



STUDY GUIDE

Group of Twenty



LIST OF ABBREVIATIONS

AI – Artificial Intelligence

E.g. – Exempli Gratia

FAO – Food and Agriculture Organization of the United Nations

GDP – Gross Domestic Product

G7 – The Group of Seven

G20 – The Group of Twenty

ICT – Information and Communication Technology

IEA – International Energy Agency

IMF – International Monetary Fund

MIT – Massachusetts Institute of Technology

NAFTA – North American Free Trade Agreement

OECD – Organisation for Economic Co-operation and Development

UN – United Nations

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PRESENTATION LETTERS

GABRIEL CABRAL

Gabriel Cabral, also known as Gabs, is the loveliest person you will ever meet. He's on 6th semester of Law at UFRN and can be a little bit shy in your first contact with him, but I know this shyness is going to be reverted and he's going to surprise you. It's his second time as a SOI director and he is so passionate and engaged on doing things. It is necessary to expose that Gabs is culture, he's all into classic music, movies, outfits, classic everything. Also, he has an artistic soul and already did a short film that is on Youtube called Unit Logic System. He likes to go the beach to watch the sunset, go out with friends and drink. He has a passion for dogs (specially Victoria's dog Apple), they are like family for him. So Gabriel is an extremely fun person and makes you feel amazing when you're around him, everyone needs a person like him into their lives.

JOÃO LUÍS

It is João Luís' time to be introduced. João is 19 years old and he's on the 6th semester of Law at UFRN. João's path of simulations is still short, but has a lot of potential: he was a director last year at UniSim, and this year at UNEMUM. This is his second SOI, the first one where he's going to be a director. João Luís is a shy guy who loves the arts. He is a lover of pop music and his favorite band is Keane. He also loves dogs. Who doesn't, right? In his academic life, João loves his International Law and his Criminal Law. And, I must say, this guy is very intelligent, and very competent. You can always trust that he will do a good job. Unfortunately, our fellow director doesn't like partying that much, and says we probably won't see him at the SOI parties... Unless we convince him! Other than that, he's a very sweet guy, and if you ever have any doubts or need anything, you can always count on him to help you!

PEDRO MOTA

It's time to introduce our academic director Pedro Mota - also known as global citizen. Firstly, Pedro, just arrived from France, currently is at his 8th semester of Law at UFRN, and this is his second year as a SOI director. About the nickname, it is not for nothing. Pedro accumulates lots of appointments and events in Paris, Rome, Buenos Aires, Sao Paulo, Brasilia and several other cities - it is a very difficult task to keep up with this man's schedule.

Including, before you fall in love: he finds himself in a serious relationship - and, as a real global citizen that he is, his romance is with a Spanish girl, the friendly Patricia. Well, the life of a diplomat in training requires a great deal. So, the baggage of simulation of this young man is also not to be left aside. He, who has been participating at SOI since high school, has already been at other simulations from various parts of Brazil and, obviously, of the globe. Pedro dominates all the four languages required by Instituto Rio Branco and has an oratory to leave anyone open-mouthed. And his qualities do not stop there! Pedro, besides all, also has a great ability in locution, being known for his live broadcasts in Panela Chopp Time - a very important Radio in Natown. Pedro also surfs very well, knows box and represents the ~fitness generation~ in our committee. To top it all: if you are organizing a party, do not forget to call Pedro(!), who, with his voice and his guitar talent, cheers up anywhere - he even had a band of forró! Here is our diplomat.

VICTÓRIA LOUISE

Victória, better known as Vic, is a 19-year-old cute baby who studies Law at UFRN. She entered the “magic world” of simulations when she was in High School and have not left it since then. In spite of her shyness, this intelligent girl is really outgoing and active. As such, she is always ready to hang out with friends and maybe help the ones who are giving the famous “PT”. One ought to mention that Vic loves drawing and tap dancing (yeah, you’ve read it correctly, she does tape dance really well)! As you can imagine, this urban conceptual, vintage and artsy girl does like indie songs and is a great Coldplay fan. Having watched all Disney movies more than a hundred times, Vic has got more information about them than Wikipedia and Yahoo together (okay, I might have exaggerated a little, but she is a cinephile and Disney lover indeed). As if that were not enough, Vic knows absolutely everything about zodiac signs. In case those characteristics have not permitted you recognize Vic as you walk through the corridors of our beloved Sector 1, pay attention at this information: **she is the most fashionable person in the “glorioso curso de Direito”**. In fact, judging by the elegant clothes she wears, you can tell she is a diva who was teleported from the 1970s and joined us in order to make the SOI 2018 the best edition of the project up until this point!

LAYSE DIAS

Layse is a 30-year-old woman in a body of an 18-year-old girl. She is ahead of her age just like old geniuses were - so, do not miss the opportunity to ask for an autograph while you can. It is still free. Nourishing an early appetite for libertarianism and law practice, she envy's both Theresa May and Harvey Spector altogether. Probably they are now commenting Layse's ideas while watching the royal family wedding. Furthermore, she still finds time to develop recipes on cakes and sweets alike. She is single. That is to say: if you're interested in law and economics and cake, don't miss a chance: ask Layse for a dinner after the sessions!

ELLEN MONIELE

Ellen, or should I say, little vegan princess. You may think that she is a fantastic and incredible woman, but she is actually much more: she does yoga, she does voluntary work, she helps the gringos (a very active AIESEC member!), she bakes AMAZING (vegan and NON-VEGAN) meals, but most importantly, she has a heart of gold. To me, she is a sunflower, that, if you're lucky enough, will bloom into your life. She loves all kinds of lives, everything matters, and she can see the beauty on a simple sunset. After all, is there anything more precious than that? Give love and feel love, that is what Ellen stands for. Finally, I must confess that I am extremely happy for the time we spent together. Keep spreading love, Sunflower!

1 INTRODUCTION

Since the earliest groups of people began being created, human beings have been using their capacity of rational thought and their creativity to find ways to survive. That was often possible by using the available supplies to invent gadgets and tools which were able to simplify their lives. Since then, the human ability to create has always been developing, and the world of today is known for all this accessible technology that helps us in various sectors.

It is true that those advances made possible for our society to go through a considerable growth: they increase effectiveness in several areas, such as agriculture, medicine, and engineering; they bring a lot of entertainment and commodity to people's homes; they also amplify the phenomenon of globalization and ease the access to information. All these benefits increase the profit in the world's economy. There are innumerable advantages brought by those resources; they are vastly used in everyday life and it is hard to imagine a world where they did not exist.

There are also new technologies being developed right now apart from the ones mentioned above. Artificial intelligence and robotics, for example, are still very new for the population, but all these innovations look very promising and will probably be more common in a near future.

Even though they bring many positive impacts, the issue that needs to be thought about now are the negative ones. In such an unequal society, it is indispensable to reflect about the part of the population who are left out from all that progress. The first and the second industrial revolutions are examples of times when the vast advances interfered negatively in the lives of the workers. Since then, it is not hard to notice that technologies are cheaper and easier to deal with, and they have been substituting human labor in some sectors of the economy.

It is possible to conclude that the contemporary society is made of complex relationships, and everything is connected. For it to function harmonically, it is necessary that all the parts are working, because if one of them is prejudiced, it will affect others.

Even if the technological and economic sectors are functioning well and developing, it is fundamental to impose limits to them if they are causing others – like the social sector – to get worse. For example, the growth in economy can be positive for one part of the population,

while the other one has its situation aggravated, increasing social inequality. In accordance with this argument, the present debate is crucial so that there can be an actual growth in all parts of society.

2 COMPETENCES

The Group of Twenty (G20) is an international forum that brings together the world's leading and emerging economies. Its countries hold 85% of the world's gross domestic product (GPD), and two thirds of the global population¹. The main focus of G20 meetings – which gather ministers, foreign ministry emissaries (also known as “Sherpas”), central bank governors, and world leaders – is to discuss key global economic issues. It exists since the reunion of the Group of Seven (G7) in 1999, where they decided that having a more inclusive body, with more members, would make the meetings more efficient in addressing the world's financial challenges.

The G7 began as a group of finance ministers of four major industrialized countries, which needed to discuss the 1973 oil crisis. From there on, the body continued gathering, adding other countries to it every few years. By 1998, there were eight members in the committee, until Russia was ejected due to the annexation of Crimea. Now, the G7 consists of Canada, France, the United States, Italy, Japan, and the United Kingdom, as well as the European Union. All those leading economies are associates of the Group of Twenty alongside 12 emerging countries.

The following topics will expose more about what the committee's structure is like, showing how the system inside of it works with the participants, as well as what its function in the world is, and what it aims to achieve.

2.1 Structure

The presidency of the G20 rotates annually and there are not any permanent members on the secretariat. That happens because of its nature, an informal political forum. Therefore, each year a different president is responsible for bringing an agenda, with the consultation of all the other countries, ensuring that the system works in an inclusive way for everyone. The

¹INVESTOPEDIA. **Group Of Twenty - G-20**. Available at: <<https://www.investopedia.com/terms/g/g-20.asp>>. Access: 29 Mar. 2018.

president is also supported directly by the called “Troika”, which consists in the past and next hosts. This ensures more consistency and continuity for the agendas².

Apart from the 19 countries and the European Union, the Group of 20 often invites a few leading international organizations every year to participate in the reunion and bring their contributions. Some examples are the United Nations (UN), the World Bank and the International Monetary Fund (IMF). That brings the discussions to an even more global level, making the agenda’s impact broader.

Beyond that, the forum has a set of engagement groups: civil society organizations, from the 19 participant nations, which represent different sectors of society. The purpose behind this is that the G20 seeks to draw perspectives and expertise beyond its member governments. That would enrich their agendas, solving the challenges faced by the committee, more appropriately and effectively. Each engagement group is chaired by one of its national members, who send recommendations formally to the G20 ahead of the summit. The groups are as follows: Business, Civil Society, Labour, Science, Think Tanks, Women and Youth³.

2.2 Main goals

The Group of Twenty is a forum that concentrates the world’s leading and emergent economies. All those countries face challenges, either internally or internationally, and it is easier to solve them, alongside other nations that face the same problems or that have the power to help. The G20 gathers once a year, in order to reform international financial institutions, improve financial regulation and implement the reforms needed in each country’s economy. By doing that, the G20 finds ways to strengthen the global economy.

During the past decade, this committee had a key role on the world’s recovery from the last economic crisis from 2008. Even though the demands during the period were more urgent and pressing than today’s demands, the current ones are not less relevant. The ongoing focus, after the recovery, is the growth, so that the economy can keep evolving constantly. But not only that, the goal is to help society as a whole, promoting dialogue about global affairs,

²G20 TURKEY. **G20 Members - G20**. Available at: <<http://g20.org.tr/about-g20/g20-members/>>. Access: 29 Mar. 2018.

³G20. **How does the G20 work?**. Available at: <<https://g20.org/en/g20/how-it-works/>>. Access: 29 Mar. 2018.

addressing a variety of issues and building consensus to develop global policies that help humanity face all the challenges⁴.

