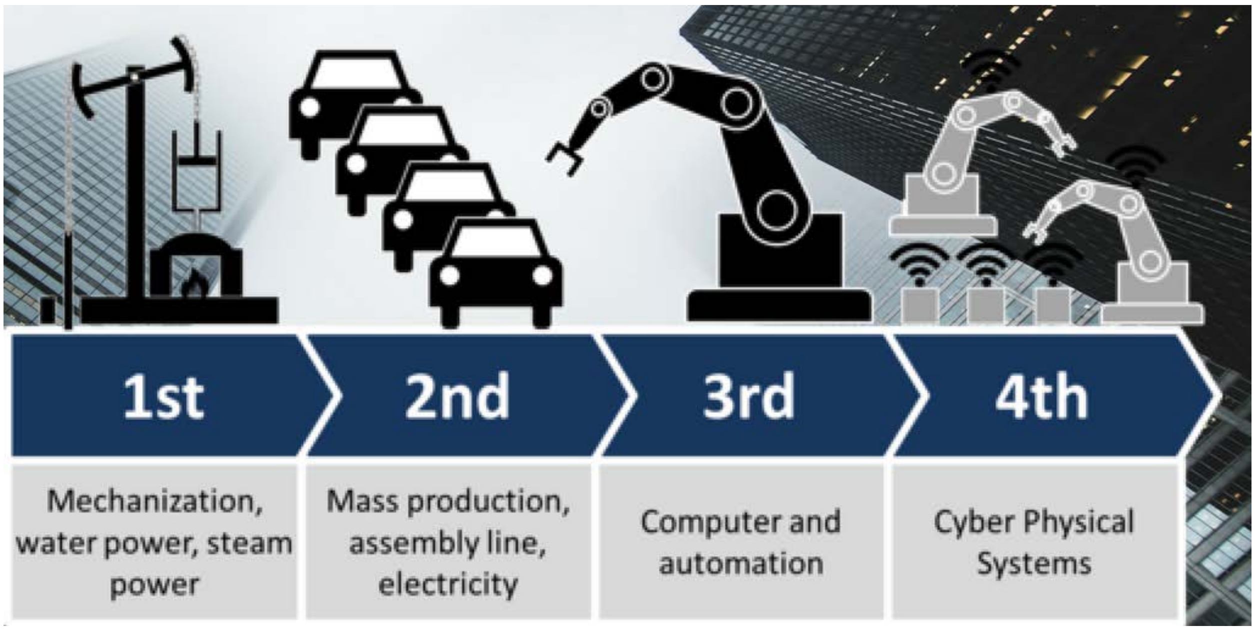

Figure 1. Graph with a summary of industrial revolutions

This whole area is being encouraged in a number of countries, especially first world countries, through many working groups and opening research projects and funding research activities linking industry and universities to promote innovation, but applied innovation and Prototypes at the end. For example, in Germany, the government is strongly promoting "Industrie 4.0" and the "Industry Working Group 4.0" was established. Many different research and innovation projects are currently underway, nationally as well as internationally, to build new technologies and standards to come to hold the fourth industrial revolution. At the same time, many industrial companies, end users and integrators, are showing increasing interest in these results.

In this transformation, sensors, machines, parts and IT systems will be connected along the value chain beyond a single company. These connected systems (also known as physical cyber systems) can interact with each other using Internet-based protocols and analyze data to predict failure, autoconfiguration, and adaptability to changes. Industry 4.0 will make it possible to collect and analyze data through machines, allowing for faster, more flexible and more efficient processes to produce higher quality goods at reduced costs. This, in turn, will increase manufacturing productivity, shift economics, industrial creative growth with improved and integrated simulation and collaboration tools.

MAIN COMPONENTS OF THE INDUSTRIAL REVOLUTION 4.0

The Industry 4.0 revolution takes into account important aspects from the technological, industrial and social point of view. The so-called Cyber Physical Systems (CPS) are becoming increasingly important in this context, that is, the networking of embedded systems that interact with both other similar devices and with the others over the Internet. CPS is an evolution of embedded systems because it requires the devices beyond the capacity of processing, communication capacity and an interaction with systems and a corresponding in the virtual world, making the device can be visualized as a virtual tool.

Along with increased automation in the industry, the development of intelligent monitoring and autonomous decision-making processes are particularly important in order to be able to optimize processes and add value in the entire supply chain almost in real time. We will highlight the main foundations for this revolution.

