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AUTOMATION WITHIN THE AUTOMOBILE INDUSTRY

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ABSTRACT

Industry 4.0 entails a paradigm change and a challenge for economy and employment. The advances of this industry generate major demands regarding the level of education required in these jobs.

We have conducted a research in relation with the glaring improvements that new technologies have brought since the First Industrial Revolution to this moment, specifically, in the automotive industry.

This work includes three main sections. The first section explains the concept of automation, its evolution through the different industrial revolutions, the factors that have helped its development as well as the benefits and drawbacks that we may find. At the end of the section, we mention the consequence of robotics on the employment.

The second section focuses on automotive industry, and analysis its evolution throughout history, the several existing levels of automation along with the advantages and disadvantages of these, as well as the way Industry 4.0 have promoted the popularity within the sector of Smart Factories.

And finally, the third section judges the current relevance of the Autonomous Vehicle (AV) which is already functioning as test projects in some countries, and every time, there are more companies that are interested in investing in its development.

Key-Words:
Automation, Industry 4.0., Smart Factory, Autonomous Vehicle

1.INTRODUCTION

New technologies are progressing at tremendous speed and these involve innumerable advances along with the development of several tools as automation, Artificial Intelligence (AI), digitalisation, the Internet of Things (IoT), robotization, among others which imply an increment on productivity, quality and also efficiency.

Following the emergence of the first useful steam engine during the 1st Industrial Revolution which was created in Great Britain in the XVIII century until the 4th Industrial Revolution, which we currently are in, the economy has experimented great changes. We have passed from a subsistence economy to an industrial one, and then, to a consumer economy that we currently have. (Hidalgo, 2018)

However, there are some doubts about employment in the future. As Hidalgo (2018, p.23) claims, “the man’s race against machines has existed from the emergence of the those”.

The arrival of Industry 4.0 involves a paradigm change, where the figure of experiential consumer is increasingly important. Within the period of these advances, we have to bear in mind concepts that 40 years ago were unimaginable, as cyberattacks, smart factory, *carsharing*, or *robotaxis.*

The current study is primarily focused on the automotive sector since it is one of the most dynamic and important industries, and also because of its weight in world economy. All those reasons become this type of industry a clear example, that after its evolution throughout history, of making possible the observation of how these technological advances have totally transform the way of producing, the product and its consumption.

Along with the progress within the automotive sector, we can observe the emergence of 6 levels of automation, established by SAE (Society of Automotive Engineers) in 2013. The concept of *smart factory* and the figure of the autonomous vehicle which is driverless, also become important in this period and bring about a real challenge regarding technology, legislation and insurances, infrastructures and traffic security, among others.

2.THEORETICAL FRAMEWORK

2.1. What is automation?

The term "automation" (from the Greek word *automatos* which means "self-moving" and the verb *maiomai* which means "to deliver" or "to seek after/for") is related to the need of reducing human assistance in processes of production, that is, to save labour effort. (Gutiérrez, et al., 1994).

According to *Real Academia Española* (RAE), the concept of "automation" refers to the state or condition of automating (RAE, 2018), meaning that "automatic" is a characteristic of a machine or a device: which functions fully or partially by itself. (RAE, 2018)

From a general perspective, ISA (The international Society of Automation) states that "automation is the creation and application of technology to monitor and control production and delivery of product and services" (2017).

Ford Motor Company defines the term automation as the art of using mechanical devices to manipulate work pieces in and out of machines, to handle pieces between two processes with the purpose of erasing scrap and do it in a synchronized way with the production equipment in a way that the production chain can be fully or partially controlled through control command tables located in strategic points of the manufacturing company.

Industrial automation is considered as the handling of company information for the decision making process as it happens. It includes informatics and automated control for the optimum and autonomous execution of the processes designed by engineering criteria, and according to the company management plans. (DNP, Colciencias. Plan Estratégico del Programa Nacional de Desarrollo Tecnológico Industrial y Calidad, 2000-2010).

Nonetheless, in modern Encyclopaedia Britannica's words, "automation can be defined as a technology concerned with performing a process by means of programmed commands combined with automatic feedback control to ensure proper execution of the instructions. The resulting system is capable of operating without human intervention"

2.2. History of automation

2.2.1 Industrial Revolutions

Firstly, we consider it important to be driven to the definition of "Industrial Revolution" by the British professor David S. Landes (1979, p.1):

"The words 'industrial revolution' - in small letters - usually refer to that complex of technological innovations which, by substituting machines for human skill and inanimate power for human and animal force, brings about a shift from handicraft to manufacture and, so doing, gives birth to a modern economy".

Addressing to the definition above, it is claimed that an industrial society make profit from the technological development of itself in order to substitute the force of humans and animals, as well as the turbines provided by machines. We are talking about a vast change which transformed the paradigm that human force is only capable of working for a certain amount of time; that the wind can stop blowing; or that a turbine may stop rotating if water freezes or dries. Otherwise, a machine never stops producing since they are created for lasting so many time, but with the required maintenance. Thus, it is confirmed that a machine produces more energy than a large number of humans or animals.

1st Industrial Revolution

The first industrial revolution is dated in the second half of the XVIII century (1750-1780) in England. Nevertheless, it is developed in other countries at a later date.

The historical context of Europe in that time entails a shift from feudalism, which was implemented in the Middle Ages where there was a contractual relationship between feudal lords and peasants, to capitalism where a salaried job appears and allows workers to obtain capital gains.

Therefore, the predominantly agricultural and artisan economy changes to an industrial and manufacturing economy.

The reason why an industrial economy appears in England is due to the following reasons, according to professor Phyllis Deane (1987):

1. *"Widespread and systematic application of modern science and empirical knowledge to the process of production for the market;*

2. *Specialization of economic activity directed towards production for national and international markets rather than for family or parochial use*
3. *Movement of population from rural to urban communities*
4. *Enlargement and depersonalization of the typical unit of production so that it comes to be based less on the family or the tribe and more on the corporate or public enterprise*
5. *Movement of labour from activities concerned with the production of primary products to the production of manufactured goods and services;*
6. *Intensive and extensive use of capital resources as a substitute for and complement to human effort;*
7. *Emergence of new social and occupational classes determined by ownership of or relationship to the means of production other than land, namely capital"*
   (p. 18 and ff).

Modern science allowed inventors to enhance their projects which was also a consequence of the trust that capitalists (funders) had on them. Inventors developed machines which were applied and specialized into each production sector as agriculture, mining, industry or transport. Once machines are developed, factories appear.

Due to the mass production, national markets were not able to cope with the produced goods, so that, international markets were the ones who began consuming those goods.

Thus, PortalEducativo (2009) explains it in the following lines:

Division of labour led to a significant increment of productivity as well as a reduction of production costs, which at the same time it also caused a reduction of prices and greater number of consumers.

Private companies emerge as a result of the development of medieval *bourgeoisie*. During the XVII and XVIII centuries, the transatlantic trade permitted this companies to gather a substantial amount of capital. This wealth allowed the English *bourgeoisie* to invest in industrial business more and more, and as a consequence, the artisan unions lost the control of that activity which was under their control.

Bourgeois were the owners of factories, machines, commodities, manufactured goods, capital and a significant part of farmlands and urban properties.

The manufactured goods were created in developed sectors as the steel or textile industry. The elaboration process of the final product in both industries was completely “revolutionary” comparing to previous centuries, since in this time, we can observe the progress in line production and greater quantities of goods.

These sectors changed the way of production thanks to their new commodities which allowed production development; substituting the charcoal for the mineral or the wood for the iron. Thus, the mechanised labour substitutes the manual one thanks to the undoubted intervention of new energy sources.

2nd Industrial Revolution

The 2nd Industrial Revolution strengthened and also improved the profound advances of the 1st Industrial Revolution. In this period, the European powers were Germany, France and Italy. Also, Japan and USA were the world powers. This time started in 1870 and concluded in 1914.

New sources of energy, new productive sectors, as well as different ways or organizing the labour were developed during these years. In other words, a globalized economy emerged.

The new energy sources researched and developed were electricity and oil. Regarding electricity, it involved the invention of the telephone, telegraph and radio, as well as illumination through the bulb. Referring to oil, transportation was improved since the combustion engine was created.

Nevertheless, concerning the new productive sectors, it is worth to talk about the chemical industry which was applied to some fields of medicine, quotidian materials or colorants. Food industry, also, entailed longer traceability of the products and improvements in transport and storage. In relation to the steel industry, new metals were developed and iron suffered innovative processes regarding its treatment.

The innovative ways in the organization of labour were proposed by F. Taylor whose work “The Principles of Scientific Management” (1911) talks about an increment of productivity by decreasing the spare time of the worker. He also hypothesized about work specialization and standardized processes.

Moreover, Henry Ford applied the line production in his factories through work specialization, and as a result, there was an improvement in times and he lowered the product price at the final production, the car. This method of labour organization was called “Fordism”.

The commercial and financial globalization was caused by the need of getting great amount of commodities at cheap prices. That was the way the control of the major powers over Africa and Asia was understood, since the commercial relations were expanded. However, these relationships created extreme inequality where the country which were owners of the production resources controlled those owning the natural resources and low-skilled labour force.

3rd Industrial Revolution

Based on the studies of Virgilio Roel, given the precedents explained above, during the fifties, sixties and seventies of the XX century, the technological progress suffered an exponential growth along the years.

In 1973, the turning point happened when the crude oil prices increased continuously:

1973 .... US$ 5,8 / barrel

1974 ...... US$ 12,8 / barrel

1978 ...... US$ 13,1 / barrel

1979 ...... US$ 27,4 / barrel

1980 ...... US$ 35,2 / barrel

(Roel, V. 1998).

The above fact marked the characteristics of this period which were the following:

- New technologies had to use energy in a moderate way since oil price was excessively high.
- An expansion of the use of new technologies through collective and individual life.
- New technologies will entail high productivity. Therefore, a decrease of the use of valuable or traditional commodities will happen in contrast to the former technologies used before.

This period allowed that all the mass production developed in the previous industrial period individualizes. Those field that guaranteed the three characteristics were: robotics, genetics and telecommunications.

On the counterpart, the American economist, sociologist, writer, orator, politician and activist named Jeremy Rifkin claimed that, nowadays, we are living in the 3rd Industrial Revolution, a fact that the European Parliament confirmed in 2007.

This claim is based on 5 fundamental pillars comprising:

1. Renewable sources
2. Building as positive power plants
3. Storage technologies based mainly on hydrogen
4. "Smart Grid" technologies or intelligent power distribution net
5. Transportation based on electrical vehicles

Jeremy Rifkin (2007) claims that nowadays, *"Internet technology and renewable energies were about to merge to create a powerful new infrastructure for a Third Industrial Revolution (TIR) that would change the world. In the coming era, hundreds of millions of people will produce their own green energy in their homes, offices, and factories and share it with each other in an "energy Internet," just like we now create and share information online*"

This "energy Internet", as he confirms, will modify our way of living and working and will open new markets that will generate great opportunities to expand commerce. Moreover, wars on energetic resources will end which will mean the start of a new era of real international cooperation where the use of carbon will disappear in order to end with the disasters derived from climate change.

4th Industrial Revolution

Schwab, writer and funder of the World Economic Forum, introduces the term "4th Industrial Revolution". We can read certain aspects that are similar to the ones by Rifkin, as the importance of introducing digital technology in society during the last half century. Nonetheless, the difference between them can be shown in Schwab that has discovered that it is possible a transition from a 3rd to a 4th industrial revolution while Rifkin defends that it is too soon to have the 3rd industrial revolution ended.

We are talking here about an extreme transformation of the production system, businesses and society as the result of the speed, the scope and impact of systems.

Therefore, it is a phenomenon that it is among us and will provoke profound and systematic changes. The key technologies in the development of this revolution can be grouped in three sectors: physical nature, digital and biological. The impact of these three technologies will affect aspects such as the economy, businesses, globalisation, society and even individuals.