3 HISTORY

The contemporary society's technological resources were only made possible after centuries of development. Since early human communities, gadgets are made with the available supplies in the moment, with the purpose of making life easier and better for people. Throughout the years, there has been so many advances in those resources that the current population does not see itself without them. However, in order to explain how mankind got to this point, it is necessary to go through three times where there were major improvements in technology in a short amount of time, in a way that changed humanity's course.

3.1. The First Industrial Revolution

Some say that the first Industrial Revolution was the time when mankind developed the most since the Neolithic. Indeed, this period (the second half of the XVIII century) represented a drastic change in the ways society worked. It came right after the era of great navigations, and the countries had been working in the feudal system for a few centuries. The vast majority of the population lived and worked in farms and basically the only people who held the wealth were the nobles.

The revolution found its start in England, after going through another revolution in 1688, where the supremacy of the Parliament was established⁵. Amongst the factors that made the first industrial revolution possible was the ascension of the bourgeoisie, which happened by reason of the creation of the liberal English state. The rural population started migrating to the cities as a result of the advances in technologies that made agricultural activity more efficient, consequently decreasing the need of labor in that sector. Moreover, the number of urban areas in the country increased. Many people started working in manufactories, instead of in farms. That caused an increase in people's demands and commercial activities started to rise⁶.

⁴G20 TURKEY. **About G20 - G20**. Available at: <<http://g20.org.tr/about-g20/>>. Access: 29 Mar. 2018.

⁵BBC. **British History in depth: The Glorious Revolution**. Available at: <http://www.bbc.co.uk/history/british/civil_war_revolution/glorious_revolution_01.shtml>.Access:30 Mar. 2018.

⁶ENCYCLOPEDIA BRITANNICA. **Industrial Revolution: Definition, Facts, & Summary**. Available at: <<https://www.britannica.com/event/Industrial-Revolution>>.Access:30 Mar. 2018.

During that time, a lot of factories ascended, in which the aristocrats employed the working class that had moved to the cities from the fields. The cheap labor caused the factory owners to profit. In behalf of the increase in demands mentioned above, they had to find a way to enhance productivity.

That's where the technological development comes in, once again. People started using steam to create energy, and coal to generate heat, which made it easier and cheaper to operate the machines. Besides, these means of production were expanded, increasing productivity, as well as decreasing the labor demanded, so the factory owners were spending a lot less money to make their products. Consequently, the products were being sold at a cheaper price, and more people were buying them, making the owners profit more.

The steam utilization also enabled new forms of transportation to be created. It actually changed the scenery of the country: a lot of railroads and canals were built around for the locomotives and the boats which used steam as a cheap source of energy. It became even more accessible for the selling of products⁷.

This cycle of productivity and profit repeated itself with many industries in Britain, also, the commerce started taking new directions, this time towards the international market. A lot of the products produced in England had to be supplied because there were many of them. Then, the advances in technology made it simpler to travel and trade, thus, the products began being exported. Importations also increased, specially of the materials needed for the textile industry that was being promptly developed. In addition to that, India was the largest producer of cotton, hence, they had a good trading relationship with the United Kingdom⁸.

This movement began in England, but it did not take long to influence the rest of the world. With English experts traveling to spread the word of Industrial Revolution, as well as steam engines being exported, many other countries, such as the United States and the ones in western Europe, started revolutionizing their own economies and societies. However, in most of them, differently the pioneer nation, the government took a larger part in those changes⁹.

⁷MONTAGNA, Joseph. **The Industrial Revolution**. Available at: <<http://teachersinstitute.yale.edu/curriculum/units/1981/2/81.02.06.x.html>>. Access:30 Mar. 2018.

⁸OXBRIDGE NOTES. **Growth Of Overseas Trade During The Industrial Revolution**. Available at: <https://www.oxbridgenotes.co.uk/revision_notes/economics-university-of-cambridge-british-economic-history/samples/growth-of-overseas-trade-during-the-industrial-revolution>. Access:30 Mar. 2018.

⁹ONLINE ESSAYS. **Industrial Revolution in Different Countries**. Available at: <<http://onlineessays.com/essays/history/his127.php>>. Access:30 Mar. 2018.

It is important to take note that the even though part of the society was become much richer than ever before, the other part did not have the same success. Because of the population growth in the cities, labor was very easy for the bourgeoisie to get. Thus, the people who did not own factories or land had to fight for jobs, or they would be unemployed and therefore excluded from society. The owners did not have to make an effort to give the employees good work conditions because they needed the job and felt lucky to even have one. They did not get paid much and had to work many hours a day. Women and children worked too and were often paid even less than men.

Since the work consisted in operating machines, and because of the high number of people who wanted to get jobs, the work became a lot more specialized. While, before the revolution, artisans had the know-how¹⁰ regarding the production of goods, now the employee usually had to make only a few movements repetitively for hours. That and the poor hygiene conditions in the factories made the life expectation decrease. Besides, a lot of people also worked in mines to collect coal, which was even more hazardous.

In short, the capitalist system introduced led to social inequality. While the aristocrats became richer and their quality of life increased, the proletariat became only poorer. Because of the constant abuse that part of the population suffered, they began organizing themselves in trade unions, which would lead to protests and fighting for their rights as the working class. Even though they did achieve some important goals, society continues on with the same economic system until this day¹¹.

3.2 The Second Industrial Revolution

*The period 1859-1873 has been characterized as one of the most fruitful and dense in innovations in history*¹². Also known as the age of technology innovation, the Second Industrial Revolution was period of great technological improvement, particularly in the fields of agriculture, manufacturing, chemicals, transportation, communication and electricity. Hence, that modernization lead to groundbreaking advancements in the industry, such as the increase of productivity and enhancement of the production quality.

¹⁰*Know-how*: it means the practical knowledge and ability to do something.

¹¹VICENTINO, Claudio; DORIGO, Gianpaolo. **História geral e do Brasil**. 1st ed. São Paulo: Scipione, 2013. pp. 396 – 400.

¹²Mowery and Rosenberg, 1989, p. 22

One of the most defining aspects of the Second Industrial Revolution was the change of nature between the relation of organization and production. That is, most definitely, a consequence of the rise of science¹³– inventions like Steel Mills, Refrigerator, Electric Light, Typewriter, Radio, Skyscrapers, Automobile, Telephone, Diesel Engine and the Airplane made it possible for the industry ascent in a way never witnessed before, wherefore, impacting the social-economic system as a whole. In the words of Joel Mokyr¹⁴, “*The second Industrial Revolution turned the large technological system from an exception to a commonplace.*”

“*The consequence of changing production technology was the rise of technological systems*”¹⁵. In other words, those innovations (along with the ones resulting from the First Industrial Revolution) were the very first sparks that ignited the creation of all the great technological resources that we have in hand nowadays. The refurbishment of the systems – mostly chemical industry, oil refining, energy generation and methods of transportation – allied with the scientific background, truly recreated and defied the social and technological paradigms of the post-modern times.

Amongst the many novelties brought by the Second Industrial Revolution, it is worth stressing the followings. Firstly, the immense growth of the steel industry in this period was due to one the scientific invents of the period: the Bessemer Converter¹⁶, which enabled the mass-production of steel - one of the most important prime-base materials for construction of bridges, railroads, skyscrapers, large ships, guns, tanks and much more. Consequently, decreasing the cost of its production and the labor requirements; furthermore, increasing the scale and speed of manufacturing. In summary, all these products had its production boosted and its cost ebbed down.

The popularization of the steel production allowed many more sectors to develop consecutively. The transportation sector, for instance, experienced a sudden replacement of iron to steel as the standard material for railway rail and the construction of ships. Regarding train’s machinery, besides being cheaper, steel was also a more resilient material, thus enabling the

¹³ Vaclav Smill called the period 1867-1914 “The Age of Synergy”, which differed from the First Industrial Revolution, once that the inventions were science-based.

¹⁴MOKYR, Joel. **The Intellectual Origins of Modern Economic Growth** Available at: http://e-tcs.org/wp-content/uploads/2012/10/mokyr-the_intellectual_origins_of_modern_economic_growth.pdf Accessed on: March 30th, 2018.

¹⁵(Hughes, 1983, 1987)

¹⁶ BUDAPESTI MUSZAKI ES GAZDASÁGDTUDOMÁNYI EGYETEM, **Iron and steel making** Available at: www.att.bme.hu/en/education/.../Lectures/03_Iron%20and%20Steel%20Making.pdf Accessed on: March 15th, 2018.

carriage of greater amounts of load for more significant distances. Concerning the ships, being steel a lighter material, it set up the possibility of building larger vessels, as well as transporting heavier shipments.

*“In 1825, British inventor William Sturgeon introduced an invention that laid the foundation for a larger scale revolution in electronic communications: the electromagnet.”*¹⁷ Finally, it is indispensable to reinforce the outstanding relevance of the use of electricity in the Second Industrial Revolution: its first effective application in communication.

All of these advancements are considered to be the first steps towards the current era of globalization, since these were the primal efforts to the ongoing state of instant connection and communication of people around the globe. According to Hülya Kesici Çalõúkan¹⁸, *“it created a new economy characterized by faster growth in productivity, measured by output per hour”*.

3.3 The Third Industrial Revolution

*“Threats create society, and global threats create global society”*¹⁹. It is well known that humanity is now facing a unique period in its timeline, in which society has developed a myriad of different ways of connecting with others; the diffusion of information is instantaneous and, with the improvement the old methods of transportation (along with the creation of new ones), it seems as if time and space are now distortable elements. However, these current times brought to life new challenges and threats.

According to reports from the International Energy Agency (IEA)²⁰, it is expected that, if the ongoing energy policies do not change, energy prices will increase drastically over the next years. Besides that, pursuant to studies provided by the Food and Agriculture Organization of the United Nations (FAO)²¹, *“Global food prices have been rising, threatening to reach record*

¹⁷ THOUGHTCO. The History of the Electric Telegraph and Telegraphy Available at: <https://www.thoughtco.com/the-history-of-the-electric-telegraph-and-telegraphy-1992542> Accessed on: March 10th, 2018.

¹⁸ ÇALÕÚKAN, HülyaKesici, **Technological Change and Economic Growth** Available at: https://ac.els-cdn.com/S1877042815036538/1-s2.0-S1877042815036538-main.pdf?_tid=2c022fb3-49cd-44e2-aafb-9b3307b8fa4a&acdnat=1522423258_5ca0fd271f2475d3e69080ec10d1815b Accessed on: March 30th, 2018

¹⁹ BECK, Ulrich **What is Globalization?**Cambridge: Polity 2000.

²⁰WORLDWIDE WATCH INSTITUTE **Energy Agency Predicts High Prices in Future**Available at: <http://www.worldwatch.org/node/5936>Accessed on: March 31st, 2018.

²¹FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS**“Global Food Price Monitor”**Available at: <http://www.fao.org/giews/food-prices/home/en/> Accessed on: March 31st, 2018.

levels in the coming months if current trends continue”²². Finally, it is primordial to reinforce the fact that the levels of unemployment over the past years is rapidly increasing, as shown by researches²³ from the World Bank.

