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THE IMPACTS OF INDUSTRY 4.0 AT ETEC FERNANDO PRESTES

Marinês Christofani
Master in Education from the Postgraduate Program in Education at Uniso
Professor at: ETEC-SP. Sorocaba, SP
http://lattes.cnpq.br/9426990866372335

Fernando Silveira Melo Plentz Miranda
Doctor in Education, Master in Law.
Permanent Professor of the Postgraduate Program in Education at: Uniso. Sorocaba, SP
http://lattes.cnpq.br/8957212235067504

Abstract: The objective of this article is to analyze professional and technological education policies in Brazil, their debates and conflicts, notably in relation to the challenges faced by the São Paulo Network of Professional and Technological Education in the face of Industry 4.0. It expands the debate on the effects of digital technology on the training of students, as well as presenting the potential of this educational branch, whether in the growth of supply or in the effective intellectual and technical development of students. The methodology was based on bibliographic and documentary studies, as well as selected journals. The results indicate the growth in demand from Industry 4.0 for trained professionals capable of working according to the characteristics of this mode of production and the experience of implementing courses focused on Industry 4.0 at the Fernando Prestes State Technical School (ETEC) in the municipality of Sorocaba, SP.
Keywords: Public policy; Technological professional education; Industrial Revolution; Industry 4.0.

INTRODUCTION

The following text will provide the reader with a retrospective of the Industrial Revolutions that have occurred to date, making a parallel with the technologies presented in each period, bringing with greater emphasis information on the Fourth Industrial Revolution that began in mid-2011, and its impacts, culminating in the Era of Industry 4.0, shaping all the technological developments that transformed the mode of production and communication as well as the ways of working in this period. After this introduction and explanation of this scenario, the reader will have a vision of how Industry 4.0 is being approached academically in the city of Sorocaba, exemplifying with the analysis of the Logistics Technical Course Plan and actions at the Faculty of Technology (Fatec) of Sorocaba.

According to Souza, situation analysis does not occur in a neutral way and is a complex and difficult task, requiring the researcher to obtain detailed knowledge of the categories and the ability to "perceive, understand, discover meanings, relationships, trends from the data and information" (1984, p. 8). Furthermore, the analysis must focus on structures.

According to the author, among the large volume of information conveyed on various subjects, the researcher needs to differentiate facts (daily occurrences) from events (those facts that acquire a special meaning for the country, group or person). It is also necessary to identify the scenarios (spaces where social plots occur), the actors (individuals or groups that represent certain roles within the web of relationships) and the power relations (which can be confrontation, coexistence, cooperation, dominance or subordination).

Therefore, analyzing the impacts of Industry 4.0 at ETEC Fernando Prestes is not something simple that will end in this study, but this will be a starting point for new decisions and actions that must be taken by Management and those responsible for the Paula Souza Center Curriculum Laboratory. This curriculum is periodically reviewed every four years, through a committee of technicians in the area and people related to the job market linked to the course axis.

CONCEPTUALIZING INDUSTRY 4.0

To understand the possible impacts that the so-called Industry 4.0 causes in our daily lives, it is worth explaining here what this term really expresses, and how it interferes with the mode of production and consequently how it reflects on education and training for work.

Industry 4.0 receives this definition as explained by Santos as:

> [...] a project within the scope of the German government's high technology strategy that promotes the computerization of Manufacturing. The objective is to achieve the smart factory (Smart Manufacturing) which is characterized by adaptability, resource efficiency and ergonomics, as well as the integration of customers and business partners into business and value processes. Its technological base is made up of physical/ cybernetic systems and the Internet of Things. Experts believe that Industry 4.0 or the fourth industrial revolution could be realized within a decade (SANTOS, 2015, p 12).

The term Industry 4.0 was initially used at the Hannover Fair, in Germany, in 2011. This expression became known through the Industry 4.0 initiative, also known as the 4th Industrial Revolution. This revolution brought a significant impact on the productivity of industries, promoting greater efficiency in production, better communication and interconnection between production and the company, in addition to the generation of new products and services through technologies. These technologies can be categorized into specific fronts, such as physical technologies (autonomous vehicles, 3D printing, advanced robotics, etc.), digital technologies (Internet of Things - IoT, big data, blockchain technology, etc.) and biological technologies (biotechnology and genetics).

