POLITECNICO DI TORINO

NEW AFTER SALES PROCESSES AND CONNECTED VEHICLE SCENARIO

Master's Degree in Mechanical Engineering

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A Mamma e Papà,
vi voglio bene.

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SOMMARIO

Si sente sempre più spesso parlare di Industria 4.0 per indicare il radicale cambiamento di paradigma che il settore manifatturiero sta affrontando in questi ultimi anni grazie alla diffusione delle tecnologie digitali e alla loro integrazione nella filiera produttiva.

Nell'Industria 4.0 i big data, i robot, i data analytics e la comunicazione tramite Internet si diffondono nelle fabbriche e snelliscono il processo di produzione rendendolo più efficiente, dinamico e adattabile alle esigenze del mercato.

Lo scopo di questa tesi è stato lo sviluppo, l' automatizzazione e la digitalizzazione dei processi After Sales, anche grazie all'invenzione e alla progettazione di un dispositivo IoT connesso (la cui invenzione è stata brevettata) , che opera come fonte di dati, e che comunica con altri dispositivi quali monitori / display, cloud , totem ed in futuro con i veicoli. Esso può archiviare ed elaborare dati raccolti dal suo utilizzo con un back end centralizzato, permettendo lo studio di alcuni parametri prestazionali all'interno dell' officina e calcolarne e ottimizzarne l'efficienza, inoltre si è riusciti a creare un canale di scambio informazioni fra i vari enti molto performante e digitalizzato.

ABSTRACT

Industry 4.0 is mostly known as a radical changing paradigm faced by the manufacturing sector during these past few years. The spreading of digital technologies and their integration in the production sector is one of the main characteristics of industry 4.0. As concerns industry 4.0, big data, robots, analytics data and internet communication are spread in factories, making the production process easier, more efficient, dynamic and suitable to market requirements.

The purpose of this thesis concerns the development, the automation and digitalization of After Sales process. To reach this purpose, a connected system IoT has been realized and mapped out. This system works as a data source and it is able to communicate with other devices, totem, and, in the future, it will possibly communicate even with vehicles. It is able not only to store and process collected data with a centralized backend, but also to study some performance parameters, being able to calculate and optimize its efficiency. Moreover, a digitalized channel where information are shared between companies has been designed.

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NOMENCLATURE

FCA	FIAT CHRYSLER AUTOMOBILIES
AS	AFTER SALES
IOT	INTERNET OF THINGS
LDT	LOCATION DETECTION TECHNOLOGIES
MEC	MOPAR EXPRESS CARE
H-MI	HUMAN – MACHINE INTERFACES
SS	SMART SENSORS
AD	ADDITIVE MANUFACTURING
CNC	COMPUTER NUMERICAL CONTROL
SLA	STEREO LITHOGRAPHY APPARATUS
MIMO	MULTIPLE INPUT MULTIPLE OUTPUT
TSO	TECHNICAL SERVICE OPERATIONS
ML	MACHINE LEARNING
EQ	EQUIPMENT TOOLS
KPI	KEY PERFORMANCE INDICATOR
POC	PROOF OF CONCEPT

INTRODUCTION

During the six months of internships spent at Fiat Chrysler Automobilies in Mopar, I have an important work experience in the After Sales sector in the industrial field. This internship has been improved in terms of the experience, the client and of all the actors inside the workshop, stating that it was a very useful place or the official dealer of the group, the Mirafori Motor Village of Turin. I started by benchmarking the after sales for several brands as well as positioning Mopar over the others. This is the best way to deal with the problem of an intervention and therefore it is necessary to reserve or not, at the moment in which the notice of the end and repair to the customer will be made.

For the part of innovation and technology it is a IoT registry device that functions as data sources, making the office repair a digital experience, and improving the speed of information exchange between customer, service advisor , technician, storekeeper and workshop manager.

CHAPTER 1 - MOPAR

1.1 Introduction

It is the official after sales department for all Fiat Chrysler Automobiles brands, the one and only "brand of brands". A guarantee for motorists and their point of contact with the Group. They work alongside each brand, assisting customers in all after-sales needs and ensuring their satisfaction and loyalty. Originality, because Mopar is an essential part of the group that designs, develops and manufactures the vehicles of the Fiat Chrysler Automobiles group and is therefore able to guarantee original and quality products. Mopar has an unparalleled role in the automotive universe, being able to boast of visibility, wide range of services and an unparalleled passion compared to any other service and spare parts company in the sector. It started off as a brand of antifreeze products, and today Mopar is present in over 150 countries supplying spare parts, accessories, services and customer assistance along the entire driving experience of the vehicle [1].

1.2 Innovations

Among the various innovations introduced in the last ten years by Mopar we find in the United States, for example, in 2008, the introduction in the FCA dealers of the "Express Lane" service, which offers rapid interventions, such as oil changes, and that currently has more than 1,000 operational offices in the United States and more than 1,750 open points in over 20 countries worldwide.

Also noteworthy are the first "apps" for smartphones that manage vehicle information, wireless chargers and dynamic assistance in the tablet-based workshop, without forgetting the limited edition vehicles built entirely in the

factory, starting with the Mopar '10 Challenger. . The last Mopar '16 Ram Rebel has been sold since 2010 in 3,650 units.

You say Mopar and it is impossible not to combine it with the Jeep brand with which it has created a new line of Jeep Performance accessories dedicated to off-road enthusiasts with ad hoc spare parts for those who love adventure. And for them, at the end of last year the new "Crate Hemi Engine Kits" were launched, which allows owners of models built before 1975 to have all the famous Hemi power.

Since 2012, the Mopar brand operates in Emea alongside FCA brands and is the only one to know in depth any model and to take care of all the customer's needs, both when buying a vehicle and in subsequent stages to customize it with exclusive services and accessories. Today its mission is expressed in the new tag "At your service" which marks an evolution in positioning the brand and which will appear on all the institutional communication, services and products. In particular, Mopar offers its customers a wide range of accessories, tailor-made for the Group's cars. The products available in the catalog are unique because they are developed in direct collaboration with the vehicle design platform.

1.3 In the WEB

The institutional website of Mopar.eu was then recently renewed in its graphic form and represents a point of reference for customers, dealers and authorized workshops. The Dealer Locator can be found on the site, which allows you to identify the center closest to the user, and you can also report problems to a dedicated support team or discover the accessories dedicated to FCA vehicles. Added to this are spaces dedicated to maintenance, original spare parts, warranty plans, after-sales products and services of the Group, after -sales contents of the individual FCA brands, up to the Reserved Area, with services, offers and exclusive features for owners of Fiat, Alfa Romeo, Lancia, Jeep, Abarth and Fiat Professional vehicles.

Another flagship of Mopar is the "Customer Care" service which, thanks also to the contribution of the operators of the customer service center of Arese, provides information and support to FCA customers every day.

CHAPTER 2 - FOURTH INDUSTRIAL REVOLUTION

2.1 Introduction

Since the following research has been carried out during the first period of my internship, I believe it is important to talk about this historical period, mostly characterized by technological innovations.
This section will be an introduction to all new enabling technologies that will be applied in the automotive sector.

2.2 The fourth industrial revolution

Industry 4.0 is an expression that has its roots in Germany. This utterance, in fact, was coined during the annual Hannover Fair in 2011, by a working group dedicated to Industry 4.0, chaired by Siegfreid Dais, the multinational engineering and electronics company Robert Bosch GmbH, and Henning Kagermann of Acatech (German Academy of Sciences and Engineering). When we talk about industry 4.0, we refer to the fourth industrial revolution, which has made the world much different, thanks to the highly cognitive and highly autonomous automation solutions [2]. Unlike the revolutions of the eighteenth, nineteenth and twentieth centuries, it is not possible to date it, still, as a revolution, it is going to bring about considerable changes on a global scale.

2.3 Industry 4.0

The revolution of the early '70s is known for the entry of electronics and information technology that have led to a growth in the industrial sector of automation, increasing production from a quantitative point of view. Industry 4.0 is also known as the 'digital revolution' and focuses in particular on all those digital technologies that are able to increase the interconnection and cooperation of resources (people or computer systems), trying not to confine it to one single sector/area. However, the changes will be extremely clear, even the radical ones that will affect the industrial sector, since they will deal with the production of goods and services. Since it can be considered the heart of my research, the data will have a leading role: at first, the data were just mere information about a small local system, but then it became a tool that creates and brings value. It is through this kind of data, in fact, that the computing power of the machines is determined and the economy moves. For all these reason, it can be considered one of the four cornerstones of this revolution. The other three factors are:

- Analytics – which refers to all those analysis operations carried out after data collection. Eventually I will focus on these processes, explaining more clearly their definition, exploitation, and employment implications
- Human-machine interaction-relationship – refers to the ways in which humans can interface with a machine: the different programming languages, certain tools and interfaces (HMI);
- Manufacturing - also known as the bridge between digital and real. Once the data have been collected, processed and made the tool usable, the last step is to find out the tools to produce the goods. What these tools have in common is the communication, or in other words, the interconnection between several elements of a system. High levels of communication and the optimal exploitation of all those services related to it will become the primary objective to anyone who wants to enter in a 4.0 perspective. In

order to do embrace this perspective it is necessary not to rely on those technologies that led to the start of the revolution itself. For this reason, they are defined as 'enabling' technologies and can be divided in two huge groups according to the application fields [3]. The first group concerns that set of technologies and services closer to IT (Information Technology) such as:

• Cloud - management of copious amounts of data on external servers, that makes the information available to anyone who has the authorization;

• Big Data - analysis of a copious amount of data, collected to optimize products and production processes;

• Cyber-security - security during operations on the network and on open systems.

The technologies of the second group, however, are closer to the operational level and can be distinguished in:

• Augmented reality - augmented reality can find application in any industry. In the industrial sector, for instance, it acts as a support for production and maintenance processes [4];

• Advanced HMI - human-machine interfaces are those devices (display) that allow humans to interact with the machine or with the system in general;

• Additive manufacturing - covers all the production of manufactured articles carried out using the 3D printer;

2.4 Expected benefits

Industry 4.0 is a revolution that gradually involves an increasing number of sectors (medicine, industry, education, etc) that are slowly increasing their level of digitization through the use of modern technologies. An environment in which the processes will be completely automated will be created, and, since it is supported by a special communication system, these processes will be able to exchange data with other systems, monitor and act accordingly. In

this way, both the presence of intelligent machines its efficiency in its respective application areas will increase.

2.4.1 Production sector

In the industrial sector the term “manufacturing” means something that will lead to improvements across the entire production line. The new technologies will be introduced in every single step that goes from the processing of raw materials to the delivery of the finished product. Production will be performed at reduced costs, with greater speed, avoiding economic losses caused by downtime or errors and trying not to affect negatively the quality of the product. Moreover, augmented reality, following the operator step by step, will make the assembly, maintenance or testing phases simpler and safer. As regards companies in general, however, it is not just machinery that affects productivity and market position. Big companies must take into account management decisions that can produce not only positive effects but also negative ones. Therefore, certain data analysis algorithms (data mining) are designed to simplify the decision-maker's activity.

2.4.2 Civil society

Talking about the social level, evolution can be considered the key-word. The effects that will be produced will change many aspects of a fellow’s daily life. Modern and functional tools have already affected many activities carried out during spare time or working time. An example of this phenomenon could be the boom in sales of wearable devices (around 19 million in 2014) [5], which, among other features, can monitor heart rate, receive calls and messages simply by connecting to a smartphone. A leading role is also played by embedded systems, which are responsible for repeatedly executing specific operations defined by a software, respecting, if necessary, also real-time. These systems are everywhere and everybody uses it without even noticing: the simplest example of these kind of devices could be the microwave, while the most complex could be a car or a medical instrument. When it comes to Industry 4.0 in the social field, it is easy to think of a smart home (Smart Home) where the level of interconnection is

reached making all electronic devices visible on the network and managed remotely by the user via smartphone or tablet. Digging deeper about this topic, it is necessary to introduce the term Smart City. This utterance is often misunderstood, and it is more complex than anyone can even imagine. First of all, by using the term Smart City we do not necessarily refer to a 'digital city', where there is a high level of digitization or the presence modern technologies. On the contrary, when we talk Smart City, we refer to a city efficiently managed in every aspect, in order to ensure sustainable development and a high quality of life. Therefore, a Smart City includes an organic set of factors that increase the development of a city, such as: economic activities, environmental resources, relations between people, mobility and the method of administration.

2.5 Costs

It is a matter of fact that there are a lot of benefits. However, as in most cases, the occurrence of an event can produce two kinds of results: favorable or unfavorable.

2.5.1 Impact on employment

The introduction of robots into factories brings with it not only a more efficient production in several respects, but also an inevitable reduction of jobs. The work of a robot often equals that of 10 men, with the difference that the one produced by the robot will be more precise, identical to the previous one and less prone to imperfections. The problem concerning jobs is shared by the entire industrialized population of the world and is caused not only by an increase in the field of technology, but also by the high request of the knowledge necessary to exploit these technologies. Referring to the research *The future of the jobs* presented at the World Economic Forum, it emerged that about 7 million jobs will disappear in the next 2-3 years and will be replaced by about 2 million concerning the activities of the 'future'.

This shift towards new professional figures is not going to not happen in a uniform way in all the States: in Italy, for instance, there will be a draw with 200 thousand created and as many lost places, better than other countries like France or Germany. The activities implied in this change of perspective will be those of the administrative and productive sectors, with 4.8 and 1.6 million canceled seats respectively. On the other hand, this situation will be partially equalized by the other sectors, such as: financial area, management, information technology and engineering.

2.5.2 Cyber-security

The unemployment is not the only inconvenience caused by this revolution, even if, perhaps, it is the problem that arouses more concern. With industry 4.0, companies and public bodies must invest more and more on the protection of cyber physical and IoT systems, since these, on one side, are able to change the lifestyle and the production methods, on the other side, they generate problems concerning safety. In fact, it is important to be aware of the risks you can encounter when whole systems are connected to each other through the network: a simple attack on a weak link is enough to break the whole chain. This is the reason why protection is not only necessary for the data and the infrastructures that contain them, but also for their network. In 4.0, attention will be paid to the centuplicated 'cyber-security.'