It is clear that, if the present system continues, humankind will suffer from a tremendous crisis, in multiple sectors. Not only that, but the perspective of a collapse of economy and the impossibility of a sustaining *way of living*, are no longer just a distant hypothesis, but a horrifying reality. In that matter, it is worthy stressing the words of Jeremy Rifkin²⁴

“We are in the early stages of a convergence of Internet communication technology with a new form of energy that is by nature distributed and has to be managed collaboratively and scales laterally. We’re making a great transition to distributed renewable energy sources. And we distinguish those from the elite energies—coal, oil, gas, tar sands—that are only found in a few places and require significant military and geopolitical investments and massive finance capital, and that have to scale top down because they are so expensive. Those energies are clearly sunseting as we enter the long endgame of the Second Industrial Revolution”.

Therefore, the Third Industrial Revolution is understood as a growing phenomenon, and a conjoined effort to preserve and maintain the sustainability of life in society, where internet technology and renewable ways of energy come together and create new possibilities for the generations to come. Furthermore, the Third Industrial Revolution is also characterized by democratization of production, sustained by affordable manufacturing tools and its connection to the internet. As noted by Troxler²⁵, that implies two major consequences:

“First, affordable tools do not require huge capital investments, they bridge the labour capital-divide; the owner-maker is re-emerging. Second, digital tools connect designing and manufacturing, they bridge

²² POPULATION REFERENCE BUREAU **Rising Global Food Prices Threaten to Increase Poverty** Available: at <https://www.prb.org/rising-global-food-prices/> Accessed on: March 31st, 2018.

²³ THE WORLD BANK **Unemployment, total (% of total labor force) (modeled ILO estimate)** Available at: <https://data.worldbank.org/indicator/sl.uem.totl.zs> Accessed on: March 31st, 2018.

²⁴ RIFKIN, Jeremy, **The third industrial revolution: How lateral power is transforming energy, the economy, and the world**. New York: Palgrave Macmillan. 2011

²⁵ TROXLER P. **Making the 3rd industrial revolution**. In: Walter-Herrmann J, Büching C (ed) *FabLabs: Of machines, makers and inventors*, Transcript Publishers, Bielefeld 2013.

the white-collar-blue-collar-divide; the designer-producer is having a comeback”

Finally, in the words of Anderson²⁶, the “*Third Industrial Revolution is best seen as the combination of digital manufacturing and personal manufacturing”*

4 A COMPENDIUM ON TECHNOLOGICAL RESOURCES

It is correct to affirm that the technology has been developed at an unthinkable pace. The internet, for example, that had - not a long time ago - scandalized much of the population for its miraculous tools, is no longer shocking. Here is a fact: what we know as technology is changing every second and assuming different holes in our lives.

Therefore, in order to understand technological resources, it is elementary to comprehend what the technology consists of; how it has been developed over the time and, finally, how technology presents itself today and what is expected of the coming days, noting the increasing evolution of robotics and artificial intelligence.

4.1 A definition about Technology

First, it is impossible to pursue academic research without standardizing some concepts. In this case, we cannot pretend to understand, for example, the history of technology if we do not know, for sure, what technology signifies. Finding a concept of technology is crucial to get a clear understanding of its nature and examining how it can influence our lives²⁷.

Anyway, the dynamic of the technology has contributed to the existence of various definitions and concepts of technology, which lead us to a previous conclusion: defining the concept of technology is not an easy task²⁸.

Technology can be seen as two primary components: i) a physical component which comprises of items such as products, tooling, equipment, blueprints, techniques, and processes;

²⁶ANDERSON, C. in WIRED MAGAZINE **In the next industrial revolution, Atoms are the new bits**. Available at: http://www.wired.com/2010/01/ff_newrevolution/all/1 Accessed on: March 31st.

²⁷WAHAB, Sazali Abdul; ROSE, RaduanChe; OSMAN, SuzanaIdayuWati. **Defining the Concepts of Technology and Technology Transfer: A Literature Analysis**. International Business Research Vol. 5, No. 1; January 2012. Available in:<http://dx.doi.org/10.5539/ibr.v5n1p61>. Access: 29 Mar. 2018.

²⁸Reddy, N. M., & Zhao, L. (1990). *apud*. WAHAB, ROSE and OSMAN, *op. cit.*, 2012.

and ii) the informational component, which consists of *know-how* in management, marketing, production, quality control, reliability, skilled labor and functional areas²⁹. Thus, technology is not necessarily physical, made by devices, and neither only knowledge, but, by this optic, it is intrinsically associated to the production and economics.

Nevertheless, part of the scholars sees technology indifferent manners. Research has already indicated technology as a “cultural system”, concerned with the relationships between humans and their environment³⁰ and also that “*technology connotes the practical arts, bodies of skills, knowledge and procedures for making, using, and doing useful things*”³¹.

Despite the disagreements about what would be technology, the concept that best suits this research and which will be used from now on considers technology as “*the development and application of tools, machines, materials and processes that help in solving human problems*”³².

Henceforward, technology can be cultural, can be a physical element, can be knowledge, procedures or even art, but what is really important is that it helps to solve human problems – or it was designated to help, even if it ultimately could not.

4.2. The evolution of technology

The history of technology precedes the humanity itself. It can be said that some hominids, older than *Homo sapiens*, were the first to use tools. The first of the hominids date back as far as fourteen million years and closely related to the great ages. Therefore, the first tools date from 10 million years before present, in the period after named as “dawn stone age”, but it appears to have taken eleven or twelve million years for the tool-making habit to emerge³³.

The technology changed when the humans discovered for the first time how to make fire, ability that distinguished humans (or, being more specific, the *Homo Erectus*) from the rest of other species. This ability is seen as one of the first major advances in the early history of technology. It is important to point that this activity dates from about 600,000 BC. The uses for

²⁹ KUMAR, V., KUMAR, U., & PERSAUD, A. **Building Technological Capability through Importing Technology**: The Case of Indonesian Manufacturing Industry. *Journal of Technology Transfer*, 81-96, 1999. Available in <http://dx.doi.org/10.1023/A:1007728921126>. Access: 29 Mar. 2018.

³⁰ Tepstra and David (1985) *apud* WAHAB, ROSE and OSMAN, *op. cit.*, 2012.

³¹ Merrill (1968) *apud* WAHAB, ROSE and OSMAN, *op. cit.*, 2012.

³² REISMAN, A. *Transfer of Technologies: A Cross-disciplinary Taxonomy*. *The International Journal of Management Science*, 2006.

³³ McNEIL, Ian. *An encyclopedia of the history of technology*. 1st edition. London: Routledge, 1990. P. 5.

the fire were many, such as warmth, cooking, curing of hides, protection in scaring off wild animals and illumination for the social life of the tribe after darkness had fallen³⁴.

Once the fire was tamed by the humans, it became possible to improve the tools used, passing from a sort of technology that consisted in tools built from the stone, to the development of the blade technology, in the Paleolithic, or old stone age, approximately 35,000 years ago³⁵.

Some years later, mankind stop being a group of nomadic hunters to settled agricultural villagers. This change, started about 10,000 years B.C., only was feasible because of this mentioned technology: the agriculture, whose creation is linked to an accidental cross-fertilization of some wheat seeds, possibly the first plant to besown as a crop³⁶. With agriculture, the humanity could remain on common ground, without having to worry about large displacements for hunting.

The following most relevant technology was the wheel, in 3,500 B.C. in Mesopotamia. It was, in general terms, a simple mechanism, made of a round flat stone with a hole in the center to act as a flywheel when spinning³⁷. The wheels allowed to build vehicles, which were used, initially, for ritualistic and ceremonial purposes and, surely, to transport goods³⁸. The invention of the wheel is probably the most important invention of all time. This technology started being used as gears during the middle age and it was equally relevant for the industrial revolution, since it allowed the invention of mechanical devices³⁹.

Down the line, in Egypt, some basics machines were already employed. It is the case of the lever, the wheel and axle and the wedge, which were in common use about 3,000 B.C. In effect, the *shaduf* used for irrigation and the balance beam for weighing were applications of the lever. As a building people, drill bits, chisels, rasps, door hinges, edging for ploughshares, bearings, spindles, hoes and building utensils were simple technologies already applied by the Egyptians⁴⁰.

³⁴ McNeil, *op. Cit.*, 1990, p. 6 – 7.

³⁵ McNeil, *op. Cit.*, 1990, p. 9-11.

³⁶ McNeil, *op. Cit.*, 1990, p. 11.

³⁷ McNeil, *op. Cit.*, 1990, p. 16.

³⁸ BASALLA, George. *The Evolution of Technology*. Cambridge: Cambridge Univertisty Press, 1988. (Cambridge History of Sciences Series). Available in <[https://books.google.com.br/books?id=EBtnG36-1WIC&lpg=PA1&ots=nJwEWYef1c&dq=the evolution of technology&lr&hl=pt-BR&pg=PP5#v=onepage&q&f=true](https://books.google.com.br/books?id=EBtnG36-1WIC&lpg=PA1&ots=nJwEWYef1c&dq=the+evolution+of+technology&lr&hl=pt-BR&pg=PP5#v=onepage&q&f=true)>. Accessed in 24 Mar. 2018, p. 9.

³⁹ Slaughter, J. *History: Invention of the Wheel*. Ministry OfSciency And Technology Of Nigieria, 2014. Available at <http://www.notap.gov.ng/content/history-invention-wheel>.

⁴⁰ McNeil, *op. Cit.*, 1990, p. 16.

Furthermore, in Ancient Greece, the Greeks invented the horizontal waterwheel, a kind of predecessor of the turbine, which was the first form of power of non-animal origin. This work was improved in Rome, with the first machine in which gears were used to transmit power. Anyway, as the Greeks and Romans were people who used slave labor, there was no great concern with mechanization in order to save labor, and so these inventions were of little expressiveness to the epoch⁴¹.

Basically, during this same period, in the other side of the world, the Chinese were also developing new technologies and making some remarkable advances. According to McNeil, “*they had cast iron as early as 350 BC, some thirteen centuries before it was known in the West; they developed the double-acting box bellows; steel was produced in the second century BC; they invented papermaking about AD 100*”⁴².

There are not many records about the evolutions with technological resources during the Middle Age, although it is known that this era was the scene of great small evolutions, just like the crank and the print, which allowed us to rediscover technology from then on⁴³.

The third age provided some great advents, indispensable for the contemporary world. One of them was the clock; with it, the timekeeping methods – which were all based in natural events before – were revolutionized⁴⁴. Also, it was in this period that the optic developed, invented, almost at random, in 1608⁴⁵.

Down in the timeline, the Factory System, by the time of the 18th century, guided the production of new technologies. The factories, just like the textile industry, used to employ the force of some machines, all operated by a steam engine or, at least, a water wheel, with the human labor, of course⁴⁶. Without slavery⁴⁷, employers had the motivation to invest in labor-saving technologies, since they would save money.

