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Faculty of Business Economics

Master of Management

Masterthesis

How the introduction of driverless cars is disrupting the car industry?

Florian Bohet

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization International Marketing Strategy

SUPERVISOR :

Prof. dr. Wim VANHAVERBEKE

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Summary

The central goal of this research paper is to analyze how the car industry will be disrupted by the introduction of driverless cars. New technological advancements in global positioning, digital mapping, computing power, sensor systems and artificial intelligence have made driverless cars a reality. Currently, this new generation of cars is already being tested on our roads but is just waiting for a new legislation to authorize its utilization.

The primary objective of this research is to show the importance of creating innovative ecosystems for the development of driverless cars. All car manufacturers are not prepared equally to develop this new technology. Some have already created successful ecosystem and others are still nowhere. Car manufacturers need to collaborate with IT companies like Google, Apple or mobility providers like Uber and Lyft if they want to take the lead of the development of this new generation of cars. To achieve ground-breaking success, they will have to combine their knowledge and resources. All these partners will, of course, take different advantages and benefits from these collaborations. These observations will lead us to the second objective of this report, namely determining who the big winners of the development of driverless cars will be. I used the information provided by experts to answer this question. The third objective of this research is to define a new business model for carmakers since driverless cars will revolutionize our way of moving and will push traditional car manufacturers to rethink their strategy, position and business model in order to follow this new trend. Carmakers will also have to find new sources of revenues to ensure their economical survival in the future.

This report also contains, on the one hand, a case study of Volvo, a pioneer in the development of autonomous driving systems that has developed a partnership with Uber to accelerate its development of driverless cars. This is a concrete example to illustrate the successful strategy, which carmakers should try to follow. On the other

hand, I also wanted to have the point of view of an expert who does not belong to the car industry to have relevant additional information at my disposal.

The outcome of my research leads to the conclusion that the introduction of driverless cars will completely disrupt the car industry. Carmakers will have to create ecosystems with high tech partners and adapt their business models to meet the customers' new needs.

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Introduction

"Up to 15% of new vehicles sold by 2030 could be fully autonomous". This statement from a 2016 McKinsey report brought my attention on the future of the automobile. I had already heard that car manufacturers or IT companies like Google were making tests on roads but I had no idea where the car industry was in the development of this new technology and if it was feasible. This made me decide to investigate this subject.

In 1930, in the Futurama exhibition at the New York World's fair, a self-driving car was a utopian vision of the city of the future. How could a car drive without a human interaction? But now, 90 years, later fiction has become reality. The development of new technological advancements in global positioning, digital mapping, computing power, sensor systems and artificial intelligence have allowed the development of a new mode of transportation, thereby changing radically the perception we have had of cars so far. Today the automotive sector is changing fast and consumers are more interested in systems and technologies embedded in cars than in horsepower (Kersten Heineke, 2017).
The creation of driverless cars was made possible thanks to the emergence of disruptive trends which have gained momentum: autonomous driving, shared mobility, connectivity and electrification. These trends not only led to massive shifts in the business model of traditional automotive companies but also opened the door for new players (Matthias Kasser, 2017).

So it seems driverless cars will definitely revolutionize our lives and our way of moving (Jeremy Warner, 2016) and, so it is interesting to know how car manufacturers will face this new situation. To find out, I will, in this report, first answer the following sub-questions: in which ecosystem do car industry need to evolve in order to develop driverless cars? Who can lead these ecosystems? Who will benefit more from the creation of driverless cars? And what business model will become the new source of revenues for car manufacturers? The developments and results obtained will allow me

to finally come to the main reflection question: “How will the introduction of driverless cars disrupt the car industry?”

In this master thesis, I will identify the kinds of companies involved in the development of driverless cars, investigate what types of partnerships are necessary to make this development possible, establish who is likely to win or loose in this trend towards driverless cars and finally determine the potential of this new technology and its impact on the car industry.

The present master thesis comprises three chapters. Chapter 1 describes the initial and current situation in the car industry regarding the development of driverless cars. It also explains what an autonomous car is and what the different levels of autonomy are. Chapter 2 is the core of this thesis. In this part, I will answer the sub-questions by using the concepts of innovation ecosystem, leadership prism, business model and value blueprint. That will help me to respond to the main research question. Chapter 3 introduces the case study research that I did about Volvo to give a concrete example of what a car manufacturer should do to face the new situation. This chapter also contains a report of an interview with a professor of the University of Liège and my research methodology. In the conclusion, I will give an answer to all the questions raised all along this work and suggest avenues for further research.

Chapter 1: Initial situation

What is the current situation in the car industry?

Nowadays cars are no longer just hardware platforms but they have also become software platforms. The car industry has entered the fourth industrial revolution called the industry 4.0. The first industrial revolution involved mechanization, water and steam power. The second one saw the apparition of the assembly line led by the car industry thanks to Henry Ford. And the third industrial revolution was created by computers and automation. When we look into industry 4.0, it is a new world in which the physical world is going to coexist with unprecedented amount of data, computer power and other technological advances. (Asutosh Padhi, 2017)
The automotive industry is in a new shifting phase, which is expected to be rapid and fundamental because its products are changing considerably. This transformation is due to the convergence of four disruptive technology-driven trends. (Simon London 2017, Matthias Kasser 2017, Kersten Heineke 2017)

The first one is autonomous driving. It refers to the car's capacity to go from a point A to a point B without human intervention. The autonomous driving level is classified from level 0 to 5 where 0 represents the lowest level of autonomy and five the highest but I will talk about it later. In 2016, only one percent of the vehicles sold were equipped with basic-partial autonomous driving technology (level 2 of autonomous driving). But today, 80% of the top ten OEMs (Original Equipment Manufacturers) have announced their willingness to develop highly autonomous technology (level 4 and 5 of autonomous driving) to be ready for the road by 2025. (Kersten Heineke 2017)

The second disruptive technology-driven trend is connectivity. Cars are now computers on wheels and generate massive amounts of data. They have become smarter and are able to perform a multitude of tasks in the same way as computers. As vehicles will be connected to the external world and able to communicate with one another, drivers will benefit from a much wider range of services. Moreover, nowadays customers are giving more and more importance to connectivity and they consider their cars as part of their

connected network. They are no longer interested in horsepower, but rather in connectivity features. Automakers cannot afford to ignore this evolution and to satisfy their customers' need they absolutely must embed connectivity into their cars.

Electrification, the third disruptive technology-driven trend, represents a good alternative for internal combustible engine and is used for battery applications in electric cars. Because of stricter regulations to carbon emission from world governments, automakers have no other choice than to switch from combustion engines to electric batteries. Moreover, several European countries are considering banning the sales of gasoline and diesel cars in the next decades. To be in line with these new legislations, automakers have to develop and promote electric cars. Some OEMs like Tesla, BMW, Nissan, Volvo and Toyota are pioneers in the process of electrification and have already developed a wide range of electric and hybrids cars. Car manufacturers really need to include electrification in their plans for the next years if they want to satisfy the new government requirements in terms of carbon gas emission. OEMs aspire to equip 50% of all their new models with electric batteries by 2021. (McKinsey, 2017)

The last trend, the most utopian one, is shared mobility, i.e. a vehicle is shared among different users and kept in operation 24 hours a day in order to optimize both its utilization and resources. So, instead of leaving a car in a garage for a whole day, someone else could use it. Google plans to increase car utilization from 5% to 75% by developing this system. The benefits will be numerous: fewer cars will be needed for the same amount of use and the number of cars in the streets will be considerably reduced. Shared mobility offers another interesting advantage. It allows people to use a car only when they need it and it is leading little by little to a different mobility behavior. As a result, OEMs expect that one out of ten cars sold in 2030 could be a shared vehicle. And this ratio will continue to grow to reach one-third in 2050. (McKinsey, report 2016) However, the number of shared cars will be more important in big cities like New-York, London, Paris or Shanghai where there is a high population density and an important traffic congestion than in cities in the country side.