It is wrong, however, to think that attacks may occur just from outside by hackers, whose only purpose is to cause damage to a company or public bodies. Studies have shown that most of the violations are committed by a company provider or an employee who has access to privileged accounts and that, in 75% of cases, sensitive information are sourced from the workplace. These kinds of actions are committed by employees out of disinterest who, by habit or negligence, do not care about the data they work on and expose the company to possible intrusions or loss of data. To solve the problems related to the cyber-security, in a business environment, are necessary:

- Knowledge of the company's processed data. Being able to distinguish important data, knowing where they are stored and developing methods or software that guarantee basic security;
- Awareness of risks coming from outside, from banal email affected by viruses, to possible access to the server or cloud archive;

As concerns the latter case, employees alone cannot solve the problem on their own, since a hacker can infiltrate a network in infinite ways. To minimize risks, cyber intelligence tools can be introduced: the solutions that do not operate when an attack has been suffered, but, on the contrary, that collect daily information to prevent an attack, ensuring the company itself and its customers: availability, integrity and privacy.

2.5.3 Privacy

Privacy is the instrument that has been helping human beings protecting their privacy. Only an individual, in fact, can decide who is authorized to be aware of sensitive or identifying personal information, establishing the limits within his data might be disclosed. Therefore, with progress many personal data such as health status, political ideals or interests are often easily deductible, this makes the control of such data complex and onerous. Thus, it sounds correct to state that nowadays it is necessary to make changes and adapt our ideas to the new reality. For these reasons, privacy regulations need to be introduced. Privacy regulations are creating slowdowns to the already established technologies: an example could be the data collected by fitness trackers, whose use ends when they are graphically represented on a smartphone. In a more advanced society, these kinds of data can be saved on a cloud system and analyzed by a remote physician or an intelligent system, identifying possible pathologies and treating them in advance. Since privacy, in terms of industry 4.0, plays a leading role, it is necessary to shape a complete and up-to-date legislative system. Since the first step concerns the processing of personal data, the conference held in Milan on 17 January 2017, organized in collaboration with Clusit, Cefriel, Deib and Europrivacy 'The New European regulation on the processing of personal data: the most

important elements' has been an extreme inspiration. The purpose of this event was to present and explain the salient points of the new European legislation on the processing of personal data that will come into force in May 2018. The topics in question were:

• the impacts of legislation on digital products and services in various areas, such as digital payments, application areas connected to the Internet of Things;

• the developments of the new regulatory approach in relation to the security measures that had to be taken in order to protect personal data;

• the Codes of Conduct

• the changes introduced by the new Regulation and the relationship between the current legislation and the Regulation

• the responsibilities of outsourced service providers (outsourcing)

• the rules of behavior in the management of data breaches

The importance of this event is twofold: on the one hand, it sensitizes companies, public administrations, professionals and small and medium-sized enterprises about the subject of privacy, addressing the issue of the role and the enormous responsibilities involved; on the other hand, it helps companies along this path, drawing guidelines that would eventually lead them to embrace the new legislation.

2.6 Environment 4.0

Industry 4.0 has been perceived by many states, some of which have immediately learned the potential that would have offered in the not too distant future. Technological progress has eroded the boundaries between business that had been established over time by determining for many factories, the beginning of a competition with larger and more advanced realities, with which they were not used to colliding before. This is a problem that all the countries, who more or less, have faced each other. Countries such as France, Germany or the US have quickly started programs focusing on Industry 4.0, whose common purpose is to finance projects or investments of factories inside their country, allowing them to establish themselves on the

global market. In the USA, for example, there is about $ 0.5 billion of public commitment that has been invested in both research projects and in institutions and laboratories of excellence for technological diffusion and skills. The French government, on the other hand, has engaged in a project that envisages re-industrialization that aims at a general modernization of the factories. It is a rather large project and, as such, requires numerous and important investments by the individual activities. The public commitment, with a figure that exceeds € 10Bn, however, is no less and provides plans for subsidized loans and tax incentives for private investment. While Germany provides about € 1 billion for tax breaks for investments in technology start-ups and funding for business planning and research centers. In Italy, unlike other states, there is a double contrast that complicates the pursuit of competitiveness in the global market. We have excellences recognized all over the world as the Cpm3 and the Avio Aero4 that have already invested in Industry 4.0 for some years. This shows that our country is not foreign to development. In fact, it has a certain notoriety in the field of Smart Execution (production, logistics, maintenance, quality and safety & compliance) thanks to the Internet of Things and Big Data technologies. Small and medium-sized enterprises, dependent on the performance of the internal market, are not in contrast in our country. They are not able to financially support the investment to adopt new machinery. In fact, according to UCIMU5, one in three factories have machinery that is more than 20 years old, and only one factory in 10 has less than five. In addition, 80% of companies have plants with no integration to an IT system. In fact, making old machines compatible with new technologies, it becomes burdensome especially for those very small realities. To solve this problem, the Italian government is intent on launching a national investment plan divided into 3 years from 2017 to 2020. In the government plan several objectives are illustrated, among which are:

• an increase of € 10 billion in private investments

• an increase of € 11.3 billion in private spending in ... with a greater focus on 4.0 technologies

• training of about 200,000 university students and 3,000 managers specialized in 4.0 subjects

• 100% increase in students enrolled in Higher Technical Institutes on topics 4.0

• 100% of Italian companies covered by 30 Mbps by 2020 [6]

• 50% of Italian companies covered by 100Mbps by 2020

• an increase of € 1 billion in development contracts focused on investments 4.0

A public commitment of 13 billion euros distributed over 7 years is also guaranteed to cover the aforementioned investments made in 2017, through super-amortization and hyper-depreciation

CHAPTER 3 - ENABLING TECHNOLOGIES

Industry 4.0, even if global, has not been implemented uniformly among the various countries both in terms of timing and in the choice of investments to be made. In any case it is possible to recognize a common element that initiated the revolution. This element is characterized by the set of enabling technologies such as: Internet of Things, Big Data, Robotics and Additive Manufacturing, through which companies have the opportunity to radically innovate their business model [7] . Below I introduce an applicative vision of the enabling technologies describing also the link between the technology itself and the Industry 4.0 and also illustrating its practical utility.

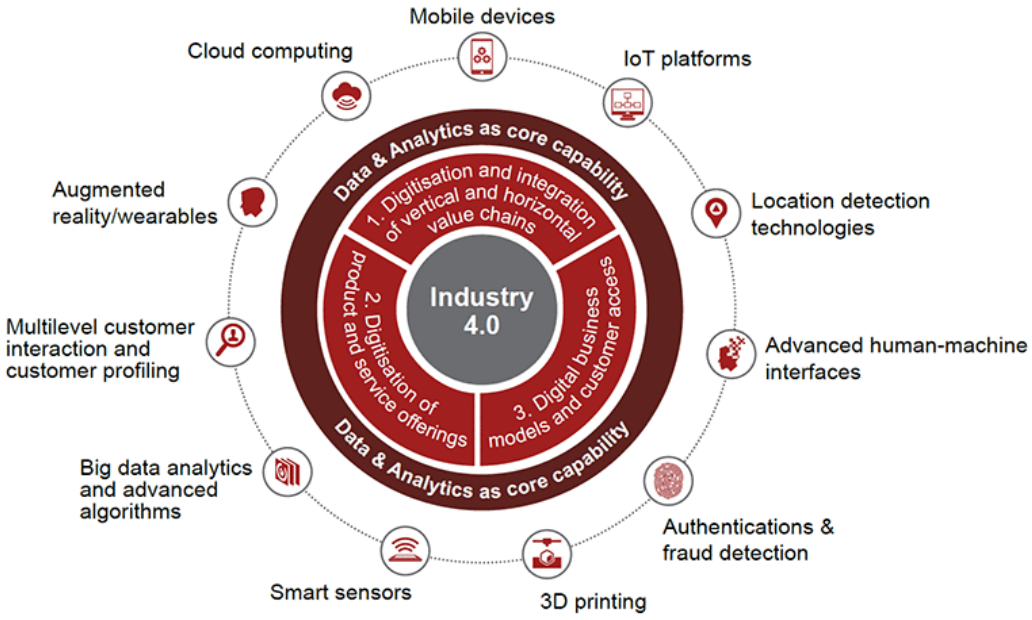


Figure 1. Enabling technologies

3.1 Internet of Things

Internet of Things, a term used for the first time by Kevin Ashton, a researcher at MIT (Massachusetts Institute of Technology), defines that set of 'smart' objects that, in addition to performing geolocation, processing, acquisition and identification actions, succeed to interface with the world of the network and consequently access all the services it can offer. Special Rfid5, QRcode or NFC6 labels identify by an IP address or each object, like a cyber physical system. With this technology, the network is used as a means of transmitting data to remote servers or other devices, which are also interfaced to the Internet. An object classifiable as IoT [8] , depending on the hardware that defines it and the environment in which it must operate, may be able to communicate with one or more devices depending on the case. So let's talk about a connection:

• One to One - is the basic and simplest functionality that an IoT device can perform: direct communication with a second device. It is the case of a car that, equipped with self-diagnostic tools, is able to send information to the mechanic's computer

• One to Many - more large-scale data transmission in which there is a center that instructs many receiving sensors, based on information that it had received from them, and elaborated previously. Like the Tesla automaker, which improves the efficiency of its cars, already in circulation, based on data gathered by the same

• Many to Many - is the most complete form of IoT in which millions of sensors communicate with millions of devices creating a dense network of information that can manage whole activities independently

According to some estimates, carried out by research companies and operators in the sector, IoT devices will be able to exceed 25 billion units by 2020. This is because more and more sectors (domotics, robotics, avionics, automotive and biomedical industry, telemetry) use a growing number of devices, connected to the Internet, to monitor and then carry out consequent actions. For example, in urban planning, the street lamps can be equipped with sensors that indicate whether the lamp is working or to detect the air

quality by informing the reference body in an appropriate manner. The Internet of Things is therefore an evolution that extends the internet to objects and real places.

3.2 Advance Human Machine Interface

The human-machine interface (HMI) is that device or software that allows humans to interface with one or more machines. It is therefore possible to supervise and manage, through a single or multi-touch display, the correct functioning of any simple or complex system. The software used plays the important role of 'translator' that shows, in the most user-friendly way, all the information it receives, making it easier for the user to manage the machines. Originally this technology was predominantly stand-alone as it was integrated into the controlled machinery. The new solutions, however, provide remote locations that give the possibility to manage even a complex system, at a distance. If before, man-machine interfaces were mostly used to manage industrial processes, today they are used in almost any social sphere. With the Internet of Things (which we will see later) all objects can be interfaced with the network, and therefore can be managed remotely. If before the interface was a complex software on a terminal composed of 4 screens, today it is sufficient an application and a smartphone to control any system.

3.3 Additive Manufacturing

The AD (3D Printer) is a new technology used for the production of 3D objects. To do this it uses an older technology called CNC (Computer Numerical Control) that converts a drawing file CAD1 into an ISO file containing certain numbers and letters. The combinations of these two elements communicate to the machine, connected to the numerical control, the coordinates in which to work and the tool to be used. Starting from a

CAD project it is therefore possible to create a product by depositing, layer by layer, the material on a surface until it is completely realized.

Why has Additive Manufacturing been so successful?

An alternative to additive production is that for 'removal'. It starts from a block of material and then remove it until the desired object is obtained by means of a cutter, drill or lathe. Although today there are high precision cutters with 4 or 5 rotation axes, in some fields, it has been replaced by additive printing. The drills in fact:

- bring waste material
- they are more dangerous due to the high temperatures and to the splinters that can be created during processing
- requires more space and larger means able to position and transport it
- require a more complex control software as a toolpath is required with CAM2 which determines the dimensions of the block to be machined, the dimensions of the milling cutter and its speed

Another reason is accuracy. In certain sectors, such as prototyping (also in the medical field) or hobby, such a level of precision is required that is unattainable, at least for now, by milling machines. The characteristics of the additive printing that have decreed its success are the innumerable varieties of materials and the techniques that can be used.

- Stereo Lithography Apparatus (SLA) – stereo lithography was one of the first techniques used in the AM. It consists of a laser that solidifies portions of liquid resin contained in a tank. The materials used are mostly photosensitive epoxy resins, for the creation of transparent prototypes, and ceramic materials resistant to high temperatures (300 ° C).
- Multi Jet Modeling (MJM) - as in molten deposition, a wax filament is heated and deposited on the construction platform. Before depositing the next layer, the structure is solidified with the use of UV rays
- Fused Deposition Modeling (FDM) - developed in the late 1980s by Scott Crump, co-founder and director of Stratasys , and marketed in the 1990s. It is the most known and used technique and consists in the deposition

of material through a nozzle. The extrusion nozzle is heated to the point to make the material malleable but still allowing it to cool in a short time thus allowing a horizontal and vertical development of the product

• Selective Laser Sintering (SLS) - a very popular technique with which you can create 3D objects of plastic, glass, ceramics, nylon and metals. Use a laser that welds the particles of the chosen material together.

• Color Jet Printing (CJP) - a professional technique for 3D metal printing in which objects are formed by gluing metal particles and then sintering them3 (or merging them). The negative aspects are: the need for a separate cooking phase in a special furnace and high costs; it is therefore suitable for large-sized items

• Directed Energy Deposition (DED) - or Laser Cladding, uses a laser to dissolve the powder that is slowly released and deposited by a robotic arm to form the layers of an object.

The potential of additive printing is endless. In a short time we moved from the design and construction of models to the construction of prosthetics. It is in this field, the medical one, that additive technology has caused more sensation, not limiting itself to prosthetics, but also reproducing rigid body structures such as bones and teeth. Remaining in the medical field, the research aims to artificially realize the soft tissues of the organism making them functional. In engineering, the aviation department of General Electric has already started projects for the creation of engine parts (nozzles, engine blades, turbines) for aircraft using materials such as titanium, aluminum and nickel-chrome. Furthermore, a project was planned for the construction of a bridge, on a canal in Amsterdam, through 3D printing. The MX3D technology will be used, a 6-axis robot equipped with tools and software able to monitor the development of the project.