⁴¹In McNeil (*op. Cit.*, 1990, p. 18-19) words : “*However, the Romans were well supplied with slaves and hence not encouraged to invest in labour-saving mechanization. Watermills did not increase greatly in number until the fourth and fifth centuries AD, towards the end of the era of the Roman Empire*”.

⁴²McNeil, *op. Cit.*, 1990, p. 25-27.

⁴³McNeil, *op. Cit.*, 1990, p. 18-19.

⁴⁴McNeil, *op. Cit.*, 1990, p. 22-24.

⁴⁵ “*Two children playing in this unlikely environment put two lenses in line, one before the other, and found the weathervane on the distant church tower miraculously magnified*” McNeil, *op. Cit.*, 1990, p. 25.

⁴⁶McNeil, *op. Cit.*, 1990, p. 28-29.

⁴⁷From the point of view of work, some critics point out that, despite the work was salaried, the conditions of this work were absolutely precarious and the salary was extremely low, which ended up assimilating wage labor to slavery. About this subject, it is recommended the film Daens (1992), directed by StijnConinx, that portrays the labor relations at the time.

Therefore, as shown, technology has been created and developed in different manners and in various fields throughout history, which contributed to the technological resources to reach their current state.

4.3 New Technologies and its impacts

As stated in the introduction of this chapter, the technology has been developed at an increasingly difficult speed to follow. Softwares, robot and new devices come up every day, within various other resources that can be exploited by the human being.

Therefore, in this topic, we will discuss, briefly, about some of these new forms of technologies that have emerged, addressing what to expect and how they might be useful to the human being.

4.3.1 Artificial Intelligence

Firstly, the term “artificial intelligence” (AI) was first used in 1956 by John McCarthy, at the first academic conference on the subject, besides it did not start the journey to understand if machines can truly think, which began a lot before⁴⁸.

After this conference, from 1957 to 1974, the AI expanded. People realized that machines, like computers, could stock more information, become faster, economical, and, obviously, more accessible. All these things as result of some algorithms that taught machines how to learn by themselves⁴⁹.

However, today, the AI is a term used to define “*the study of the computations that make it possible to perceive, reason, and act*”⁵⁰. It can be viewed, *prima facie*, as having two parts: i) a part engineering, which is geared towards solving real world problems; ii) a part science, which is focused in explaining various sorts of intelligence⁵¹.

⁴⁸ MCGUIRE, Brian et al. **The History of Artificial Intelligence**: The turing test. Washington: University Of Washington, 2006. Available in <<https://courses.cs.washington.edu/courses/csep590/06au/projects/history-ai.pdf>>. Access: 31 Mar. 2018.

⁴⁹ ANYOHA, Rockwell. **The History of Artificial Intelligence**. 2017. Harvard University. Disponível em: <<http://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/>>. Access: 31 Mar. 2018.

⁵⁰ WINSTON, Patrick Henry. **Artificial Intelligence**. 3. ed. Massachusetts: Addison-wesley Publishing Company, 1993, p. 5. Available in: <<https://courses.csail.mit.edu/6.034f/ai3/rest.pdf>>. Access: march 31 2018.

⁵¹ WINSTON, *Op. Cit.*, 1993, p. 6.

Furthermore, accordingly the words of the professor Patrick Henry Winston, from the Massachusetts Institute of Technology (MIT), artificial intelligence should not to be confused with psychology or computing:

*From the perspective of this definition [the one in the previous paragraph], artificial intelligence differs from most of **psychology** because of the greater emphasis on computation, and artificial intelligence differs from most of **computer science** because of the emphasis on perception, reasoning, and action.*

Henceforward, it is important to consign that, in general, applications on AI should have a well-defined task, an implemented program and a set of principles, which characters can be judged. Also, they can be of use in helping to solve difficult real-world problems, being a potential generator of new opportunities. It can, in addition, help the science to improve some mankind's qualities, getting us to a better level.⁵²

In addition, nowadays it is possible to say that Artificial Intelligence is everywhere. It is present in our computers, cell-phones, smart watches and series of others devices. Living in the age of "big data" and knowing that a person is not enough to handle the huge sums of information, the AI became our alie. Due to this context, the AI has already been fruitful in several industries such as technology, banking, marketing, and entertainment, in which it can perform some functions with greater excellence than a human being⁵³.

Hereafter, the employ of AI tends to increase even more. *"In the immediate future, AI language is looking like the next big thing. In fact, it's already underway."*⁵⁴ Shortly, we can imagine some simple (or not so simples) activities, like driving and translations, being made by software. In a longer term, it is admissible that the AI will surpass human cognitive abilities in all tasks⁵⁵.

4.3.2 Robotics

In the first place, the word "robot" came from Czech, meaning, in the original language, worker or servant, and it was coined in 1920 by a Czech novelist Karel Capek⁵⁶.

⁵²WINSTON, *Op. Cit.*, 1993, p. 14.

⁵³ ANYOHA, *Op. Cit.*, 2017.

⁵⁴ ANYOHA, *Op. Cit.*, 2017.

⁵⁵ ANYOHA, *Op. Cit.*, 2017.

⁵⁶KAPILA, Vikram. Introduction to Robotics. University of New York (NYU). Available in: <<http://engineering.nyu.edu/mechatronics/smart/pdf/Intro2Robotics.pdf>>. Access: 01 Apr. 2018.

Additionally, today, a robot is, according to Robot Institute of America, “a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks”⁵⁷.

When it comes to robotics, it is elementary to point that, even considering the great advances in this area (which includes the development of robots capable of babysitting, washing, cleaning and others activities), this science still needs to face a lot of barriers. Simple activities for humans, such as walking and balancing, are still not as simple for robots. It is necessary to congregate various software cameras and others applications to allow the machine to know how equilibrate its weight and do not fall when trying to move⁵⁸.

However, there are already robots capable of having conversations with humans, even expressing some “feelings” by facial expressions. Behind them, there are always plenty of software working to discriminate and comprehend what the human said so they are able to find an adequate question. As notable cases, one can mention a robot called Sophia, who had even a citizenship recognized in Saudi Arabia⁵⁹, and the robot Philip Dick, which looks like the deceased actor⁶⁰.

In this regard, it is necessary to recognize that robotics is an area that has greatly advanced and excelled, even though the enormous challenges that prevent it from building machines as resourceful as the mankind.

5 THE ISSUES OF UNEMPLOYMENT: AN ANALYSIS OF THE CURRENT GLOBAL SITUATIONS

Aiming to, at least, minimally understand this section, it will be divided in three parts: firstly, analyzing the global unemployment and its factors today, passing to an economic

⁵⁷KAPILA, *Op. Cit.*

⁵⁸YOUTUBE. **Artificial Intelligence And Robotics The Future Is Now Documentary 2016 HD**. Available in: <https://www.youtube.com/watch?v=t6iJrNE7nwQ>. Access: 01 Apr. 2018.

⁵⁹STONE, Zara. **Everything You Need To Know About Sophia, The World's First Robot Citizen**. 2017. Forbes. Available in <<https://www.forbes.com/sites/zarastone/2017/11/07/everything-you-need-to-know-about-sophia-the-worlds-first-robot-citizen/#7915670d46fa>>. Access Apr 01 2018.

⁶⁰HANSON ROBOTICS. **Philip K. Dick**. Available in: <<http://www.hansonrobotics.com/robot/philip-k-dick/>>. Access Apr 01 2018.

overview of the AI introduction in the labor market and, finally, picturing (un) employment scenarios to the foreseeable future.

5.1 Unemployment in the current World Economy

According to the International Labor Organization, the number of unemployed individuals reached the mark of 200 million people in 2017⁶¹. To the current year, the aforementioned organization previews that another 2.7 million shall be unemployed by December⁶². Amongst the main factors to this outcome, the growing of workforce at a faster pace than jobs creation seems to be the leading cause to joblessness.

The unemployment phenomena cannot be reduced to a single category, once different causes compose the issue. On the word of Kimberly Amadeo⁶³, there are seven causes of unemployment. Four out of seven would cause the so called frictional unemployment. This type of unemployment is when employees decide to leave their jobs to find a better one. Moreover, two causes comprise the structural unemployment. This category is quintessential to the analysis as it fits to the AI impact, when workers' skills or income requirements no longer match the jobs available. The seventh cause is related to cyclical unemployment.

5.1.1 Frictional Unemployment

Unemployment can be a result of a voluntary decision. A fraction of the jobless find themselves in that position because they saved enough money, so they can quit unfulfilling jobs. They opted for the “luxury” to search until they find a fulfilling opportunity⁶⁴.

A second cause might be explained by the movement of people for unrelated reasons. This group concerns the ones that quitted their jobs due a necessity of displacement to another city⁶⁵.

The entrance of new workforce in the market can be considered as a third reason to unemployment; namely, recently graduated students. They look for a job that fits their new skills and qualifications, conjuring a reason for youth unemployment. The fourth reason is when job seekers re-enter the workforce. People sometimes go through a period in their lives when

⁶¹INTERNATIONAL LABOR ORGANIZATION. 2017. **World Employment Social Outlook**.

⁶² Ibid.

⁶³AMADEO, Kimberly. 2017. **Seven Causes of Unemployment**. The Balance.

⁶⁴CARRÈRE, Céline. 2015. **”Trade and Frictional Unemployment in the Global Economy”**. Université de Genève.

⁶⁵ Ibid.

they stop looking for work or even working. This cause can be motivated by several reasons, such as stop working to raise children, looking for elderly relatives and so on. These are common situations in the dynamics of workforce and equally in the job searching process⁶⁶.

5.1.2 Structural Unemployment

Differing of the frictional unemployment, this category is not considered voluntary nor short-term. The structural causes to joblessness usually steer to long-term unemployment. Historically, the motivations here within are related to advances in technology. In other words, it is the case when computers or robots replace workers. As an outcome, most of these workers need more training before they can get a new job in their field. The structural changes associated to AI will be discussed later on.

A sixth possible cause is the job outsourcing. When a company moves its manufacturing, logistics or call centers to another location, workers in the former country are dismissed. Labor costs can be much cheaper in different territories where there is a lower cost of living and broader tax/labor legislations. As an example to be set, a similar event took place after NAFTA was signed in 1994, when various manufacturing jobs from all over the world moved to Mexico.

5.1.3 Cyclical Unemployment

Imagine a scenario where there are fewer jobs than applicants. It was technically named as demand-deficient unemployment. Furthermore, when this event happens during a recession phase of certain business cycle, it becomes a cyclical unemployment. As already witnessed, low consumer demand can originate a cyclical unemployment. It is expected that companies decrease significantly their profits when demand falls. Additionally, if they do not foresee sales to increase anytime soon, dismissals will most likely happen.

The reason of being cyclical lies on the fact that the higher is unemployment rate, the higher will be the consumer demand to drop, leading to a system where demand-drop causes unemployment and this very same unemployment causes more demand-drop. It definitely outcomes in large-scale unemployment. Well known cases comprise the Great Depression of 1929 and the financial crisis of 2008.