Table 1. Examples of occupations more or less prone to automation

More prone to automation

Probability	***Occupations***
0,99	Telemarketers
0,99	Tax preparers
0,98	Insurance Appraisers, Auto Damage
0,98	Umpires, Referees, and Other Sports Officials
0,98	Legal Secretaries
0,97	Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop
0,97	Real State Brokers
0,97	Farm Labour Contractors
0,96	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive
0,94	Couriers and Messengers

Less prone to automation

Probability	***Occupations***
0,0031	Mental Health and Substance Abuse Social Workers
0,004	Choreographers
0,0042	Physicians and Surgeons
0,0043	Psychologists, All Other
0,0055	Human Resources Managers
0,0065	Computer Systems Analysts
0,0077	Anthropologists and Archeologists
0,01	Marine Engineers and Naval Architects
0,013	Sales Managers
0,015	Chief Executives

Source: Carl Benedikt Frey y Michael Osborne, University of Oxford, 2013.

2.3. Factors that have promoted automation

According to Ana Caballero in her article for the newspaper "*El mundo*" in the "Digital Booster" section dated from April, 2018, the term "4th Industrial Revolution" belongs to Germany in 2013 and was used to refer to the changes in the manufacturing processes through the use of new technologies.

She claims that, "since 2013, the German government has been working in a high technology project with which they try to find full independence of human labour in the production as well as the hyper connectivity of all the processes"

According to the *economipedia web*, the fundaments for the fourth industrial revolution are:

- The “Internet of Things” (IoT)
- Robotics
- Connected devices
- Cyber-Physical System
- Do It Yourself (DIY)
- Industry 4.0 (cyber factory and smart-manufacturing)

Besides, according to Nicholas Davis, Head of *Society and Innovation*, member of the Executive Committee, World Economic Forum of Geneva, and Dereck O’Halloran, Head of *Shaping the Future of Digital Economy and Society*; member of the Executive Committee, World Economic Forum, in their article published in the web page www.weforum.org, “*Globalization and technology are intimately intertwined. The movement of people, goods and ideas is accelerated and broadened by new forms of transport and communication. And technological development is, in turn, enhanced by the diversity of ideas and the increased scale that comes from global reach.*

During each phase of globalization, technology has played a defining role in shaping both opportunities and risks. As the Fourth Industrial Revolution drives a new phase of globalization – “Globalization 4.0” – here are five things we can learn from looking backwards, and forwards, at the impact of technology.”

In addition to these authors, Klaus Schwab, founder and executive chairman of the World Economic Forum claims in an article published in the web mentioned above: “Globalization is a phenomenon driven by technology and the movement of ideas, people, and goods. Globalism is an ideology that prioritizes the neoliberal global order over national interests. Nobody can deny that we are living in a globalized world. But whether all of our policies should be “globalist” is highly debatable.

This moment of crisis has raised important questions about our global-governance architecture, the challenges associated with the Fourth Industrial Revolution (4IR) are coinciding with the rapid emergence of ecological constraints, the advent of an increasingly multipolar international order, and rising inequality. These integrated developments are ushering in a new era of globalization. Globalization 4.0 has only just begun, but we are already vastly underprepared for it. Clinging to an outdated mindset and tinkering with our existing processes and institutions will not do. Rather, we need to redesign them from the ground up, so that we can capitalize on the new opportunities that await us, while avoiding the kind of disruptions that we are witnessing today.

This is not a matter of free trade or protectionism, technology or jobs, immigration or protecting citizens, and growth or equality. Those are all false dichotomies, which we can avoid by developing policies that favour “and” over “or,” allowing all sets of interests to be pursued in parallel.

To be sure, pessimists will argue that political conditions are standing in the way of a productive global dialogue about Globalization 4.0 and the new economy. But realists will use the current moment to explore the gaps in the present system, and to identify the requirements for a future approach. And optimists will hold out hope that future-oriented stakeholders will create a community of shared interest and, ultimately, shared purpose.

The changes that are underway today are not isolated to a particular country, industry, or issue. They are universal, and thus require a global response. Failing to adopt a new cooperative approach would be a tragedy for humankind. To draft a blueprint for a shared global-governance architecture, we must avoid becoming mired in the current moment of crisis management.

Specifically, this task will require two things of the international community: wider engagement and heightened imagination. The engagement of all stakeholders in sustained dialogue will be crucial, as will the imagination to think systemically, and beyond one’s own short-term institutional and national considerations.”

2.4. Benefits and Drawbacks

In the following section we are going to investigate the benefits and drawbacks in economy regarding the advances of new technologies as automation, robotics and Artificial Intelligence (AI).

- Regarding the **benefits**:
    - Firstly, a significant increase in productivity after implementing new technologies can be shown. Technologies as automation in production processes which produces a quality increase and error decrease since automation is more precise than any process by artisan labour.
    - Secondly, thanks to the reduction of costs, there is a better use of the production resources, there isn’t dead time and also, it produces a reduction of the number of workers but without decreasing productivity.

As Rifkin specifically shows in his book “The Zero Marginal Cost Society”, robot sales grow in the manufacturing industry which has less labour force; that is known as “lights-out manufacturing”

- Thirdly, it is important to consider the reduction of the production time as a consequence of automation, which allows them to spend that time in innovative design and creativity, i.e. it entails more efficiency.
- Lastly, new technologies give more flexibility to companies due to the constant innovation if these which can be rapidly adapted to specific necessities of each company or the global market.

- Regarding the **drawbacks**:
    - Firstly, it is worth to mention the high initial investment required to implant and maintain new technologies. Here we are talking about the installation of machinery, processing automation, constant software updates …which are very efficient and profitable but not all companies can afford these.
    - We consider also important to talk about cybercrime; which with globalization and the relevance of new technologies, it is more frequent to observe attacks from hackers to companies. That Is the reason why an accurate computer security is of paramount importance to prevent those attacks.
    - Another drawback that we can observe is the planned obsolescence which implies a considerable flux of electronic scrap and only a 20% of these are recycled and the rest ends in countries as Ghana which has become in one of the electronic landfill of the world since it received around 50 tons of electronic scrap last year.
    - Finally, the implantation of new technologies causes a loss in jobs since it entails a productivity increase at the expense of the workers. The most affected sectors are the ones with low-skilled workers where the job consists in repetitive and routine tasks. With the advances of the new technologies, *voxpopuli* estimates that 34% of the jobs will be affected by automation in 2030.

When we consider Artificial Intelligence as a support to automation, we can find advantages and disadvantages too.

According to the web page “quierotec.com”, the **advantages** of AI are:

Almost 0% of errors; space exploration; reach the nadirs of earth since it can be used to dig and get more gas or used in the mining industry; do repetitive labour; make the quotidian easier for example with smartphones; detect frauds as a falsified or duplicated credit card; as there is no emotions, the thinking is logical and the rationale decisions are made without the influence of the emotional part; applications in medicine; decisions are made quicker; robotic pets that can help depressive patients as well as keeping them active; and finally, there is no need of sleeping, thus, they can be working 24 hours/day.

And as the **disadvantages**:

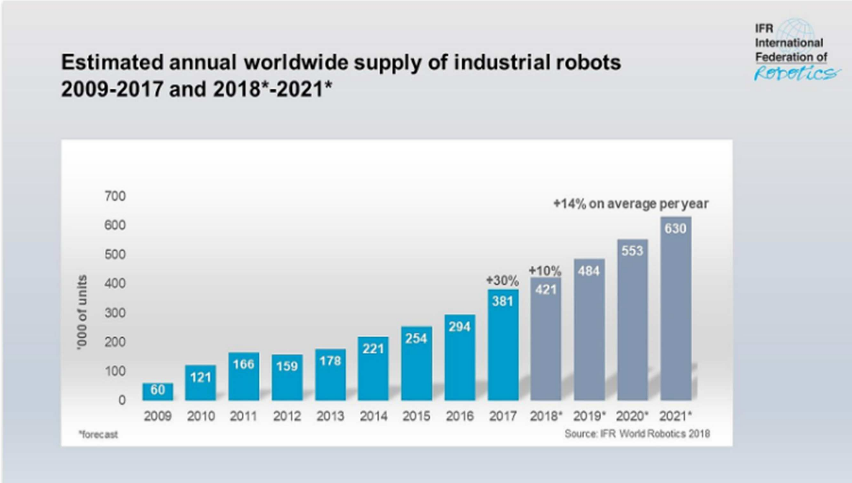
We can observe that there are people who consider it unethical that AI is almost human; also the high cost; machines can storage a great amount of data but this storage, the access and recovery will be not that effective as the human brain or that effective as humans since they can alter their responses depending on changing situations. AI does not have the human part that can be useful in jobs which require the care and protection of human beings; lack of creativity; increment of unemployment; in wrong hands it can be dangerous since if AI can be programmed to do mean things since they do not have conscience that prevent it; and finally, there is a fear of replacing humans, because ideally humans should be the owners of these machines.

2.5. Robotics in the workplace

The great technological advances, as we have explained before, have led to a growing importance of robotics and automation in the current economy. This is caused by the significantly positive effects for companies.

As positive aspects within automation for companies, we can talk about an increment in productivity and quality with no need of hiring more employees, as well as a decrease in costs and production errors. That is why, every time, more companies decide to invest in automation. These advances prove the existence of an inverted relation between productivity and employment, since productivity has always been associated to an increase of employment. However, thanks to the application of innovations promoted by ICTs, productivity and quality notably improve and there are more reduced personnel. Consequently, the world demand of robots in the last years has increased, especially in China. According to IFP (International Federation Robotics) the sales of industrial robots have increased a 31% in 2017 in comparison to 2016, and it is estimated an increment of 14% annual until 2021.

Figure 1. Estimated annual worldwide supply of industrial robots



Source: International Federation of Robotics (IFR)

In view of this situation, citizens hesitate about the employment in the future. Even businessmen resorted to relocation, mostly in China in order to take advantage of the cheap labour force. Now these businessmen want to reposition their production and decided to use robots to produce, since they are cheaper and more efficient than cheaper industrial workers. “If the current pace of implementation of technology in the manufacturing sector remains, it is likely that job vacancies in factories, that they were 163 million in 2003, will be reduced in some millions for 2040 which will mean the end of mass manufacturing production in the world” (Rifkin, 2014).

The service sector, specifically the knowledge one, is the less affected by all the technological advances at this moment, however, it is jeopardized by the advances on Artificial Intelligence. An example can be found in the programme “e-discovery”, where all kind of legal documents are thoroughly analysed at a speed that not even the best law experts can reach.

Some sectors where we can observe automation are: the cleaning sector with the automatic vacuum cleaners (the brands “Roomba” or “Conga”, that are increasingly being used for domestic cleaning), the medicine sector (far-reaching endoscopy which allows to visualize an endoscopy from the other part of the world at millions of kilometres and with great precision), exoskeletons, and logistics (automobiles without driver).

These technological advances imply a world challenge, where population should adapt through policies and change according to the new requirements of these technologies.

The consulting firm “McKinsey Global Institute” and its published article show us the impact of robotization on the labour market in the future decade (until 2030). In its reports, the analyses include almost 46 different countries and around 800 jobs.

We consider it important to mention the devastating facts regarding labour market such as the loss of around 400 and 800 million of jobs. The most affected economies would be those from first-world countries. However, for example, Mexico that has very low salaries, would not be that affected by robotization (only a 9%).

This information would entail a re-education of workers in most cases, since they would have to modify their skills they offer to adapt them to the current markets. Jobs more vulnerable to automation would be the ones that consist on physical labour o data processing.

3. AUTOMATION IN THE AUTOMOBILE INDUSTRY

3.1. History of automobiles

The DGT (Dirección General de Tráfico) defines the term "automobile" as "from a mechanical point of view, automobile means that it moves autonomously, and is applied to vehicles that move through the power of an engine" (DGT, 2016).

The automobile industry, after the advances achieved by the industrial revolutions, has experimented several changes since its beginning in 1769 to current days.

The origin of automobiles sets in 1769 when the French and military engineer, Nicholas Joseph Cugnot, designed the world's first automobile which was a self-propelled mechanical land-vehicle, called the "Fardier à vapeur" in French and steam-powered dray in English. (Kretz, 2012)

The vehicle mentioned above was a three-wheeled automobile whose front wheel was of traction and direction. A steam boiler was situated in the front wheel, just above and the power unit was steered by means of a double handle arrangement. It moved at a speed of around 4km/h. (Murias, 2017)

Provided that the "Fardier à vapeur" did not meet the military expectations owing to poor weight distribution and lack of speed due to the power unit, among others, Cugnot designed, a year after, a second prototype which was more complex to drive and caused the first automobile accident in history in 1771 since it knocked down accidentally a stone wall. (Parissien, 2013)

Despite that, Cugnot kept working in a third prototype of the "Fardier" which was finished in 1771 and was located in the Musée des Arts et Métiers. (Murias, 2017)

Ilustration 1. Le Fardier a vapeur

Source: Autonoción

Therefore, years later, between 1832 and 1839 the first electric car of history was invented by the Scottish Robert Anderson. It was a carriage whose engine was electric and powered by non-rechargeable primary cells and it reached 6km/h (Prieto, 2018; Hyundai).