3.4 Cyber Physical System

The Cyber Physical System is perhaps the computer system that has determined, more than any other, the beginning of Industry 4.0 also because it was one of the first systems able to exchange information, in a continuous way, between the physical world and the virtual world. The CPS are composed of different parts, also coming from different manufacturers, that collaborate together to carry out certain operations. These systems must respect the three 'C' scheme: control, communication and computational capacity. They are software, communication technology, sensors and actuators for the detection and measurement of phenomena in the real world. The CPS already do not have boundaries per se. Many are already used in the most varied fields: in medical devices, in environmental control systems and critical infrastructures, in energy storage and distribution systems and in smart structures in general. The potential and usefulness of Cyber Physical System increase if they are interfaced to the Internet.

3.5 Cloud

Cloud is a service provided by a supplier, such as an external company or provider, which allows any authorized customer to share, store or process data. Between the customer and the supplier there may be a third figure, that of the client manager, who chooses and configures the services offered by the supplier but offers added value as software applications. A cloud service, to be defined as such, must respect certain characteristics. One of these is global accessibility. It is the distinctive feature of clouding, that is, being able to access information from any terminal and from anywhere in the world. Since the late 1990s, with the huge growth of internet users, the cloud has been increasingly successful. Even the IT giants, like Microsoft, began to invest in this technology, gradually strengthening their web services. Today the cloud has permeated many aspects of everyday life: from online shopping services to e-mail services, from online editor applications (photos, texts) to streaming

platforms, etc. Its use, with the integration of the IoT in society, is further expanding. Many devices such as microcontrollers, may require, in the long run, a memory that is too large to be embedded in some object or require information processed by other microcontrollers. It therefore exploits a cloud storage which can contain hundreds of TeraByte of data and make it accessible to anyone who has the authorization.

3.6 BigData

It is important to know that today any object connected to the network and any service, online or otherwise, produce data. The flow of information is such that the only data accumulated in the last two years have now reached the order of zetabyte (1021 bytes). If, due to the size, these data are not used, the storage of the same is made vain. The term BigData refers not only to the actual amount of data, but to its analysis. In this regard, the analyst Doug Laney, who works today with Gartner.inc7, articulated in 2001 a definition of BigData based on three concepts:

• Volume - need to determine relevant data within a huge amount of data

• Speed - with a data flow that is now traveling at unprecedented speeds, organizations need to be able to process data fast enough

• Variety - in addition to speed, organizations are confronted with the enormous variety of existing data (numeric files, text files, audio, video, data from stock exchange quotes, etc.)

From the analysis of the data any kind of information useful to private individuals or companies can be extrapolated and it is performed by means of data mining, process of extraction of 'knowledge' from large databases. Data mining takes advantage of appropriate algorithms and techniques such as grid computing, in-database processing and in-memory analytics that identify associations, pattern8 or sequences, making information available and immediately useable in decision making. This is the case of UPS, the renowned worldwide courier, which tracks data on 16.3 million packages for 8.8 million consumers, with a daily average of 39.5 million requests for

monitoring by customers . Only by analyzing data from sensors of about 46,000 vehicles, the UPS has saved only in 2011 over 8.4 million liters of petrol by cutting 85 million miles on daily routes. In this regard, there is the initiative ORION (On-Road Integration Optimization and Navigation), the research project, on these activities, the largest in the world. The project makes use of numerous data including those from online maps, with which it will be able to reconfigure, even in real time, the routes that drivers must travel. Another use of BigData are the proposals of e-commerce sites, online shopping or streaming (Netflix, Infinity, etc.). Amazon, Ebay and many others show in the 'home' of their site the recommended products specifically for each customer. The choice between billions of products is made by analyzing the purchases, research and preferences that the user performs daily online. Beyond simple marketing or, importantly, optimizing transport and processes in general, the real capabilities of data processing have already been demonstrated years ago by Google. In Mountain View, Google's headquarters, they call it a process of 'now casting' (forecast of the present), according to which it is possible to make predictions by analyzing the searches on google made by millions of users. This is the case of Google Flu Trends, a system that in 2008 was able to predict the progress of influenza outbreaks in the US only by analyzing the research carried out of flu symptoms and the geographical areas in which the research was carried out.

3.7 Machine Learning

With Machine Learning we go beyond simple automation and we enter the artificial intelligence field, where we study how to reproduce the mental processes from a computer. Machine Learning is similar to the previously described data mining. Both analyze large amounts of data from which to extract useful information. What differentiates these specific analytical techniques are users. Information obtained with data mining is exploited by man in order to make improvements to certain operations, while those

obtained through Machine Learning are used by machines. So an object becomes intelligent not only because it sends and receives data but also because it is able to learn from them without human intervention. Elaborating the results of previous computations performed and data just received can produce results increasingly more precise and reliable. The use of an intelligent system makes it possible to reach objectives otherwise difficult to reach in any sector. If a computer is able to learn it will be possible to create more and more advanced and bypassable safety systems, or to create systems able to predict the occurrence of certain problems.

3.8 Wearable

Wearable devices are devices or 'gadgets' that can be worn by people and animals. What differentiates a wearable object from any other is the ability to interact with other devices and to interface with the internet. It may be able to save information on the web by connecting, via bluetooth or wifi, to a smartphone. The wearable devices have, immediately, struck the attention of man. In 2014 alone, around 19 million devices were sold worldwide, including 600 thousand in Italy alone. According to a market survey conducted by the IDC (International Data Corporation), more than 112 million pieces are expected to be sold in 2018, although this number is set to increase. The success is given by the variety of existing devices thus attracting the interest of every type of person. The best known and most popular are the fitness tracker with the main function of pedometer and sports watches which, in addition to the pedometer, can detect heart rate, position, clock and much more depending on the models. Always in the sports field we have smart clothing, apparently normal garments but with special technologies that make them more functional. To stay on the subject, in Italy two projects considered to be valid, from the OWT (Observatory of Wearable Technology), are very valid. One is 'ComfTech', which makes hi-tech clothing to monitor the vital parameters of newborns, while the other is 'Sensoria', with its Fitness Socks, Fitness Bra and Fitness T-Shirt. To the well-known wearable devices dedicated to fitness, are added: Head-mounted

displays for virtual reality, smart jewels, implantable devices and many others. All these types of devices have been grouped into 3 macro-categories that define their characteristics.

• Complex Accessories - to be fully operational they require connection to another device. (ex: fitness traker)

• Smart Accessories - slightly more self-contained, that is, they connect to the network and can perform some functions without the support of other devices

• Smart Wearables - work in complete autonomy, managing not only to connect but also to perform complex actions, such as browsing or downloading. (ex: Google Glass)

3.9 Robotics

Robotics, born as a branch of mechatronics, is an interdisciplinary science in that it requires the involvement of several disciplines: computer science and psychology, linguistics and automation, mechanics and biology. He is dedicated to the design and construction of automated systems designed to help or fully replace the man in his duties. Robotics, as far as automation is concerned, is no longer science fiction but has become a reality that involves us in our daily rituals, so from the primary sector that has been the industry, with the 'robotic arms', we reach the:

• Humanoid robotics - one of the most fascinating research fields in which we try to create robots with human features, equipped with artificial intelligence and able to act autonomously with the help of servomotors and video cameras. The leading nation is Japan, where for fifteen years we have been working on the robot 'Asimo', the most advanced in the world. Italy has also dedicated itself to this field of research by building, at the Italian Institute of Technology in Genoa, the humanoid robot 'R1'

• Service robotics - deals with producing robots that perform useful services to human beings (excluding manufacturing). Not only do caregivers for the elderly, rescue robots such as firefighters or domestic robots that clean

and cook are developed in this field, but also exoskeletons and robotic prosthetics for post-disease or accident rehabilitation are developed.

• Robotics for surgery and medical telepresence - the robot 'Da Vinci' has been developed in robotic surgery, which with its thin remote-controlled arms allows performing minimally invasive procedures to the heart, prostate, uterus and lungs. As regards medical telepresence, on the other hand, possible solutions are studied that allow the specialist to visit his patients remotely.

• Educational robotics - introduces children and young people into the world of robotics. It allows, in fact, to make robots starting from scratch. Many schools in the world have already integrated this discipline in their studies as it does not require engineering skills, but it is necessary a special kit and the use of the 'Choregraphe' software.

3.10 Virtual Reality & Augmented Reality

The market today offers affordable prices, tools that allow the user to see virtual objects while maintaining a link with the real world. This operation is carried out, albeit in a different way, by two technologies recognized under the name : virtual reality and augmented reality. The difference between these two expressions is explained below, thus allowing one to recognize the tools that use technology rather than the other.

3.10.1 Virtual reality

Virtual reality is a simulation or reconstruction, generated by a computer, of life, environments or real situations. It is able to immerse the user in a not - real world, involving him fully stimulating the sense of sight and hearing. At first, virtual reality was used to simulate certain jobs. This gave the possibility, for example to pilots, to train and practice in the most varied weather conditions and damage. Then wearable instruments like the Oculus Rift have spread. They have allowed anyone to take advantage of this technology because, with a low cost, you can use it for any type of entertainment such as video games, video, web browsing. Virtual reality has

uses that can affect all sectors. It is up to man to understand how to exploit them. In Italy, Salvatore Giuliano, head teacher of the high school "Ettore Majorana" of Brindisi, brought education to a next level introducing, from November 2015, the use of Oculus Rift. In fact, they allow the user to take advantage of a 360 ° view with which he can wander in the cosmos or visit a monument. With the funds provided by the PON (National Operational Program), the school intends to expand the virtual reality workstation with 6 other devices and also purchase the Leap Motion. They are joysticks to attach to the hands that allow a student to enter a chemistry or biology lab and grab some (virtual) objects, thus making the student more inclined to learning the subjects. As with all new technologies, a piece of software is required, so what about the content for education? On the web there are open source contents both free and paid, but according to Salvatore Giuliano "There is, finally, a third way: that of starting to produce them autonomously". This would allow to have a personalized study material according to the school and according to the needs of the teachers, even if this path requires advanced knowledge not only in the field of programming but also in the graphics. In addition to the Oculus Rift that occupy a medium-high price range in the market, there are the VR11 gear, for the low and medium-low price range, and the HTC lives for the high range. The HTC lives is, perhaps, the most advanced instrument (for sale to the public) as far as VR is concerned, because, thanks to laser environmental sensors, it allows the user to 'enter' the virtual world with his own body: able to sit up, stand up or run. It is also equipped with a camera and proximity sensors that detect the presence of obstacles and, perhaps less important, does not completely separate the person from the real world as it can receive notifications, calls or messages.

3.10.2 Augmented reality

Augmented reality is a technology that adds to the already existing objects digital levels generated by a computer and with which one can interact. They can be images, information or instructions that the user can use for their own purposes. Simply by browsing the web you will find countless number of

applications that rely on this concept. Some 'apps', for example, are provided by retailers for furnishing accessories, and give the buyer the opportunity to see in real time the layout and style of the future purchase. There are applications dedicated to the consultation of catalogs, maps with the relative navigator, web portals for travel reviews, restaurants and shops (2.10). Not to forget other forms of entertainment such as video games, many of which take advantage of the 'markers' QR-Code, which transmit information on the three-dimensional localization of components, developing a 3D virtual object. As for virtual reality, the tools that allow a person to exploit augmented reality are many and differ in features (image quality, accessory tools, memory) and portability. The most common is the smartphone as it only needs the camera (now present in all models) and an application. Then there are the smart glasses. They have determined the development of a real market based on the competitiveness between already established companies and startups. The list of applications and sectors in which this technology can be used are numerous. Those listed are the least part and every day there are new ones.

CHAPTER 4 – INDUSTRY 4.0 IN FCA

Product and process innovation plays a crucial role in creating value for the business. FCA innovates its production processes in different ways. An example is the redesign of the establishments as "digital factories" on the basis to the modular integrated factory model, which considers the processes advanced and tools as partners, which provide support to the operator rather than replace it. FCA has recently completed the development of a new ICT infrastructure (Information and Communication Technology) already implemented in restructuring projects of existing plants and the construction of new plants.

This infrastructure, called the New Plant Landscape (NPL), offers several benefits, including:

- use of electronic data to support quality control processes;
- vehicle tracking and traceability of component suppliers;
- data available in real time on the performance of equipment and in relation to process variables that allow an easier one search for malfunctions or anomalies also favoring rapid decision-making processes at all levels;
- common user portal with optimized usability and access level to data relevant to operators;
- improved logistics flows with automatic delivery and sequencing some materials;
- better organized organization of the production line, which reduces the occupied space and the overall environmental footprint of the establishment.

Among the examples of digital revolution already in place in our factories include:

- Additive Manufacturing: FCA makes extensive use of printing technologies industrial in 3D, which is also referred to by the term "Additive Manufacturing ", both in product development and in processes of production. For example, at the Italian plant in Melfi it is possible to print prototypes directly from 3D models to the computer, eliminating the need to build molding presses and molds special or other equipment. Not just this technology It is essential to reduce time to market, but it also reduces significantly the use of materials, the generation of waste and energy consumption related to these activities.

- Wearable devices: devices such as smartphones and smartwatches are increasingly present in our production facilities to provide support to the staff of the Group's plants. An example is represented by the Alfa Romeo factory in Cassino (Italy), where about 6,000 connected devices, including smartphones and smartwatches, they transform the production of vehicles into an even more experience interconnected for factory workers.

Figure 2. Tablet for processes card

- Collaborative robots: they are industrial robots designed to work directly on the assembly line alongside human operators. One of the most recent technological developments of FCA is the Advanced Use Robotic Arm (AURA), the collaborative robot designed from COMAU, an FCA company, and launched in 2017. AURA is able to detect the proximity of a human collaborator (or any other component in the automation process) as well the actual contact and the intensity level. AURA is inspired by the typical human interactions. Thanks to AURA, FCA is the only home automotive company whose internal automation company has managed to develop a unique solution with collaborative robot (COBOT) with the highest load capacity available on the market today.

Figure 3. Collaborative robots

4.1 - The new establishment of Cassino for Alfa Romeo

Even Italy, even if with some delay, and it is not said that it is bad, is projecting towards the so-called Industry 4.0. A new way of making a factory and working with all that today's technology allows to implement from Advanced Manufacturing Solutions to the Industrial Internet, also passing through the Cloud. A world in complete evolution that in Italy sees its most important reality in Cassino with FCA and Alfa Romeo that have tightened a strong collaboration with Samsung to allow workers better quality of work with a consequent greater efficiency that clearly translates into a qualitatively produced superior for the final user.