⁶⁶ Ibid.

5.2 Introduction of Artificial Intelligence in the Labor Market

Due the recent arrival of feasible AI offers in the market, academics still struggle to find a consensus on which level of automation – and consequently the level of unemployment considering the human role in work – Artificial Intelligence will bring to the workplace. The bigger could be the automation, the smaller would be the human role and the job vacancies for the *homo sapiens sapiens*.

On the one hand, some consider that progress in AI are not the ultimate wave in the long course of automation⁶⁷. On the other hand, another stream defends that AI diverges from past innovations: as artificial intelligence becomes each day nearer to human general intelligence, much of humanoid labor could become obsolete and be replaced by AI in all spheres. With such perspective, AI development would not be an extension but the apex of technological evolvment – it could drive history to a point that is strikingly different from the implications of previous movements of innovation and might represent the term coined by James Barrat⁶⁸, defined as “Our Final Invention.”

Even disregarding the longstanding impacts that this kind of tech can enact, undoubtedly it has the aptitude to unsettle labor markets in a significant way, affecting laborers throughout many professions and skill levels yet in the short and medium runs. The scale of these unsettlements will hinge on two important considerations: the velocity and the factor bias of progress in AI⁶⁹.

For instance, Frey and Osborne⁷⁰ advise that forty-seven per cent of jobs in the United States economy are at risk of being replaced by advances in AI-related fields. Amongst the areas in which human intelligence has recently become inferior to artificial intelligence comprise several applications of trading in financial markets, radiology, paralegal work, driving and others.

⁶⁷ GORDON, Robert. 2016. **The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War**. Princeton, NJ: Princeton University Press.

⁶⁸ BARRAT, James. 2013. **Our Final Invention: Artificial Intelligence and the End of the Human Era**. New York: St. Martin’s Press.

⁶⁹ United Nations Department of Economic and Social Affairs. 2015. **“United Nations World Population Prospects: 2015 Revision.”**

⁷⁰ FREY, CARL BENEDIKT, AND MICHAEL A. OSBORNE. 2017. **“The future of employment: How susceptible are jobs to computerization?”** *Technological Forecasting and Social Change* 114: 254-280

Likewise, the interest in this kind of technology has risen expressively: Google Trends shows that search interest in the topic “artificial intelligence” has quadrupled in four years⁷¹.

Considering velocity, productivity has improved rather slowly, yet the world seems to be seized by AI eagerness. In case AI innovations are introduced in the economy at the similar slow pace as shown by latest productivity statistics, then the transition will be slower than the wave of mechanization during the 20 years between the 1950s and 1970s; giving the idea that disruptions may not be very significant. Nevertheless, three possible outcomes shall be regarded: a) some suggest that productivity is not yet well measured, because quality improvements couldn't be, at this point, accurately captured. In addition, there are equally unmeasured deteriorations in productivity, such as declines in service quality as customer service is increasingly automated⁷².

Point ‘b’, the total implications of AI improvements might obey a delayed pattern, likely to what happened after the presentation of computers in the 1980s. A famous quote by Robert Solow pointed out in the late 80s “you can see the computer age everywhere but in the productivity statistics.”⁷³ Just after the 1990s that a noteworthy rise in aggregate productivity could be identified, due a sustained investment in computers and a reorganization of business practices. Finally, point ‘c’: unquestionably, a discontinuity in productivity growth might take place, as defended by the supporters of a technological singularity⁷⁴.

On the factor bias, the unsettlements caused by AI innovations hinge on whether they are labor-augmenting or labor-saving⁷⁵. A question shall be answered: at a certain wage, the innovations would lead to more or less demand for labor? One might say that AI will mainly help humans in being more productive and look to such developments as intelligence assisting innovation, “IA (intelligence assisting, rather than AI)”⁷⁶. Even though we acquiesce that most AI innovations seem to be supplementary to certain jobs (work related to applying AI to problem-solving) it is also true that taking a larger standpoint, improvement in AI steers more towards replacing human labor.

⁷¹ <https://trends.google.com/trends/explore?q=%2Fm%2F0mkz>

⁷² Kurzweil, 2005.

⁷³ SOLOW, Robert. 1980. “A contribution to the Theory of Economic Growth”. The quarterly journal of economics.

⁷⁴ Ibid. Kurzweil, 2005.

⁷⁵ HICKS, John 1932. **The Theory of Wages**. London: Macmillan.

⁷⁶ STIGLITZ, Joseph E., and GREENWALD 2015. **Creating a Learning Society: A New Approach to Growth, Development, and Social Progress**, with Bruce C. Greenwald, New York: Columbia University Press.

5.3 Possible Outcomes

Presently, AI is at a point where it strictly surpasses human intelligence in a number of specific areas, e.g. playing chess, identifying patterns in x-rays, and so on. This kind of activity is what is commonly called “narrow artificial intelligence”. Contrarily, humans are better on applying their intelligence across a wide spectrum of domains. This ability is named as “general intelligence”.

Considering the case in which AI reaches and outshines human levels of general intelligence, drastically different considerations would have to be regarded. Previsions of optimists vary as to the advent of general artificial intelligence. Some might say, at best, by 2029⁷⁷, however, the average estimate in the AI expert community is between 2040 to 2050, with most experts pointing a 90% probability to human-level general artificial intelligence arising within the current century⁷⁸. A minor stream deems that general artificial intelligence will never see the light of the day. Albeit, if human-level artificial general intelligence comes to reality, there is almost a consensus that AI would right after growing into super-intelligent, being more intelligent than humans and technological development would prone to accelerate, bolstered by intelligent machines. Bearing in mind these projections, we shall seriously contemplate about the repercussions of artificial general intelligence for humanity, especially for what it implies for our economy as well as for inequality⁷⁹.

Supposing that our socio-economic system will be kept even with the dawn of artificial general intelligence, there are two key hypotheses to contemplate. The first is that men and machine will merge, in a way that humans will boost themselves with ever more advanced technology so their capabilities (physical and mental) will be increasingly defined by the state AI development rather than by traditional human biology⁸⁰. The second one is that AI units will develop independently from humans, “with their own objectives and behavior”⁸¹.

5.3.1 Boost of Human capabilities with AI

The showcase in which humans will enhance themselves with machines may steer to a large growth in human inequality, except if policymakers recognize the menace and take action

⁷⁷KURZWEIL, Ray. 2005. **The Singularity Is Near: When Humans Transcend Biology**. New York: Viking.

⁷⁸BOSTROM, Nick. 2014. **Superintelligence: Paths, Dangers, Strategies**. Oxford: Oxford University Press.

⁷⁹ACEMOGLU, Daron. 2002. “Directed Technical Change.” *Review of Economic Studies* 69(4): 781-809

⁸⁰Kurzweil, 2005, *ibid*

⁸¹BOSTROM, Nick. 2014. **Superintelligence: Paths, Dangers, Strategies**. Oxford: Oxford University Press

to balance access to “human enhancement technologies”. If intelligence becomes a matter of ability-to-pay, it is not hard to realize that the wealthiest (enhanced) humans will become orders of magnitude more productive (or more intelligent) than the unenhanced, leaving the biggest part of the population each day further behind⁸². That is why humanity shall prepare to structural changes in the workforce, independently of growing attached or detached from machines. Actually, if intelligence enhancement becomes feasible, then (unless preventive actions are taken) it is hard to picture how to dodge such a consequence. For those who can pay for it, the incentive to buy enhancements is huge, even because they are still in competition with other wealthy humans who might overtake them. For the ones who cannot allow themselves to purchase the latest technology will have to depend on what is in the public domain, and if innovation increases, **the gap between the best technology and what is publicly available will increase**. Imagine the effects of it in the labor market.

Since the well-off enhanced humans have separated sufficiently far from the unenhanced, they could be effectively considered as a different species of artificially intelligent agents⁸³. To emphasize the difference in productivities, Yuval Harari has labeled the two classes that may result “the gods” and “the useless.”⁸⁴ If that becomes a reality, the two scenarios here described (humans attached or detached from machines) will have, at the long-run, similar outcomes.

5.3.2 AI independent development

Passing to showcase where artificially intelligent entities develop independently from regular (or unenhanced) humans we shall see that one of the probable characteristics of any autonomous intelligent entity is that it will interact by chasing intermediate objectives or “basic drives” that are instrumental for any final objective⁸⁵. Amongst these objectives are the self-preservation, self-improvement and resource accumulation, which will ease for the “entity” to achieve its final goals.

⁸²ACEMOGLU, Daron. 1998. “**Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality.**” *The Quarterly Journal of Economics* 113(4):1055-1089

⁸³ACEMOGLU, Daron and Pascual Restrepo. 2016. “**The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment.**” NBER Working Paper 22252.

⁸⁴HARARI, Yuval N. 2017. **Homo Deus: A Brief History of Tomorrow**. New York: Harper.

⁸⁵OMOHUNDRO, Stephen M. 2008. “**The Basic AI drives.**” In: *Artificial General Intelligence 2008: Proceedings of the First AGI Conference*, edited by Pei Wang, Ben Goertzel, and Stan Franklin, pp. 483-492. Amsterdam: IOS.

To conjure the possible economic structure in that case, Korinek presumes that there are two different types of entities, **unenhanced humans and AI entities**, which are in a Malthusian race and differ in “how they are affected by technological progress”⁸⁶. At the very crux of Malthusian models is the idea that survival and reproduction require resources, which are potentially limited. Traditionally, Malthusian models capture this by describing how limited factor supplies interact with two related sets of technologies, a production and a consumption/reproduction technology: firstly, humans supply the factor labor, which is used in a production technology to generate consumption goods. Secondly, a consumption/reproduction technology converts consumption goods into the survival and reproduction of humans, **determining the future supply of the factor labor**.

Through the course of human history, Malthusian dynamics, in which scarce consumption goods limited the survival and reproduction of humans, guaranteed a good explanation of the state of humanity, at least until when Malthus published his *Essay on the Principle of Population* to describe the resulting Iron Law of Population⁸⁷. Considering the latest 200 years, humanity, at least in well-off countries, was lucky to flee from the Malthusian restrictions: capital gathering and rapid labor-augmenting generated by the Industrial Revolution meant that our technology to produce consumption goods was constantly ahead of the consumption goods required to assure our physical survival. However, this state of affairs is not ensured to last forever.

Korinek also compares the production and consumption/reproduction technologies of humans and AI entities and observes that they diverge: on production, the element human labor is **quickly losing ground to the labor provided by AI entities**, captured by the notion of worker-replacing technological progress that was introduced earlier⁸⁸.

That said, we shall begin to recognize that machines can already be part of a large variety of economic transactions – trading financial securities, placing orders, making payments, and so on. Thus, wouldn’t be bizarre to imagine they could in fact engage in all of what we now understand as economic activities. Korinek and Stiglitz suggest that “if an outside observer

⁸⁶KORINEK, Anton. 2017. “**Humans, Artificially Intelligent Agents, and the Return of Malthus.**” Working paper.