It was not until 1880 that rechargeable cells and assembly line production were created.

We consider it important to mention that the first car which outreached 100Km/h was an electric one named “La Jamais Contente” in 1889. A fact that happened during a speed race in Acheres, France, between the car designer, Camille Jenatzy, and the Count Gaston de Chaseloup-Laubat. Jenatzy reached 105,88 km/h and exceeded his opponent’s mark of 92,78 km/h. Jenatzy got a name in the history of the automobile industry. (Sociedad Técnica de Automocion, 2011)

Ilustration 2. La Jamais Contente

Source: 20minutos

Electric cars dominated the market at the end of the XIX century and the beginning of the XX century, comparing the internal combustion engine cars, since the latter were provided by an engine which was started by hand cranking using a hand crank, was noisy also and the driving was even more complex than the one in the electric cars.

Because of all those reasons mentioned above, electric cars were the most popular ones within population until 1912, due to the advent of the “Ford Model T” car. This car achieved a reduction on the engine source noise and carried electric starting which was invented by Charles Kettering, and erased the need of the hand cranking starter. (Guía del vehículo eléctrico II, 2015; Hyundai)

Thanks to the application of Fordism[1] , based on Taylorism[2] , Ford Motor Company achieved to reduce considerably the production costs as well as de production time of an automobile which was then 12 hours per car and it was accomplished to be done it in 100 minutes per car (Prieto, 2018).

The reduction of the production costs allowed Henry Ford to decrease the prices of the cars, making them more affordable for the middle-class. Ford Company increased its workers' salaries, in order to permit them to become buyers of their own products. For the first time, the automobile was at the reach of a middle-class American family. (Parissien, 2013)

Ford Model T was an icon in the twenties history.

Ilustration 3. Ford T

Source: motorpasion

The sale increment on the internal combustion engine cars caused an increase on gas demand which entailed a fall in oil prices. This way, it resulted in a considerable growth of the sales of petrol cars, and at the same time, it caused the electric cars to fade into oblivion and also caused a disastrous fall on their sales (Guía del vehículo eléctrico II, 2015; Hyundai).

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[1] Fordism: Industrial mass production system which emerged in the XX century. It promotes specialization and the reduction of costs. It is based on Taylorism and it is named Henry Ford.

[2] Taylorism: Production efficiency methodology. It was created by the engineer and economist Frederick Taylor.

In the end, the assembly line production of Ford Model T entailed a significant turning point in the automobile industry, in consumer habits and social changes, spreading rapidly to different countries causing a new era of industry.

If we turn back in time, we can see that in 1885, it was created the first car propelled by an internal combustion engine (petrol one), called "motorwagen" by Karl Benz. On 29th of January in 1886, Benz applied for the patent of his vehicle, thus, he is known as the father of the automobile. The patent was number 37.435 and this was considerate as the birth certificate of the automobile. (Parissien, 2013; Prieto, 2018)

Ilustration 4. Motorwagen

Source: Okdiario

It was a three-wheeled automobile and reached a maximum speed of 18km/h, and was the responsible of the firs long-distance journey by automobile. The journey was 100km long from Mannheim to Pforzheim, and was driven by Karl's wife, Bertha Benz, in 1888. After this, the viability of the engine car was proved, which promoted the growth of Benz & Cia Company (Parissien, 2013).

Despite that, during 1836, the first diesel car was presented to the International Motor Show in Berlin, which was the Mercedes 260 D. it reached 100Km/h and was the first series-produced diesel car (Costas, 2011).

Ilustration 5. Mercedes 260D

Source: diariomotor

Lastly, it is important to say that Chrysler Imperial was the first car which incorporated a certain aspect of automation in 1958. This car was the first which introduced the cruise control (Speedostat)[3], that is a usual system in cars nowadays. The Speedostat patent, US2519859A, corresponded to the blind engineering Raph Teetor in 1950, who was the first in designing the first automatic system of speed control (Ibáñez, 2018).

Since then, numerous technological systems and advances have been developed aiming to increase security and comforts in driving. Features such as the Anti-Block System (ABS), Assisted Paring System, Light Detention and Ranging (LIDAR), Electronic Stability Control (ESC), Pre-Collision System (PCS)…

As we have shown, the automobile industry has experimented several important advances since *Le Fardier a Vapeur* to new models which incorporate the last technologies in automation as Tesla Model 3, Firefly (Google) and other models mentioned in the following sections.

In the following section, the different current levels of automation in automobiles will be explained, as well as the new advances in the automobile sector and the challenges that these advances carry.

3.2. Automation in the automotive industry

According to Olona (2018, p.40) "Automated driving offers the opportunity of tackling several important social challenges in result of the road haulage in security areas, energetic efficiency and social inclusion".

There are different levels of automation regarding automobiles and the range is from 0 to 5, according to the degree of vehicle autonomy.

The first level of classification of automation is settled by the National Highway Traffic Safety Administration in 2013.

A year later, in 2014, the Society of Automotive Engineers (SAE) set the automation levels, the ones that are established nowadays. Since 2016, the NHTSA adapt the automation levels implemented by the SAE. Therefore, in the next paragraphs, the different levels of automation created by the SAE J3016 are thoroughly explained:

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[3] Speedostat: Name fomerly given to cruise control system.

Firstly, level zero is characterized by inexistence of automation, i.e., the driver intervention is fully required.

Secondly, level 1 of automation is known as assisted driving since it includes vehicles with brake/acceleration support to the driver.

Thirdly, level 2 offers partial automation which includes steering and brake/acceleration support. At this level, the driver is still responsible of the driving.

Then, level 3 of automation entails a conditional automation, the system takes total control of the vehicle when all the conditions required are met, including the monitoring of the environment. The driver becomes a backup user in case of being required.

Level 4 of automation implies high automation where the vehicle is capable of performing all driving functions and the driver is not expected to be ready to control. An example could be the new Honda NeuV Concept 2017 that uses an “emotion engine” and recommend or apply different choices according to the driver’s personality and emotions.

Lastly, level 5 of automation, covers full automation, the vehicle performs all driving functions, thus, the driver presence is not necessary neither required. This level is expected to be reached at the end of the next decade.

Table 2. Levels of Automation

SAE's levels of *driving* automation are descriptive rather than normative and technical rather than legal. Elements indicate minimum rather than maximum capabilities for each level. In this table, "system" refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*, as appropriate. This table also shows how SAE's levels definitively correspond to those developed by the Germany Federal Highway Research Institute (BASt) and approximately correspond to those described by the National Highway Traffic Safety Administration in its May 30, 2013, paper titled "Preliminary Statement of Policy Concerning Automated Vehicles." (See section 6.3, below.)

SAE level	SAE name	SAE narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
***Human driver* monitors the driving environment**								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
***Automated driving system* ("system") monitors the driving environment**								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**		

Source: SAE

It is important to say that, despite claims as Elon Musk's, Tesla CEO, who said, " by year-end 2020, people will be able to relinquish all responsibility to Autopilot and fall asleep while being transported from point to point"[4], nowadays, vehicles are in level 2 of automation, in a way, that the driver must be concentrated in the driving and keep the hands on the steering wheel to avoid accidents.

The arrival of fully automated vehicles is expected to be between 2020 and 2030. (Capgemini, 2018; McKkinsey, 2019)

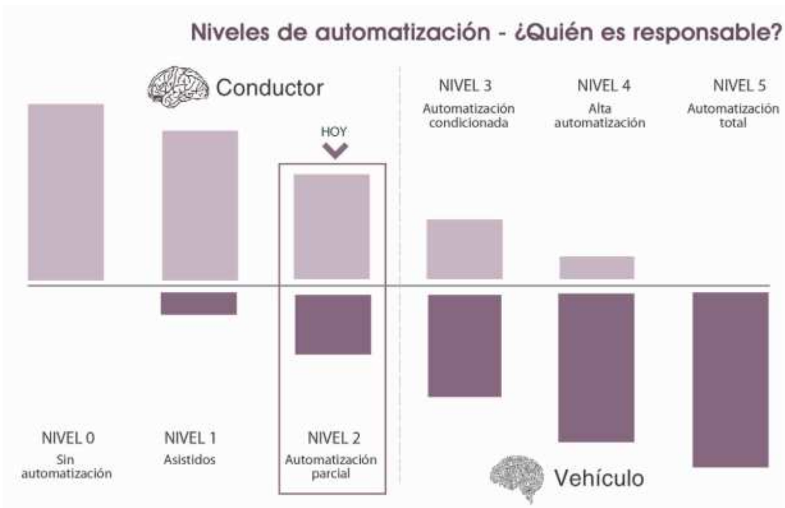
[4] Retrieved from Elon Musk podcast accomplished through ARK invest (2019).

The great technological advances in the automobile sector, the popularity of the vehicles in level 2 of automation and the trust on them by users have prompted to total losses, as the one by Tesla Model S in May, 2016 in Florida, o the one in Tempe (Arizona) in March, 2018 caused by a test autonomous car of the Uber company.

These accidents and advances created the need of changes in law regulation, since the arrival of the autonomous vehicle required from a reform in civil liabilities and insurances. That is because in case of accident, it would be necessary to define which responsibilities belong to the driver and which to the car manufacturer.

The automobile magazine "Centro Zaragoza" proposes the following degrees of responsibility according to the different levels of automation.

Figure 2. Responsibility according to the levels of Automation.



Source: Centro Zaragoza Magazine

We cannot deny that there has been an important gap between the last technological advances and legislation, since the latter does not advance as quick as technology. USA is the most advanced country regarding legislation within the field of autonomous driving. Around 30 states have proved laws in this field, although California, Silicon Valley's headquarter, has considerably stood out since it is the state that is more advanced and permissive in relation to the autonomous driving regulation.

4th of October in 2017 the AV START Act was approved, it regulated the framework that will ensuring the safety of automated vehicles on the road. This law requires, firstly, the presence of a human driver in the car who control the driving of the vehicle;

secondly, it requires the driver to do a certain course regarding autonomous driving; and lastly, it requires the vehicles to incorporate the willingness to drive in safe mode in case of software error.

Autonomous cars started to be tested in USA in 2010 while in Europe it did not until 2015.

Regarding Europe, in 2016, the text belonging to the Vienna Convention (1968) was modified by the United Nations Economic Commission for Europe (UNECE) and it included the definition of the terms “Autonomous vehicle (AV)” and Automatic Driving Systems (ADS).

According to estimations of the European Commission, the autonomous vehicle market was expected to provide revenues of a higher quantity than 620.000 million of euros in the automobile sector and 180.000 million in the electronics sector by 2025.

By means of the European Parliament resolution of 15 January 2019 on autonomous driving in European transport, the European Commission stated the need of meeting the challenges that autonomous vehicles involve regarding the standardization, legislation, civil liability, cyberattacks, traffic safety, data protection, technical infrastructures, insurances and employment. All this entails the installation of event data recorders (EDR) in vehicles for future problems in regards to civil liabilities in case of accidents.

Horizon 2020 programme that has aimed around 300 million of euros at the research and innovation of automated vehicles between 2014 and 2020 through projects as L3PILOT and ENSEMBLE.

It is important to state that Germany is the most advanced country of the EU, because in 2017, a law regarding the autonomous driving was approved and it allowed the circulation of autonomous vehicles under the supervision of a driver at the steering wheel. The mentioned law established that vehicles had to have a black box as planes do where everything what happens during the driving be registered, in a way that responsibilities will be determined in case of accident.

In terms of Spain, in 2015, the first experience of autonomous vehicles occurred when a Citroen Grand C4 Picasso from PSA group made a driverless road trip of 600 km from Vigo to Madrid.

