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Chair of Competition and High-Tech Markets

Disruptive Technologies and their Impact on the Labor Market

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# Disruptive Technologies and their Impact on the Labor Market

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Disruptive Technologies and their Impact on the Labor Market

The impact of Technology has been, in the mere definition of the human being, always more present. The focus on research and innovation of technology, as well as the enthusiasm and the worries that it causes, often lead to distract attention from a careful consideration of the entire context as a whole. In the limits of any biological metaphor, it can be argued that between human being and Technology there is a tight relationship of coexistence and mutual advantage. It can be said that there is a sort of “symbiosis”: our species blended with all the new innovation and instruments that creates and produces. It is quite impossible not proving the easiness that technology generates in different realities, such as social’s and professional’s, through, ex plurimis, the transfer of activities, competences, and even decisions, which in the past were belonging to humans, to machines and artificial intelligence robots. All of these concepts bring to another consideration: the technology advancement entails a minor material compliant in the form of an increasing dependency of human to technology itself.

If, on one hand, history tells us that the rhythm of technology progress is constantly increasing over time, due to the fact that a set of new discoveries serve as basic ground for others, newer and larger, on the other hand, it is required to notice that the consequences, of the technology evolution itself, cannot be confined to its immediate effects. There are (and there will be) always unexpected, unpredictable, and undesired effects. Moreover, technology evolution is marked from very fast changes, fastened to actualization mechanisms, thanks to which the immediate adjustments to innovation tend to take the root into the profound society structure, by chaining together the “homo technologicus” with the permanent presence of such innovations and evolution.

1 “L’avvento di Homo Technologicus”, Giuseppe O. Longo, Scienzainrete.it, 18.03.2015
Can the impact of technology being predicted with absolute certainty?

Today, the present scenarios and the hypothesis of the future are, often, built through conjectures filled with high degrees of predicting and diagnostic competences. Nevertheless, one thing is sure: the asymptotic evolution of new technologies requires, as *conditio sine qua non*, a corresponding and updated education, which would be able to allow a fair adaptation to the continuous changes.

What impact these things just said had and will have on the labor market?

The advent of new technologies, the emerging of new professional opportunities, new markets, new sectors, and the continual quantitative and qualitative modification of human-machine interaction, have brought radical changes in work’s structure and essence. These work’s transformations can be read either under an optimistic, than a pessimistic lens. From one perspective, technology advance will definitely bring a bunch of new opportunities in almost every field of applicability: smart cities, wearable devices, interconnected sensors and items, smart manufacturing organizations, and a quite all customization of every individual need thanks to huge amount of available data. From the other perspective, instead, several academic studies, as well as other reliable sources, have shown that the increasing automation of some tasks, mostly related to routine and ruled-based tasks, is laying on the line a very big portion of the labor market.

My study, with obvious humility, will attempt to illustrate possible scenarios and feasible applications that the evolution of technology will necessarily imply.

The thesis will be structured as follow: the first part, from chapter 1 to 3, will regard the different Industrial era, from the first Industrial revolution to the futuristic concept of Industry 4.0 and Internet of Everything. In order to give a reliable interpretation of the abovementioned contents, it is correct to make an initial distinction between the meaning of Industrial revolution and the term Machine age, used as title for each chapter.

Figure 1 represents the different time frames associated with the four stages of the Industrial Revolution.
The Industrial Revolution kicked off with the invention of the steam power engine and the first mechanization of manual work at the beginning of the 1800s. The second Industrial Revolution has been associated with the beginning of the mass production techniques implemented by Henry Ford and its first concept of “smart factory” in the early 1900s. Going ahead, over the past thirty years, with the advent of electronics and IT revolution, the entire world assisted to a radical transformation in terms of living and working attitudes. Then, the third Industrial revolution employed electronics and information technology to achieve increased automation of manufacturing processes, which have brought to a machine take over of a substantial proportion of manual and cognitive jobs. The last Industrial revolution refers to the evolution of PCs into smart devices that has also been accompanied by other trends that combine miniaturization and the unstoppable growth pace of the Internet. These results in the convergence of the physical world and the virtual world in the form of Cyber-Physical Systems, as well as the rise of the Internet of Everything, the concept of Industry 4.0 and the new future of smart factories.

In this thesis work the different stages of the Industrial revolution are represented under the term of Machine Age, following and adapting, to some extent, the categorization made by Brynjolfsson and McAfee (2014). Thus, within the First Machine age, presented in the first chapter, are grouped the first and the second industrial revolution, covering the period from the 1800s to the information revolution; following, the Second Machine age is going to represent the third industrial revolution, and the rise of a social and economic problem called the “hollowing-out” of the labor market; finally, will be presented, as the Third
Machine age, the last industrial revolution, which involves the technical integration of CPS into manufacturing and the use of the Internet of Everything in almost every sector and industrial processes.

The second part, instead, will stress the accent on the possible implication of technology progress, through a cross comparison analysis of several scenarios based on different methodologies. The final goal would be drawing a future action plan, strong enough to face the challenges that technology advancements will definitely bring, thus understanding if the employment is suffering or benefiting from it.