⁸⁷MALTHUS, Thomas Robert. 1798. *An Essay on the Principle of Population*. Project Gutenberg.

⁸⁸ KORINEK, Anton. 2017. “**Humans, Artificially Intelligent Agents, and the Return of Malthus.**” Working paper.

from a different planet were to witness the interactions among the various intelligent entities on earth, it might not be clear to her if, for example, artificially intelligent entities such as Apple or Google control what we humans do ‘via a plethora of control devices called smartphones that we carry with us or whether we intelligent humans control what entities such as Apple and Google do’⁸⁹.

A main stream considers that, in the very beginning, those missing the skills which are useful in an AI-dominated world may find that they are increasingly at a disadvantage in competing for limited resources, and they will see their incomes decline, expanding the gap and world inequality. The proliferation of AI entities will at first put only modest price pressure on scarce resources, and most of the scarce factors are of relatively little interest to humans (such as silicon), so humanity as a whole will benefit from the high productivity of AI entities and from large gains from trade. From a human perspective, this will look like AI leading to significant productivity gains in our world. Furthermore, any scarce factors that are valuable for the reproduction and improvement of AI, such as **human labor skilled in programming, or intellectual property**, would experience large gains.

Therefore, to fully comprehend the impact of AI in unemployment, it is necessary to wait and see which of the foreseeable hypotheses will take place, or what hybrid of them will flourish. Depending on whether humans will be integrated or disintegrated of AI, the substitutability of human labor will strongly vary. As already mentioned, unemployment caused by structural changes will certainly become a more common reality. However, the scale of it will largely depend of which ways Artificial Intelligence and humans will trail: together or detached? We shall wait.

6 TECHNOLOGICAL DEVELOPMENT AS A DECISIVE FACTOR ON THE DECREASE OF JOB OFFERS?

Since the 18th century, workers have been compelled to adapt to new means of production. Hence, the impact caused by technological development on labor market has often

⁸⁹KORINEK, Anton. 2017. “**Humans, Artificially Intelligent Agents, and the Return of Malthus.**” Working paper.

been the object of intense discussions. Although movements similar to Luddism⁹⁰ have not been reported in recent years, there is a concern amongst workers and economists from several countries that the automation process shall result in job losses. On the other hand, some scholars genuinely believe that new machines used in industrial production are directly related to progress, thereby being beneficial to workers.

Considering the evidence of the “Fourth Industrial Revolution”, the improvement of artificial intelligence and machine learning has had several consequences in the social field⁹¹. That ongoing process has driven the transformation of industries by changing the characteristics required for people to access or remain in the labor market. The automation enabled by technologies including robotics and artificial intelligence brings the promise of higher productivity, and consequently economic growth, increased efficiencies, safety, and convenience.

Nevertheless, several occupations which used to be in-demand some decades ago face a great risk of extinction nowadays. The case of word processors provides a clear example of how technological development may imply job displacement. Also known as typists, those professionals used to be hired by numerous companies in countries such as the United States. Nonetheless, advances in technology “[...] have made electronic business transactions more popular”⁹², thence that clerical job has become increasingly obsolete. According to data provided by the U.S. Bureau of Labor Statistics, word processors shall see an employment decline of 33.1 % in the period between 2016 and 2026⁹³.

Notwithstanding technological development has threatened the existence of some professions, it is important to mention that several economists have asserted that people who

⁹⁰In the beginning of the 19th century, the Luddite movement took place in Great Britain. As stated by the historian Eric Hobsbawm, it comprehended “[...] several distinct types of machine breaking, which for the most part existed independently of each other [...]” (p.58). In this regard, it ought to be said that the above-mentioned word may refer to the destruction of the industrial machinery by workers who were not hostile to it itself, but used that coercion in order to obtain higher wages and other benefits. In addition, that term is utilized to describe the wrecking that was caused by worker’s aversion to new means of production, “[...] especially labour saving ones” (p.61). HOBBSAWM, Eric John. **The machine breakers**. [2018]. Available at: <<http://web.csulb.edu/~ssayeghc/theory/wintertheory/machinebreakers.pdf>>. Access: 29 mar. 2018.

⁹¹WORLD ECONOMIC FORUM. **The future of jobs: employment, skills and strategies for the Fourth Industrial Revolution**. 2016. Available at: <http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf>. Access: 29 mar. 2018.

⁹²STEBBINS, Samuel; SAUTER, Michael. **Will your job disappear?**. 2016. Available at: <<https://www.usatoday.com/story/money/business/2016/03/05/247-17-disappearing-middle-class-jobs/80517434/>>. Access: 29 mar 2018.

⁹³BUREAU OF LABOR STATISTICS. **Fastest declining occupations**. 2018. Available at: <https://www.bls.gov/emp/ep_table_105.htm>. Access: 29 mar. 2018.

have got fired would find other jobs themselves. From this point of view, automation and computing should not be seen as factors which trigger mass and structural unemployment⁹⁴. In fact, as some careers disappear, other labor occupations are created in consonance with market and social needs.

In this context, the sector of Information and Communication Technology (ICT) has been responsible for the massive creation “[...] of jobs in the advanced and the emerging economies”. In the member-states of the Group of Twenty, the jobs related to ICT sector correspond to a percentage between 4.66 and 6.45 of total employment in the business sphere. In order to illustrate that trend, it is worth exposing the case of Brazil, a country in which Information Technology Industry was accountable for 16 per cent of the jobs created between 2010 and 2013⁹⁵.

In India, 3.5 million people work in the Information Technology-Business Process Outsourcing industry currently. Albeit incipient, the research done on the boundaries between technological development and employment rates indicates that, besides creating middle class jobs, automation and computing have permitted several citizens to use digital tools to which they did not have access previously⁹⁶.

By creating a myriad of jobs in the most automated sectors, the development of new machines, along with their utilization in labor activities raise productivity and therefore boost economy. Consequently, that process increases the demand for services and indirectly creates jobs in fields that apparently have not been very affected by it. Goos, Konings and Vandeweyer estimate that, in Europe, “[...] *cada empleo del sector de alta tecnología (que incluye tanto la fabricación como los servicios intensivos en conocimiento) genera cinco puestos de trabajo adicionales de baja tecnología en la región en la que se ubica la industria*”⁹⁷.

⁹⁴ ROGOFF, Kenneth. **The impact of technology on employment**. 2012. Available at: <<https://www.weforum.org/agenda/2012/10/king-ludd-is-still-dead/>>. Access: 29 mar. 2018.

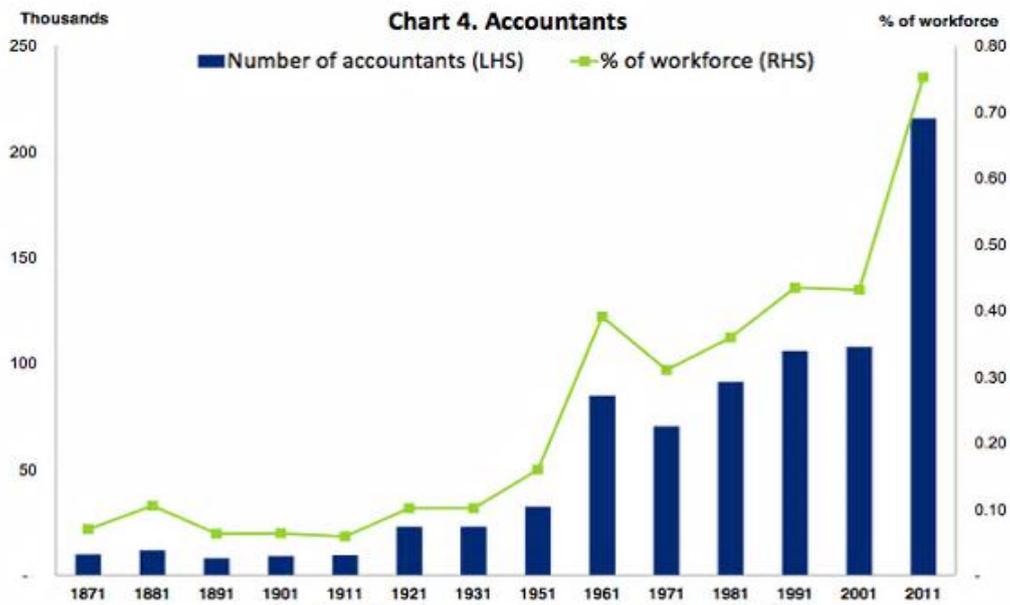
⁹⁵ WORLD BANK GROUP. **The effects of technology on unemployment and implications for public employment services**. [201-]. Available at: <<http://g20.org.tr/wp-content/uploads/2015/11/The-Effects-of-Technology-on-Employment-and-Implications-for-Public-Employment-Services.pdf>>. Access: 29 mar. 2018. p.3.

⁹⁶ *Ibidem*, p.3-7.

⁹⁷ “[...] *each job in the high-technology sector (which includes both manufacturing and knowledge-intensive sectors) generates five additional low-technology jobs in the region in which the industry is located*” (translated by us). BBVA RESEARCH. **El impacto de los avances tecnológicos en el mercado laboral**. 2016. Available at: <https://www.bbva.com/wp-content/uploads/2016/10/Situacion_ED_oct16_Cap2.pdf>. Access: 29 mar. 2018. p.2.

As claimed by Ian Stewart, Debrapratim De and Alex Cole, technological advances are followed by a great need for specialized workers. Through the analysis of employment patterns in England and Wales over the last 140 years, those economists have concluded that they have had significant impact on the rising of employment rates in areas such as medicine, education and accounting. To evince that connection, the study carried by them alludes to the exponential growth in the number of people working in the accounting sector: in 1871, there were 9,832 accountants in the abovementioned countries; by 2011, that number had increased to 215,678⁹⁸.

Chart 1: The increase in the number of accountants in Eng. and Wales from 1871 to 2011



Source: ENGLAND AND WALES CENSUS RECORDS (apud STEWART; DE; COLE, 2015, p.10)

However, the diffusion of technological progress has mostly been incremental and gradual over time, involving improvements and adaptations of existing technology⁹⁹. Historically, it is known that after a technological revolution, new and better jobs are created after the initial displacement of workers, but they need new skills to adapt to the new jobs¹⁰⁰. It

⁹⁸ STEWART, Ian; DE, Debrapratim; Cole, Alex. **Technology and people: the great job-creating machine**. 2015. Available at: <<https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/finance/deloitte-uk-technology-and-people.pdf>>. Access: 29 mar. 2018.p.10.

⁹⁹ DEPARTMENT OF ECONOMIC & SOCIAL AFFAIRS. **The impact of the technological revolution on labour markets and income distribution**. Available at: <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf>. Access in: 10 Mar. 2018.

¹⁰⁰ CENTER FOR GLOBAL DEVELOPMENT. **Technological Revolution and the Future of Work**. Available at: <<https://www.cgdev.org/blog/technological-revolution-and-future-work>>. Access in: 10 Mar. 2018.

must be recognized that the need for new skills is even more critical today because of the pace and breadth of technological change.