The DGT in Spain is quite restrictive, it issues circulation authorizations to test this type of vehicles since 2015, within a maximum period of two extendable years. However, it can only be requested by manufacturers, laboratories and universities.

The first autonomous bus is expected to come to Spain in spring of 2020, and it will go through the "Ruta de los Volcanes[5]", i.e., the Volcanos trip.

Experts claim that there is lack of legislation regarding the vehicles with automated levels of 4 and 5, specially in Spain.

Fernando Navas (2019) from Navas & Cusi law in an article published in xataka, firm states that "current legislation is not prepared for completely autonomous vehicles"

Mario Arnaldo who is the president of AEA (Associated European Drivers), emphasize the idea that nowadays, "a modification of civil liabilities is required in order to create an objective liability that will need to be defined".

Miguel Caso Florez in (El País, 2019), Technical Director at the World Road Association confirms that "it is urgent that Governs, supported by expert committees on ethics, programming and industry, stablish rules and a clear framework aimed at the development of these vehicles"

Besides legislation, there are other important aspects to consider as insurance companies.

According to studies of the DGT, 90% of traffic accidents are caused by the human factor, then, with the autonomous vehicles, it is expected that the amount of accidents diminishes and consequently, the insurance premiums decrease too.

The spread of autonomous mobility can reduce the insurance premiums by around 10% and 30% until 2015, according to a report by BBVA. (Situación de Seguros BBVA Research, 2019)

Autonomous cars are a challenge for insurance companies that will have to adapt to the situation and the new demand, changing their social benefits and policies in a way that are adapted to the new way of driving. (Mapfre)

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[5] Ruta de los Volcanes: Usual trekking route that croses La Palma Island from north to south, from Pilar Refuge to "salinas de Fuencaliente".

It is worth talking about a very significant change in the driver that it becomes another passenger in the vehicle, in level 5 of automation.

Mario Arnaldo, president of AEA, present the idea of creating a compensation fund and an independent accident research agency composed by professionals specialized in accidents caused by autonomous cars, because of the difficulty of distributing the responsibilities regarding these vehicles.

Due to the advances, it gains importance the cyberattacks which should be covered by insurance companies.

As we have mentioned before, more companies are working in prototypes of autonomous vehicles, which implies discrepancies regarding the concept of these.

According to Ana L. Olona (2018, p.41):

"The Advanced Driver Assistance Systems (ADAS) and the new autonomous technologies have the potential to make vehicles safer, since they can reduce, and almost completely eliminate, the errors by the human facto. Security in vehicles has reached a very high lever lately, but one ADAS and new autonomous technologies have been incorporated to the market, the highly automated vehicles will change the interface man-machine and will demand new and modern communication concepts between car and driver. The driver will be able to act intuitively and use the system".

In contrast, Jorge Villagra, the head of the program "Autopía del Centro de Automática y Robótica (UPM-CSIC)" (2014) claims that "the reason why products that should be available are not is because there are risks that not even experts are capable of quantify, and, consequently, we cannot ensure that they will be safe risks"

3.2.1. Benefits and Drawbacks

Automation in vehicles entails certain benefits and drawbacks that we will explain in the following paragraphs.

Among the benefits, firstly, we can talk about a significant improvement in traffic safety since the driver image as we know it nowadays disappear, i.e. the image of the driver as a 90% responsible of the traffic accidents.

Secondly, it implies an environmental enhancement, because these vehicles are electric and are zero-emissions vehicles (ZEV). That is, they do not pollute neither acoustically nor atmospherically.

Thirdly, the flux of vehicles is regulated, they can choose the less-travelled roads avoiding traffic jam, in this way, their fuel consumption and time is reduced.

Last but not least, autonomous vehicles permit the mobility of any type of group of people with any problem. Level 5 of automation allows that any disabled people, even blind, can move to any place with no limitations, gaining independence.

Regarding the drawbacks claimed by RACE (2018), firstly, there is a lack of legislation related to this specific type of vehicle regarding civil liability and insurances.

Secondly, cybersecurity starts to be of paramount importance since the driving of these cars relies fully on the software which exposure these kind to technological attacks by hackers.

Another problem is the huge amount of money that has to be invested in infrastructures by manufacturers, and also individuals who want to buy these specific vehicles.

Besides, it entails a high level of maintenance, so users have to attend the plausible system updates to avoid accident.

Lastly, the incorporation of black boxes which register the activity inside the cars which brings about several debated related to the user privacy.

Tesla Company was the first one which take a major step and launched the “Autopilot”, however, every time there are more and more companies that opt for autonomous driving. Among these companies are Google with its Firefly, Audi, Volvo, Mercedes Benz or Baidu…

3.3. Industry 4.0 in the automobile sector

Since Henry Ford’s line production called Fordism to Toyotism[6] nowadays, the automobile industry has been affected by great changes in relation to product and production.

According to Oliva Navarro, I4.0 concept refers to the mixed use of different technologies that nowadays are being used, and others that are being developed. The

[6] Toyotism: Just-in-time production which is a mass production method emerged in Japan and replaced Fordism in 1970.

latter are known as enabling technologies which are Big Data, Robotics, Artificial Vision, Cloud Computing, IoT, augmented reality and Additive Manufacturing (AM).[7]

As we have already mentioned in the introduction of this work, we live in a globalized world where technology is of paramount importance.

Industry 4.0, known also as 4th Industrial Revolution, fully transforms the production process from a traditional one into an integrated production process through the use of IoT, resulting in an increase of flexibility and replacement of jobs by line production connected and highly automated by the introduction of robots.

The application of this industry is vital and entails a challenge for industry but at the same time, it creates an opportunity to grow and to make companies more competitive.

Automation and robotization demands in relation to the automotive industry are quite strict due to the high competition in the sector and the existing market changes. Currently, there is a tendency of clients to search for experiences. The experimental consumer image is getting more important and companies have to be adapted to the new demands.

Nowadays, automobile manufacturers all own a web page which allows clients to be widely informed by the Company, its models, and even are allowed to customize the model they like the most and meet a date online in the nearest concessionaire.

As Christian Vollmer, new Vice-President for Production in SEAT, claims in an article about 4.0 Industry in (El Pais 2018) that “making an effort jumping on the 4th industrial revolution is not an option but a must for all the companies which want to make an impact at short and long term. 4.0 industry implies the greatest revolution within economy and market sector at every level and at a vertiginous speed.

Automobile industry leads the global demand in industrial robotics with a share of 30% approx. of the total. Industrial robotics are followed by metal, electronics and food industries. (Área de estrategias sectoriales, CCOO, 2018) in 2017, electronics industry almost substitutes the automobile industry as major petitioner of industrial robots, but its global demand of electronic components was jeopardized by the commercial crisis between USA and China (IFR, 2019).

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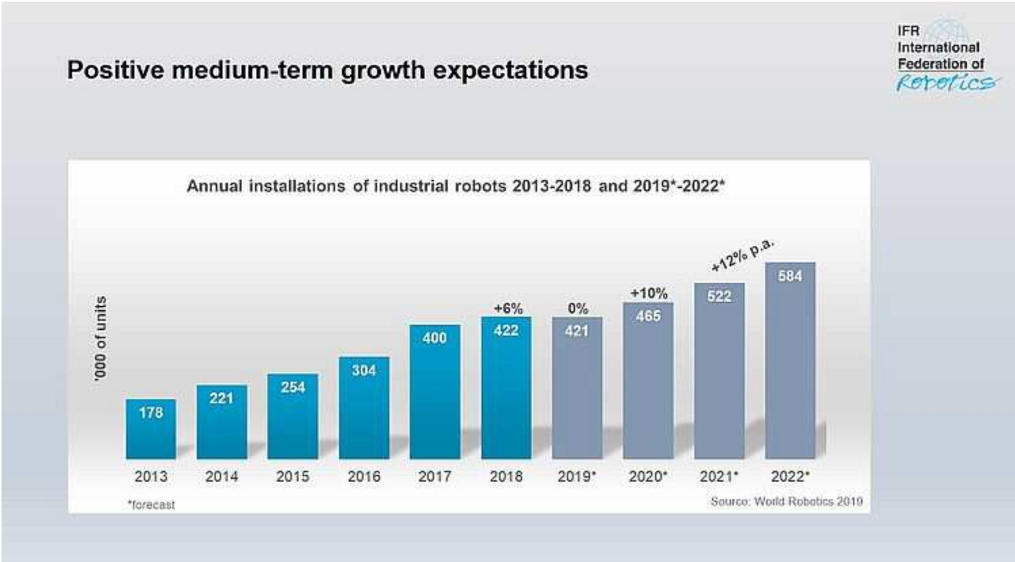
[7] TFM of Edgar Daniel Oliva Navarro “Industria 4.0: Retos y Oportunidades en las Factorías de Automoción, 2018”

According to information from the IFR (2019), the global demand of robots by de automobile industry increased by 21% in 2017 in contrast to the previous year.

World Robotics shows that the Annual installations of industrial robots spent 16.500 million of dollars in 2018, resulting in an increase of 6% than the year before. Despite that, the IFR predicts a decline in 2019, although it also predicts an annual increase of 12% between 2020 and 2022.

Figure 3. Positive medium-term growth expectation



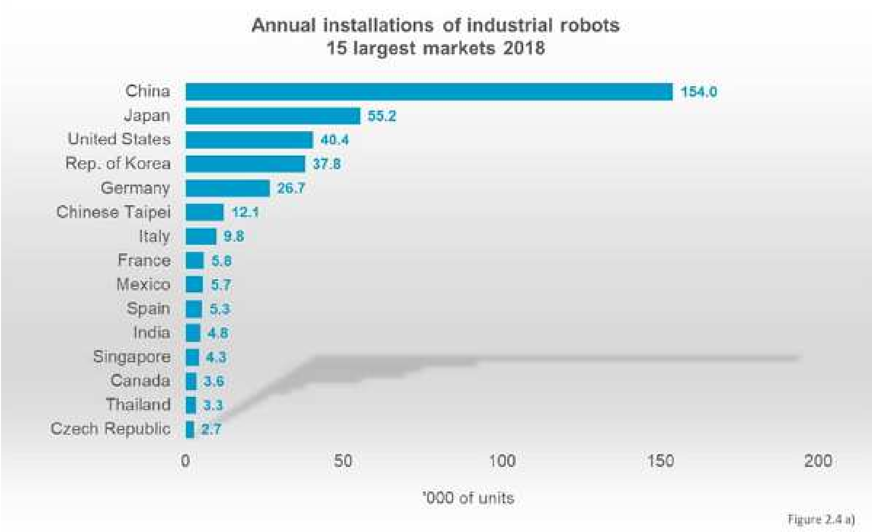
Source: World Robotics 2019

In 2018, the main markets of industrial robots were China, Japan, Corea, USA and Germany. IFR (2019) states that "79% of industrial robot installations took place in 5 key markets: China (39,351 units), Japan (17,346 units), Germany (15,673 units), the United States (15,246 units) and the Republic of Korea (11,034 units)."[8]

Spain is the fourth position in the European ranking, after Germany, Italy and France, as well as the tenth in the world ranking as requestor of industrial robots. (AER, 2018)

[8] Retrieved from International Federation of Robotics, 2019.

Figure 4. Annual installations of industrial robots 15 largest markets 2018



Source: AER

According to International Organization of Motor Vehicle Manufacturers (OICA, 2019), Spain, after Germany, is the second European manufacturer of automobiles.

The automotive industry is a key pillar in economy, since it represents 3.8% of EU GDP and 12.5% of European exports. This industry produces also a dragging effect due to the stimulation on other economic sectors. (Consenso del Mercado, 2019)

Regarding Spain, as ANFAC in its annual report of 2018 confirms, the automotive industry represents 10% of Spanish GDP, and, the first trimester of the current year the poorer performance in relation to exports since 2015.

Among the main causes of this decrease, the environmental restrictions have greatly intervened, as well as the fall of the demands of internal combustion engine cars, the lack of infrastructures (for example, charging spots for electric cars) and the political instability of the country. Besides all that, we can add the intended ban of internal combustion engine cars by 2040 proposed by the current President-in-Office, Pedro Sanchez.

The growing importance of 4.0 Industry has promoted considerable changes in the production processes of the sector.

Industry 4.0 entails new concepts as Smart Factory, Big Data, AI, Lean Manufacturing…which are important for us to know since they are currently an actual part of the automotive industry.