Industry 4.0 implies a process of continuous improvement to deal with new technological paradigms, affecting both the industry and service sectors, and consequently impacting industrial work and the training needs of the workforce (Bianchi, 2010; Bresser-Pereira, 2013).

The Fourth Industrial Revolution was preceded by three other revolutions, which all had a considerable impact on the world economy, making use of different forms of technology for the manufacture of products and mainly in the labor relationship between living beings.

This representation of Industrial Revolutions, illustrated in figure 1, in a simplified and didactic way, emphasizes the technological characteristics of each Revolution, the supposed period of beginning and the action that led to its manifestation, thus being a historical and unique process.

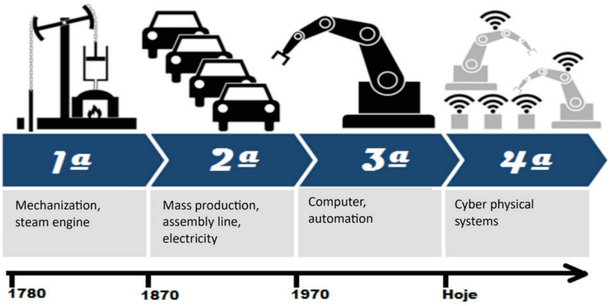

Figure 1 - Industrial Revolutions and their technologies

Source: Adapted, Duarte (2007, p.27)

Starting from a technical point of view, Santos, Alberto, Lima and Charrua state that, "[...] Industry 4.0 represents a natural evolution of previous industrial systems, from the mechanization of work that occurred in the 18th century to the automation of production as currently occurs" (2018, p.115). With the evolution of automation and information systems with ERP (Enterprise Resource Planning) and MES (Manufacturing Execution System), productivity in factories has increased exponentially, but there still remains a "gap" in communication between ERP and the process of production, where the solution could lie in improving decision-making in real time, and information technology, elements that promise to revolutionize in the Era of Industry 4.0.

However, the Fourth Industrial Revolution cannot be associated only with better mechanization of industrial work processes, but mainly with the use of intensive forms of information technology and tools available in this universe, considering the interface of the physical universe and the connectivity of the virtual environment, The drivers of this new era are the relationships between Cyber-Physical Systems, the Internet of Things, the Internet of Services, Smart Factories and other technologically advanced forms.

Thus, according to Hermann, Penteck and Otto, Industry 4.0 is made up of:

> • Cyber-Physical Systems (Cyber-Physical Systems [CPS]): integrate physical objects and their models, represented in networks, as well as services based on available data;
>
> • Internet of Things (IOT): builds a communication network between people and devices, using everyday objects in order to make the internet ubiquitous;
>
> • Internet of Services (Internet of Services [IOS]): uses the internet structure to enable the supply and demand of services;
>
> • Smart Factories: they are based on the connectivity of the Internet of Things (IOT) and the provision of the Internet of Services (IOS), managing complex systems that integrate machines and humans in a network, whose plants have their demands fulfilled by Cyber-Physical Systems (CPSs) and communicate via the Internet of Things (IOT). (HERMANN, PENTECK AND OTTO, 2016)

Considering this, we can say that Industry 4.0 reflects the presentation of the Fourth Industrial Revolution to the world, where it establishes several technological changes mediated by robotization and artificial intelligence, culminating in major changes in the productive and labor field, causing a re-elaboration of the system. distribution of society's capital and consequently a new version of capitalism.

There is also an integration between cyber-physical systems and the internet of things and services, thus giving a leap in manufacturing operations, envisioning Smart Factories with the use of autonomous robots and simulators, with detailed actions, using less and less human labor.

As a practical example of use, Almeida also explains how this synergy of the Internet of Things in sharing with the wireless sensor network occurs in everyday life:

> [...] Wireless Sensor Networks (WSNs) are sensing devices with limited processing and communication power and energy constraints, as they are often powered by batteries. When used together, WSNs function as a large distributed, autonomous and cooperative system. These networks make it possible to verify a variety of phenomena that are described by some physical quantities, such as temperature, pressure and humidity. Recently, the concept of WSNs is being expanded due to the inclusion of "abstract" quantities, such as capturing faces, iris or fingerprints, places visited and registered in foursquare, location of a vehicle on a road network, location of individuals in a crowd, etc. There are several applications where WSNs and the Internet of Things are used to strengthen urban systems in general. We can mention different solutions for the integration of "smart" vehicles capable of interacting with each other to share information about accidents or congestion; environmental monitoring aimed at monitoring air quality, beaches or rivers and predicting catastrophes; and building automation, thus allowing the design of intelligent environments. Some applications in the field of intelligent urban transport that use the Internet of Things as a basis are emerging every day. The driver assistance service, for collaborative collision detection, aims to inform a greater number of nearby vehicles of the occurrence of a collision. In this case, the sensing data are the coordinates of the collision, the speed of vehicles on an avenue indicating a sudden deceleration, a cluster of stopped vehicles or data reported by passengers on social networks or navigation applications. The data collected by this application can be made available or processed by different platforms, such as the system embedded in