FCA had a Factory 4.0 in mind for a long time, ie a workplace where everything was eco-friendly and highly technological. A place where you can count on the best quality levels for your cars leaving the plants but also the best efficiency capable of speeding up production time and allowing to "revolutionize" what had already been introduced with previous industrial revolutions [14] .

Figure 4. Display of Cassino Plant

An update to today's technological world that is inevitable and that in the modern production center of Cassino has seen its culmination with the digitalization of the various departments and the introduction of smartwatches, smartphones and tablets marked Samsung able to connect people, machines and products in a union increasingly essential.

The Cassino Alfa Romeo plant was built in 1972 near the historic Benedictine abbey in the town of Piedimonte San Germano. From a small production center over the years Cassino has seen its plants evolve, reaching the current two million square meters of which 530 thousand are covered. Cassino begins its production history with the construction of the Fiat 126, a successful model that immediately launches the center of Lazio production ready to make also the new Fiat 131. The '80s will see the first signs of "robotized" industry with the installation of the Robotgate Comau, a highly automated system that allows to lighten and speed up the work of the operators of the boring department: a precursor of today's Industry 4.0.

The following years saw an increase in activity and only five years later the production of the new Fiat Regatta took off. In little more than ten years the company manages to root the neighboring Lazio territory allowing incredible numbers of employment and becoming one of the most important production centers for Fiat. Here is what will happen the productions of the Fiat Tipo, the first with fully galvanized body that will be produced with a rate of 1000 units per day. But still Fiat Tempra, in its three versions, the new Fiat Bravo, Brava and Marea that allow Cassino to carry out new processes for the modernization of its work machines. It is in 2001 that the now "old" Robotgate is retired and in Cassino a major restructuring phase takes place with the dismantling of the old production lines that leave room for an important technological leap called the Open Gate system that reduces errors in welding phase and above all achieves greater efficiency. All this allows the

plant to travel to 250 thousand cars a year with the construction of the new Fiat Bravo in 2007. In Cassino, however, the new FCA thinks of a real revolution and in 2016, thanks to the entry at full capacity of the chain destined for the new Alfa Romeo Giulia, the factory is officially renamed the Alfa Romeo plant in Cassino: it is the beginning of the "fourth" industrial revolution for FCA and Alfa Romeo and the Lazio plant becomes a forerunner of what will be the Factory of the future. Today the Cassino plant has a production capacity of around 1,000 cars per day thanks to the "certosino" work of about 4,300 highly specialized employees. A factory that represents the best synthesis of the constructive knowledge of FCA in the world automotive field, where people, technology and environment interact in harmony to create premium cars of the highest prestige like Alfa Romeo Giulia and Alfa Romeo Stelvio. An important milestone for Cassino.

Figure 5. Image of Cassino Plant

The real technological renewal of Cassino and above all of Alfa Romeo comes with Giulia: the sports sedan that in 2016 has given life to the brand's new era through its revolutionary style, sportiness and technology standards. It is thanks to this in fact, all the elements that have made Alfa Romeo one of the most desirable brands coexist and can be summarized in three precise

concepts: absolutely Italian design, high performance engines and unique and cutting-edge technical solutions. Giulia is a new generation car with one of the most innovative safety systems and with the presence of the most advanced infotainment system. Every on-board control is simple, essential and intuitive. A new approach that allows the driver to concentrate solely on the road and driving pleasure, in a perfect symbiosis between man and machine. This is the new concept that Alfa Romeo wanted to bring in a new category of cars like the new Alfa Romeo Stelvio, the first SUV of the Italian brand in over a century of history, which expresses the authentic "Alfa spirit" in a sport utility. Stelvio is a car that gives even the most demanding driver an exciting driving experience and, at the same time, the highest level in terms of comfort and versatility typical of this category. Alfa Romeo Stelvio, therefore, transforms any journey into a unique experience and certainly winks at the best technologies today both in the construction phase and intrinsic to the machine. Innovating does not mean to automate the "factory" tout court, taking away jobs, mortifying staff competence: it means reaching an intelligent factory, in which people and tools are integrated; without the people, in fact, no type of innovation would be possible. This is the thought of FCA, Alfa Romeo and Samsung, who in Cassino wanted to make a firsthand experience of the concept and reality of the new way of doing industry in the era of advanced technology. A digitalization of the production facilities that will allow FCA to make its production chain even more efficient, also and above all to improve an increasingly important aspect: the quality of the work of line operators. The first phase of the digitalization process involved all the information available within the factories. Display devices have been integrated such as specific high-brightness Samsung monitors along the production line but also eBoard touchscreen in some strategic points on which the production trend is shown.

Figure 6. Display on the assembly line

In the case of anomalous situations, warnings are generated immediately taken up by the Team Leader ready to solve any anomaly and above all not to delay the entire assembly line. The second phase of the digitization project then presents some particularly interesting aspects. Thanks to the gathering of all the information coming from the Team Leaders, who have the responsibility of a working group, it was possible to understand in detail the needs of the line operators and therefore to personally design the solutions and devices that could help them to perform at best work. Here are two solutions that, integrated between them, could have met the needs and the greater efficiency: a smartphone and a smartwatch. Samsung has therefore made available technologically advanced devices and a solution, Samsung Knox, customizable and able to ensure total security of data on the terminal. In this case, thanks to the Samsung smartphone, every Team Leader has the opportunity to interact with the production line at any time and especially in every point of the same. The adoption of the smartwatches to be allocated to line personnel has then proved to be one of the most innovative aspects of the digitization project: a "wearable" device used inside of the production plant to streamline processes, improve workflows and ergonomics. The Samsung Gear S3 Frontier has allowed the total customization of the device and is the

only one on the market that can be used in all its functions without having to be necessarily connected to a smartphone.

Figure 7. Smartwatch

Fully integrated with the MCA (Manufacturing Execution System) of FCA, the information system that manages the entire production system, the Samsung device is used as a professional equipment in some sections of the production line. In this case the operator, having reached his position, receives from the MES the list of operations to be performed on the vehicle being worked; Once the operation is complete, send the confirmation via Gear S3 Frontier, the activity is recorded as completed and the production line can continue to the next phase. In the event that, on the other hand, an operation cannot be carried out for any reason, the operator is able to generate a signal from the device to the responsible Team Leader.

Figure 8. SmartTV

With an approach like the one made by FCA, Alfa Romeo and Samsung, ready to support a cultural change and that considers the investment to be functional to the transformation of the company, the company becomes capable of competitiveness and allows the advantages that this brings with it,

in terms of flexibility, speed, higher productivity, safety, sustainability but also product innovation. In short, an idea of Industry 4.0 that is increasingly reality and that every Italian company must make its own to improve its production processes. Alfa Romeo has already done it and Cassino is a reality to be envied by many.

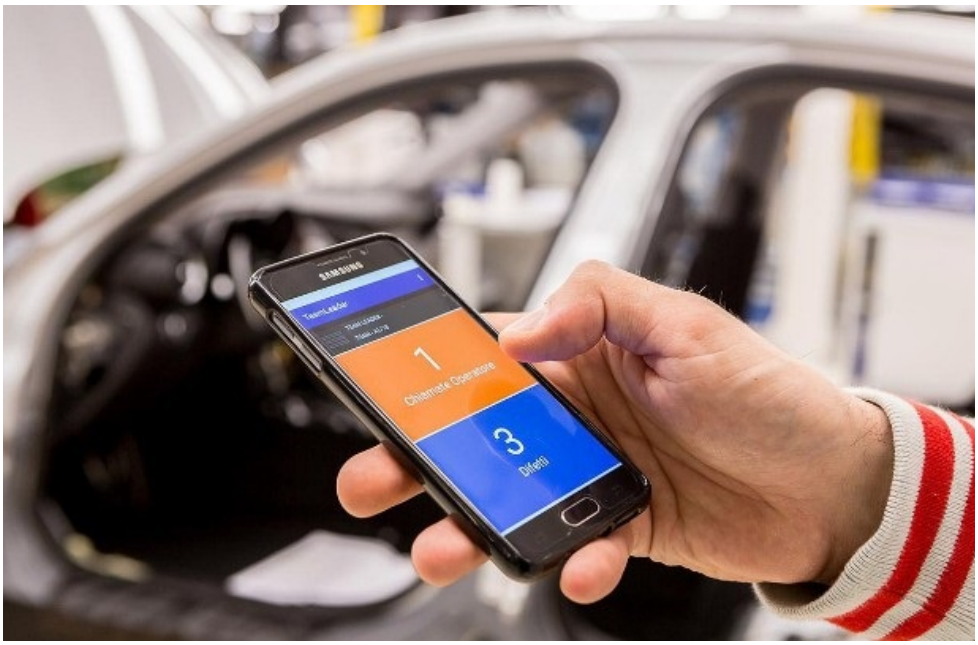


Figure 9. Smartphone for advancement

CHAPTER 5 - 5G CONNECTIVITY

5.1 The great possibility

2020 will be the year of the wireless revolution because by this date the 5G will debut, the next mobile communication standard that will allow to connect everything at high speed making many of those projects that today are only on paper. Thanks to the 5G users can always count on a very high band available with a very low latency. Above all, the 5G will make reality of all those projects that today seem science fiction: think, for example, connected cars, the digitization of road infrastructure, the Internet of Things, smart homes and all those new technologies that would require a constant presence of a very wide band network to work. The 5G, more than the previous standards, represents a great possibility for development for companies and builders. As for the other standards (those currently used today are 2G, 3G and 4G), 5G simply means "5th Generation" [10] , ie fifth generation. What exactly is from the technical point has not yet been precisely defined. What is clear today is the objectives that this new standard will have to offer. The Next Generation Mobile Networks Alliance therefore generally defines with "5G" a standard capable of satisfying the following scenarios:

- data rates of tens of megabits per second for tens of thousands of users
- 1 gigabit per second simultaneously to many workers with offices on the same floor
- several hundred thousand simultaneous connections for massive wireless sensor networks
- significantly enhanced spectral efficiency compared to 4G
- improved coverage
- enhanced signal efficiency
- significantly lower latency compared to LTE

Therefore, the 5G should not only guarantee much more bandwidth than today, but satisfy new and more complex scenarios of use. Once the standard has been created, it will be possible to work on the first compatible devices, on the infrastructures necessary for its implementation and on all the regulatory problems concerning the distribution of frequencies, their use and their costs.

In 1991 the 2G was born, which was essentially all focused on voice services. With 3G we thought not only about conversations but also about the use of internet in high speed mobility. With the current 4G, however, the mobile broadband internet sector has had the upper hand with a clear improvement not only of speed but also of efficiency. But the current 4G is not suitable to support a technical evolution that requires that "everything is connected with everything". The 5G is thought of as a silent revolution that will go everywhere in the lives of people, a new world nervous system that will innervate every home and every street, every device and every action of everyday life. It is not just a matter of bandwidth, because there will be a clear improvement also from the point of view of the efficiency of communications. With the Internet of Things, each device will be interconnected and will look for synergies with other devices; thanks to the 5G, moreover, each IoT entity will have less consumption and a battery life multiplied 10 times, thus greatly increasing the autonomy and the consequent opportunities. There will be billions of objects connected to the network at the same time all over the world: the current networks would certainly not be able to handle such a large amount of connected devices, but the 5G can do so, always guaranteeing high speed and very short response times thanks to the possibility of always using the best frequency for transmission. Latency will indeed be in this fundamental context: one cannot speak of a "nervous system" if the response times were such as to reduce the instantaneousness of the reactions. Among the technologies that could be used, the millimeter waves that exploit very high portions of spectrum (between 30 and 300 GHz) but that present many challenges in real application even if, theoretically,

they would allow to guarantee enormous advantages. The 5G, however, should be able to exploit portions of the spectrum between 6 and 100 GHz with a technical solution very similar to MIMO (Multiple Input Multiple Output) thanks to the use of multiple antennas installed capillary throughout the territory. In fact, we speak of the use of "Small Cell", which positioned in a capillary manner will guarantee a high degree of coverage in every environment. The 5G will not only serve to surf the internet quickly from smartphones and tablets, but will allow you to create a fast network to which every single "thing" will be connected. The smart cities of the future, the real ones and today only hypothesized in far-fetched chimeras, will necessarily be all connected with the 5G because it will allow to manage all the services and devices of the city. Traffic, traffic management, services for the citizen, security sensors, video surveillance, everything will be connected and managed remotely through this fast and low-latency network. Self-driving cars will have great benefits from this network because it will allow real-time dialogue with road infrastructures, obtaining vital information for driver safety. The same road nodes will talk to each other to ensure better traffic management by diverting the car route in case of problems. The cars will be able to talk to each other exchanging information on traffic and security. Even the smart home will benefit a lot from the 5G because all smart objects in the house will be able to talk to each other, receive information from outside and be managed remotely from a single device. And this is just a glimpse of the potential of 5G because a fast, widespread and efficient network can allow you to manage all sorts of devices. Facebook, for example, believes that the 5G will go hand in hand with virtual reality both for gaming and to offer a series of services of added value for the citizen. In the context of augmented reality, this immediacy will be even more fundamental, bringing cloud resources directly into the eyes of users and in full interaction with the surrounding devices. The 5G, in short, represents the driving force of an innovation that will make humanity take a true step forward in the concept of "Networked Society". According to a Qualcomm estimate, by 2035 the turnover of around 5G will already amount to 12.3 trillion dollars, thus

identifying a flywheel for the essential economy and enormous opportunities for those who will take charge. New products, new services, new solutions, new industries, new balances: a fundamental step that will go far beyond the technical characteristics of the new standard and new devices.