Historically, innovation in the automotive industry has proceeded along stable axes such as better performance, design, safety features, etc. It goes without saying that the emergence of the four above-mentioned trends will deeply modify the business models of traditional car manufacturers and that the car industry will inevitably shift to a completely new paradigm. The door will be wide open for other players who are better adapted to new technology (for example mobility providers such as Uber or Lyft, tech companies such as Google and Apple or new carmakers such as Tesla). They will enter the market and succeed while forcing established players to reinvent the structures that previously allowed them to succeed. (Olaf Sakkers, 2016)

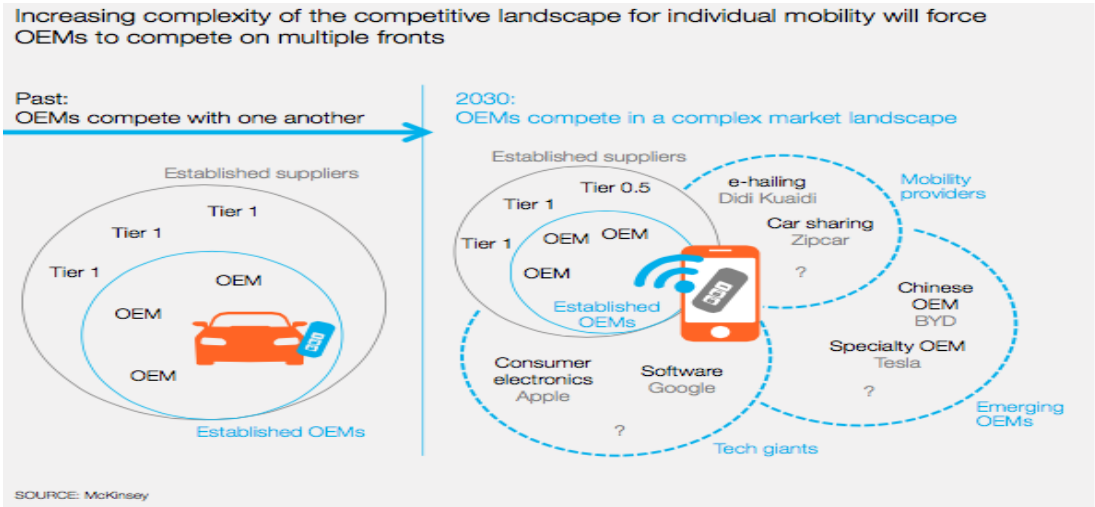


Figure 1: *The increasing complexity of the competitive landscape for individual mobility from Automotive revolution – perspective towards 2030, McKinsey&Company, 2016, p 13.*

Figure 1 shows how the increasing complexity of the competitive landscape for individual mobility will force OEMs to compete on multiple fronts. In the past OEMs were competing with each other and they were included in a network with their suppliers. There were no interactions with other types of companies. But now, new players such as mobility providers, tech companies and emerging OEMs are contributing to great changes and increasing the competition in the automotive industrial landscape by bringing their knowledge and skills about new technologies that traditional

automakers do not master. The car industry is thus moving from a competition among peers (OEMs against other OEMs) toward new competitive interactions between OEMs and new entrants. It is in OEMs' best interest to compete on multiple fronts and not to overlook autonomous technology, electrification, mobility and connectivity issues if they want to remain in the arena and not to be beaten on their own ground. In order to be able to follow this new tendency OEMs will have to make strategic moves to shape the automobile industry's evolution. (Paul Gao, 2016)

Firstly, OEMs need to prepare for uncertainty. They have to anticipate new market trends and explore new alternatives to the traditional business models in order to continually create the biggest possible value for customers.

Secondly they have to form partnerships with the new entrants across the market landscape by sharing their resources and knowledge. In other words they have to create open and scalable ecosystems. Figure 1 shows the types of companies likely to form these ecosystems. They can be split in four categories: tech companies, mobility providers, established OEMs and emerging OEMs. OEMs such as Volvo, Toyota or BMW will deliver autonomous driving and electrification technology, mobility providers such as Zipcar or Didi Kuaidi will conduct research about shared mobility and IT companies such as Google or Apple will develop connected platforms. It is only when all these solutions are put together that firms will be able to create an efficient network of driverless cars. So connectivity and shared mobility absolutely need to be embedded in cars to create successful driverless cars.

Thirdly OEMs have to operate transformational changes. They need to align their skills and processes to guaranty the creation of value for customers, cyber security, data privacy and continuous product updates. Data and privacy protection represents a huge challenge in the driverless cars technology. Hyper-connected cars will allow car manufacturers to trace drivers' journeys and to localize them at any time. And, of course, a question immediately comes to mind: what are they going to do with that personal

information? There is also a security issue: are the vehicles protected from hackers? Can an ill-intentioned individual take the control of the car? These questions cannot go unanswered if the actors of the ecosystem want to earn end-users' trust and confidence.

Fourthly they have to shift their value proposition from traditional car sales and maintenance to integrated mobility services. Software will take the place of hardware and OEMs have to adapt their business model in order to collect the maximum of revenue from mobility services and data collection. They have to find a way to monetize this amount of data.

OEMs really need to be the leaders of the ecosystem they will create with IT companies, mobility providers and new OEMs simply because they are the ones that have the most to lose in this car industry disruption.

The new automotive industry landscape will take the form of a big ecosystem where firms from totally different sectors will collaborate to satisfy customers' new needs and expectations. This innovation ecosystem will provide many challenges but also many opportunities. On the one hand it will be challenging to create a good communication between firms and to coordinate them. That will obviously require effort, time and money. But on the other hand creating an ecosystem will provide important competitive advantages for firms that are part of it because they will be able to develop technology in a more efficient way. Competitors will therefore find it more difficult to rival.

What is a driverless car?

What is concretely a driverless car? The Tech Target network defines it as "a robotic vehicle that is designed to travel between destinations without a human operator. To qualify as fully autonomous, a vehicle must be able to navigate without human intervention to a predetermined destination over roads that have not been adapted for its use".

You have also to know that driverless cars are also called autonomous cars or self-driving cars and I will use these three terms throughout this report.

Driverless cars represent a revolution for the car industry because as stated before car manufacturers will have to adapt their business models and their way of working by creating ecosystems. This new generation of cars represents the future of mobility and will definitively revolutionize our way of moving. But not all autonomous cars have been created equal. That is why they have been classified in six different levels of car autonomy by the SAE international (Society of Automotive Engineers), a US-based professional association. It goes from "no automation" to "full automation". Here below is an explanation of each of these six levels:

- Level 0 is characterized by no automation. The car is fully controlled by a human driver and there is no driving assistance except some automated warnings and automated braking systems. Today the big majority of cars have this level of autonomy. We can take the example of a Dacia with no driving assistance options.