Furthermore, it is important to expose the appeal of employers to replace workers with machines. Thus, it is considerable given that machines require no wages or benefits, take no sick days or vacations, provide a consistent, highly reliable quality of work for up to twenty-four hours a day, seven days a week if needed, and incur no injuries. Also, they require no workers' compensation, do not complain or disclose proprietary information, and do not quit, retire, strike or take coffee breaks¹⁰¹.

The appeal is also due to the capacity of robots and artificial intelligence being less prone to distractions and negligence, when performing repetitive and tedious cognitive work. In fact, the wider use of these technologies in basic information and data analysis poses a considerable threat to white-collar employees today¹⁰².

In this context, the global workforce is expected to experience significant churn between job families and functions. According to a World Economic Forum report, current trends could lead to a net employment impact of more than 5.1 million jobs lost to disruptive labor market changes, over the period 2015–2020, with a total loss of 7.1 million jobs—two thirds of which are concentrated in routine white-collar office functions, such as Office and Administrative roles¹⁰³.

As robots and other computer-assisted technologies take over tasks previously performed by labor, there is increasing concern about the future of jobs and wages¹⁰⁴. It is estimated that 65% of children entering primary schools today will likely work in roles that do not currently exist with new technologies¹⁰⁵. In the United States and China, the world's

¹⁰¹ JOURNAL OF EVOLUTION AND TECHNOLOGY. **Technology, Unemployment & Policy Options: Navigating the Transition to a Better World**. Vol. 24 Issue 1 p26-44. 2014. Available at: <<https://jetpress.org/v24/marchant.htm>>. Access in: 7 Mar. 2018.

¹⁰² FOX & HEDGEHOG. **Are we all going to lose our jobs in this technological revolution?**. Available at: <<http://www.foxhedgehog.com/2017/06/are-we-all-going-to-lose-our-jobs-in-this-technological-revolution/>>. Access in: 11 Mar. 2018.

¹⁰³ WORLD ECONOMIC FORUM. **The Future of Jobs**. Available at: <http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf>. Access in: 5 Mar. 2018.

¹⁰⁴ ACEMOGLU, Daron. RESTREPO, Pascual. **Robots and Jobs: Evidence from US Labor Markets**. 2017. Available at: <<https://economics.mit.edu/files/12763>>. Access in: 7 Mar. 2018.

¹⁰⁵ WORLD ECONOMIC FORUM. **How technology will change the future of the work**. Available at: <<https://www.weforum.org/agenda/2016/02/the-future-of-work/>>. Access in: 4 Mar. 2018.

manufacturing powerhouses, there are fewer people working in the manufacturing sector today than in 1997, thanks, at least in part, to automation¹⁰⁶.

Consequently, these technologies also raise difficult questions about the broader impact of automation on jobs, skills, wages, and the nature of work itself. Accordingly to David Autor, an economist at Massachusetts Institute of Technology (MIT), the changes on the types of jobs “are not always for the good.”¹⁰⁷.

Insofar as Asian wages rise, factory managers are already looking for opportunities to replace employees with robots, even in China. As the advent of cheap smartphones fuels the boom in Internet access and purchases; ergo, a vast number of retail jobs shall be eliminated. Back-of-the-envelope calculations suggest that, worldwide, technological change could easily lead to the loss of 5-10 million jobs each year¹⁰⁸.

Hence, the transition of the global economy to a digitalized and automated economy has profound and unresolved implications on labor across the world. Along with these lines, the severe tension between rapid technological evolution and relatively slow adaptation of the labor has manifested into economic challenges, like unemployment as well as political upheavals in Europe and the United States¹⁰⁹.

It is critical to note that artificial intelligence and disruptive technologies will impact not just the nature of work but also the relationship that workers have with their employers, with colleagues, and with the State¹¹⁰. Therefore, just as these new technologies hold immense promise, they are also seen as a threat, potentially disrupting labor markets and contributing to income inequalities¹¹¹. In this regard, reference could be made to the reduction of the number

¹⁰⁶ MIT TECHNOLOGY REVIEW. **How technology is destroying jobs.** Available at: <<https://www.technologyreview.com/s/515926/how-technology-is-destroying-jobs/>>. Access in: 5 Mar. 2018.

¹⁰⁷ ROTMAN, David. **How Technology Is Destroying Jobs.** MIT Technology Review Magazine. 2013. Available at: <http://www.shellpoint.info/InquiringMinds/uploads/Archive/uploads/20130802_How_Technology_is_Destroying_Jobs.pdf>. Access in: 7 Mar. 2018.

¹⁰⁸ WORLD ECONOMIC FORUM. **The impact of technology on employment.** Available at: <<https://www.weforum.org/agenda/2012/10/king-ludd-is-still-dead/>>. Access in: 7 Mar. 2018.

¹⁰⁹ FOX & HEDGEHOG. **Are we all going to lose our jobs in this technological revolution?.** Available at: <<http://www.foxhedgehog.com/2017/06/are-we-all-going-to-lose-our-jobs-in-this-technological-revolution/>>. Access in: 11 Mar. 2018.

¹¹⁰ CENTER FOR GLOBAL DEVELOPMENT. **Technological Revolution and the Future of Work.** Available at: <<https://www.cgdev.org/blog/technological-revolution-and-future-work>>. Access in: 10 Mar. 2018.

¹¹¹ DEPARTAMENT OF ECONOMIC & SOCIAL AFFAIRS. **The impact of the technological revolution on labour markets and income distribution.** Available at: <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf>. Access in: 10 Mar. 2018.

of middle class workers in the OECD countries, which is directly related to the skill-biased technical change that has happened simultaneously to technological development¹¹²

Lastly, even if today's digital technologies are holding down job creation, history suggests that it is most likely a temporary, albeit painful, shock; as workers adjust their skills and entrepreneurs create opportunities based on the new technologies, the number of jobs will rebound¹¹³. However, that adaptation is conditioned to the implementation of several measures by State agents and subjects of the corporate world, inasmuch as it will depend on the training of the workers who need to be reinserted in the labor market and on a wide discussion to minimize negative impacts in advanced and developing countries.

7 CONCLUSIONS

It is correct to affirm that the technology has been developed at an unthinkable pace. The internet, for example, that had - not a long time ago - scandalized much of the population for its miraculous tools, is no longer shocking. Here is a fact: what we know as technology is changing every second and assuming different papers in our lives.

Therefore, in order to understand technological resources and the way it might change our relationship with the labor, it is elementary to comprehend what the technology consists of; how it has been developed over the time and, finally how technology presents itself today and what is expected of the coming days, noting the increasing evolution of robotics and artificial intelligence.

First, in summary, the dynamic of the technology has contributed to the existence of various definitions and concepts that try to describe it, which is why choosing a concept of technology is not an easy task. Despite of that, the concept that best suits this research considers technology as "*the development and application of tools, machines, materials and processes that help in solving human problems*"¹¹⁴. Hence, what is really important is that technology

¹¹² REENEN, John Van. **Wage inequality, technology and trade: 21st century evidence**. 2011. Available at: <<http://eprints.lse.ac.uk/47494/1/OP028.pdf?frbrVersion=2>>. Access in: 29 Mar. 2018.

¹¹³ ROTMAN, David. **How Technology Is Destroying Jobs**. MIT Technology Review Magazine. 2013. Available at: <http://www.shellpoint.info/InquiringMinds/uploads/Archive/uploads/20130802_How_Technology_is_Destroying_Jobs.pdf>. Access in: 7 Mar. 2018.

¹¹⁴ REISMAN, A. Transfer of Technologies: A Cross-disciplinary Taxonomy. The International Journal of Management Science, 2006.

cannot be seen apart from humanity, since it is made to help in solving human problems – or it was designated to help, even if it ultimately could not.

In addition, the discovery of technology precedes the humanity itself, insofar as some hominids already employed their knowledge's to build tools with stones. Down in the line, the development of technology has been noted in different manners and in various fields throughout history, which contributed to the technological resources reached they current state, whereupon emerges artificial intelligence and robotics.

All things considered, the technological advancements reported in recent years have had numerous consequences on the world economy. On account of its pace and breadth, the ongoing process of automation and computing has changed the relationships between employers and employees, thereby leading to the restructuring of labor markets. In this context, unemployment emerges as a great social issue, which is directly connected to the improvement of robotics and artificial intelligence. In spite of that, it is essential to mention that scholars often diverge on how those variables are related to each other. On the one hand, there is a widely held view that technological development betters working conditions, enhances productivity and foments economy. On the other hand, some economists do assert that it will reduce employment rates and therefore exacerbate poverty.

To such a degree, it is affirmative that the debate respecting technological development and unemployment must be observed from multiple perspectives. Thus, is there a direct relationship between technological development and unemployment? Is technology a factor that brings improvement in people's quality of life? Will technological development succeed in replacing human labor in a few years? Jobs lost through technological development will be rewarded by the creation of new ones? In light of this, to arrive at a possible solution about the problem presented by the Committee.

REFERENCES

ACEMOGLU, Daron and Pascual Restrepo. 2016. **“The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment.”** NBER Working Paper 22252.

ACEMOGLU, Daron. 1998. **“Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality.”** The Quarterly Journal of Economics 113(4):1055-1089

ACEMOGLU, Daron. 2002. **“Directed Technical Change.”** Review of Economic Studies 69(4): 781-809

ACEMOGLU, Daron. RESTREPO, Pascual. **Robots and Jobs: Evidence from US Labor Markets.** 2017. Available at: <<https://economics.mit.edu/files/12763>>. Access in: 7 Mar. 2018.

AMADEO, Kimberly. 2017. **Seven Causes of Unemployment.** The Balance.

ANDERSON, C. in WIRED MAGAZINE **In the next industrial revolution, Atoms are the new bits.** Available at: <http://www.wired.com/2010/01/ff_newrevolution/all/1>. Accessed on: March 31st.

ANYOHA, Rockwell. **The History of Artificial Intelligence.** 2017. Harvard University. Available at: <<http://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/>>. Access: march 31 2018.

BARRAT, James. 2013. **Our Final Invention: Artificial Intelligence and the End of the Human Era.** New York: St. Martin’s Press.

BASALLA, George. **The Evolution of Technology.** Cambridge: Cambridge University Press, 1988. (Cambridge History of Sciences Series). Available in: <[https://books.google.com.br/books?id=EBtnG36-1WIC&lpg=PA1&ots=nJwEWYef1c&dq=the evolution of technology&lr&hl=pt-BR&pg=PP5#v=onepage&q&f=true](https://books.google.com.br/books?id=EBtnG36-1WIC&lpg=PA1&ots=nJwEWYef1c&dq=the%20evolution%20of%20technology&lr&hl=pt-BR&pg=PP5#v=onepage&q&f=true)>. Accessed in mar. 24 2018.

BBC. **British History in depth: The Glorious Revolution.** Available at: <http://www.bbc.co.uk/history/british/civil_war_revolution/glorious_revolution_01.shtml>. Access: 30 Mar. 2018.