In the following section, we will focus on the importance and popularity acquired by Smart Factories, specifically in the automotive sector.

3.3.1. Smart Factories in the Automotive Industry.

Smart Factory is an emerging concept that has its origin in the 4.0 industry. This concept includes different technologies as AI, IoT, the Big Data and robotics which are characterized by flexible and sustainable production processes

There are several definitions for this term of Smart Factory, as for example, Techtarget (2018) that defines it as followed,

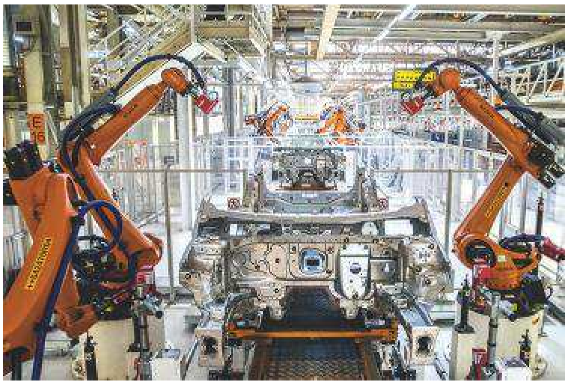
“A smart factory is a highly digitized and connected production facility that relies on smart manufacturing. Thought to be the so-called factory of the future and still in its infancy, the concept of the smart factory is considered an important outcome of the fourth industrial revolution, or Industry 4.0.”

According to Hozdié’s words (2015, p.31):

“A Smart Factory is a manufacturing solution that provides such flexible and adaptive production processes that will solve problems arising on a production facility with dynamic and rapidly changing boundary conditions in a world of increasing complexity. This special solution could on the one hand be related to automation, understood as a combination of software, hardware and/or mechanics, which should lead to optimization of manufacturing resulting in reduction of unnecessary labour and waste of resource.”

Currently, the concept of Smart factories has been used by important automobile companies as Audi which launched an interview called “Encounter” in 2015 to present this concept. Audi also presented a project called “Smart Factory 2035” as a factory of the future, without assembly lines. Audi uses already the virtual reality to instruct its employees. Besides, we have also “The Smart Factory” which belongs to SEAT and is located in Martorell; this Factory has more than 2000 robots in its production plant, uses Additive Manufacturing, augmented reality, among others, and it facilitates exoskeletons at disposal of its employees to help them in their job.

Ilustration 6. Seat Smart Factory (Martorell).



Source: Lancelotdigital

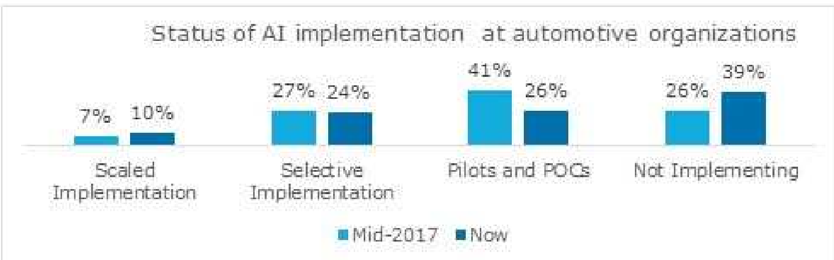
The report named Automotive Smart Factories: How Auto Manufacturers Can Benefit from the Digital Industrial Revolution by Capgemini in 2018, is based on a poll directed to more than 320 automobile manufacturers and reveals that these manufacturers expect that 24% of their production plants become smart factories by the end of 2022.

The report mentioned shows that automobile industry is the most enterprising one in regard to intelligent factories since the 49% of automobile manufacturers have invested for it and exceed the 250 million of dollars.

Despite these claims, the report also shows that the 42% of automobile manufacturers confirms to encounter problems when conducting their projects of intelligent factories.

However, according to a new study of Capgemini, named "Accelerating Automotive's AI Transformation: How Driving AI Enterprise-wide Can Turbo-charge Organizational Value", only 10% of automotive enterprises are implementing projects of AI, whose figure of companies within the sector that use AI in its production process has diminished in comparison the one in 2017. This way, these percentages are shown in the next Figure, Figure 5, related to the world demand of robots by the IFR.

Figure 5. Status of AI implementation of automotive organizations



Source: Capgemini 2019

As the previous figure shows, the number of companies that implements AI at scale has increased a 3%, however, the number of companies which does not implement AI has considerably increased a 13%, from 26% in 2017 to 39% in 2019. On contrast, we should emphasize the reduction from a 41% to 26% of companies with AI pilot projects.

All this is due to the important investment that an implementation like this entails, according to the claims of the report.

Thanks to the analysis, Capgemini also states that 16% of automobile manufactures could enhance their operative gains through the scaled implementation of AI.

Another aspect to emphasise is the existence of start-ups related to the automobile production as Canoo that outsources its production to other companies as Magna International or Faurecia. This way, these start-ups do not pay maintenance costs or experiment the bottlenecks .[9] For example, the Audi Q3 and Audi A1 that is produced in the SEAT Factory in Martorell.

The emergence of these Smart Factories that use cobots[10] and industrial robots as well as a highly automated in the automotive sector, reveals the challenges of the 4th Industrial Revolution that at the same time, jeopardize employability.

3.3.2. Employment in the automotive industry

According to the information of the annual report of ANFAC 2019, the automotive industry represents 9% of the total of the active population in Spain, thus, it is a sector of paramount importance for economy.

There are different types of opinions regarding the growing concerning about employment in automotive sector, and even more after the automotive crisis caused by the decline in sales and private car exports in Europe, and in Spain.

The automotive sector has been affected by several reasons as protectionist politics of world markets. Another reason is pollution since most car companies gather a huge stock of vehicles.

Regarding pollution, the government has announced measures against vehicles that stay above a certain level of CO_2 stablished by EU, due to the dangerous situation of

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[9] Bottleneck: Fase de la cadena de producción que ralentiza el proceso de producción global.

[10] Colaborative robot: robot designed to work as a human colleague in assembly lines.

climate change. This is forcing governments to match taxes of diesel and oil, increasing the tax liability of diesel.

Besides, according to European regulations, the emissions of vehicles will not exceed 95 grams per kilometre, if so, manufacturers will have to cope with penalties per each commercialized vehicle since 2021.

we consider it important to mention, the growing popularity of carsharing which is an alternative that satisfy mobility needs of users without the obligation of burdening the costs of a private vehicle or taxes or insurances.

Regarding the 4.0 industry and employment in automotive sector, there are doubts because of the technological advances, many plant operators are afraid of being substituted by machines or robots as it happened to Charlie's father in the fiction movie of "Charlie and the Chocolate Factory".

Some experts as the general manager of Manufacturing & Resources Industry at Microsoft states that "the growing automation opens new professional careers and the access to new jobs through professional readjustment. And this is only the beginning. Everyone has very attractive opportunities here" (Çaglayan Arkan, 2019).

According to data from PwC (2018), jobs will be reduced at half by 2050 due to the change of model in the automotive sector. PwC consultancy claims that, due to the carsharing and automation, the jobs of plant operators will be reduced by 60% for 2030. In contrast, the demand of engineering will grow considerably, even reaching a growth of 90%.

The responsible for Innovation and Smart Factory of SEAT, Francisco Requena in (El Mundo, 2018) claims that "if we are capable of training these people to learn to innovate and change their culture, the exit is assured".

On the other hand, Capgemini (2019) states that: "AI is seen more as a job-creator rather than a job-destroyer". This is identified through his report which holds that 100% of executives affirm that AI creates new job roles.

In view of this situation, some users joke about these through memes in social media and web pages.

Ilustration 7. AI Memes

Source: Becominghuman *Source: Facebook*

On the contrast, employment in the automotive industry has been always characterized by its stability, since 85% of its job roles are indefinite according to a study called "Situación y perspectivas en el sector del automóvil: medidas ambientales, digitalización y automatización de la industria" (Area de estrategias sectoriales CCOO, 2018).

The maximum number of employments in the vehicle manufacturing companies was reached in 1991 (111.000). Since that year until 2009, there was a decrease of 45% of jobs in the sector. 37% until 2007; 16% in the eighties; 27% in the nineties; 13% during the first decade of XXI century; and it is not yet recovered, in 2017, the employment of 2007, locating in -1,4% of annual average in those 10 years. Despite that, since 2013, it is growing an annual average of 3%.[11]

[11] "Análisis de la situación y perspectivas en el sector del automóvil: medidas ambientales, digitalización y automatización de la industria (Área de estrategias sectoriales perteneciente al sindicato Comisiones Obreras, 2018)".

4. AUTONOMOUS DRIVING IN THE FUTURE

Given the technological advances in automation, experts assure the creation between 2020 and 2030 of cars with level 5 of automation, i.e., driverless.

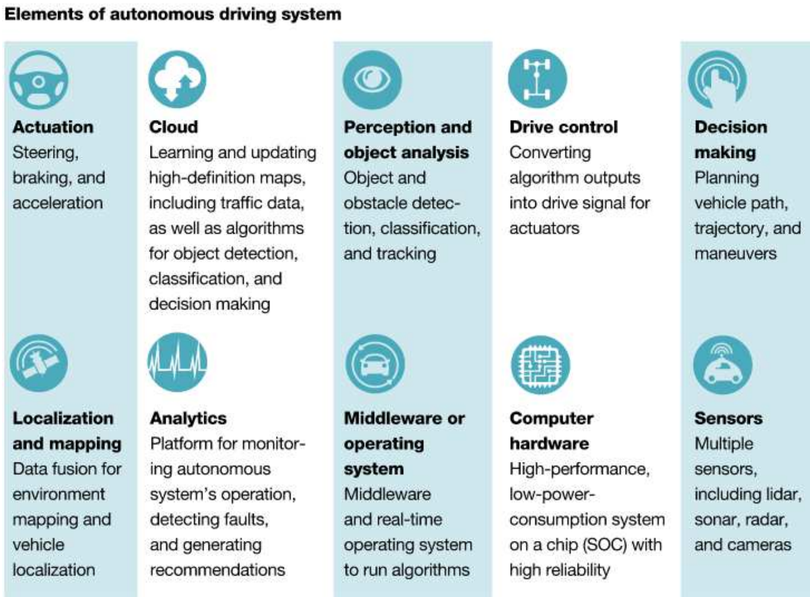
DGT (2015) in Spain defines the autonomous vehicle (AV) as:

"The vehicle that can guide itself through technologies that permit the driving without the need of an active control or supervision on behalf of a driver, whether that autonomous technology is activated or not, in a permanently or temporary"

Autonomous vehicles use different kind of technologies which guarantee their correct functioning. These technologies include features that will worth it to mention. Firstly, the radar which detects environmental elements through the emission of ultrasonic waves. Secondly, the Lidar, which is a rotating device installed atop an autonomous vehicle, creates 3D representation and provides a 360-degree view of the surrounding. Then, we have the GPS, which allows to know the localization of the vehicle, and the IMU that measures and reports the speed and direction.