- Level 1 is formed by cars with driver assistance. The driver, by choosing a certain driving mode, can enjoy some assistance that the car provides, for example steering or breaking by itself. But a human driver is still needed to take control of the car and to drive. The new Volkswagen Polo belongs to this category thanks to its Emergency Braking System. It is able to brake by itself in front of an obstacle.

- Level 2 is the partial assistance. Here we can find cars that are embedded with an autopilot but human drivers are still needed. They have to be alert all the time and ready to take over the control of the vehicle in case of failure of the autopilot system. Model S of Tesla belongs to this category thanks to its system of autopilot. The car is embedded with driver assistance technologies including Traffic Aware Cruise Control and Auto steer with lane change, which enables automatic steering but with a speed restriction.

- Level 3 is represented by the conditional assistance. The technology inside the vehicle is more developed and the vehicle can do more things by itself. It can manage its surroundings, change lanes, steer and brake on motorways for example. However, the driver must be aware and ready to take back the control of his vehicle in case of problem. At this level the car is not yet totally autonomous and the driver needs to be behind the wheel. As an example we can mention Audi A8 equipped with the Traffic Jam Pilot that manages starting, steering and braking in slow moving traffic at up to 60 km/h.

- Level 4 represents the cars with high automation. At this level the car is able to drive by itself, the driver does not have to touch the wheel and to keep an eye on the road anymore. The driver can just sit in the back and relax. However if the car does not manage to read something on the road it will ask for the driver's assistance. This kind of car is now being tested a lot on highways with a view to making this technology available as soon as possible. The best example is the Google/Waymo self-driving vehicle.

- Level 5 is characterized by full automation. At this stage human interventions are no longer needed. The cars are fully autonomous and there is no pedal and wheel. These cars can drive even if there is no human inside. This level of automation is still a prototype and has not yet been tested on the road.

Autonomous cars from level 0 to level 3 have already been commercialized and we can find them on our roads. However for the autonomous cars of level 4 and 5, car manufacturers are continuing their research and development in order to test their reliability. In this report I will mainly focus on level 4 and level 5 of autonomous cars and I will try to explain the impact of this new generation of cars on the car industry.
The initial situation and driverless cars now being defined, I will now start responding to the research questions of this report.

Chapter 2: Actions that car manufacturers have to take

To know how the introduction of driverless cars is disrupting the car industry, I think it is necessary to first find an answer to the following sub-questions: in which ecosystem do car industries need to evolve in order to develop driverless cars? Who can lead these ecosystems? Who will benefit more from the creation of driverless cars? And what business model will become the new source of revenues for car manufacturers?

To this end, I will firstly highlight the importance of creating innovation ecosystems for the development of driverless cars, secondly, I will establish the leadership prism based on the partners present in the whole ecosystem, and thirdly, I will give some tracks for new business models. Finally, I will conclude by creating a value blueprint to determine the value proposition of these ecosystems.
I will also give definitions of the concepts I use in this report and then apply them to driverless car issues.

Innovation Ecosystem concept:

This section will help us to respond to the first sub-question, which is: in which ecosystem do car industries need to evolve in order to develop driverless cars?
I will start by defining what an ecosystem is and then I will give some examples to illustrate the development of driverless cars.

J.F Moore (Harvard business review, 1993) defined a business ecosystem "as a dynamic structure of interconnected organizations that depend on each other for mutual survival. Companies create an ecosystem around their products in order to extract benefits from them. Creating such ecosystems is not an easy task. It requires a good organization and coordination between the different partners involved in the innovation process".

But a definition is not sufficient to determine what an ecosystem is. I therefore decided to go further and to collect the points of view of various experts in this field. Here below I have summarized and classified their opinions to get a clearer and more precise idea.

Firstly, Luciana A. Almeida states that a business ecosystem is an economic community supported by organizations who interact through assets and services and produce value to customers. She sees technology, partnerships, collaborators, investors, retailers and clients as parts of the ecosystem. According to her, these factors are the key elements to determine the success of an ecosystem. She also adds that, nowadays, innovation is a key point to any company that wishes to remain competitive. In the past, innovation depended exclusively on the company itself but now companies seem to be more and more willing to work together because developing new technologies has become really expensive. Almeida also comments that the success of a company does not depend only on its internal capacity but also on the role of its collaborators (Luciana A. Almeida, 2015).

Secondly, Ron Adner thinks that succeeding in innovation ecosystems requires a clear, specific plan for how the different elements and actors need to come together. He also adds that an ecosystem is a world of permutation, all need to work together simultaneously and the combination of possible roles is vastly greater (The Wide Lens, 2012).

Thirdly, Bart Leten insists on another important element: innovation ecosystems generate value for partners by reducing development costs and risks and by combining complementary knowledge that will enable partners to address problems with high complexity. He also adds that ecosystem partners could subsequently use the knowledge created within ecosystems to support their own businesses (Bart Leten, 2013).

And finally, Claude Leglise (Executive director; center for innovation leadership) also enhances the importance of the ecosystem. He explaines that: “Our future wealth is

completely tied to the wealth of the ecosystem and the wellbeing of the ecosystem. Therefore, it is to our advantage to make sure that this whole thing evolves positively". That means that firms need to collaborate and work together if they want to evolve positively. If they all participate in the wellbeing of the ecosystem, the ecosystem will inevitably become more efficient and that will have positive impacts on all firms.

To sum up, the driverless car technology is so complex and asks so many human and financial resources, that car manufacturers will not be able to develop them alone. An ecosystem must absolutely be created to exchange ideas, resources and technology. Collaboration is essential as firms can affect or be affected by the activities of the other ones. In order to guarantee successful collaborative innovation initiatives, partners of the ecosystem also need to establish the IP-model (intellectual property, i.e. the protection of creations of the mind, which have both a moral and a commercial value. The IP typically grants the authors of an intellectual creation exclusive rights for exploiting and benefiting from their creation (ESA, 2018)) that determines their value appropriation potential.

Examples of ecosystems:

To illustrate the importance of innovation ecosystems, here is a non-exhaustive list of companies that have created partnerships in order to progress in the development of driverless cars.

Firm A: car manufacturer	Firm B: IT company or mobility provider	Description
GM (General Motors)	Lyft (on-demand transportation company)	GM invested 500 million $ in Lyft. With this collaboration, they want to create an on-demand fleet of driverless cars. [1]
Fiat Chrysler	Google	Google has already started to work on its own autonomous cars but created a collaboration with Fiat-Chrysler in order to develop self-driving minivans using sensors and computer systems developed by Google. [2]
Volvo	Uber (transportation network company)	Uber invested 300 million $ in the Swedish automaker because of its safety record. Uber wants to create a driverless fleet. [3]
BMW	Trio of 3 IT companies: Intel (provider of semi-conductors), Mobileye (provider of sensors) and Delphi (provider of hardware components)	In 2016, BMW, Intel and Mobileye decided to join their forces to make self-driving cars a reality. With this collaboration they want to launch the production of driverless cars into series by 2021.