the car itself, the occupants' cell phones, or even a cloud service. All actors involved, cell phones, cars, traffic lights, etc. they need to interoperate through the Internet as proposed by the Internet of Things. With the advent of vehicles with sensing and communication capabilities, studies, results and innovations in intelligent transport systems have been consolidating. A cheap and scalable way of sensing traffic objects is the use of RFID (Radio-Frequency Identification) tags. Brazilian legislation already provides for the incorporation of RFID tags into cars, thus facilitating the implementation of systems such as tracking, vehicle counting and automatic toll payment (siniav.net). The simple counting of vehicles allows applications such as identifying congestion, controlling parking spaces, measuring attendance at events and identifying the flow of vehicles on roads. Tracking, in turn, allows the identification of routes, which can be used to understand drivers' habits and thus improve the flow of vehicles. Furthermore, tracking allows the identification of congestion and even the identification of speeding violations (by analyzing the time spent traveling between two points). Another very important topic that has been treated with great attention in all social spheres is environmental monitoring. These scenarios represent the most traditional applications in WSNs, however the growing need for integration of these applications with society requires immediate interoperability of WSNs with the Internet. Some immediate examples are the availability of air quality data on citizens' cell phones, a flood alarm on SmartTV or residents' cell phones near a risk area, or the availability of micro-scale information, collected on site, to large weather forecasting centers, which generally only have macro information obtained from satellites. A very useful application, although futuristic, would be to use different air quality sensors built into our cell phones, in order to feed micro information into a large data collection system that, combined with data from monitoring stations, would have a greater precision and effectiveness regarding risk points. In this application, the convergence of the entire system, that is, cell phone sensors, monitoring station and data collection center must be carried out via the Internet made possible by the Internet of Things. Finally, we have intelligent environments whose design entails serious technological challenges that range from new sensors and embedded devices to applications that run on a browser or cell phone (ALMEIDA, 2015, p. 7).

The difference in Industry 4.0 is the fusion between the physical and virtual worlds based on cyber-physical systems, as was also seen in the example above. Furthermore, this fusion is verified where complex physical systems require communication with the digital world to enable better performance and efficiency. The Internet of Things, therefore, refers to the integration of physical and virtual objects into networks connected to the Internet, allowing "things" to collect, exchange and store a huge amount of data, in which, once processed and analyzed, these Data generates information and services on a large scale. The "Internet of Services" is basically the use of the Internet to create new value alternatives for the services sector.

Thus, it is not only in industries that the Fourth Industrial Revolution is perceived, but consumers are also impacted by the new revolution, as Schwab puts it:

> Customers, whether as individuals (B2C) or as companies (B2B), are increasingly at the center of the digital economy, which is about how they are served. Customer expectations are being redefined in experiences. The Apple experience, for example, is not just about how we use the product, but also about packaging, branding, shopping and customer service. Apple is therefore redefining expectations to include product experience.
>
> Traditional approaches to demographic segmentation are shifting to digital criteria targeting, where prospects can be identified

> based on their willingness to share data and interact. As ownership rapidly gives way to shared access (especially in cities), data sharing will be a necessary part of the value statement. For example, car sharing will require the integration of personal and financial information across multiple companies in the banking, automotive, services and communications sectors. Most companies claim to be customer-centric, but their claims will be tested as real-time data and analytics are applied to the way they serve and serve their customers. The digital age is about accessing and using data, refining products and experiences, fostering a world of continuous adjustments and refinements, while ensuring that the human dimension of interaction remains at the heart of the process. The ability to leverage multiple data sources — from personal to industrial, lifestyle to behavioral sources — provides granular knowledge about a customer's shopping journey; something unthinkable until recently. Today, data and metrics (indices) provide crucial, near-real-time insights into customer needs and behaviors that drive marketing and sales decisions. This digitalization trend is currently moving towards greater transparency, meaning more supply chain data, more data at consumers' fingertips, and therefore more peer-to-peer comparisons on the performance of the products they supply. they transfer power to consumers (SCHWAB, 2016 p.59).