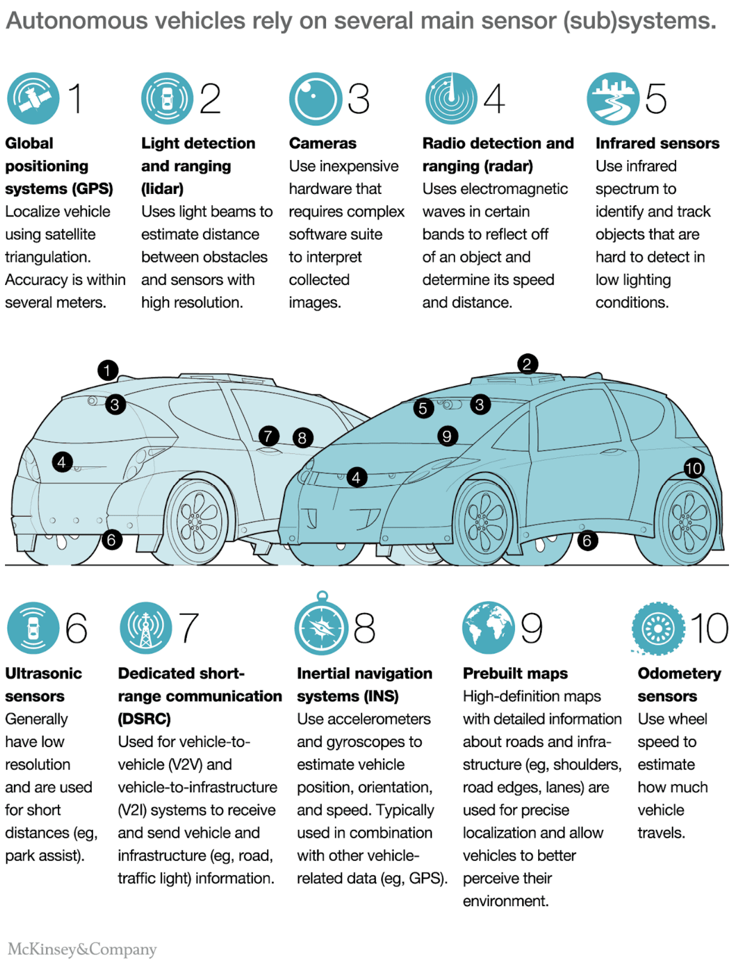
Besides, we find the lane-keep assistance which consists on cameras that recognize the boundaries of the lanes. These cameras are located behind de side mirrors. Next, other integrated feature is Stereo Vision which includes two cameras located on the windscreen, and permits a 3D Vision, visualizing animals or pedestrians. Another feature that is integrated in these autonomous vehicles is the odometer sensor which attaches to each wheel a rotator sensor and it is possible to measure the speed of the vehicle. And lastly, we have the infrared sensors that allows to see objects or people with bad lightening. (RACE, 2018)

Tabla 3. Elements of Autonomous Driving System



Source: McKinsey, 2017

Figure 6. Subsystems of an AV



Source. McKinsey 2017

Nowadays, there are lots of companies that are immersed in the world of AVs, as the main ones which are Tesla and Google, or minor ones as Uber, Volvo, Mercedes, Audi, Apple (Titan Project), Baidu or Toyota. In fact, Toyota has arranged a presentation of its autonomous vehicles in the Olympic Games in Tokyo 2020 (Calvo, 2017).

What is more, Google has created the first Factory of autonomous car in the world, called Waymo, and is located in Michigan, USA. Indeed, Google will built, thanks to an agreement with the manufacturers, the autonomous versions of the Jaguar I Pace and Chrysler Pacifica, integrating the autonomous software and hardware.

From a report of Global Consumer Insights (2019), PwC claims that 22% of cosumers are interested in AV, and 24% of them will use these casr in the future.

Popularity and advances regarding the AV promote the emergence of the fifth-screen economy which can be shown in the update of V10 software from Tesla that includes a videogame (Cuphead), Netflix, Spotify and Karaoke, among others.

Ilustration 8. Inside-view of a Tesla Vehicle with V10 Software

Source: Computer Hoy

With the emergence of the AV come along a war of business opportunity for those which offer robotaxis and this increases the competitive tension between companies. In USA and China has proved and set up pilot programs to test the reliability of this technology, Europe is a step behind, though.

Elon Musk, Tesla CEO, has planned to offer his own fleet of robotaxis and launched it in the market as well as an application where Tesla owners could offer their vehicles as taxis, in a way, that these vehicles would self-finance. In order to bolster the idea, Musk offers money to those users who participate in the application.

On contrast, Waymo which belongs to Alphabet conglomerate and formerly known as "Google self-driving car Project", is offering its taxi service in Phoenix and Sillicon Valley. In fact, these taxis have transported 6.299 passengers in the first month as a component in the pilot program of robotaxis in California, according to reports of Techcrunch (2019).

Ilustration 9. Autonomous Vehicle by Waymo

Source: PrimerHub

Then, Uber that is currently facing an accusation for hiding a cyberattack, however, Uber had an arrangement with Volvo, and they have presented the autonomous Volvo XC90 that will include the figure of "Mission Specialist" [12] as a higher security guarantee.

Ilustration 10. Volvo XCV90

Source: Motorpasion

[12] Mission Specialist: Driver trained to supervise the working of the vehicle and take control in case of error.

In china, the Company Didi has currently launch a pilot Project of AV in Shanghai and it is totally free. It is important to emphasize the alliance of Baidu with Volvo, that it is the first time that joins a foreign company to create AV in 2018.

Europe is more reticent regarding the autonomous driving, since the robotaxis has not been promoted due to the restrictive measures and controls in relation to this type of vehicles.

However, it is expected the first robotaxis to arrive to Europe due to a contract signed by Google, Renault and Nissan which want to present a robotaxi service in Paris. This fleet of taxis would drive through a route of 34km located between Charles de Gaulle airport and Le Defense.

There is not a fixed date for it, but it is expected to be before the Olympics Games in 2024. The initiative has the support of French Island which has invested 100 million of Euros to de development of infrastructures to accomplish a safe driving of autonomous vehicles.

These companies should face the consequently distrust on the autonomous driving, due to great number of accidents produced by autonomous vehicles.

It is important to say that, at the moment, autonomous vehicles would continue driving with a driver until these would be trusted by governments and citizens, as well as when legislation would adjust to the current world of automation in the automotive industry.

5.CONCLUSION

The growing reliance of tools emerged in the period of Industry 4.0 as IoT, Robotics, AI, Smart Factories, connectivity and implementation of automatic production processes by companies have promoted clear benefits like a significant increment of productivity with a minor number of workers, of quality and a reduction of costs.

Nevertheless, these technological advances entail also some drawbacks as the loss of Jobs since the percentage of automatized employments grows every time more. Every time there are less and less physical human employees in front of desks to attend people personally, such as Decathlon, McDonalds or some supermarkets that all use the Rfid technology, i.e. self-service checkouts. However, there are some theories regarding employment evolution, “employment will not be destroyed or created, but transformed” (Hidalgo, 2018, p.166).

It is important to say that “So far, automation through information technology in general and AI in particular has created more jobs than it has eliminated, and has created more interesting, higher-paying jobs” (Russell and Norvig, 2004, p. 1034).

Despite that, thanks to the evolution of ICTs and Smart Factory, employment grows along with the skills and knowledge required to acquire those jobs.

The increasingly demand of robots is evident, and is led by the automotive sector, which covers around 30% of world demand (IFR, 2019).

Along with the advances of the automotive industry from the “Fardier a Vapeur” to the AV, there are new mysteries to bear in mind as the liability issue in case of a traffic accident. They are requiring to cope with several issues and transformations until its fully implementation, like for example, the limitation of responsibilities of the driver and vehicle or software manufacturers in vehicles with level 2 to 4 of automation.

Therefore, driving schools should include in driving classes the use of highly automated vehicles, as with level 3, 4 or 5. Besides, the insurance companies should adapt the new market generated by the emergence of these vehicles as we have been able to demonstrate with this research project, that every day there more companies that bet for investing in the creation of highly automated vehicles.

A true fact is that progress is coming, slowly but surely, and society is not prepared to be conscious of the great change that autonomous driving implies.

But this certainly is no wonder taking into account that, in the future, more alarming claims by taxi drivers against autonomous driving, such as the ones in relation to *ludismo* presented by English workers against weaving machines in the XIX century (Hidalgo, 2018).

As Russell and Norvig point out (2004, p. 1035) “AI, if widely successful, may be at least as threatening to the moral assumptions of 21st-century society as Darwin’s theory of evolution was to those of the 19th century.”

All in all, the future is full of big questions. The implementation of AV entails a challenge economically speaking as well as political and socially, that is more a reality every day.

6.BIBLIOGRAPHIC REFERENCES

AER Automation. (2019). España bate su récord histórico instalando 5.266 robots industriales en 2018. Retrieved 01 October 2019, from https://www.aer-automation.com/espana-bate-su-record-historico-instalando-5-266-robots-industriales-en-2018/

Álvarez, S. (2009, November 18). Mercedes 206 D de 1936, el primer turismo diesel de la historia. Diariomotor. Retrieved 9 September 2019, from https://www.diariomotor.com/2009/11/18/mercedes-260-d-de-1936-el-primer-turismo-diesel-de-la-historia/

Álvarez, S. (2019, June 14). Uber y Volvo presentan el XC90 autónomo de producción: tu futuro robo-taxi. Diariomotor. Retrieved 14 October 2019, from https://www.diariomotor.com/noticia/uber-volvo-xc90-autonomo/

ANFAC (2019). Informe Anual 2018.

Área de estrategias sectoriales perteneciente al CCOO industria (2018). Situación y perspectivas en el sector del automóvil. Medidas ambientales, digitalización y automatización de la industria. Retrieved 11 June 2019, from https://industria.ccoo.es/9ddeee3ef0745110d18ae92f9a4bc706000060.pdf

Aspromec. (2019). La Smart Factory ya es una realidad. Retrieved 27 September 2019, from https://aspromec.org/la-smart-factory-ya-es-una-realidad/

Automation (undated). Modern developments. Retrieved 24 September 2019, from https://www.britannica.com/technology/automation/Modern-developments

Barajas, O. (2019, June 02). Tesla competirá con Uber con sus propios robotaxis sin conductor. Electrónicos online Magazine. Retrieved 11 October 2019, from https://www.electronicosonline.com/tesla-competira-con-uber-con-sus-propios-robotaxis-sin-conductor/

Böni, S. (2018). Smart Factory: Audi's Car Production of the Future. Retrieved 2 October 2019, from https://www.spotlightmetal.com/smart-factory-audis-car-production-of-the-future-a-758621/

Camós, J. (2013). 100 años de Ford en cadena, o cuando Ford reinventó la Industria del Automóvil. Retrieved 16 September 2019 from https://www.motorpasion.com/industria/100-anos-de-ford-en-cadena-o-cuando-ford-reinvento-la-industria

Capgemini España. (2019). Impulsamos la inteligencia artificial en el sector de automoción: El número de empresas del sector de automoción que implementan IA a escala alcanza el 10%. Retrieved 27 September 2019, from https://www.capgemini.com/es-es/instituto-de-investigacion-de-capgemini/impulsamos-la-inteligencia-artificial-en-el-sector-de-automocion/

Capgemini. (2018). Automotive Smart Factories | Research Report. Retrieved 2 October 2019, from https://www.capgemini.com/resources/automotive-smart-factories/?utm_source=pr&utm_medium=referral&utm_content=automotive_none_none_pressrelease_none&utm_campaign=disruptdigital_dti_automotive_smartfactories

Caso, M. (2019, January 19). El dilema de los coches autónomos: ¿Qué elegirá el coche? ¿Atropellar a un peatón o chocar el vehículo poniendo en peligro la vida de los que van dentro?. El País. Retrieved 2 October 2019, from https://elpais.com/elpais/2019/01/02/opinion/1546455278_349208.html

Chatterjee, V. (2018). Society of Automotive Engineers (SAE) Automation Levels for cars. Retrieved 23 September 2019 from https://www.automotivelectronics.com/sae-levels-cars/

Chaves. J. (2004) “Desarrollo tecnológico en la Primera Revolución Industrial”. Retrieved 23 January 2019, from https://dialnet.unirioja.es/servlet/articulo?codigo=1158936

Clemente, P. (2018, May 16). Robots, 3D y Realidad Virtual en la planta de SEAT. El Mundo. Retrieved 2 October 2019, from https://www.elmundo.es/economia/innovadores/2018/05/16/5af9ba56ca474156348b4603.html

Coche autónomo: ¿quién responde si falla?. (2019, February 13). Retrieved 13 October 2019, from https://www.autofacil.es/coches-autonomos/2019/02/13/coche-autonomo-responde-falla/45636.html

Código de Tráfico y Seguridad Vial, edición actualizada de 16 de julio de 2019. Boletín Oficial del Estado.