[1] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/
[2] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/
[3] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/

		In 2017, these 3 partners decided to include Delphi in their partnership. Delphi became a development partner and system integrator of the autonomous driving platform. They work together in the areas of perception, sensor fusion, and high performance automated driving computing. Delphi will also provide hardware components. [4]
Daimler	Bosch (provider of vehicle technology with hardware, software and services to offer complete mobility solutions)	They joined their forces to advance in the development of fully automated and driverless cars. They have a development agreement to bring fully automated (level 4) and driverless (level 5) cars to urban roads by the next decade. [5]
BMW, Mercedes, Toyota, Ford and Changan	Baidu (the Chinese Internet browser, the equivalent of Google in China)	Baidu invested 200 million $ in the development of the AI (artificial intelligence) with these car manufacturers. [6]
Jaguar	Waymo (Google self-driving car project)	Jaguar Land Rover and Waymo will develop together the world's first premium self-driving electric vehicle for Waymo's driverless transportation service. Waymo is planning to buy 20,000 vehicles from the car manufacturer.[7]

***Table 1**: Examples of ecosystems*

[4] https://www.press.bmwgroup.com/global/article/detail/T0270913EN/bmw-group-intel-and-mobileye-announce-delphi-as-a-development-partner-and-system-integrator-for-their-autonomous-driving-platform?language=en
[5] https://www.daimler.com/innovation/case/autonomous/bosch-cooperation.html
[6]https://www.lesechos.fr/01/06/2017/LesEchos/22457-073-ECH_tandem-germano-chinois-dans-la-voiture-du-futur.htm
[7] https://media.jaguar.com/news/2018/03/waymo-and-jaguar-land-rover-announce-long-term-partnership-beginning-self-driving

After analyzing this table some comments can be made about how ecosystems are created. First of all, these examples of innovation ecosystems combine IT companies and mobility providers with car manufacturers. This collaboration can take two different forms. On the one hand firms can join their resources and knowledge in order to develop technology. They create a platform to establish a connection between them. It is the case with Daimler and Bosch, and with BMW, Intel, Mobileye and Delphi. On the other hand firms can also invest in other firms so that they can use the technology they developed. In this case it is more a transfer of resources and knowledge between the partners. We have here the example of GM that invested in Lyft. In this case it is the car manufacturer that invested in the mobility provider or in the IT company but sometimes it is the opposite. Uber, for example, invested 300 M$ in the car manufacturer Volvo or Baidu injected millions for the development of AI (artificial intelligence) with different OEMs. These giant IT companies and mobility providers possess as many resources as car manufacturers and so they can take the lead of some partnerships. With the progress of technology, these IT firms represent now the most powerful firms in the industrial landscape.

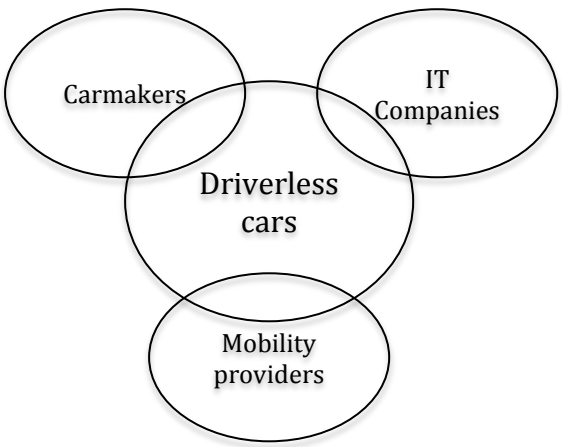


Figure 2: *Innovative ecosystem for driverless cars*

As already mentioned, ecosystems are necessary to develop the driverless technology because each firm individually does not have the sufficient resources and knowledge to do it by itself. Companies need each other. Moreover, if firms manage to create an efficient ecosystem, rivals may experience more difficulties in competing with them,

simply because a group of companies owns more resources and knowledge and so will take the lead of progress.

In conclusion, to launch a successful product and revolutionize the automobile industrial market, firms need to establish consolidate ecosystems.

Examples of acquisitions:

In addition to the precedent described collaborations we can also notice that some companies like Ford, GM or Uber acquired start-ups that develop driverless cars technology. With these acquisitions they want to obtain exclusive access to driverless technology; they want to be sure these start-ups will not sell the results of research to competitors. In these cases we are not in the situation of an ecosystem because the biggest firm buys the smallest one in order to have a unique use of its knowledge and skills. But I think that is also important to have in mind that some firms use this method in the race for the development of driverless cars.

Firm A:	Firm B:	Description
Ford	Saips	Ford acquired Saips, an Isreali startup, specialized in machine learning and computer vision. With this acquisition, the car manufacturer wants to facilitate its production of mass fully autonomous vehicles by 2021. [8]
GM	Cruise automation	GM purchased Cruise automation, a startup based in San Francisco, specialized in the design and development of level 4 and level 5 cars, for 1 billion $. GM will therefore build the world's largest fleet of self-driving cars. [9]
Uber	Otto	Uber bought Otto, a German startup specialized in the manufacturing of self-driving vehicles for industry with the ultimate goal of making human driving obsolete, for 680 million $.[10]

***Table 2**: Examples of acquisitions*

[8] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/
[9] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/
[10] https://www.techrepublic.com/article/7-autonomous-vehicle-partnerships-that-will-shape-the-future/

Leadership prism:

Now that ecosystems created for the development of driverless cars have been defined and illustrated, we will in this new section concentrate on the following sub-questions: who can lead these ecosystems? And who will benefit more from the creation of driverless cars?

To answer these questions, we will use the leadership prism developed by R. Adner. This tool will help us to identify the actors in an ecosystem who are going to be the leaders and those who are going to be the followers. It will also help us to identify the surplus the actors can expect from participating in the ecosystem.

As we can read in the book written by Ron Adner, ecosystem "leader" and "follower" do not map onto ecosystem "winner" and "loser". If we want to have a successful value proposition each partner needs to win. We will not have one looser and one winner but two winners or two losers. An ecosystem is created to generate surplus for all the partners involved and not only for the leader. Claude Leglise summarizes this idea perfectly: "You have to manage the future of the ecosystem. It is a really complete system with lots of people. So the role that we are trying to play is one of leadership, which is very different from wanting to own everything."

Adner adds that the ecosystem leader's core challenge is firstly to create a blueprint that creates value for the end user, secondly, to assure that all necessary partners get enough surplus to warrant their participation, and thirdly, to leave enough value in the end to make the leader's own efforts worthwhile.

Moreover, in the absence of a credible leader, meaningful progress will be impossible. Indeed, the role of the leader company is a key element in the success of ecosystems; it needs to give the positive impulsions to its partners in order to motivate and stimulate them in the ecosystem. The leader has to fix the objectives and to be sure everybody goes in the same direction. As Leten and co said: the particular role of the orchestrator

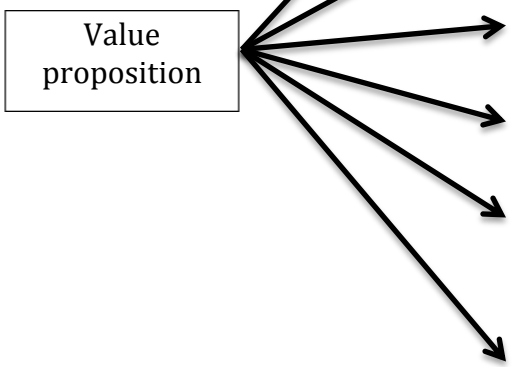
in shaping the innovation ecosystem, stimulating cooperation amongst partners, setting the research agenda, and adding value through its own capacities can be an important determinant of the ecosystem success.

However in the ecosystem, the leader is the first one to invest and the last one to receive his profits. Followers, on the contrary, invest later and receive the recovery of their investment quicker. As they are taking major financial risks, it is only natural for leaders to earn a bit more in the end.