According to Schwab (2016), we will not only have the advent of Industries, but a set of technological processes linked to the Fourth Industrial Revolution, with this production, which is based on decision-making arising from data captured, stored and processed in virtual models, which allow monitoring and decision-making in real time, in the plant, in distribution and even in the after-sales of products. Therefore, the consumer will be constantly bombarded with information and ways to search for data that will be transformed into information that will be used to control and coordinate processes, thus procedures reach dimensions beyond manufacturing.

Thus, smart factories are capable of capturing information, making decisions and replanning in real time (reprogramming), allowing changes in case of errors in customized production. Thus, the internet of services comprises the opening of data and services on the internet that allow communication with customers and, thus, immediate adaptation to demands (FIRJAN, 2016).

The Federation of Industries of Rio de Janeiro System (FIRJAN), in 2016 published a document called "Technological Trends", which aims to create a favorable environment for these new technologies to be disseminated and incorporated by the industry, which reinforces the idea that Digitalization applied to industry, energy and infrastructure is fundamental to increasing global competitiveness and influencing the country's economic development, which includes:

> [...] It is possible to state that, despite the current economic-political scenario, Brazil is in a period of transition, capable of generating great opportunities for a new cycle of development, based on technology for industry. With the arrival of Industry 4.0 and its implementation in Brazilian industries, the great challenge for the country focuses on factors such as: obtaining intelligent strategic policies, incentives and promotions from the government; bring together businesspeople and industry managers with vision, boldness and proactive stance; have technological development and training of highly qualified professionals by academic and research institutions, preferably in close proximity to industry. By progressively overcoming the challenges, it will be possible to absorb and implement in the national industry the set of technologies and advantages that this fourth industrial revolution is capable of bringing, establishing Brazilian competitiveness in the face of the great world powers and even pioneers in this process of adopting the Industry 4.0 (FIRJAN, 2016, p.17).

This new era has as its main challenge the connection of Industry 3.0 with automated and digital systems, which culminated in "lean automation" with Industry 4.0, proposed with the mediation of the internet, and artificial intelligence tools that disseminate new forms of production and distribution of products, identifying new business models previously unthought of.

INDUSTRY 4.0 AT ETEC FERNANDO PRESTES

In the context of the courses offered by the Paula Souza Center at ETECs, for example, taking for example the analysis of the Logistics Technical Education Course Plan, we find timid inclusions about the 4th Industrial Revolution, in the technological bases of the third semester of the course, a small approach to the technological innovations introduced by Industry 4.0. in the subject Information Technology Applied to Logistics, as exemplified in figure 1, by the excerpt:

Technological Bases

Different types of organization:

- Evolution of information technology applied in logistics
- Information technology and industry 4.0
    - ✓ Advanced robotics applied in production processes
    - ✓ Digital transformation and industry 4.0
    - ✓ Internet of Things (IOT)

Theme 1: Development of logistical organizational processes.
4.11.19.1: Matrices indicating curricular components guided by themes.

- ✓ Artificial intelligence and its importance in industrial automation
- ✓ Communication and customer relations through social media
- ✓ Digital commerce and technology
- Universe of automation of logistics processes and operations
    - ✓ Material flow
    - ✓ Production
    - ✓ Product movement

Figure 1 -Part of the Logistics Technician Course Plan

Source: www.etecfernandoprestes.com.br

These inclusions are minimal and it is up to the teacher to explore and expand this knowledge, however, the curriculum reflects the CPS institution's concern with training students for the constantly evolving job market. However, as mentioned by Zancun (2016), this evolution in teaching still occurs gradually, because although many Brazilian industries are automated, digital manufacturing has not yet been completely mastered in Brazil. There are industries that are still in the Second Revolution with very simple systems and have not even automated (use of computers) their manufacturing system, for example they still use simple machines such as lathes and milling machines. While others are at different stages of technological development. Therefore, with investments and a vision of the future, companies can advance to more advanced stages of technology, gaining competitiveness.