5.2 5G between doubts and potential problems

The 5G is theoretically something exceptional, but from many parts it also underlines its invasiveness. A network that really connects everything can put people's privacy at risk and, in the absence of the necessary measures of control, prevention and transparency, the problem could be burdensome and pervasive. Each connected object can collect data that companies can use without the user being aware of it: the potential of big data would be outclassed by the dangers of Big Brother, thus expanding the gray area surrounding a technology of this magnitude. Furthermore, if manufacturers cannot guarantee a high security standard, each connected device could potentially be used by crackers for illegal activities, potentially putting people at risk. If on the one hand the 5G can bring great benefits, it is certainly necessary to evaluate the problems to solve them properly before it is too late. Vulnerability and privacy are issues that must be addressed calmly and seriously before making this revolution debut. These are issues that must be faced in parallel with the development of technical solutions that will allow 5G to conquer the market. Moreover, once again, there is a risk that the digital divide in the world will further increase the gap between the countries that adopt this new standard with those that even today do not even have an adequate mobile network: a two-speed world could expand differences and bubbles of poverty, a situation already widely known and which must be faced with political / institutional responsibility. 5G, timing 2020 is the date of the official 5G debut, but this does not mean it will be available immediately. Initially there will be few areas covered by this network which will progressively be subsequently extended to the whole territory. It will therefore take several years before the 5G can really be the revolution that everyone dreams of today. Someone is already burning the times making

small demonstration networks, but all this is following the proprietary roads that are not yet standardized: simple proof-of-concept, in short, to ensure that 5G can be seen and understood, discussed and tested, metabolized in the its potential in preparation for the moment in which it will have to be put into a common factor in society. Ulf Ewaldsson, Senior Vice President and CTO at Ericsson, explains how much standardization can be a pivotal way for a quick adoption of 5G. The temptations of fragmentation may be the only real obstacle, because net of any divisions will be the interest in guiding the development of the new network.

CHAPTER 6 - CONNECTED VEHICLE ON BRANDS AND APPLICATION

6.1 Introduction

Vehicle have acquired a very current and radical technological innovation that has radically transformed the automotive sector. In recent years, more and more cars are being searched on the market with radar, cameras, remote diagnostic systems and other telematic tools that, thanks to internet connections and mobile devices, are able to communicate with the outside world (with road infrastructure, with other vehicles, with other devices) [11]. The tour includes new adaptation actions also for the automotive aftermarket sector and, in particular, for workshops offering assistance, such as remote communication between driver and repairer. Assistance will always be more effective and controllable. Respond to being in constant change and remain competitive, but also aim at an ever greater specialization and continuous and qualified training.

6.2 Use Case

The smartphone has now become the "control room" of our daily life and the automotive industry tries to connect to the car and smartphone network in the best way.

Audi offers for the first time in a Mini-SUV, a total integration with the smartphone. The telephone, via a special antenna in the glove compartment, connects wirelessly to an external antenna, improving reception. In addition, phones that support this technology can be recharged wirelessly.

Opel, for the Adam vehicle, offers a system for the mobile phone induction charging. In this way the battery will recharge wirelessly while driving. The competition offers this system only for larger and more expensive car models.

Volvo will be the first carmaker in the world to eliminate vehicle keys. The opening will take place via smartphone. Thanks to an app, you can open and close the doors via Bluetooth and start the engine. Volvo has introduced this new technology to the Mobile World Congress and, next spring, the first test will be held in Gothenburg. Later, this technology could also be used on rental cars. In the future, customers may pick up or return a car at the rental service, even before the opening or closing time.

Figure 10. Smartphone key Volvo

It has not yet been defined which system will have to become standard for smartphone integration. Apple uses "CarPlay", Google "Android Auto" and other "Mirror-Link" smartphones. Most Seat and Skoda car models support all platforms, regardless of their operating system.

Figure 11. Smartphone as a screen

Opel is the only manufacturer that offers a LTE connection on the car segment with a price below 10,000 euros, such as the Karl. Overall, eight car models will be connected to this Hotspot. This connection is already included in the scope of delivery, together with the Opel personal assistance service and the automatic emergency response service, which will become mandatory from 2018.

Tesla releases various updates for the S and X models via the Internet, sending them directly to the vehicle. In this way, the American company is able to offer even greater autonomy for its E-Cars.
For all older models, Porsche offers the possibility to install the real-time traffic information service, already included in the standard equipment of the new cars.

Reading Web pages by vehicle is not pleasant. Unless it is a Tesla car that offers a large screen that greatly simplifies the display.

Figure 12. Hotspot

After the fatal accident in the US, Tesla's AutoPilot ("semi-autonomous" driving system) has aroused strong criticism. However, this did not change Tesla's projects and the completely autonomous driving system will continue to be developed, unlike what happens to European manufacturers. The system

will also increase comfort. The modern cars are able to move without driver intervention, you can park them without being driving and can be "supervised" through the smartphone. All this is made possible by smart apps and digital assistants.

The new E-Class is able to park autonomously via a smartphone app. The maneuver will be possible both in the transverse and longitudinal parking stalls. The Mercedes app is free: simply register the vehicle.

Figure 13. Parking with app

For the first time, Audi, BMW and Mercedes have formed an alliance. These three big car manufacturers have adopted Nokia's cartographic service Here. The three manufacturers also use map data for self-driving cars. Traffic queues are today almost a rule and it is therefore increasingly important to be able to exploit connected navigation. Thanks to real-time traffic information, the navigator can search for alternative routes.

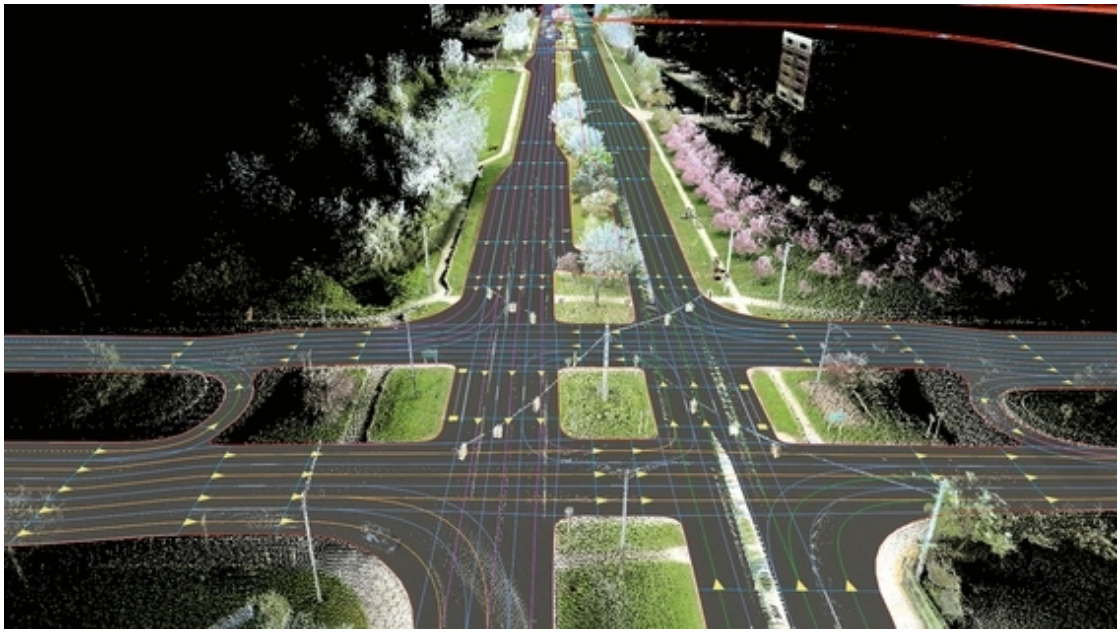


Figure 14. Connected Traffic

The use of Google Maps as a navigator has already been chosen by Audi. The service is now also adopted by Skoda, a sister company of VW. As soon as you enter a destination, Google Street View displays the surroundings of the place on a large 8-inch touchscreen. The system will soon be installed on other models too.

While real-time traffic information is now a standard on expensive cars, cars usually offer navigation without these important messages. Volkswagen, for the new version of the Up, offers a navigation app that, using data from the Dutch specialist TomTom, shows how to get around the queues.

Record screen. Mercedes integrates in the car a high resolution dual display, 12.3 inches wide (31.2 cm), which seems suspended in the air. With it you will be able to view in large format the maps for navigation.

Figure 15. Inside Mercedes

Assistants for emergency braking have also become standard on cars and can avoid accidents in urban traffic. Mercedes, with the new class E, takes a step forward: the system also provides for steering, after making sure that the maneuver does not cause another dangerous situation; avoiding, for example, investing a pedestrian in the event of a collision looming.
Radar systems that can control the traffic behind your car already have several, but the assistance system of Audi to get out of the car safely, works even when the car is stationary. The system alerts the driver before the latter opens the door, if a vehicle is approaching from behind. On the coupé version, equipped with long doors, the assistant will prove useful.

Assistants for driving on the motorway prove to be a very useful innovation and the goal will be to design a system that allows driving without driver intervention. To achieve this, however, ideal conditions must exist, such as perfectly visible horizontal signs. Volvo has presented a system that recognizes the edges of the carriageway, even without this signage.

Figure 16. Edge Detenction

For the moment, the self-driving car remains an idea for the future, but some car manufacturers are working to make this dream come true, continuing to experiment with models that can move without any driver intervention.

The "Autopilot" system also reappears in this category, given that its use is also foreseen for the "Assisted Driving" project. The name tends to irritate, because similarly to other systems, the driver should keep his hands on the steering wheel and the Autopilot would only provide assistance.

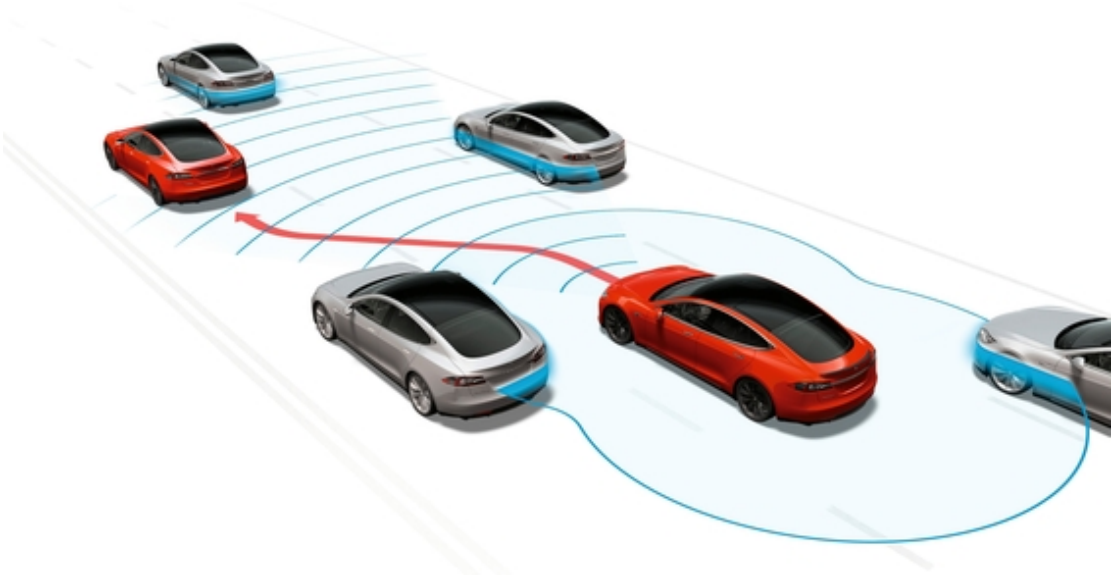


Figure 17. Autopilot with sensors

On the revised version of the A3, Audi installed the traffic assistant, already present on the larger models. This compact car, if desired, is now able to move without driver intervention, reaching a maximum speed of 60 kilometers per hour.

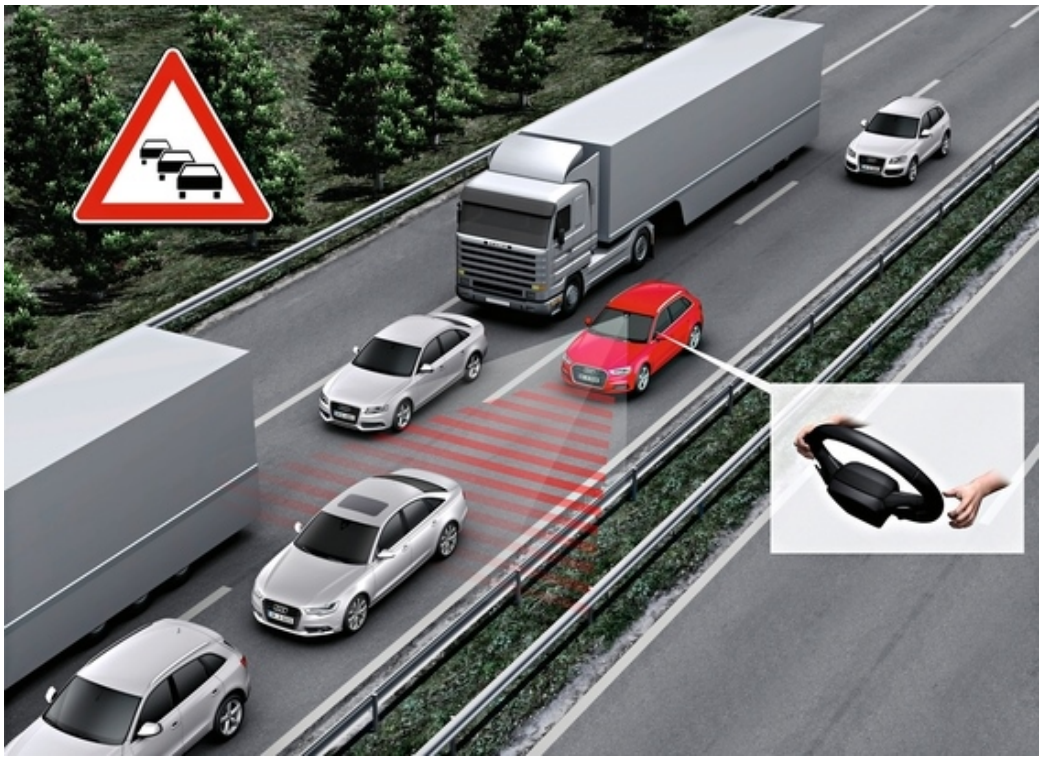


Figure 18. Traffic jam assistant

In the past, updating the maps of the browser was expensive, in fact the producers offered the new cartographic material on CD-ROM, which generally cost over one hundred euros. BMW now sends these updates directly to the car infotainment service via the Web. The service is free for three years. The connected car is not only helpful for driving, but also for related activities, which could save visits to the workshop.