As regards driverless cars, when we look at the different examples of ecosystems stated in the previous section, we can notice that the leaders are not always the same. This function can be taken up as well by a car manufacturer, a mobility provider as by an IT company because these types of companies have enough resources and skills to do it. All of them can gain from the creation of driverless cars, so they have an incentive to stimulate and lead ecosystems. This new technology represents large opportunities in their own sector and if they are not in the good ecosystem they run the risk of loosing a lot. Moreover, two key principles will guarantee the success of an ecosystem: communication and trust between the partners. If a leader fails in establishing them, his ecosystem will never be successful.

Now that we know who can lead an ecosystem, let's examine who will benefit more from the creation of driverless cars?
The table below presents the leadership prism for driverless cars wherein all the actors involved in this new technology have been taken into account, namely not only car developers but also importers, retailers and end-customers. We cannot overlook the fact that these three actors will play a very important part in the success of driverless cars. Besides, there is a high risk driverless cars will not be developed and expanded if all the actors do not gain a surplus from their creation.
However, it is difficult to measure the surplus each partner will obtain. This surplus is the difference between the relative benefits and the total costs generated by the creation

of driverless cars. I measured these benefits and costs with values from 0 to 5 (0 corresponds to the lowest benefits and costs and 5 to the highest benefits and costs) and I contacted by e-mail four experts: Bart Pyl, Senior Product Manager of Volvo car Belux, Xavier Winnepenninxks, technical partner BMW Belgium, Dries Vanmarsenille, category manager Toyota Belgium and Damien Ernst, Professor at the University of Liège, to make a ranking for each partner and so determine who the biggest winner of this new technology could be. ***(See Appendix 1)***



Partners	Relative benefits	- Total costs	= Surplus
Tech companies	4	3	1
Mobility providers	4	2	2
Car manufacturers	5	3	2
Importers	4	1	3
Retailers	3	2	1
End customers	5	1	4

Figure 3: *Leadership prism for driverless cars. Relative benefits and total costs for each partner. Adapted from "The Wide Lens", R. Adner, 2013, p. 118.*

Figure 3 represents the average results of the information I collected from my survey with the four experts. First of all, it is important to mention that the creation of driverless cars will generate a positive surplus for all partners. This new technology will thus be supported by each partner and its chance of success is more than certain. The efforts made by the leader of the ecosystem have contributed to enough surplus for all partners and left enough value in the end.

In this figure, we can also directly observe that the biggest winner will be the end-customers. This is easily explained by the fact that their total benefits will be very high and their total costs tiny. They will undoubtedly benefit the most from driverless cars as this new technology will make their lives easier.

Importers rank second. Their high surplus is to be attributed to the fact that they will not have to invest in the development of driverless cars but will nonetheless take advantage of their success. Carmakers simply cannot do without importers if they want to sell their vehicles across the world. Importers will always be the port of entry on foreign markets for brands.

Car manufacturers and mobility providers take the third place.
Car manufacturers will certainly be the ones that will derive maximum benefit from creating driverless cars but they will also be those, along with IT companies, investing and spending the most. Indeed, given the huge costs involved, mainly such types of companies will be able to encourage the development of autonomous driving systems. Mobility providers, like Uber, being the best prepared to provide the kind of services resulting from this new way of moving, have seized the opportunity offered by this new technology. They, too, are investing massively in it.

IT companies and retailers are in the last position: they will gain the lowest surplus. IT companies, as stated before, will inject a lot of money in R&D but the expected returns on investments will not be that high for them.
Retailers, for their part, will have a decreasingly less important role to play in the car industry. Customers will no longer need to go to the garage to have their cars maintained. It will be possible for them to download updates for their cars on the Internet. And if they want to buy a car, they will do it on the web, too. E-commerce will thus deeply impact the car industry and the role of the retailers will have to be completely rethought. Nonetheless, carmakers are convinced retailers are still important to establish a contact between companies and the end-customers. They

consider them as the standard bearers of the brand. This issue deserves to be developed further, that is why I will look into it in the next section of this report.

In conclusion, a promising future awaits the driverless car technology and, consequently, this will profitably impact the whole car industry. However, if car manufacturers want to adapt to the new changes and remain at the forefront, their business models will have to be modified drastically.

Business model:

This last section will help us to respond to the last sub-research question, namely: what business model will become the new source of revenues for car manufacturers?

But firstly what is a business model? A business model as defined by Osterwalder (2010) describes the rationale of how an organization creates, delivers and captures value. The business model is like a blueprint for a strategy to be implemented through organizational structures, processes and systems. Ultimately, business model innovation is about creating value for companies, customers and society. It is about replacing outdated models. The scale and speed at which innovative business models are transforming the industry landscape today is unprecedented. Entrepreneurs really need to understand the impact and importance of defining a good business model. They need to continually invent, design and implement new business models in order to have successful business (Osterwalder, 2010).

To answer our last sub-question it is important to know the background of the automobile industry and what its previous business model was.
The fundamental features of cars have not changed much for about 100 years and neither the business model that supports their production. (Olaf Sakkers, 2016)
Throughout this period, carmakers have leveraged resources to spend heavily on vehicle R&D (Research and Development) to create differentiated, high-end and higher-margin vehicles. They have also spent a lot on advertising to promote their brand and elaborated a large distribution network of retailers to ensure that the vehicles can reach the customers everywhere. Even if there were a lot of investments in the automotive industry to constantly improve the quality and comfort of the vehicles there were no real revolutions in terms of business model. Carmakers were only focused on selling their vehicles. Since connectivity did not exist, there were no other services to be provided.

But the emergence of driverless cars will create new opportunities for car manufacturers. The progress in connectivity and shared mobility will push them to modify their business model. They need to identify, understand and take profit of new opportunities in order to survive because there will be no more money to be made from building cars in the future. (KPMG report, 2017) Carmakers have now to modify their downstream business model in order to generate revenues by collecting data and renting mobility services.

Modification on the downstream business model:

Before explaining the modification to bring on the car manufacturers' downstream business model, it is important to define what downstream and upstream processes are. The upstream process involves finding and extracting raw material. It consists in all the steps before creating the final product. Then the downstream process consists in assembling the parts collected in the upstream to create the final product and deliver it to the final customer. (Bryan Bass, 2018)

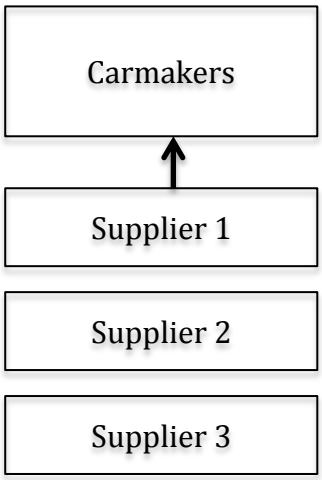


Figure 4: *Traditional supply chain*

In figure 4, the upstream is composed of the current automotive supply chain, which is formed by a pyramid where we find at the top the carmakers and below we have all the tiers of suppliers that develop parts according to the needs of the automakers. Thanks to their position on the top of the pyramid, carmakers can squeeze the margin of their

suppliers by creating competition between them and that can therefore cut the costs of their vehicles. With this pyramidal system carmakers have just to assemble the pieces received from suppliers and put their badge on the assembled vehicles. This traditional supply chain system has remained relatively unchanged until now. (Olaf Sakkers, 2016) When the cars are assembled and ready for sale, the upstream is finished and we enter the downstream of the car manufacture business model. Carmakers have now to connect the vehicle with the end-customers and do it through different intermediaries, which are importers and retailers.