Going into details, in the first part, the entire focus was on travelling through again the different stages of the “Machine Ages”.

The combination of several innovations, linked by a common denominator, which was the industrialization, created significant changes by revolutionizing both industrial production and socio-economic context of each country. A first milestone could be considered the creation of the steam engine, which laid the foundation for the implementation of new machines that revolutionized the UK industries in terms of higher production and few workers needed to perform a single task. This brought to the first protests and the rising of the concept of technological unemployment.

With the beginning of the second Industrial Revolution, new discoveries brought to a huge expansion of markets boundaries that led to a sort of limitless technology advancements potential.

From a study conducted by Katz and Margo, (2013) over the period 1850 to 1880, it was shown that the introduction of purpose-built machinery (e.g. assembly line) and the rise of large factories resulted in the shift from farm laborers to machine operatives. In manufacturing, for instance, there was an increased demand for clerks, supervisors and managerial, technical and professional occupations. In services, increased demand for unskilled service workers (e.g. travel), medium-skilled services (e.g. sales) and skilled services (e.g. managers). However, the same analysis showed that the manufacturing distributions exhibit hollowing out between 1850 and 1910 with a declining share of skilled artisans, and rising shares of operatives and white collar workers.
The first two stages of the Industrial Revolution were just the beginning of a process of polarization of the labor market, which Keynes defined as “technological unemployment” (Keynes, 1930) and that will continue to grow in the following stages.

Indeed, in the second Machine age several studies (Acemoglu, 2011) (Autor and Dorn, 2013) (Autor et al, 2003) (Osborne and Frey, 2013) have analyzed the effects of technology advancements, especially regarding the obsolescence of some skills and the rise of new ones, as a percentage of employment share loss. The results have shown that the labor market of different countries, both in Europe and US, is experienced an economic phenomenon called the “hollowing out”, or the job polarization, of the labor market by which, dividing the total share of employment in three ranks of jobs, low, middle and high ranked jobs, according to the level of skills sets necessary to perform a specific task, it is possible to identify an expansion of high-ranked and low-ranked jobs over the middle ones. What the scholars have tried to demonstrate, was that one of the main causes of such a phenomenon has to be connected with the technology advancements and the simultaneous changing of the skills-set workers are required to have in order to be successfully competitive in the labor market, against the race of machines.

In the third Machine age, however, the evolution of technology practices has opened new opportunities in different sectors, and has broadened the field of applicability of artificial intelligence and advanced machines. Thanks to the always larger number of interconnected devices and the availability of huge amount of data, gathered from sensors and actuators installed almost everywhere, organizations are implementing new strategies to unlock the value of the so-called Internet of Everything. Furthermore, the important topic in the third machine age is the concept of Industry 4.0 and advanced manufacturing. Advanced manufacturing is an envisioned state of operations in which all relevant and synthesized information are made available when, where and in the form in which it is needed across manufacturing supply chain, and to all the stakeholders. In this way, inside a smart factory, all the machines will be connected to each other and to the plant itself through several platforms that will grab all the information available from sensors and actuators. The interaction between machine-to-
machine and machine-to-human will be extremely enhanced, and thanks to the power of the Internet of things and the huge world of interconnected devices, the manufacturing industry will shift from the concept of mass production, to the one of mass customization. In this scenario it will be hard to say if the technology advancements would disrupt more jobs than it would create; however, what is, once again, certain is that workers have to modify or to upgrade their skills-set, by focusing more on communicational and interpersonal skills, as well as in advanced engineering and mathematics fields.

In the second part, in order to identify a good pattern of results, it was drafted a methodology comparison regarding different future scenarios and technology applicability. There were selected three different scenario’s methodologies based on: surveys and trends, futurologists’ visions, and literatures’ analysis.

From a cross comparison analysis, it was shown that technology advancement is, actually, reducing the employment share, especially, of the middle-skilled workers and all the kinds of works related to manual and repetitive tasks, mostly due to a simultaneous change in the skills sets required by employers. Indeed, technology progress is strictly correlated to an updating of skills for all the workers, either for low- and middle-skilled, and either for high-skilled ones.

Figure 11: Scenario’s comparison

![Scenario's comparison](image)

Source: Internal calculations

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2 Even though both UKCES and PWC provide four and three, respectively, different scenarios, the differences between each other are not relevant in the understanding of the positioning map.
That said, technology can be considered as a source of economic and employment growth if, and only if, institutions and governments will implement several reforms that aim to create a sort of bridge between the level of education, the skills sets that workers are requiring to have, and the technology progress. Education challenge, policies that would have the goal to enhance technology progress with incentives, funds, and R&D improvements, and, finally, guaranteeing a secured and trusted cyberspace in which data and information can flow freely, are all possible action plans for ensure a better future cohabitation between human and machines.

Concluding, it would not be correct to deny the role that technologies have had, and have on the global economic and social structure, but it is also required to consider that “when a machine is created to do the work of a Man, something is taken away from the Man!”

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3 Quote from the movie “Start Trek: The Insurrection”, 1998
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