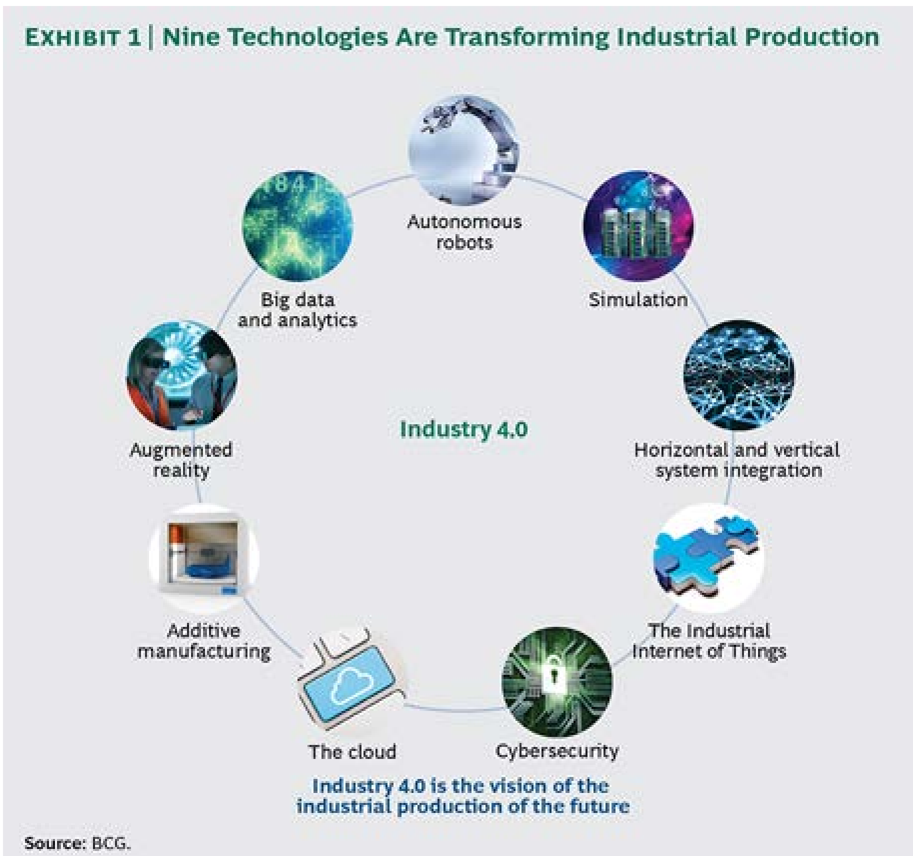

Figure 2. New technologies that are transforming industrial production and are bases for Industry 4.0. Source: (https://www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/)

Simulation

In the engineering phase, 3-D simulations of products, materials and production processes are already used, but in the future, simulations will be part of an integrated process, from design, with tools that will be integrated with the Machine code (LADDER, Function Blocks, IEC 61311). This will reduce the gap between design, prototyping and production. These simulations will generate real-time data to mirror the physical world into a virtual model, which may include machines, products, and humans. This allows operators to test and optimize machine settings for the next product on the line in the virtual world before the physical transition, thereby reducing machine setup times and increasing quality.

Additive manufacturing

Companies began to adopt additive manufacturing, mainly 3D printing, which is used to produce prototypes and individual components. With advanced manufacture, this manufacturing method will be widely used for the production of small batches of custom products which offer advantages of construction such as complex and lightweight designs. With the evolution of 3D printing new materials are being produced with greater strength and with shorter manufacturing time.
For example, aerospace companies are already using 3D printing to apply for new designs that reduce aircraft weight by reducing their spending on raw materials such as titanium.
Horizontal and Vertical integration systems: With the advanced manufacture, we seek to have greater control with more information of the productive process. Sensors, machines, parts and IT systems will be connected throughout the value chain of the company and also beyond a single company.

Cybersecurity

Advanced manufacturing benefits from advances in communication technologies, and with it, they tend to increase connectivity in all areas. With increased connectivity and use of standard communication protocols, there is a need to protect critical industrial systems and manufacturing lines against cyber security threats. With this, reliable secure communications as well as sophisticated identity management, machine and user access levels are essential.
Augmented Reality: Augmented reality systems support a variety of services such as training, selecting parts in a warehouse, and shipping repair instructions through mobile devices. These systems are currently in their infancy, but in the future, companies will make much broader use of augmented reality to provide workers with real-time information to improve decision-making and work procedures.

Industrial Internet and CPS: Cyber-Physical Systems (CPS) can interact with each other using protocols based on the Internet standard. Advanced manufacturing will make it possible to collect and analyze data between different machines, allowing for faster, more flexible and more efficient processes to produce higher quality goods at reduced costs. This will result in increased manufacturing productivity, turn-by-turn, industrial creative growth with better integration, simulation and collaboration tools. The CPS topic will be further detailed in topic 2.5. According to Gartner Group (GROUP, 2015) report, which lists technological and strategic trends, in the year 2013 more than 50% of Internet connections come from smart devices (called "things"). By 2011, there were more than 15 million such devices on the Web, with more than 50 billion intermittent connections. By 2020, we will have more than 30 billion devices connected, with more than 200 billion with intermittent connections.

Cloud computing

Companies are already using cloud computing for some enterprise and management applications, but with advanced manufacturing, more companies will share production-related information and information, requiring more sharing and real-time. At the same time, the performance of cloud technologies will improve, reaching reaction times of just a few milliseconds. As a result, machine data and features will be increasingly mobilized into the cloud, allowing more data-based services to production systems. Even the systems that monitor and control processes can become cloud-based.