Tesla was the first manufacturer to design cars taking into account the experience of an IT specialist. The updates arrive at the car directly via the Internet. Tesla also allows its customers to test new technologies, such as the "Autopilot" system, making them available for payment at the end of the test phase.

Figure 19. Indicator with bottoms

CHAPTER 7 - AFTER SALES & BENCHMARKING

7.1 After Sales

In After Sales the role of the dealer is more strategic than in the sale, where the car manufacturer brand plays a predominant role. Since the workshop allows the customer to repair the vehicle, it is through local marketing that the dealer is able to attract the customer.

7.2 Benchmarking

7.2.1 BMW

Since loyalty, from a certain point of view, can be considered as synonym of attraction, all of BMW's after-sales strategy is oriented towards customer loyalty. The BMW workshop is not limited to the execution of the coupons and guarantees, but it must enrich the offer with bodywork, tire service, etc. In short terms : it must be able to offer a personalized acceptance. The dealer is directly in touch with owner of a BMW: if during the sale the builder can and must do a lot, when the aftersales is introduced the role of the dealer changes : it is much more autonomous. His weapon is local marketing, thanks to the local marketing an important relationship with the customer is developed. Not all the dealers are prepared to do this. During a market crisis, almost all the economic resources of the concessionaires wanted to attract customers in the salons. Today the market is distributed, the development of the business, aiming at increasing margins, goes through the enhancement of the activities after-sales, and therefore through local communication, which must be original and innovative. This is demonstrated by the success of the

campaigns that, together with the dealers, have been made for the BMW and Mini brands to get back customers with aged cars, offering maintenance at discounted prices. The reason why this method is applied to the brand premium is because it is a useful tool that guarantees the success. The dealer, who believes and invests in the after-sales, raises the contribution margin generated by this sector: at the BMW network, after sales produces 20% of the turnover, which however contributes 50% to the profit margin. Still, what makes us able to understand how important assistance is, it is the presence of the workshops of the peripheral network. These workshops cannot consist on the profits generated by the sale of vehicle, are still standing, on the contrary: they generate very interesting profits. Among other things, after-sales is a formidable opportunity to obtain a spontaneous connection with the customer, who usually visits the showrooms once in 3-4 years, and check out the workshop at least once or twice a year. A relationship of trust is established between responsible service, or the service advisor : the technician is able to influence the customer's choices, even when he has to change the vehicle [12].

The experience that should live the customer is user friendly. When he arrives at the workshop he immediately does the reception and meet the technician whose task is to understand the problem and put the vehicle on the lift All the part of bureaucracy must be streamlined to the maximum, in order to focus on the real reason that lies behind the customer visit : the technical intervention. For this reason the Service Advisor of BMW use the iPad to follow the acceptance process, with a program that has already preloaded all the data of the customer, his vehicle and the repair that must be performed. The service manager is first and first of all a manager: he must take care of everything. He must know how to communicate to his interlocutor and must learn to speak the customer language. Furthermore, in BMW models built since the year 2000, the main vehicle data, such as the chassis number and the mileage or the need for assistance, are stored in the vehcile key. This data can be

obtained in the workshop of the BMW Service Center via an electronic reader : the Key Reader.

Figure 20 . Key Reader

7.2.2. Mercedes Benz

As concerns Mercedes, the objectives are: profit, customer satisfaction and loyalty. The indicators of success are: the growth in turnover, the increase of the customer loyalty rate, the attraction of new customers, the defense and the increase of the level of user satisfaction and the increase of the margins. The dealer must be the synonym of excellence, through which the mission finds its ideal fulfillment to achieve success, in an absolutely win-win strategy. To achieve this result, all the possibilities offered by digital and social communication are explored: by quickly getting the Mercedes Benz message to the customer, the right information at the right time are transmitted. The online booking project for assistance appointments is a clear example of this. The after-sales has always had an approach too traditional in managing the workshop repairs : the problems linked to the vehicle have always forced the

customer to ask for assistance and make an appointment. Now they are themselves proactive: they call them the customer when the diagnostics in the vehicle alert them that the time has come to perform a repair. Contacting the customer, and informing him that, for example, the dashboard control system will soon inform him that the scheduled maintenance is about to expire, it formulates a transparent and detailed economic offer. The customer receives further advantages of the after-sales promotional campaigns and he chooses where and when to fix the appointment.

7.2.3. Seat Service Monitoring

Ability to view short videos with major repairs via smartphone. Function on the status of the car that allows you to display on the mobile device the elements of the dashboard allowing the motorist to check the situation of levels, such as fuel and oil, during the trip or while the car is parked. The app allows the reception of warnings and alarm signals on mobile devices related to engine problems or spare parts, plus allows the dealer to send messages to inform users that it is necessary to replace a piece, knowing also costs and offers .

Figure 21. Service Monitoring

CHAPTER 8 – SMART WORKSHOP & NEW AFTER SALES PROCESSES

The Internet of Things, data connections and access possibilities in an intelligent way even large amounts of data have opened up completely new opportunities for the workshops. Solutions for the connection of problems and control have already been available for a long time. The aim is to minimize the time the vehicle stays in the workshop. The increasing use of the network has changed the use of the spare parts, equipment and related car services, so we try to promote and participate in a purpose . The workshop of the future knows the state of health of vehicles used, and if necessary, advises the owner to intervene on the vehicle. The workshop has all the necessary information for repairs and is, therefore, able to perform any type of intervention in an efficient, complete, punctual manner with high quality standards. In addition, the solutions are in planning, are scheduled can be avoided, repairs can be scheduled, spare parts needed on time and reduced waiting times. All of this brings a superior advantage for commercial vehicles.

In the future the system is connected to the network: recording and control of transmissions in a continuous way in which the different vehicle components are treated. In this way it is possible to adapt both for maintenance to specific stresses and by means of transport, and to calculate in advance the residual life of the individual components. In addition, the driver can be informed about the expiration of the vehicle's maintenance or receive other measures to replace the components of the vehicle. If the driver accepts, he receives a call from the assistance center to purchase a car. At the entrance of the vehicle in the workshop, a license plate scan is performed and, immediately, all the data relating to the planned repair are carried out on the electronic job card. While

the customer support service conducts the online service, the device is able to control all the parameters of the vehicles.

The use of "augmented reality" supports the work of mechatronics, in fact the job card also transmits all the repair information to the mechatronic workstation, which also receives the vehicle data required for repair and diagnostics. This information is constantly updated via the Internet connection. Mechatronics can also use the "augmented reality" tool on their tablet. When the operator points the camera of the tablet PC on the engine compartment, the relevant information, such as the necessary equipment and repair instructions, are displayed in a real image (descriptive texts, three-dimensional objects, photos or videos).

Figure 22. SmartCar

Adapting the aftersales process to connected cars will allow dealerships to reap a wealth of benefits, including:

- **A streamlined and improved servicing process:** connected cars will enable remote access to important vehicle diagnostics, making it easier for dealerships and drivers to plan maintenance and repair work. In addition, the vehicle's software can be updated over-the-air to enable remote repairs and to 'switch-on' new infotainment features.

- **Improved dealership / customer communication:** connected cars will create a new communication channel between dealerships and customers. Human-machine interfaces (HMI) will make it easier than ever for customers to contact dealerships. Conversely dealerships will be able to issue recall notices and other important information directly to the driver.

- **Pricing transparency:** connected cars will provide dealerships with much more detailed information about driver habits (braking and acceleration data for example), which means the dealer can provide more accurate quotes as to what a service is likely to cost, or when repairs will be likely (based on wear rates) etc. Not only this, access to this data in real-time will mean that the dealership's workshop can have the parts in stock ahead of the service. All of this should add up to equal an improved customer experience and an improved bottom line for dealerships.

8.1 New After Sales Processes

Optimizing repair and delivery times is crucial for the car repairer, because it means raising the level of customer service and saving resources, thus improving the efficiency of the company. Using too much time to complete a process means generating waste. Wastes are all those activities that use resources without generating value for the customer. Saving on "useless" times certainly does not lead to giving up anything on the side of the accuracy and reliability of the service. In fact, the yield of a poor service would result in a short time the loss of customers who, disappointed by your work, do not mind to circulate bad opinions on your workshop, triggering a negative word of mouth that would be difficult to control. If the primary objective is always to offer the car driver an impeccable service in terms of time, quality and costs. Successful activities have one thing in common: they are based on operational processes, a set of standard procedures used consistently by the whole organization. This allows to achieve high-level results and value for the customer and to maintain them over time.

This new version of the Service Process Manual focuses on the client, paying particular attention to his expectations throughout the entire process and providing food for thought on the activities that can make the difference in terms of perceived service.
It represents the effort to provide a Best Practice to face the constant challenge of providing customers with an adequate level of service, aiming to exceed customer expectations, develop customer loyalty and maximize profitability.

The idea is to change the focus from having a simple process in line with the standards of care, to generate customer loyalty, enthusiasm and repurchase through an excellent service and the creation of a relationship with the customer using and applying all the new ones technologies such as IoT, Cloud and Smart Device.

The phases are divided into:

- Booking
- Acceptance
- Repair
- Quality check
- Return
- Re Contact

8.1 Booking

The booking phase can be done on site or from home via smartphone. On-site, or "Digital Reception", this is done via totem placed at the entrance of the customer area, where you can choose the service or the quick check-up if you have a problem still unidentified. The data required for booking as well as being anagraphic will obviously also concern the car, brand, model and license plate, so as to direct the customer in his dedicated aerial as a function of the Brand. The same procedure can be carried out by mobile directly from home in total comfort. You can also view your "booked" status, recognizable thanks to the license plate, on the various displays displayed in the workshop so as to be aware of the waiting time and the remote queue.

8.2 Acceptance

It is composed of a warm and professional welcome, an inspection of the vehicle status (Dynamic Reception with Tablet), through the service advisor, who takes care to listen actively and to check for any anomalies not reported during booking. It also makes inquiries about the usual use of the vehicle and any specific needs, makes an estimate of the timing of the repair and the date of delivery of the vehicle. Stipulates the estimate, as accurate as possible, distinguishing the warranty interventions from those not under warranty, with

supply of copy and asks the methodology of the payment method preferred and accepted by the customer. The estimate is also sent by email to the customer and, after the repair confirmation, the status change is notified both on the smartphone and on the display inside the customer area, so as to make the customer aware of the progress of status.

8.3 Repair

The repair phase to the technician is notified via smartphone or smartwatch, showing the job card, vehicle position inside the building and expected delivery date. The slot of time and the car passed to the next step "repair", are visible, on the workshop side through the display, where in addition to being indicated the license plate of the car being loaded, there is also the identification of the bridge where the repair will take place with the technician dedicated. In conjunction with the job card, the warehouse prepares the necessary parts for the repair, which, once they are ready, will be available to the technician via a notification. Once the repair is over, the technician will carry out the status progress in "quality control", where he will make sure that everything has been successful.

8.4 Quality Check

It consists in verifying that the requests and the problems highlighted during the acceptance phase have been resolved, that the repaired vehicle can be returned in perfect working order and without damages through a "quality" work. The customer must be provided with the documentation certifying that the work carried out has been checked. When this step is over, if everything has been verified, we move on to the next "Redelivery". Then the technician carries out the status progress that will be notified to both the Service Advisor and the customer.

8.5 Delivery

The return consists of parking the car in the dedicated space and easily accessible to the service advisor, who received notification from the technician of "fine repair and quality control", will return it to the customer after making payment.

8.6 Re-Contact

It can be done by phone or mobile, so as to receive feedback and improve customer satisfaction.

Increasing the efficiency of the workshop also means increasing productivity. In order to make the use of time more efficient, it was important to think, invent and use a device that would capture the time taken for each work order by recording the technical advances, to accurately trace the date and time of start and end of the individual interventions made to complete a contract. All times recorded are directly recorded on the relevant repair order without any further entry. By pairing the use of the track-time with the functions of analysis of the performance of the management system, the customer has raised the productivity indexes, optimizing the times and the organization of the works. Since each operator directly from his touch-screen monitor can make his identification, through the reading of badges or the use of personalized authentication codes, the user has also used timekeeping to detect attendance in an automated manner. By better organizing work and reducing labor time, it has been possible for the user to achieve the goal of delivering more quickly to the ability to serve more customers.

CHAPTER 9 – MOPAR EXPRESS CARE "THE NEW FAST MAINTENENCE SERVICE"

Mopar Express Care is the service that guarantees a list of services to your car, of the FCA group, in total convenience, speed and quality [13]. The list of services, for which real time is estimated below 40 minutes, is as follows :

- Fast Check Up
- Cabin Hygienization and Climate
- Recharge climate
- Oil and Oil Filter
- Battery Replacement
- Bulbs
- Windscreen wipers
- Brake Pads
- Antifreeze Winter Treatment
- LPG Filters and Additives
- Easy Fit accessories

The process consists of going to the workshop, where there will be one or more lift dedicated to the exclusive use of this service, without reservation, immediately receiving a quick acceptance and taking charge of the car.

Figure 23. Express Lane

Successful activities have one thing in common: they are based on operational processes - a set of standard procedures used consistently by the whole organization. This allows to achieve high-level results and value for the customer and to maintain them over time. This new version of the Service Process Manual focuses on the client, paying particular attention to his expectations throughout the entire process and providing food for thought on the activities that can make the difference in terms of perceived service. It represents the effort to provide a Best Practice to face the constant challenge

of providing customers with an adequate level of service, aiming to exceed customer expectations, develop customer loyalty and maximize profitability. The philosophy of this version is as follows:

- It has been developed for those who physically perform the care process
- It is written to help them achieve customer satisfaction in an increasingly competitive market
- Describes how to provide an effective assistance flow to offer a high level of care, ensuring that an efficient and well-organized care facility is maintained.

The goal of this release is to help you establish and improve internal control systems in order to acquire and retain customer loyalty. The idea is to change the focus from having a simple process in line with the standards of care, to generate customer loyalty, enthusiasm and repurchase through excellent service and the creation of a relationship with the customer.