In figure 5, the upstream is represented by the transfer of parts from suppliers to carmakers and the downstream by the transfer of vehicles from carmakers to the end customers.

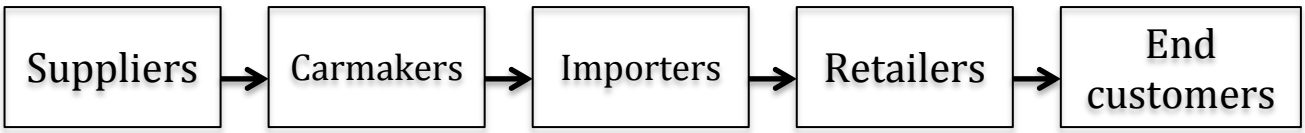


Figure 5: *The traditional upstream and downstream of carmakers.*

This schema corresponds to what the situation in the downstream automotive industry has been so far. However, this downstream now seems to be obsolete and needs to be modified. Indeed, in the future, the role of the retailer will become more and more limited and there are two main reasons to explain this phenomenon. Firstly, cars will become more efficient and will therefore need less maintenance. As a result, customers will not need to go so often to the garage. Secondly, the relationship between customers and car retailers will become more digital as customers will be able to find all the information they need about their car on the Internet. Interaction between retailers and end-customers will consequently decrease. (KPMG report, 2017) However, the importer will still remain important because carmakers need them to export their vehicles across the world.

Another consequence of the emergence of driverless cars is that the relationship between end-customers and carmakers will be facilitated due to the high connectivity of the cars. This will allow carmakers not only to collect a large amount of data about their customers but also to be put in direct relationship with them. Big platforms connecting customers and carmakers will appear and if a driver has problems with his car, he will be able to contact the car manufacturer directly and the car manufacturer will then be able to propose a direct diagnostic to the problem.

This possible direct connection between end-customers and carmakers will in the future inevitably contribute to the reduction of intermediaries' interventions and this will bring some changes to the downstream. These intermediaries will continue to exist but carmakers will be now able to be in direct relation with their end-customers. The higher connectivity of the cars will create more connected services. As for the upstream, it will remain the same.

Figure 6: *The adapted carmaker downstream structure.*

As driverless cars develop, this new system should be adopted by more and more carmakers. At the moment, only Tesla, one of the new emerging car manufacturers, has set it up. They use digitization in order to build a direct relationship with their customers. Their customers can buy a vehicle, request maintenance and make software updates just by using the Internet. The company can, thanks to this process, offers new services over the lifetime of the vehicle. In addition, the carmaker sells directly its vehicles to the customers and there are no more interactions of dealerships, just for collecting the car. Tesla modularizes its vehicles to allow direct sales to customers and bypasses dealerships. (Olaf Sakkers, 2016)

Tesla even goes further by also integrating its key components vertically. By doing so, it reduces its dependency on suppliers and controls the majority of its upstream. Tesla develops its own components for batteries and autonomous driving systems. Tesla,

contrary to traditional automakers like Toyota, BMW or Ford, develops all its technology and it is thus not involved in ecosystem with IT companies. (Damien Ernst, 2018)

Now that we have defined the new downstream of the car manufacturer industry business model we can now determine its new revenue streams. There are two possible types of new revenue streams: monetization of the data and creation of mobility services.

Monetization of the data:

Thanks to the technology embedded in cars, car manufacturers will be able to collect a large amount of data about each driver. They will be able to follow the driver's movements 24/7. So they will know where he went, his average speed, how often he used his car and many other things.

The treatment of data will become an integrated activity in the carmaker business model. All this data will help the carmakers to better understand the customers' needs to provide the best experience for them.

These data will not only be useful for carmakers but could also be a gold mine for other companies that are interested in the driver's behavior and habits. For example, leisure companies could be interested in knowing where drivers like to go for the weekends or the holidays to relax. In that way they could target some potential customers and propose them activities that fit their needs.

However, this potential revenue stream is limited by the GDPR (General Data Protection Regulator), a new European law concerning the data privacy of the users. This new law will come into force on 25 May 2018 and will limit the use of personal data. Carmakers need therefore to find an agreement with their customers to be able to use their personal data.

Creation of mobility services:

OEMs need to find the right strategy in order to move their value proposition from "hardware provider" to "integrated mobility service provider" (McKinsey report, 2016).

In McKinsey's report we can read that owning our own car is one of the most inefficient uses of money because the average utilization of a car is a bit more than one hour per day. To resolve this, car manufacturers could create a system of car renting where people would share cars and so the utilization of vehicles would be optimal.

For the moment, most vehicles are owned and we are at the beginning of the shift to new mobility technologies. (Olaf Sakkers, 2016) But this shift encouraged by Uber, one of the most important mobility providers, will be quite slow because still 67% of all the US respondents prefer driving their own car than using a shared system. (McKinsey report, 2016)

The apparition of autonomous cars of level 4 and 5 could change this tendency. Mobility services could capture a lot of market share in urban areas where the density of the population is high. By replacing the driver, automation will reduce the price per mile by about 70%. (Olaf Sakkers, 2016)

As stated before, this shift has already started and some carmakers developed new business model units and build direct relationships with customers by selling them miles rather than vehicles. Here we can mention the examples of Ford Smart Mobility, GM's Maven, Volvo's Lynk & Co, Daimler's moovel, BMW's ReachNow and VW's recently announced Moia.

This will result in the creation of a new car manufacturer downstream structure.

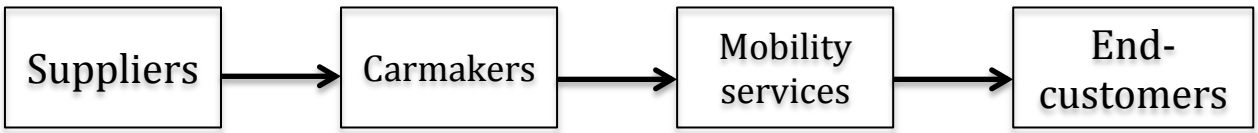


Figure 7: *The second adapted carmaker downstream structure.*

For years, carmakers have been successful because they were effective at producing vehicles in high volumes with high levels of reliability. This required knowledge in manufacturing and quality control. However, with the apparition of the new paradigm, carmakers now have to develop expertise in areas that are out of their core competency. (Olaf Sakkers, 2016)

In the past we had only the conception of physical vehicles by car manufacturers. But in the future car manufacturers will also have to deal with software and data in order to provide services, ride management and autonomous functionality. They have to become digital leaders.

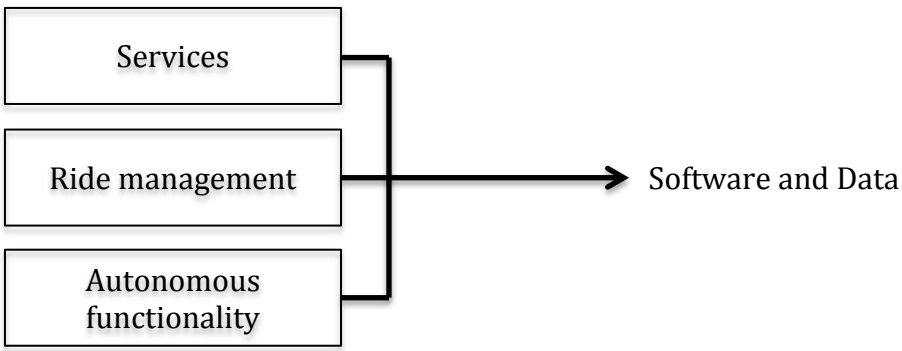


Figure 8: *The new automotive paradigm.*

In the traditional automotive paradigm cars were sold but in the new mobility paradigm miles are sold. The apparition of the mobility paradigm will create platforms that will have to deal with data and digital services. It is therefore essential for carmakers to find the good partners to guarantee the best mobility services.