Consenso del Mercado. (2019). El automóvil, un sector clave en Europa: su contribución a la economía estimula al resto de industrias. Retrieved 2 October 2019, from https://consensodelmercado.com/component/k2/18935/el-automovil-un-sector-clave-en-europa-su-contribucion-a-la-economia-estimula-al-resto-de-industrias

Córdoba Nieto, E. (2006). Manufacturing and automation. Retrieved 14 March 2019, from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-56092006000300014

Costas, J. (2011). Hace 75 años apareció el primer Mercedes diesel. Retrieved 11 September 2019, from https://www.motorpasion.com/otros/hace-75-anos-aparecio-el-primer-mercedes-diesel

Curiosidades del motor: del primer coche eléctrico al primer diésel. (2019, January 04). Retrieved 10 September 2019, from https://www.abc.es/motor/reportajes/abci-curiosidades-motor-primer-coche-electrico-primer-diesel-201901040223_noticia.html

Davis, N.; O’Halloran, D. (2018, November 08). The Fourth Industrial Revolution is driving globalization 4.0. Retrieved 24 September 2019, from https://www.weforum.org/agenda/2018/11/the-fourth-industrial-revolution-is-driving-a-new-phase-of-globalization/

Deane.P. (1987). La primera Revolución Industrial, Madrid, Península; p.7 y ss

Della Colleta, R. (2017, November 30). La robótica eliminará hasta 800 millones de empleos en el 2030. El País. Retrieved 14 March 2019, from https://elpais.com/economia/2017/11/30/actualidad/1512012918_284848.html

DGT (2016). Mecánica y entrenenimiento simple del automóvil. Retrieved 25 September 2019, from http://www.dgt.es/Galerias/seguridad-vial/formacion-vial/cursos-para-profesores-y-directores-de-autoescuelas/XIX-curso-de-profesores/Mecanica-y-entretenimiento-simple-del-automovil.pdf

Díaz, M. (2018). Así será la producción de coches en 2030. Retrieved 26 September 2019, from https://ideas.pwc.es/archivos/20181123/produccion-coches-en-2030/

Díaz, M. (2019). La quinta pantalla del coche autónomo. Retrieved 27 September 2019, from https://ideas.pwc.es/archivos/20190614/la-quinta-pantalla-del-coche-autonomo/

Dornier, P. (2019). How much are we paying in fuel taxes? Retrieved 12 October 2019, from https://www.transportenvironment.org/publications/how-much-are-we-paying-fuel-taxes

Economía Digital. (2019). Los robotaxis de Google llegarán a Europa con Renault. Retrieved 14 October 2019, from https://www.economiadigital.es/tecnologia-y-tendencias/los-robotaxis-de-google-llegaran-a-europa-con-renault_632897_102.html

El sector del automóvil podría ahorrar 32.000 millones de dólares gracias a la automatización. (2018, October 22). Retrieved 11 September 2019, from https://www.abc.es/motor/economia/abci-sector-automovil-podria-ahorrar-32000-millones-dolares-gracias-automatizacion-201810220122_noticia.html

Electromovilidad. (n.d.). ¿Qué es el carsharing? Retrieved 27 September 2019, from http://electromovilidad.net/que-es-el-carsharing/

España bate su récord en 2018 en instalación de robots industriales. (2019, September 23). Retrieved 25 September 2019 from http://www.auto-revista.com/es/notices/2019/09/espana-bate-su-record-en-2018-en-instalacion-de-robots-industriales-123137.php

Estos 15 coches han marcado la historia de la automoción. (2017, April 23). Retrieved 09 September 2019, from https://motor.elpais.com/actualidad/15-coches-historia-de-la-automocion/

Europapress. (2018). La plantilla del automóvil se recortará un 50% para 2050 por el cambio de modelo del sector. Retrieved 11 September 2019, from: https://www.europapress.es/motor/coches-00640/noticia-plantilla-automovil-recortara-50-2050-cambio-modelo-sector-20181123144736.html

Fenercom (2015). Guía del Vehículo Eléctrico II. Retrieved 2 October 2019, from https://www.fenercom.com/wp-content/uploads/2015/04/Guia-del-Vehiculo-Electrico-II-fenercom-2015.pdf

Fernández, M. (2019, June 13). Llega el primer autobús autónomo de España, 4 veces más seguro que un coche normal. El Español. Retrieved 1 October 2019, from https://www.elespanol.com/omicrono/20190613/llega-primer-autobus-autonomo-espana-seguro-normal/405960856_0.html

Frey, C. B., & Osborne, M.A. (2013). The Future of Employment: hoy susceptible are jobs to computerisation?. Retrieved from https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Fuentes, V. (2017). Uber tendrá su propia flota de taxis autónomos: 24.000 Volvo XC90 para 2021. Retrieved 30 September 2019, from https://www.motorpasion.com/tecnologia/uber-tendra-su-propia-flota-de-taxis-autonomos-24-000-volvo-xc90-para-2021

García, D. (2015). Smart factory - Audi muestra la producción inteligente. Retrieved 25 September 2019 from https://www.infoplc.net/actualidad-industrial/item/102777-smart-factory-audi-encounter

García, M. (2019, February 09). Arranca el gran negocio de los robotaxis: taxis sin taxistas. El Independiente. Retrieved 2 October 2019, from https://www.elindependiente.com/economia/2019/02/09/arranca-el-gran-negocio-de-los-taxis-sin-taxistas/

González, J. (2018). Inventos que cambiaron la historia del automóvil. Retrieved 09 September 2019, from https://www.muyinteresante.es/curiosidades-motor/fotos/inventos-que-cambiaron-la-historia-del-automovil/2

Graham, D. (2019). Waymo - Evolution of the Self-Driving Car. Retrieved 01 October 2019 from https://primerhub.com/self-driving-cars/waymo

Guzmán, J. (2017). Honda NeuV Concept 2017, eléctrico y autónomo. Retrieved 23 September 2019 from https://es.motor1.com/news/138507/honda-neuv-concept-2017-electrico/

Hayes, S. (2015). Industrial automation and Stress, c.1945-79. In Jackson, M. (Ed.) Stress in Post-War Britain. (pp. 75-93). New York: Routledge.

Heineke, K., Khampshoff, P., Mkrtchyan, A. and Shao, E. (2017). Self-driving car technology: When will the robots hit the road?. Retrieved 26 September 2019, from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/self-driving-car-technology-when-will-the-robots-hit-the-road

Hernandez, J. (2019). La apuesta de Renault y Waymo con taxis autónomos en Francia. Retrieved 17 October 2019, from https://notipress.mx/movilidad/la-apuesta-de-renault-waymo-con-taxis-autonomos-en-francia-2100

Hidalgo, M.A. (2018). El empleo del futuro. Un análisis del impacto de las nuevas tecnologías en el mercado laboral. Barcelona: Deusto.

Hozdié, E. (2015). Smart factory for industry 4.0: a review. International Journal of Modern Manufacturing Technologies, 7(1), 28-35. Retrieved 25 September 2019 from https://www.researchgate.net/publication/282791888_Smart_factory_for_industry_40_A_review

https://blog.apastyle.org/apastyle/2016/04/how-to-cite-a-blog-post-in-apa-style.html

Ibáñez (2017). De 0 a 5: cuáles son los diferentes niveles de conducción autónoma, a fondo. Retrieved 16 September 2019 from https://www.xataka.com/automovil/de-0-a-5-cuales-son-los-diferentes-niveles-de-conduccion-autonoma

Ibañez, Á. (2018, August 03). La invención del control de crucero: una genialidad de un inventor que no podía conducir porque era ciego. [Blog post]. Retrieved 11 September 2019, from https://tecvolucion.com/invencion-control-de-crucero/

Interempresas. (2019). Crece un 6% el número de robots industriales instalados en todo el mundo en 2018. Retrieved 25 September 2019 from https://www.interempresas.net/Robotica/Articulos/254914-Crece-un-6-por-ciento-el-numero-de-robots-industriales-instalados-en-todo-el-mundo-en-2018.html

International Federation of Robotics (2018). Industrial robot sales increase worldwide by 31 percent. Retrieved 1 October 2019, from https://ifr.org/ifr-press-releases/news/industrial-robot-sales-increase-worldwide-by-29-percent

International Federation of Robotics. (2018). Industrial robot sales increase worldwide by 31 percent. Retrieved 20 January 2019, from https://ifr.org/ifr-press-releases/news/industrial-robot-sales-increase-worldwide-by-29-percent

International Federation of Robotics. (2019). Industrial Robots: Robot Investment Reaches Record 16.5 billion USD. Retrieved 20 September 2019, from https://ifr.org/ifr-press-releases/news/robot-investment-reaches-record-16.5-billion-usd

Juana, R. (2017). Alemania presenta su primera ley para regular los vehículos autónomos. Retrieved 25 September 2019, from https://www.muypymes.com/2017/06/14/alemania-presenta-primera-ley-regular-los-vehiculos-autonomos

Keeney, T. (2019). Takeaways from Our Recent Podcast with Elon Musk. Retrieved 20 September 2019, from https://ark-invest.com/research/elon-musk-podcast

Korosec, K. (2019, September 16). Waymo's robotaxi pilot surpassed 6,200 riders in its first month in California. [Blog post]. Retrieved 11 October 2019, from https://techcrunch.com/2019/09/16/waymos-robotaxi-pilot-surpassed-6200-riders-in-its-first-month-in-california/ https://www.electronicosonline.com/tesla-competira-con-uber-con-sus-propios-robotaxis-sin-conductor/

Kretz, C. (2012). Le Fardier. Retrieved 09 September 2019, from http://carloskretz.com/portfolio_page/le-fardier/

KUKA AG. (n.d.). Automatización industria del automóvil. Retrieved 11 September 2019 from https://www.kuka.com/es-es/sectores/autom%C3%B3vil

La Comunidad del Taller. (2019). ¿Cómo afecta la implantación del coche autónomo a las aseguradoras?. Retrieved 2 October 2019, from https://www.lacomunidaddeltaller.es/como-afecta-la-implantacion-del-coche-autonomo-a-las-aseguradoras/

Landes, D. S.(1969). The Unbound Prometheus. Technological change and industrial development in Western Europe from 1750 to the present. United Stated of America: Cambridge.

Landes,D. S. (1979). Progreso tecnológico y revolución industrial, Madrid; Tecnos; p.15

Lasso, J. (2018, December 14). SEAT rompe la barrera de los 10 millones de vehículos fabricados en Martorell. Lancelot Digital. Retrieved 2 October 2019, from https://www.lancelotdigital.com/motor/seat-rompe-la-barrera-de-los-10-millones-de-vehiculos-fabricados-en-martorell

Llorente, M. (2019, May 26). Por el cambio, pero sin perder competitividad. Heraldo. Retrieved 25 September 2019 from https://www.heraldo.es/noticias/economia/2019/05/26/por-el-cambio-pero-sin-perder-competitividad-1316963.html

Los robots podrían quitarle el empleo a 800 millones de personas en 2030. (2017, December 01). Retrieved 14 March 2019, from https://www.elboletin.com/noticia/156589/mercados/los-robots-podrian-quitar-el-

Mancebo, J. (2018). El desarrollo del coche autónomo en España. Retrieved 13 October 2019, from https://puentesdigitales.com/2018/12/17/el-desarrollo-del-coche-autonomo-en-espana/

MAPFRE. (n.d.). El seguro de un coche autónomo Retrieved 17 September 2019, from https://www.mapfre.es/seguros/particulares/coche/articulos/seguro-de-coche-autonomo.jsp

Marchán. E (2016) La creciente automatización de los puestos de trabajo. (TFG) Universidad Miguel Hernández. Elche.

Margot, M. (n.d.) Factores de análisis para el cambio de un proceso manual a la automatización. (TFG). Universidad de Sonora. México.