9.1. Workshop Standard Processes

- Acceptance
- Repair
- Delivery

9.1.1 Acceptance

For Customer	✓ Friendly and professional reception ✓ Active listening and verification of any anomalies not reported during booking ✓ Questions about the usual use of the vehicle and any specific needs ✓ Estimate of the timing of the repair with the estimate of the intervention times (under the hour) with delivery of the vehicle (during the day) ✓ Clear estimate, as accurate as possible, distinguishing the warranty interventions from those not under warranty, with copy supply ✓ Definition of the payment method
Best Practice	➢ The Service Consultant must always wear the clothing required by the brand's Corporate Identity and welcome the Client in a cordial and professional manner ➢ The Service Consultant must be informed about updates to technical and assistance information, any campaigns, new diagnostic procedures and be aware of the sales initiatives in the post-sales area dedicated to EXPRESS CARE ➢ Service Consulting must check if and which MVP service contracts are active on the vehicle and propose new and / or combined to the already active, based on customer needs, vehicle seniority and usual usage characteristics ➢ The Service Consultant must estimate the timing of the intervention (which must always remain under the hour) and agree the time to return the vehicle (which must take place during the day) ➢ The Service Advisor must complete a repair quote, and provide a copy to the customer ➢ The Service Consultant must direct the customer to the waiting room.
Under step	1. Reception 2. Acquisition of the vehicle and feasibility verification in EXPRESS CARE mode 3. Definition of works to be performed and preliminary to the customer 4. Definition with the customer of the time of delivery of the vehicle (during the day) 5. Print and sign the acceptance sheet 6. Conclusion of acceptance

Roles	**Service Consultant:** **Case A: MOI Exclusive EXPRESS CARE** **Case B: Shared MOI EXPRESS CARE** **Case C: Shared MOI EXPRESS CARE** **Specialist Guarantees**
Instruments	**Communication portal between FCA and the Dealers** **Search Engine for Repair and Maintenance Information** **Vehicle on-board check list** **Spare parts catalogs** **Repair times**

9.1.2 Roles of Service Advisor

Service consultant	**1. Reception** • Introduce yourself to the Customer with surname, function and brand name • Make immediate acceptance
Service consultant	**2. Vehicle acquisition and feasibility verification in EXPRESS CARE mode** • Make immediate acceptance based on the list of interventions available in EXPRESS CARE mode • Listen to the complained customer and always check the possibility of performing the operation in EXPRESS CARE mode • Check for any anomalies not reported by the customer and propose it to the customer if it can be done within the hour • Check the warranty certificate and the consistency of the warranty start date with the information on the FCA systems, with particular attention to the transformed vehicles (e.g. Camper) • Communicate to the customer an estimate of the waiting time (less than 60 minutes) • Apply, in the presence of the Customer, the nylon protection of the seat cover and the driver's side mat (possibly with the brand logo), the steering wheel cover and gear shift knob protection

Service consultant	**3. Definition of works to be performed and preliminary to the customer** • List the interventions to be carried out (and / or additional if authorized by the Customer), accessories and service packages • Distinguish warranty interventions from those out of warranty • Complete the preventive form in all its parts: interventions, labor, spare parts • Communicate the value of the estimate to the Client, including the cost of the repair for out of warranty operations • Agree with the customer the payment method
Service consultant	**4. Definition with the customer of the time of delivery of the vehicle (during the day)** • Check the availability of spare parts and workshop planning • Evaluate the expected time for the intervention (Time / LOP) In the event that the waiting time and the customer profile (e.g. segment, age, mileage) make it suitable for a commercial offer on a new vehicle, report to the customer the possibility to go to the sales staff In the event that the waiting times are not compatible, but the Customer is eligible to receive the commercial offer, request consent from the Customer to send a lead to the sales staff, informing them that they will be contacted • Fix the return time of the vehicle with the customer

Service consultant	**5. Print and sign the acceptance sheet** • Update the contract form in acceptance by inserting any additional spare parts and changes in the planning • Print the order form in acceptance including the work to be performed under warranty / out of warranty (e.g. Patto Chiaro) • Have it signed by the Customer in all its parts (front and back) • Deliver a copy to the Customer and store the copy in accordance with the FCA provisions In case of impossibility or unwillingness of the customer to immediately check in the vehicle: • Remind the customer that if driving a damaged vehicle it may violate local road legislation and incur penalties from local authorities • Agree with the customer for a release for non-hospitalization • Schedule next appointment to proceed with the repair work
Service consultant	**6. Conclusion of acceptance** • Leave the customer • Park the vehicle in the area / post used depending on the type of intervention • Confirm the conclusion of the acceptance by transmitting the order form to the EXPRESS CARE workshop employee and, in the case of pre-picking or known spare parts to be collected, also to the spare parts warehouse • Accompany the customer with sales personnel, if he has decided to immediately evaluate the commercial offers on new vehicles

9.1.3 Repair

For Customer	✓ Vehicle repaired by a highly qualified technician ✓ Repair completed in less than 60 minutes ✓ Repair in the day "at the first visit" ✓ Vehicle returned repaired and without damage caused by the workshop ✓ Prompt communication of any delay in completing the repair ✓ No additional repairs unless agreed in advance
Best Practice	➢ The repair work must be assigned to the appropriately trained personnel / specialized in EXPRESS CARE interventions ➢ The procedure / quality of the repair must always be checked ➢ Customer expectations must always be met by giving the right priorities to the type of repair ➢ The costs of repair and the time to return the vehicle must be clear, always be agreed with the customer and approved by him ➢ Il The prompt contact of the customer in the event of a delay in the delivery time of the vehicle is of particular importance ➢ Additional repairs are not allowed if not previously agreed with the customer
Under Fase	1. Intervention 2. Conclusion of the intervention
Roles	**Workshop Manager** **First Level Expert Technician** **Specialized Technician:** **Case A: MOD EXPRESS CARE Exclusive** **Case B: Shared MOD EXPRESS CARE** **Case C: Shared MOD EXPRESS CARE** **Service Consultant:** **Case A: MOI Exclusive EXPRESS CARE** **Case B: Shared MOI EXPRESS CARE** **Caso C:** MOI Shared EXPRESS CARE Specialist Guarantees

Instruments	**Communication portal between FCA and the Dealers** **Search Engine for Repair and Maintenance Information** **Diagnosis tool** **Technical helpdesk** **Service manuals** **Repair times** **Workshop equipment** **Vehicle on-board check list**

9.1.4 Delivery

For Customer	✓ Vehicle ready for collection at the set time ✓ Possibility to collect the vehicle at any time ✓ Vehicle collection without "waste of time" ✓ Abnormal vehicle crashes and a fully functional vehicle ✓ Explanation of all the operations performed on the vehicle ✓ Indication of the deadlines and the importance of proper maintenance
Best Practice	➢ Be available at the delivery / return of the vehicle meeting the needs / schedules of the customer ➢ Knowing how to correctly explain all repairs carried out on the vehicle ➢ Knowing how to fully illustrate the deadlines in relation to the next maintenance interventions, explaining their importance ➢ Know how to illustrate in detail the characteristics of all MVP service contracts active on the vehicle, already underwritten previously or purchased together with the repair (range of extended warranties, maintenance programs and complementary maintenance)
Under fase	1. Preparation of the redelivery activity 2. Closure of the Redelivery

Roles	**Service Consultant:** **Case A: MOI Exclusive EXPRESS CARE** **Case B: Shared MOI EXPRESS CARE** **Case C: Shared MOI EXPRESS CARE**
Instruments	**Communication portal between FCA and the Dealers** **Quality control card**

9.1.5.Critical issues

After a series of analyzes with this type of "fast service", introduced recently in the EMEA markets there are problems in receiving accurate and truthful data for the verification that this service is efficient and productive for dealers and for customer.

9.2 Smart Workshop and New After Sales Processes for Express Care

It was thought, to improve the processes and optimize this service already at high levels, to digitize and make the queue management more intelligent through the "Queue Management System". We have developed a POC (Proof of Concept) to simulate this management.

9.2.1 QMS Mobile

It starts from the mobile app display of the nearest dedicated workshops, after you choose the service you want to perform and finally viewing the waiting time is released an online ticket that will allow us to minimize the queue in the workshop, or to go there and be served immediately.

Figure 24. Screen by smartphone

9.2.2 QMS in Loco

In the case instead we went already in the workshop to make the repair, we will have a totem where to make the choice from the list of services and add in the queue. During the waiting, it will be possible through dedicated displays, positioned in the reception, to view your status and to know how much is missing when taking the vehicle. In conclusion payment can be made before the repair.

Figure 24. Totem

9.2.3 KeyDrop In/Out

This “smartbox” is used for the deposit and collection of keys in total security and simplicity allowing greater flexibility for the technician and the customer. The process consists in making the choice of the service and receiving a code where to deposit and withdraw the key at the end of the service.

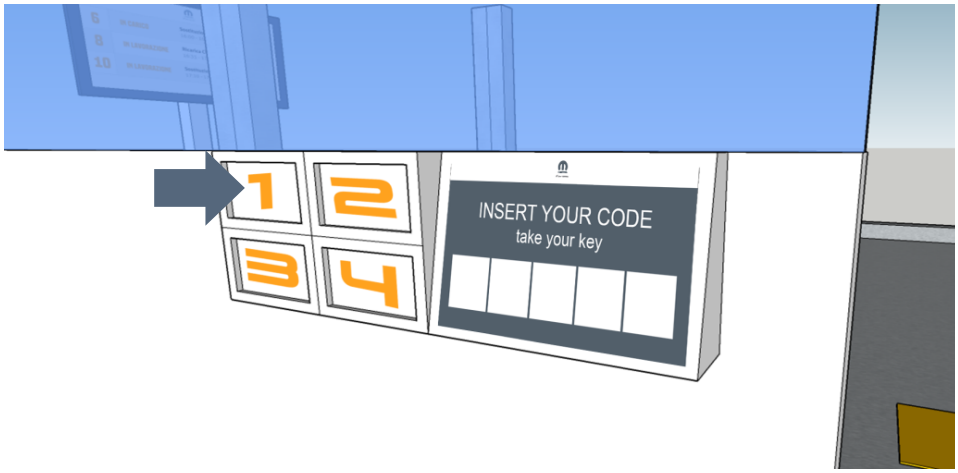


Figure 25. SmartBox

9.2.4 Workload tracking

This is a display that allows the technician to view the list of vehicle in workload of the day. The data that are shown are:

- Sequential number
- Key drop box number
- Plate - Model of the vehicle
- Type of intervention (Start - end of processing)

Figure 25. Monitor for workshop

9.2.5 Repair tracking

The display in the welcome area shows customers the progress of the vehicle and the various workings in order.

Figure 26. Monitor for customer

9.2.6 Advantages

For customer :

- **Quick & easy service choice** thanks to **connected devices**
- **Just in time flow & flexibility** thanks to **instant notifications**

For the Network :

- **Improve productivity** thanks to **hr & process optimization**
- **Recover upselling** thanks to **dynamic advertisement**

For Mopar :

- **Service intelligence** thanks to **real-time analytics**
- **Preditctive models** thanks to **machine learning**

CHAPTER 10 - IOT DEVICE ON LIFT APPLICATION

The present invention relates to IoT sensors applied to any type of lift for detection and recognition of the vehicle occupying it. In many current solutions it was still not thought to identify the car on the lift by digitizing the "free", "busy" or "assigned" status so as to monitor its use and work efficiency. To date, this change of state of the lift is carried out verbally or visibly if possible. Moreover, the presence of devices (IoT) applied on lift in other workshops has not been found to allow us as described above. It was therefore decided to solve the problem of saturation in the workshop, through this solution that limits and avoids it. The object of the present invention is indeed to have a real time monitoring in the workshop by providing the lift of sensors communicating with each other via the cloud, allowing:

- lift status identification through ultrasound sensor;
- vehicle plate recognition via smartcam;
- sending data on specific software that stores all useful information;
- measurement and optimization of performance parameters;
- user friendly data display via various displays;

Furthermore, the fundamental objective of the project was the definition of a system aimed at laying the foundations for the improvement of the workshop performance to increase its competitiveness and above all to simplify the exchange of information between the various bodies and actors present, such as service advisor, technician, workshop leader and customer.
Increasing the efficiency of the workshop also means increasing productivity. To make the use of time more efficient, the program takes the time spent for

each state and in the specific case of "processing", it is detected and recorded on the relevant repair order.

This project it is subdivided in :

- Design
- Print 3D
- Writing Code on Arduino
- Assembly of Arduino with sensors and breadbord
- Assembly on box built by 3D print
- Testing and monitoring on Lift in Workshop
- PoC (Proof of concept)
- Data analysis
- Patent deposit

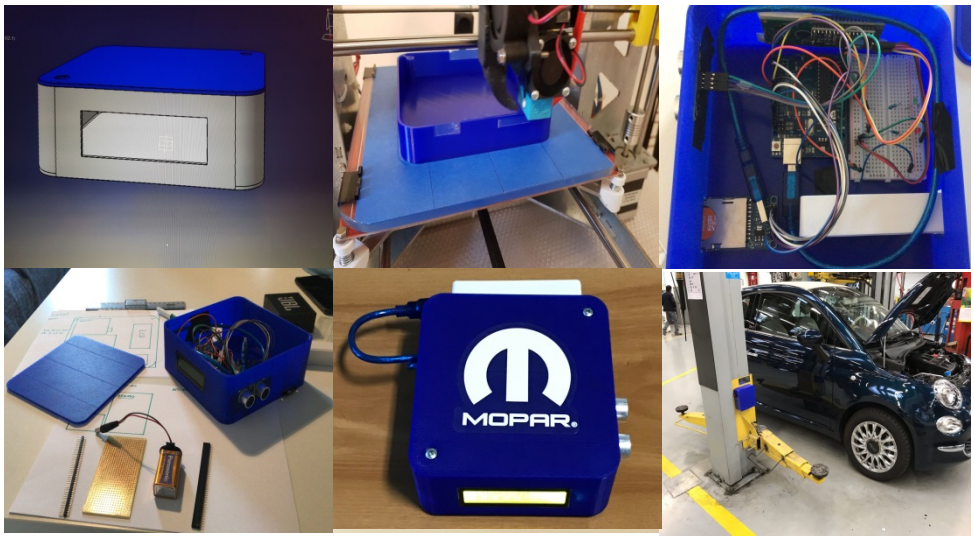
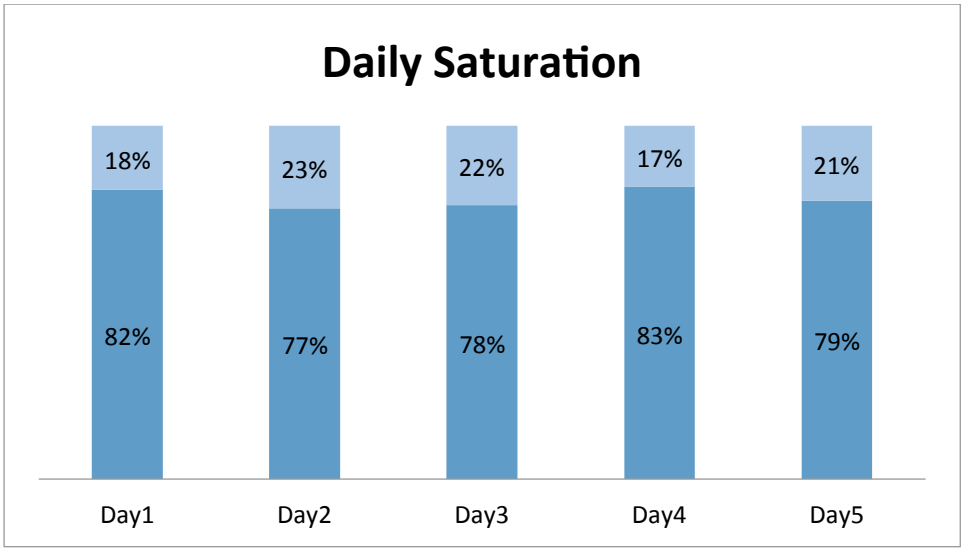


Figure 25. Step for Device

We can see from these graphs and observe that all the data calculated and developed by the monitoring of a lift can be easily extracted and analyzed in real time allowing an accurate study of the daily efficiency according to the work load. It is noted that most of the Non-Productive Time is given by the movement of the vehicle from the workshop to the machine park, or place where the return of the cars takes place. Another part is certainly given by the collection of spare parts in the warehouse, which is done manually by each technician, in fact there is not a figure that takes care of supplying the lift according to the job cards.