In conclusion, car manufacturers absolutely need to adapt their business model and value proposition in order to not fall in the same trap as Kodak. This company, pioneer in developing cameras, was blinded by its success. It completely missed the rise of digital technology and did not reinvent its business model on time. They developed the technology of the camera but they did not invest in it. With this wrong management the company lost definitely its leadership on the market.
This example shows perfectly well what carmakers must avoid doing.

Value blueprint:

After identifying the innovative ecosystems of driverless cars, establishing their potential winners and determining their new business models, we now have to elaborate a value blueprint: a diagnostic tool that identifies the current status of the ecosystem. Its aim is to create the value proposition of the ecosystem. It helps the manager to be focused on co-innovations and adoption chain risks that arise from the ecosystem. In other words it aims at identifying the risks associated with the creation of a successful ecosystem. (Luciana A. Almeida, 2015)

The value blueprint was proposed by Adner in his book the Wide Lens as a mapping tool. According to him, it is important to use it because: "If your value proposition requires multiple parties to collaborate, building a deep understanding of the structure of collaboration is critical. Creating a value blueprint is an exercise in team discipline. It forces you and your team to be explicit about your value proposition and about all the steps you will take to make it a reality. It forces you to see the issues before they become problems." The value blueprint therefore provides an overview of the parties required to deliver the value proposal of a product as well as different types of risks associated with it.

Creating a value blueprint is an exercise of communication. It forces a dialogue between the firms involved. Your assumptions and those of your colleagues and partners will be brought out of the shadows and into the light. It makes your ecosystem more explicit. (R. Adner)

Adner suggests 8 different steps to establish a value blueprint. The aim of his map is to link together the actors who make up the ecosystem and give an overview of all the parties involved in the ecosystem. Here below are the 8 different steps:

1. Identify the end-customer.
2. Identify the project.
3. Identify the suppliers.

4. Identify the intermediaries.
5. Identify the complementors.
6. Identify the risk in the ecosystem: Adner gives the advice to use a green-yellow-red traffic light continuum to characterize the status of each element of the innovation. For co-innovation risks, green means that they are ready and in place, yellow means that they are not yet in place, but that there is a plan and red means that they are not in place and there is no clear plan.

   A green traffic light means that partners are willing to participate and see clear surplus from their involvement in the ecosystem. Yellow means that they are neutral but open to inducement and red means that they have clear reasons for not participating in the ecosystem.
7. For every status that is not green, it is necessary to identify the cause of the problem and to find a viable solution.
8. We need to update the value blueprint on a regular basis. The environment changes continually and the value blueprint has to be modified accordingly.

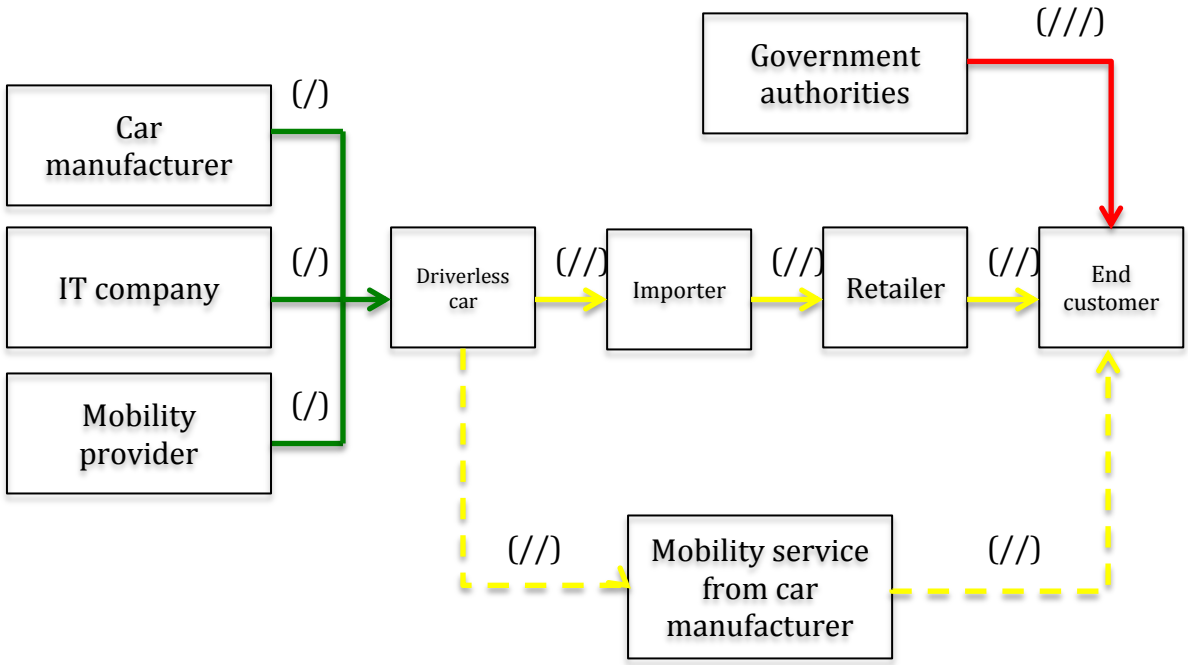
It is of course difficult to find an innovation system where all the lights are green. Yellow lights are acceptable but we need to transform them into green ones. A red light represents a danger, it is for example when a partner is not able or is not willing to cooperate in the ecosystem. This danger must absolutely be removed because only one red line in the value blueprint can provoke the failure of the ecosystem.

However, if all the lights are green, it does not necessarily mean the ecosystem will be successful. We also have to take into consideration the market environment and all the other external elements of the ecosystem to adapt the value proposition.

Thanks to Almeida, we can also add another strategic element of the innovation that is called ecosystem carryover, in which the consolidation of an ecosystem is used to create advantage over a new ecosystem. In our case it means that a car manufacturers can create new ecosystems for the development of driverless cars based on previous

ecosystems that have been already used for other technologies. By doing this the car manufacturer can add the knowledge and experience gained in the previous ecosystems to create more efficient ones. The way of creating ecosystems is similar even if their purposes are different.

In figure 9, I created the value blueprint of driverless cars based on the model established by Adner. I tried to establish the basic ecosystem for the development of the driverless car technology.



Green lines: ready and in place (/)
Yellow lines: not in place but there is a plan (//)
Red lines: nothing is already planned (///)

***Figure 9**: Value blueprint of driverless cars. Adapted from "The Wide Lens", Ron Adner, 2013, p.96.*

Earlier in this report I talked about ecosystems created by car manufacturers, IT companies and mobility providers to develop driverless cars technology. This co-innovation is already in place and started working on the development of driverless cars. This is the reason why the lines appear in green.

On the other hand, the supply chain to deliver driverless cars to end customers is not yet established. We have seen that the relationship between carmakers and end-customers will undergo a big change, which will affect importers and retailers. Car manufacturers have still to adapt their supply chain in a more efficient way to guarantee the successful launching of driverless cars; these connections are therefore represented by yellow lines.