Mayoral, C. (2019). Retos del sector asegurador ante la aparición del coche autónomo. Retrieved 17 September 2019, from https://www.bbva.com/es/es/retos-del-sector-asegurador-ante-la-aparicion-del-coche-autonomo/

McKinsey & Company. (2019). “Instantáneas” de la revolución global de la movilidad. Retrieved 13 September 2019, from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/snapshots-of-the-global-mobility-revolution/es-es

MCR, G. (2016). Ventajas y desventajas de la automatización industrial. Retrieved 2 February 2019, from https://www.mcr.es/ventajas-y-desventajas-de-la-automatizacion-industrial/

Merino, M. (2019). Por qué lo que Tesla y otros llaman "piloto automático" no es realmente un coche autónomo. Retrieved 11 October 2019, from https://www.xataka.com/inteligencia-artificial/que-que-tesla-otros-llaman-piloto-automatico-no-realmente-coche-autonomo

Mezcua, U. (2019, October 16). El «laboratorio» del PSOE propone subir en 10.000 millones los impuestos al diésel y la gasolina y pagar por usar el coche. Abc. Retrieved 17 October 2019, from https://www.abc.es/motor/economia/abci-laboratorio-psoe-propone-subir-10000-millones-impuestos-diesel-y-gasolina-y-pagar-usar-coche-201910160251_noticia.html

Miguez, C. (2018). Análisis de la evolución del diseño del automóvil desde sus inicios hasta la actualidad. (TFG). Universidad de Valladolid y Escuela de Ingenierías Industriales. Valladolid. Retrieved 11 September 2019, from https://uvadoc.uva.es/bitstream/handle/10324/31314/TFG-P-868.pdf;jsessionid=7F81F4C316F745BAE7E0E0B725CD2153?sequence=1

Montoro, L.; Martí-Belda, A.; Lijarcio, I.; Bosó, P.; López, C.; Viladrich, R.; Suárez, J. (n.d). Coche autónomo, seguridad víal y formación de conductores. Universitat de Valencia. Valencia. Retrieved 24 September 2019, from https://www.cnae.com/ficheros/files/noticias/INFORME%20Coche%20auto%CC%81nomo%20seguridad%20vial%20y%20formacio%CC%81n%20de%20conductores_%20INTRAS-CNAE.pdf

Murias, D. (2017). Así es como el automóvil se impuso en los ejércitos. Retrieved 09 September 2019, from https://www.motorpasion.com/clasicos/de-la-maquina-de-vapor-al-peugeot-phaeton-24-cv-asi-es-como-el-automovil-se-impuso-en-los-ejercitos.

Murias, D. (2019). Canoo es el coche eléctrico que pretende reinventar nuestra relación con el automóvil a partir de 2021. Retrieved 30 September 2019, from https://www.motorpasion.com/industria/canoo-coche-electrico-que-pretende-reinventar-nuestra-relacion-automovil-a-partir-2021

OICA. (2019). 2018 Statistics. Retrieved 25 September 2019, from http://www.oica.net/category/production-statistics/2018-statistics/

Oliva, E.D. (2018). Industria 4.0: Retos y oportunidades en las factorias de automoción. (TFM). Escuela de Ingenierías Industriales. Valladolid. Retrieved 26 September 2019, from http://uvadoc.uva.es/bitstream/handle/10324/29368/TFM-I-803.pdf?sequence=1&isAllowed=y

Oliván Cortés, R. (2016). La Cuarta Revolución Industrial, un relato desde el materialismo cultural. Retrieved 17 January 2019, from http://repositorio.ual.es/bitstream/handle/10835/4809/LA%20CUARTA%20REVOLUCION%20INDUSTRIAL.pdf?sequence=1

Olona, A. (2018, Jan/March). Seguridad víal en vehículos altamente automatizados. Revista técnica Centro Zaragoza, 75, 40-44.

Ortega, E. (2019). Tesla v10.0, los coches de Tesla se actualizan con un amplio repertorio de novedades. Retrieved 14 October 2019, from https://computerhoy.com/noticias/motor/tesla-v100-coches-tesla-actualizan-amplio-repertorio-novedades-500329

Oxford Adavanced Learner’s Dictionary (n.d.). Automatic_1 adjective - Definition, pictures, pronunciation and usage notes. Retrieved 15 September 2019, from https://www.oxfordlearnersdictionaries.com/definition/english/automatic_1?q=automatic

Parissien, S. (2013). The life of the automobile. London: Atlantic Books.

Parra, S. (2019). ¿Cuáles son los niveles de automatización de un coche autónomo?. Retrieved 16 September 2019 from https://www.xatakaciencia.com/tecnologia/cuales-son-los-niveles-de-automatizacion-de-un-coche-autonomo

Pastor, J. (2019). El tercer accidente fatal de Tesla revela la diferencia con un coche totalmente autónomo: el conductor debe estar alerta. Retrieved 25 September 2019 from https://www.xataka.com/vehiculos/tercer-accidente-fatal-tesla-revela-diferencia-coche-totalmente-autonomo-conductor-debe-estar-alerta

Pausch-Homblé, K. (2019). Reducción de las emisiones: el Consejo adopta normas sobre CO2 para camiones. Retrieved 12 October 2019, from https://www.consilium.europa.eu/es/press/press-releases/2019/06/13/cutting-emissions-council-adopts-co2-standards-for-trucks/

Payá, A. (2014, February 01). Los orígenes del coche eléctrico. [Blog post]. Retrieved 9 September 2019, from https://blogs.20minutos.es/coches-electricos-hibridos/2014/02/01/los-origenes-del-coche-electrico/

Peña, A. (2016, September 20). ¿Quién inventó el primer automóvil a gasolina?. Okdiario. Retrieved 9 September 2019, from https://okdiario.com/curiosidades/quien-invento-coche-gasolina-389383/fotos/benz-motorwagen-primer-automovil-gasolina?pid=389383

Pérez, E. (2019). "Para 2020 podremos dormir mientras el coche conduce", Elon Musk promete que la conducción autónoma de Tesla llegará el próximo año. Retrieved 11 October 2019, from https://www.xataka.com/automovil/para-2020-podremos-dormir-coche-conduce-elon-musk-promete-que-conduccion-autonoma-tesla-llegara-proximo-ano

PortalEducativo (2009) “La Revolución Industrial” Retrieved 29 January 2019, from https://www.portaleducativo.net/

Posventa.com. (2018). Las tendencias de la Industria 4.0 de automoción, a debate en Matelec Industry 2018. Retrieved 15 September 2019 from http://www.posventa.com/es/notices/2018/11/las-tendencias-de-la-industria-4.0-de-automocion-a-debate-en-matelec-industry-2018-57396.php#.Xba_0ehKjIV

Prego, C. (2019). El otro gran reto de los vehículos autónomos: aclarar las responsabilidades en caso de siniestro. Retrieved 13 October 2019, from https://www.xataka.com/automovil/otro-gran-reto-vehiculos-autonomos-aclarar-responsabilidades-caso-siniestro

Prego, C. (2019). Qué dice la legislación española sobre los coches autónomos: una instrucción y muchas incógnitas. Retrieved 11 October 2019, from https://www.xataka.com/vehiculos/que-dice-legislacion-espanola-coches-autonomos-instruccion-muchas-incognitas

Prieto, Á. (2018). ¿Quién inventó el coche? Si estás pensando en un alemán andas equivocado. Retrieved 09 September 2019, from https://www.autonocion.com/quien-invento-el-coche/

PwC. (n.d.). Temas candentes de la industria del automóvil en España. Acelerar el cambio para garantizar el futuro. Retrieved 12 October 2019, from https://www.pwc.es/es/publicaciones/automocion/assets/acelerar-cambio-garantizar-futuro.pdf

RACE. (2018). Coches autónomos: carrera hacia la autonomía total. Retrieved 2 October 2019, from https://www.race.es/coches-autonomos-carrera-autonomia-total

Real Academia Española (2018) "Consultar palabras". Retrieved 22 January 2019, from http://dle.rae.es/?id=4TO3M08

Resolución de textos aprobados por parte del Parlamento Europeo, de 15 de enero de 2019, sobre la conducción autónoma en los transportes europeos. Parlamento Europeo.

Rifkin, J. (2011). La Tercera Revolución Industrial: Cómo el poder lateral está transformando la energía, la economía y el mundo. España: Paidós.

Rifkin, J. (2014). La sociedad de coste marginal cero. España: Paidós.

Roel, V. (1998). La tercera revolución industrial y la era del conocimiento. UNMSM.

Romagosa, J. (2011). A cien: Jenatzy y la Jamais Contente. . Retrieved 10 September 2019, from https://www.motorpasion.com/clasicos/a-cien-jenatzy-y-la-jamais-contente

Rouco, F. (2019). Año y medio después del primer atropello por un coche autónomo: menos grandilocuencia, más investigación y nuevas preguntas. Retrieved 2 October 2019, from https://www.xataka.com/automovil/ano-medio-despues-primer-atropello-vehiculo-autonomo-grandilocuencia-investigacion-nuevas-preguntas

Rouco, F. (2019). Así justifican los escépticos del coche autónomo que éste no vaya a terminar por completo con los accidentes de tráfico. Retrieved 2 October 2019, from https://www.xataka.com/automovil/asi-justifican-escepticos-coche-autonomo-que-este-no-vaya-a-terminar-completo-accidentes-trafico

Roy, P. (2018). New research from Capgemini shows the automotive industry could gain $160 billion through smart factory adoption by 2023 onwards. Retrieved 2 October 2019, from https://www.capgemini.com/es-es/news/la-industria-del-automovil-ganara-160-000-millones-de-dolares-en-productividad-con-la-fabrica-inteligente-para-2023/

Roy, P. (2019). Informe de inteligencia artificial en el sector automoción. Retrieved 27 September 2019, from https://www.capgemini.com/es-es/news/informe-de-inteligencia-artificial-en-el-sector-automocion/

Russell, S.; Norvig, P. (2004). Inteligencia Artificial. Un enfoque moderno. Madrid: Pearson.

Sanz, M. (2019). Los robot-taxis cada vez más cerca de Europa: Waymo y Renault quieren llevarlos a las calles de París. Retrieved 17 October 2019, from https://computerhoy.com/noticias/motor/robot-taxis-europa-waymo-renault-paris-512051

Schwab, K. (2016). La cuarta revolución industrial. Debate. Retrieved 03 February 2019, from http://40.70.207.114/documentosV2/La%20cuarta%20revolucion%20industrial-Klaus%20Schwab%20(1).pdf

Schwab, K. (2018, November 05). Globalization 4.0- ¿What does it mean?. Retrieved 24 September 2019, from https://www.weforum.org/agenda/2018/11/globalization-4-what-does-it-mean-how-it-will-benefit-everyone/

Sisteplant expondrá su Automotive Smart Factory en MetalMadrid. (2018, September 09). Retrieved 2 October 2019, from http://www.auto-revista.com/es/notices/2018/09/sisteplant-expondra-su-automotive-smart-factory-en-metalmadrid-122114.php#.Xbb4hehKjIV

SIVSA (2018). Las ventajas de la Industria 4.0 en automoción. Retrieved 15 September 2019 from https://www.sivsa.com/site/las-ventajas-de-la-industria-4-0-en-automocion/

Sociedad de Técnicos de Automoción (2011). El Vehículo Eléctrico. Desafíos tecnológicos, infraestructuras y oportunidades de negocio. Retrieved from https://books.google.es/books?hl=es&lr=&id=z6VlQmSodD8C&oi=fnd&pg=PA12&dq=el+primer+veh%C3%ADculo+el%C3%A9ctrico+de+la+historia&ots=qS5-pGCVkZ&sig=YDqc1RbWx0-bWylVsw4cJu6tpH4&redir_esc=y#v=onepage&q=el%20primer%20veh%C3%ADculo%20el%C3%A9ctrico%20de%20la%20historia&f=false

Soto, L. (2018, January 30). Todo lo que necesitas saber sobre la llegada del coche autónomo. El Motor. Retrieved 30 September 2019, from https://motor.elpais.com/tecnologia/saber-coche-autonomo/

Teetor, R (1950). Patent Nº US2519859A. EE.UU. (EE.UU.)

Téllez, J. (2018, March 04). Estos son los puestos de trabajo que más peligran con la robotización. Vozpopuli. Retrieved 5 February 2019, from https://www.vozpopuli.com/economia-y-finanzas/empresas/robotizacion-automatizacion-empleo-desempleo-inteligencia-artificial-trabajo_0_1113789576.html

Tesla.com. (2019). Piloto automático. Retrieved 30 September 2019 from https://www.tesla.com/es_ES/autopilot

Vall, C.; Avilés, E. (2018). La producción del Audi A1 empieza en SEAT en Martorell. Retrieved 27 September 2019, from https://www.seatmediacenter.es/newspage/allnews/company/2018/La-produccion-del-Audi-A1-empieza-en-SEAT-en-Martorell.html

VIU (2018). Smart factory: el Internet de las Cosas aplicado a la industria. Retrieved 2 October 2019, from https://www.universidadviu.es/smart-factory-el-internet-de-las-cosas-aplicado-la-industria/

Williamson, J. G. (2012). El desarrollo económico mundial en perspectiva histórica: cinco siglos de revoluciones industriales, globalización y desigualdad (Vol. 88). Universidad de Zaragoza.