In Brazil, the concept of Industry 4.0 is being introduced and adapted according to the national reality. However, implementation faces challenges due to a lack of knowledge about the process or resistance to adopting these new technologies (Hahn, 2017). The transformation of the form of production in Industry 4.0 directly impacts the way of work, education and training of workers, meeting the needs of the constantly changing labor market.

In addition to the concept, Industry 4.0, appearing in a timid way, in some CPS course plans, as in the example mentioned above, in the technical logistics course, as part of the content of the technological bases to be studied, and remembering that there is an update of Course Plans over a period of every 4 years, we can also verify that the Paula Souza Center authorized the implementation of the Advanced Manufacturing technological course at Fatec de Sorocaba in the second half of 2018, further intensifying studies for Industry 4.0, where Sorocaba It is the hub of a metropolitan region and its business park has been diversifying and bringing in several companies, thus justifying the creation by the municipality of the Sorocaba Technological Park (PTS), aiming to promote research, the culture of innovation and entrepreneurship.

In line with PTS and FATEC, through the Advanced Research Center (NEPETInd4.0) and the Center for Excellence in Technology 4.0 (CET4.0), ETEC students were invited and participated as listeners in some events at PTS between 2018 and 2019, such as: V Workshop: Innovation, Education and Applications of the 9 Pillars of Industry 4.0, on 02/28/2018; IX Workshop: Integration of Technologies and applications in Industry 4.0 on 11/6/2019. Speakers: Prof. Dr. José Roberto Castilho Piqueira – FDTE – Poli – USP, and representatives of the companies Flex, Schaeffler, SKA, Verzani & Sandrini. The event's Communication Secretariat (SECON) indicates that:

> Professor Nelson Rampim Filho, from the Faculty of Technology of Sorocaba, coordinated the IX Workshop on Integration of Technologies and Applications in Industry 4.0, last Wednesday (06), at the Sorocaba Technological Park. The event featured lectures and the exhibition of work by students, teachers and companies (SECOM, 2020).

These are actions that move the students of Sorocaba towards the impacts of Industry 4.0, and mainly the teaching and student community of ETEC Fernando Prestes, since Sorocaba is reflecting the industrial growth of the state of São Paulo. This way, with the help of NEPTind4.0 and the integration of companies and APLS (Local Production Arrangements) and partnerships like these, ETEC seeks to suggest new courses and/or update existing ones, meeting the market vision and taking this need to CPS, to meet new demands, since the structuring of CPS course plans occurs on average every four years, through curriculum laboratories.

According to research carried out by Luz (2020), in Sorocaba, according to the Active Economic Registry Report, it was reported that in May 2019, there were more than 160 different branches of activity, with 928 registered companies, of which 55 were selected. and 33 medium-sized companies, and with this sample, the data was crossed to identify how many percent these segments of activities of companies in Sorocaba represent the necessary alignment to achieve the concept of Industry 4.0., arriving at the following information:

> It is observed that the best brands are mainly from the food, automotive, packaging, tools, wiring, IT, wood, machinery, chemical and health segments, with the average Industry 4.0 alignment being 61.05% for large companies, while medium-sized companies have a percentage of 41.52%.
>
> The studies also indicate that the highest percentage of alignment with the Industry 4.0 concept, among large companies, is in the automotive segment (89.59%). In relation to medium-sized companies, the highest percentage in this regard is in the Machinery segment (with 79.17%). (ARANHA; CARMO and RAMPIM FILHO, 2020)

Therefore, broader knowledge of processes and greater qualification in the Industry 4.0 theme are necessary requirements for professionals to implement the gains of this new Industrial Revolution that is still in its infancy in Sorocaba.

FINAL CONSIDERATIONS

Therefore, this research demonstrates that Sorocaba needs specialized people for this new scenario and Industry 4.0 brings us several impacts, both positive and negative, on the issue of employability, since there will be fewer opportunities for professional placement for those who are not qualified, according to the needs of this Revolution.

In this process, we see the need to improve skills in the use of technologies, thus generating the need for adequate professional qualification, which is one of the challenges presents in the classroom to be overcome

(SCHWAB, 2016).

It is important to note that technologies related to the process are being applied to improve the quality and products to be developed, it is also important to identify that professionals must have scientific and distinct skills, with this the market will gain a multidisciplinary collaborator. Also, there will be the emergence of new professions at a strategic level, where technologies related to the process will be acquired to improve the quality and products to be developed, always aiming for the well-being of society.

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