BBVA RESEARCH. **El impacto de los avances tecnológicos en el mercado laboral.** 2016. Available at: <https://www.bbvaesearch.com/wp-content/uploads/2016/10/Situacion_ED_oct16_Cap2.pdf>. Access: 29 mar. 2018. p.2.

BECK, Ulrich **What is Globalization?** Cambridge: Polity 2000.

BIJKER, Wiebe E.; HUGHES, Thomas P.; PINCH, Trevor. **The social construction of technological systems: new directions in the sociology and history of technology.** Anniversary Edition. Cambridge, Massachusetts: The MIT Press, 2012. Available in: <[https://books.google.com.br/books?id=B_Tas3u48f8C&lpg=PR5&dq=history of technology&lr&hl=pt-BR&pg=PR4#v=onepage&q=history of technology&f=true](https://books.google.com.br/books?id=B_Tas3u48f8C&lpg=PR5&dq=history%20of%20technology&lr&hl=pt-BR&pg=PR4#v=onepage&q=history%20of%20technology&f=true)>. Accessed in mar. 29 2018.

BOSTROM, Nick. 2014. **Superintelligence: Paths, Dangers, Strategies.** Oxford: Oxford University Press.

BUDAPESTI MUSZAKI ES GAZDASÁGDTUDOMÁNYI EGYETEM, **Iron and steel making** Available at:

www.att.bme.hu/en/education/.../Lectures/03_Iron%20and%20Steel%20Making.pdf
Accessed on: March 15th, 2018.

BUREAU OF LABOR STATISTICS. **Fastest declining occupations**. 2018. Available at: https://www.bls.gov/emp/ep_table_105.htm. Access: 29 mar. 2018.

CENTER FOR GLOBAL DEVELOPMENT. **Technological Revolution and the Future of Work**. Available at: <https://www.cgdev.org/blog/technological-revolution-and-future-work>. Access in: 10 Mar. 2018.

DEPARTMENT OF ECONOMIC & SOCIAL AFFAIRS. **The impact of the technological revolution**

ENCYCLOPEDIA BRITANNICA. **Industrial Revolution: Definition, Facts, & Summary**. Available at: <https://www.britannica.com/event/Industrial-Revolution>. Access: 30 Mar. 2018.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS “**Global Food Price Monitor**” Available at: <http://www.fao.org/giews/food-prices/home/en/>. Accessed on: March 31st, 2018.

FOX & HEDGEHOG. **Are we all going to lose our jobs in this technological revolution?**. Available at: <http://www.foxxedgehog.com/2017/06/are-we-all-going-to-lose-our-jobs-in-this-technological-revolution/>. Access in: 11 Mar. 2018.

FREY, CARL BENEDIKT, AND MICHAEL A. OSBORNE. 2017. “**The future of employment: How susceptible are jobs to computerization?**” *Technological Forecasting and Social Change* 114: 254-280.

G20 TURKEY. **About G20 - G20**. Available at: <http://g20.org.tr/about-g20/>. Access: 29 Mar. 2018.

G20 TURKEY. **G20 Members - G20**. Available at: <http://g20.org.tr/about-g20/g20-members/>. Access: 29 Mar. 2018.

G20. **How does the G20 work?**. Available at: <https://g20.org/en/g20/how-it-works>. Access: 29 Mar. 2018.

GORDON, Robert. 2016. **The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War**. Princeton, NJ: Princeton University Press.

HARARI, Yuval N. 2017. **Homo Deus: A Brief History of Tomorrow**. New York: Harper.

HICKS, John 1932. **The Theory of Wages**. London: Macmillan.

HOBSBAWM, Eric John. **The machine breakers**. [2018]. Available at: <http://web.csulb.edu/~ssayeghc/theory/wintertheory/machinebreakers.pdf>. Access: 29 mar. 2018.

INTERNATIONAL LABOR ORGANIZATION. 2017. **World Employment Social Outlook. INVESTOPEDIA. Group Of Twenty - G-20.** Available at: <<https://www.investopedia.com/terms/g/g-20.asp>>. Access: 29 Mar. 2018.

JOURNAL OF EVOLUTION AND TECHNOLOGY. **Technology, Unemployment & Policy Options:**

KORINEK, Anton and Ding Xuan Ng. 2017. **“The Macroeconomics of Superstars.”** Working paper.

KORINEK, Anton, and Joseph E. Stiglitz. 2017. **“Artificial Intelligence, Worker-Replacing Technological Change, and Income Distribution.”** Working Paper.

KORINEK, Anton. 2016. **“Currency Wars or Efficient Spillovers? A General Theory of International Policy Cooperation.”** NBER Working Paper 23004.

KORINEK, Anton. 2017. **“Humans, Artificially Intelligent Agents, and the Return of Malthus.”** Working paper.

KUMAR, V., KUMAR, U., & PERSAUD, A. **Building Technological Capability through Importing Technology: The Case of Indonesian Manufacturing Industry.** Journal of Technology Transfer, 81-96, 1999. Available in <http://dx.doi.org/10.1023/A:1007728921126>. Accessed in 29 March 30, 2018.

KURZWEIL, Ray. 2005. **The Singularity Is Near: When Humans Transcend Biology.** New York: Viking.

MALTHUS, Thomas Robert. 1798. **An Essay on the Principle of Population.** Project Gutenberg.

MCGUIRE, Brian et al. **The History of Artificial Intelligence: The turing test.** Washington: University Of Washington, 2006. Available in <<https://courses.cs.washington.edu/courses/csep590/06au/projects/history-ai.pdf>>. Access: march 31 2018.

McNEIL, Ian. **An encyclopedia of the history of technology.** 1st edition. London: Routledge, 1990.

MIT TECHNOLOGY REVIEW. **How technology is destroying jobs.** Available at: <<https://www.technologyreview.com/s/515926/how-technology-is-destroying-jobs/>>. Access in: 5 Mar. 2018.

MOKYR, Joel. **The Intellectual Origins of Modern Economic Growth** Available at: <http://e-tcs.org/wp-content/uploads/2012/10/mokyr-the_intellectual_origins_of_modern_economic_growth.pdf>. Accessed on: March 30th, 2018.

MONTAGNA, Joseph. **The Industrial Revolution.** Available at: <<http://teachersinstitute.yale.edu/curriculum/units/1981/2/81.02.06.x.html>>. Access: 30 Mar. 2018.

Navigating the Transition to a Better World. Vol. 24 Issue 1 p26-44. 2014. Available at: <<https://jetpress.org/v24/marchant.htm>>. Access in: 7 Mar. 2018.

OMOHUNDRO, Stephen M. 2008. **“The Basic AI drives.”** In: Artificial General Intelligence 2008: Proceedings of the First AGI Conference, edited by Pei Wang, Ben Goertzel, and Stan Franklin, pp. 483-492. Amsterdam: IOS.
onlabour markets and income distribution. Available at: <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf>. Access in: 10 Mar. 2018.

ONLINE ESSAYS. **Industrial Revolution in Different Countries.** Available at: <<http://onlineessays.com/essays/history/his127.php>>. Access: 30 Mar. 2018.

OXBRIDGE NOTES. **Growth Of Overseas Trade During The Industrial Revolution.** Available at: <https://www.oxbridgenotes.co.uk/revision_notes/economics-university-of-cambridge-british-economic-history/samples/growth-of-overseas-trade-during-the-industrial-revolution>. Access: 30 Mar. 2018.

POPULATION REFERENCE BUREAU **Rising Global Food Prices Threaten to Increase Poverty** Available: at <https://www.prb.org/rising-global-food-prices/> Accessed on: March 31st, 2018.

REISMAN, A. **Transfer of Technologies: A Cross-disciplinary Taxonomy.** *The International Journal of Management Science*, 2006.

RIFKIN, Jeremy, **The third industrial revolution: How lateral power is transforming energy, the economy, and the world.** New York: Palgrave Macmillan. 2011

ROGOFF, Kenneth. **The impact of technology on employment.** 2012. Available at: <<https://www.weforum.org/agenda/2012/10/king-ludd-is-still-dead/>>. Access: 29 mar. 2018.

ROTMAN, David. **How Technology Is Destroying Jobs.** MIT Technology Review Magazine. 2013. Available at: <http://www.shellpoint.info/InquiringMinds/uploads/Archive/uploads/20130802_How_Technology_is_Destroying_Jobs.pdf>. Access in: 7 Mar. 2018.

Slaughter, J. History: **Invention of the Wheel.** *Ministry OfSciency And Technology Of Nigeria*, 2014. Available at <<http://www.notap.gov.ng/content/history-invention-wheel>>.

STEBBINS, Samuel; SAUTER, Michael. **Will your job disappear?** . 2016. Available at: <<https://www.usatoday.com/story/money/business/2016/03/05/247-17-disappearing-middle-class-jobs/80517434/>>. Access: 29 mar 2018.

STEWART, Ian; DE, Debrapratim; COLE, Alex. **Technology and people: the great job-creating machine.** 2015. Available at: <<https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/finance/deloitte-uk-technology-and-people.pdf>>. Access: 29 mar. 2018.p.10.

STIGLITZ, Joseph E., and GREENWALD 2015. **Creating a Learning Society: A New Approach to Growth, Development, and Social Progress**, with Bruce C. Greenwald, New York: Columbia University Press.

THE WORLD BANK **Unemployment, total (% of total labor force) (modeled ILO estimate)** Available at: <<https://data.worldbank.org/indicator/sl.uem.totl.zs>>. Accessed on: March 31st, 2018.

TROXLER P. **Making the 3rd industrial revolution**. In: Walter-Herrmann J, Büching C (ed) *FabLabs: Of machines, makers and inventors*, Transcript Publishers, Bielefeld 2013.

United Nations Department of Economic and Social Affairs. 2015. **"United Nations World Population Prospects: 2015 Revision."**

VICENTINO, Claudio; DORIGO, Gianpaolo. **História geral e do Brasil**. 1st ed. São Paulo: Scipione, 2013.

WAHAB, Sazali Abdul; ROSE, RaduanChe; OSMAN, SuzanaIdayuWati. **Defining the Concepts of Technology and Technology Transfer: A Literature Analysis**. *International Business Research* Vol. 5, No. 1; January 2012. Available in: <http://dx.doi.org/10.5539/ibr.v5n1p61>.

WORLD BANK GROUP. **The effects of technology on unemployment and implications for public employment services**. [201-]. Available at: <<http://g20.org.tr/wp-content/uploads/2015/11/The-Effects-of-Technology-on-Employment-and-Implications-for-Public-Employment-Services.pdf>>. Access: 29 mar. 2018. p.3.

WORLD ECONOMIC FORUM. **The future of jobs: employment, skills and strategies for the Fourth Industrial Revolution**. 2016. Available at: <http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf>. Access: 29 mar. 2018.

WORLDWIDE WATCH INSTITUTE **Energy Agency Predicts High Prices in Future** Available at: <<http://www.worldwatch.org/node/5936>>. Accessed on: March 31st, 2018.