Autonomous Robots

Manufacturing has been using robots to handle complex services, but robots are evolving to greater utility. They are becoming more autonomous, flexible and cooperative. Eventually, they will interact with each other and work hand in hand with humans safely and learn from these. Robots tend to cost less and have a greater range of features than those used in today's manufacturing. For example, Kuka, a European robot manufacturer, offers autonomous robots that interact with each other. These robots are interconnected so they can work together and automatically adjust their actions according to the next product on the production line. Sensors and control units allow close collaboration with humans. Similarly, another supplier of ABB robots, is launching a two-armed robot called Yumi that is specifically designed to mount products alongside humans. Two padded arms and computer vision allow for safe interaction and recognition.

Big data

Big Data is a term that is on the rise and is used for very large or complex datasets where traditional data processing applications are insufficient. Challenges include analyzing, capturing, selecting data, grouping, searching, sharing, storing, transferring, viewing, and information about privacy. In the industrial area it can optimize production quality, save energy and improve the service of equipment. In the context of Industry 4.0, one has to integrate data from different equipment many different production sources and systems, as well as to enterprises and customer management systems, will become standard to support real-time decision making.

IoT

Internet of Things or "Internet of Things" (IoT) is a new paradigm that is rapidly gaining ground in the industry at large. According to Giusto (2010), "the basic idea of this concept is the generalized presence around us of a variety of things or objects like Radio-Frequency Identification (RFID), sensors, actuators, cell phones, etc. Which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals.

These devices will have more and more applications in our day to day and especially for the industries, where a greater possibility of product tracking, inter and intra-company interaction, automated control of the systems where in a production line the products themselves will have a Tag that will guide them by which machine and which line of production to follow, with that after each stage, and register information about the analyzes made. This can reduce the use of resources, because you will have more real-time information about their use and downtime and performance, with an emphasis on energy reduction.
This concept is key in this process and from it a number of other paradigms, methodologies and processes have to fit.

Cloud Computing

Cloud Computing is supposed to transfer business process facilities to a place that is virtually accessed over the Internet, regardless of physical distance or "clouds." With the maturation of cloud computing we will increasingly have cloud-based systems, so industrial systems will make machine and production data available in the clouds, enabling a new form of decision-making associated with greater horizontal and vertical integration in the cloud. Pyramid of industrial automation.

Horizontal and Vertical Integration

Even today, most IT systems today are not fully integrated. Companies, suppliers and customers are rarely closely connected. Neither are departments in-house, such as engineering, production, and services. Company functions for factory floor level are not fully integrated. Even designing itself from automation plant products does not have complete integration. But with Industry 4.0, businesses, departments, functions and capabilities have become much more cohesive, for example, shared CRM systems (Customer Relationship Management) that allow value chains to truly be deployed. And the traditional pyramid of industrial automation will become flat where you can access data from any machine and where the machines will exchange information and become more autonomous.

As described above the introduction of new paradigms from TICC (Technology Information Communication and Control) will have huge impacts on virtualization of the process and supply-chain ensures smooth inter-company operations providing real-time access to relevant product and production information for all participating entities. In this scenario boundaries of companies fell behind, as autonomous systems exchange data, gained by embedded systems throughout the entire value chain. The companies that will not be ready for these transformations are tied to die.

2. CONCLUSION

Industry 4.0 will address and create solutions for some of the challenges facing the world today such as resource and energy efficiency, urban production and demographic change. Industry 4.0 enables continuous resource productivity and efficiency gains to be delivered across the entire value network. It allows work to be organized in a way that takes demographic change and social factors into account. Smart assistance systems release workers from having to perform routine tasks, enabling them to focus on creative, value-added activities. In view of the impending shortage of skilled workers, this will allow older workers to extend their working lives and remain productive for longer. Flexible work organization will enable workers to combine their work, private lives and continuing professional development more effectively, promoting a better work-life balance.

This paper discussed key technologies like cloud computing, IoT, CPS for the deployment of a new industrial revolution called Industry 4.0. This new paradigm will benefit from the latest TICC (Information Technology, Communication and Control) technologies associated with greater collaboration among the players in this industrial process.

This change is already impacting the industrial area, especially in areas where the product life cycle is small and a constant search for improvement is needed, such as the electronics, automotive and aviation sectors. We need to train trained professionals to work and reason with a more global vision and knowledge permeate in different areas, which will be more closely linked. There is an open field for creating platforms, new or improved protocols, and connections between smart devices that allow you to use these new features in factory environments that are provided in Industry 4.0. You must completely develop new business models and exploit the considerable potential for optimization in the areas of production and logistics.

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Biography

Eduardo Cardoso Moraes is a Professor at Federal Institute of Alagoas. He earned B.S. in Computer Science in UFAL(Federal University in Alagoas State) Masters in Computer Science from UFPE(Federal University in Pernambuco State), and PhD in Industrial Engineering from UFBA (Federal University in Bahia State). He has published many journal and conference papers. Dr Moraes is a reviewer form IEEE Industrial Informatics Journal and CONNEPI. He has completed international PhD exchange in Germany supervised by Prof. Dr. Armando Walter Colombo. His research interests include manufacturing, industrial informatics, services-based systems, agile methodologies. He is member of IEEE and Brazilian Computer Society.

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