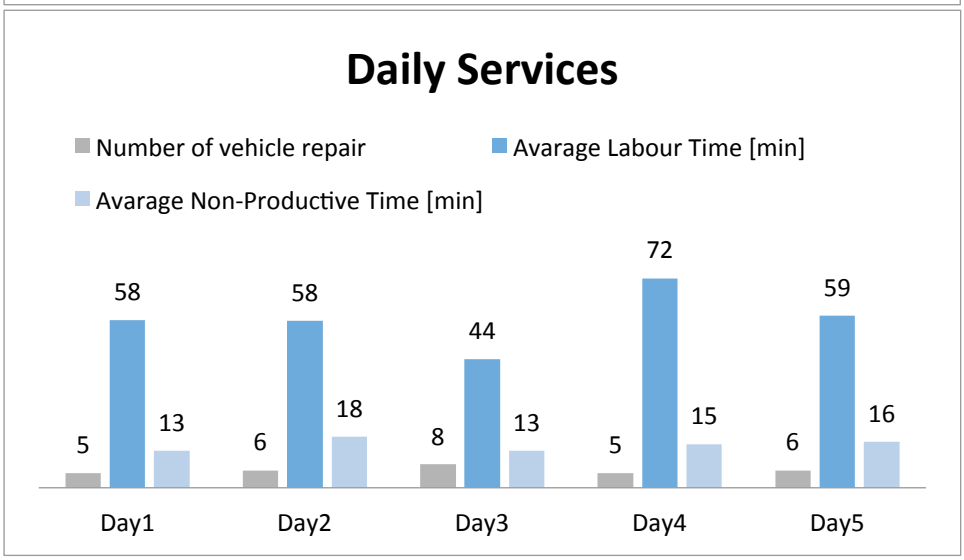


Table 1. Data Analysis

Processes description:

- Identification of the lift status by sensor
- Local data saving
- Intervention execution and time monitoring
- Automatic plate recognition of processing and positioning the vehicle in a re-delivery position

Advantages:

- Workshop time tracking
- Saving data and sharing
- Improvement efficiency
- Analytics & Data Intelligence

CHAPTER 11 - THE FUTURE OF SALES & AFTER SALES WITH BLOCKCHAIN

11.1 Intro and Why Blockchain ?

By 2020, experts estimate that 250 million connected vehicle will be on roads across the globe. With each vehicle equipped with more than 200 smart sensors, a deeply-connected infotainment system, and advanced cloud-based core informatics, the need for data management will be as crucial as maneuvering through rush hour traffic. The marriage of blockchain and automotive technologies provides exciting solutions to some of the most pressing automotive issues, today especially those facing the connected car industry. And as with most marriages, one partner is likely to do most of the driving. In this case, the power of blockchain technology will drive innovation and solutions across the entire automotive ecosystem. Indeed, we are seeing the emergence of the blockchain automotive industry even now.

11.2 What is Blockchain?

Blockchain is the new generation of the Internet, or better yet the New Internet. For greater accuracy, it is believed that it may represent a sort of Internet of Transactions and for those who look beyond the concept of transaction, the Blockchain can represent the Internet of Value. For others it is the digital representation of four very clear and strong concepts: decentralization, transparency, security and immutability. The Blockchain is a technology that allows the creation and management of a large distributed database for the management of transactions that can be shared between several nodes of a network [15]. This is a database structured in Blocks (containing multiple transactions) that are connected to each other in a network so that every transaction initiated on the network must be validated

by the network itself in the "analysis" of each individual block. The Blockchain thus consists of a chain of blocks that each contain multiple transactions. The solution for all transactions is entrusted to the Nodes that is called to see, control and approve all transactions by creating a network that shares on each node the archive of the whole Blockchain and therefore of all the blocks with all transactions. Each block is also an archive for all transactions and for the entire history of each transaction, which can only be changed with the approval of the network nodes. Transactions can be considered unmodifiable (except through the repetition and the "re" - authorization of the same by the entire network). Hence the concept of immutability. The Blockchain is a large database for managing encrypted transactions on a decentralized peer-to-peer decentralized network that gives the name to a new technological platform, which allows to redefine and reset the way we create, obtain and exchange value . The Blockchain is doing with the transactions what the Internet has done with the information and it is doing it thanks to a process that combines distributed systems, advanced cryptography and game theory. Blockchain is a decentralized database that stores assets and transactions on a peer-to-peer network. It is a public registry for managing data related to transactions in blocks and managed by encryption by network participants who verify, approve and subsequently record all the blocks with all data of each transaction on all nodes. The same "information" is therefore present on all nodes and therefore becomes unmodifiable if not through an operation that requires the approval of the majority of nodes of the network and that in any case will not change the history of that same information. Blockchain is not an application, it is not a system, it is not a technology. The Blockchain is a new paradigm for the management of information that allows to guarantee the real immutability of data because it is able to guarantee and certify the complete history of all data and operations connected to each transaction. It is a technology that allows the exchange of information and different types of values on the Internet. There are many types of transactions that can be supported and managed with the Blockchain. Payment is an example, as are transactions related to the

exchange of goods and services or the management of information linked to contracts.

The Blockchain is a series of blocks that store a set of transactions validated and correlated by a Timestamp. Each block includes the hash (a non-invertible computer algorithmic function that maps an arbitrary length string into a predefined length string) that uniquely identifies the block and allows connection to the previous block by identifying the previous block.
The basic components of the Blockchain:

- Node: they are the participants in the Blockchain and are physically constituted by the servers of each participant;
- Transaction: consists of the data that represent the values object of "exchange" and that need to be verified, approved and then archived
- Block: is represented by the grouping of a set of transactions that are combined to be verified, approved and then archived by the Blockchain participants
- Ledger: it is the public register in which all transactions carried out in an orderly and sequential manner are "noted" with maximum transparency and in an unchanging way. The Ledger consists of the set of blocks that are chained to each other by an encryption function and thanks to the use of hashes
- Hash: it is an operation (Non-Invertible) that allows to map a string of text and / or numeric of variable length in a unique and univocal string of determined length. The Hash uniquely and securely identifies each block. A hash must not allow to go back to the text that generated it.

Each block therefore contains several transactions and has a Hash placed in the header. The Hash records all the information related to the block and a Hash with information related to the previous block that allows to create the chain and to link one block to the other. The transaction contains information on the recipient's public address, the characteristics of the transaction and the cryptographic signature that guarantees the security and authenticity of the

transaction. The Blockchain is to be seen as a public and shared register consisting of a series of clients or nodes. The Blockchain is organized to automatically update itself on each of the clients participating in the network. Every operation carried out must be automatically confirmed by all the individual nodes through cryptographic software, which verify a package of data defined by private key or seed, which is used to sign the transactions. Guaranteeing the digital identity of those who have authorized them.

In the world there are countless types of goods for which it is necessary to certify ownership. It was decided to apply this technology both in the sales field, or in the car market; both in the After Sales area so as to have smart contracts that allow us to easily obtain all the maintenance and operations performed on the car. The reasons that led me to the application on this sector were:

- high changes in ownership (in Italy 3.5 million trades in 2014) and need for verification;
- centralized current process (managed through PRA - Public Register of Automobiles), complex and onerous;
- native existence of a digital code associated inextricably to the physical good (eg number plate, chassis number);
- very widespread and high unit value asset;

11.3 Dubai To Release Blockchain-Based System To Track Vehicle Lifecycles

Dubai's Roads and Transport Authority (RTA) has announced plans to launch a Blockchain-based vehicle lifecycle management system in 2020 that would provide customers which a history of their vehicle from "the manufacturer all the way to the scrap yard," local news outlet Arabian Business reported yesterday [16]. The Blockchain project, formed in connection with the Dubai 10x initiative, would show a transparent record of where each vehicle is at any moment of its life cycle. The initiative plans to begin by covering all cars in Dubai before expanding to all cars in the United Arab Emirates (UAE). The Dubai 10x was launched last year at the World Government Summit by Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, the Crown Prince of Dubai, and the chairman of the Dubai Executive Council. Its website states that it aims to "embrace disruptive innovation as a fundamental mantra of their operations and to seek ways to incorporate its methodologies in all aspects of their work." According to Mattar Al Tayer, the chairman and executive director of the RTA, this vehicle lifecycle management system will be the world's first government platform that can provide a genuine record of a vehicle's history:

"The platform benefits many stakeholders including car manufacturers, dealers, regulators, insurance companies, buyers, sellers and even garages, providing transparency and trust in vehicle transactions, preventing disputes and lowering the cost of services. It tracks ownership, sale, and accident history to create smart, more efficient systems for supply chains." This vehicle lifestyle Blockchain initiative falls in lines with Dubai's goal to become the first Blockchain government by 2020. In October of last year, Dubai announced that it would release its own cryptocurrency, emCash, through its local government. Also in October, Dubai hosted its first government-backed training program for Ethereum Blockchain developers in collaboration with a Brooklyn-based Blockchain company.

However, both Dubai and the United Arab Emirates also released several warnings last fall to the public about the risks of Initial Coin Offerings (ICO) and the use of cryptocurrencies as legal payment, due to their anonymity and potential use for nefarious purposes.

11.4 Porsche will be the 'first' to experiment with Blockchain technologies for cars

Automobile manufacturer Porsche is exploring Blockchain apps in its vehicles in cooperation with the Berlin-based startup XAIN.
In their press release published, Porsche stated that the company is the first automobile manufacturer to implement and successfully test Blockchain in a vehicle [17]. Possible applications for Blockchain technology range from locking and opening car doors via an app, with the possibility for temporary access authorization, to new and improved business models through encrypted data logging. Porsche also stated that Blockchain technology could be applied in further improving the safety and capabilities of driverless cars. Financial strategist for Porsche, Oliver Döring, is convinced of the tremendous potential of Blockchain technologies:
"We can use Blockchain to transfer data more quickly and securely, giving our customers more peace of mind in the future, whether they are charging, parking, or need to give a third party, such as a parcel delivery agent, temporary access to the vehicle. We translate the innovative technology into direct benefits for the customer".

According to Porsche, Blockchain features could speed up the process of opening and locking the car with an app by 6 times. This is made possible when "the car becomes part of the Blockchain, making a direct offline connection possible – that is, without diversion through a server". Current

approaches still require an online connection and the alignment of the car's data with its server-stored equivalent. Other companies in the automotive industry are also experimenting with the application of Blockchain technology. For example, the supplier ZF, the bank UBS, and the software giant IBM are working on a so-called "Car eWallet", which could enable secure transactions at charging stations, in multi-story car parks, and at toll stations.

CHAPTER 12 – CONCLUSION

The opportunity to do an internship experience at a company like Fiat Chrysler Automobiles was for me a very important opportunity for professional growth, which allowed me to get to know a totally new and fascinating reality. In my thesis, I wanted to show how a "lean" company uses the value of information, in a delicate and important process like that of the After Sales management on the net on all cars. The timely and accurate communication of data concerning the faults and defects that are found on the cars after delivery to the customer allows us to provide immediate assistance in order to reduce the time required to solve problems. These aspects of the service offered today are of great importance for any customer-oriented organization, even more so for an elastic company composed of various brands. In the process of managing anomalies from the sales network, information flow plays a critical role. In addition to the assistance to the dealer in solving the problem, it is necessary to:

- Decide which spare parts, replaced during repairs, to return to the company, because maybe they concern breakdowns on recent models or because they are "delicate" components from the point of view of safety and cost.

It is essential to have a system that manages all this information and guarantees the traceability of all the data involved, guaranteeing immediate availability at all times and during the process.
In particular it must:
Follow the car during the internal analysis phases, until the final result that explains the reasons for the failure and possibly leads to actions aimed at eliminating the problem, in view of the process of continuous improvement of the offered process.

Having a database, that is a cloud, able to classify the problems that caused the malfunctions, with a historical overview of all the activities carried out to solve them, in order to know how to act on similar problems in the future.

The analysis of the latter combined with the objective is to group into a single system, not only the information concerning the occurrence of anomalies in the network, their diagnosis and the replacement of the particular that caused the problem, but also the collection of data concerning every single detail returned to the company and the activities carried out thereafter on it.
We have shown the importance of applying the concepts of process traceability and computerization, two cornerstones of lean thinking, which are widespread throughout the after-sales service system and all the activities connected to it.

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