In addition to the adaptation of their supply chain, carmakers have also to create mobility services represented by the yellow dotted line. This new kind of service could satisfy the new needs of the customers and could be more in line with the new way of moving that driverless cars will provide. Providing mobility will become an important service in the car industry.
Finally, last but not least: government authorities as external contributors have also to be taken into account because there is at the moment no clear legislation about the driverless car. Its utilization is not yet authorized everywhere and governments still have to clarify their position. They have also to adapt roads' infrastructures to facilitate the use of driverless cars. As nothing has been done so far and that the use of driverless cars is not allowed yet, the line is red.

The creation of this value blueprint does not mean that the innovation will be a success. However, its creation allows us to analyze a wide range of possibilities regarding its success, or failure, depending on the components of the ecosystem and their alignment with product's value proposal (Luciana A. Almeida, 2015). The value blueprint needs to be flexible and not static. When there are modifications in the ecosystem, for example with a change in technology, partnerships, collaborators, investors, retailers or clients, the value blueprint needs to be updated accordingly. The value blueprint is sensitive to all changes occurring in the ecosystem.

Chapter 3: Case study Research

After responding to the sub-questions of this thesis, I will now make a case study research to give a concrete example of a car manufacturer involved in the development of autonomous driving systems. At the beginning, I wanted to interview the representatives of three different car manufacturers to conduct a cross case analysis but due to a timing problem and a lack of favorable agreements, I could only meet Bart Pyl, the representative of Volvo Belux. This discussion allowed me to have a clearer vision of the position of Volvo in the development of driverless cars and with whom the company was collaborating in order to achieve its objectives. I thought Volvo could be considered as an interesting company as its goal is to have no injured or killed person in one of its new cars by 2020. This objective can be only reached thanks to the development of an autonomous driving system. I wanted therefore to know where Volvo was in the development of such a technology and if this objective was feasible.
In addition to this interview, I conducted another one with Mr. Damien Ernst, professor at the University of Liège, expert in electrification and artificial intelligence, to have his point of view about the development of driverless cars. His contribution is not a case study but an additional source of information on the subject.

These two direct face-to-face interviews generated secondary data and additional knowledge to help me to validate what I found in my desk research. ***(See Appendix 2)***

Methodology:

The design of my case study research is based on the book: "Case study research and applications" from Robert K. Yin (2018). This book aims at helping scientists to deal with the challenges of doing case study research. The author gives tips to design good case studies and to collect, present and analyze data fairly. According to him: "the fundamental goal of case study research is to conduct an in-depth analysis of an issue, within its context with a view to understand the issue from the perspective of participants." He stipulates also that a case study research as to be chosen if the main

research questions are “How” or “Why” questions, if there is little or no control over behavioral events, and if the focus of study is a contemporary phenomenon. These three conditions were fulfilled for my case.
According to Robert K. Yin, the realization of a case study consists in four different steps: designing the case study, preparing to collect case study evidence, collecting case study evidence and finally analyzing case study evidence.

To elaborate my case study, I needed to establish first the quality of my research design. To this end, I used four tests: construct validity, internal validity, external validity and reliability. These tactics occurred during the data collection, data analysis or compositional phases of the research.

Tests	Case study tactics	Phase of case study research in which tactic is addressed
Construct validity	• Use multiple sources of evidence • Have key informants review draft case study report	Data collection Composition
Internal validity	• Do explanation building • Use logic models	Data analysis
External validity	• Use theory in a single cases studies	Research design
Reliability	• Use case study protocol	Data collection

Table 3: *Case study tactics for four design tests. Adapted from “Case study research and applications”, Yin, 2018, p.43.*

After establishing the quality of my research design, I could choose between four types of designs, based on the 2X2 matrix in figure 10. These four types of design are holistic

single case designs (Type 1), embedded single case designs (Type 2), holistic multiple case designs (Type 3) and embedded multiple case designs (Type 4) (Robert K. Yin, 2018).

For this report, I decided to use a holistic single case design. This single case is justified because it can represent a significant contribution to knowledge and theory building by confirming, challenging or extending the theory. Such a case study can help to refocus future investigations in an entire field. And holistic is also justified by the fact that I needed only one unit of analysis for my case.

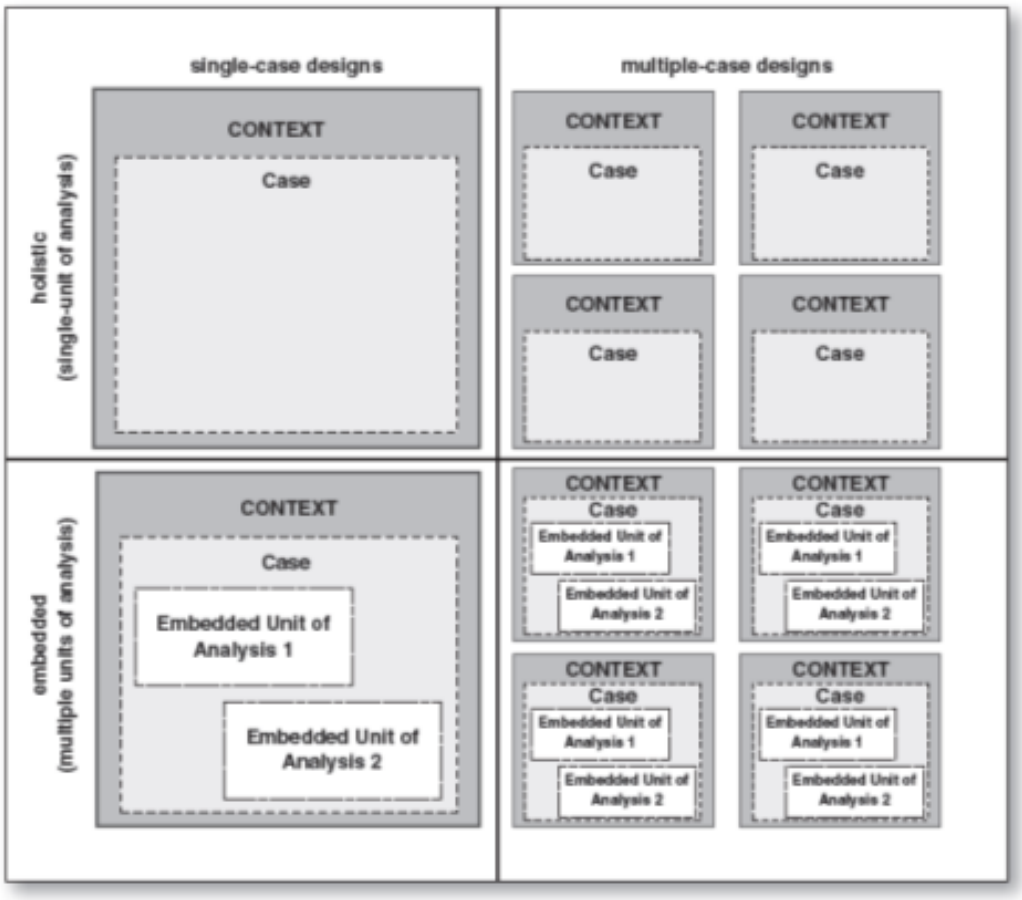


Figure 10: *Basic types of designs for case studies. Adapted from "Case study research and applications", Yin, 2018, p.48.*

Secondly for the case study preparation, I needed to develop a protocol for the study, screen the candidate case and conduct a pilot case study. The protocol is an effective way of dealing with the overall problem of increasing the reliability of the case study and is directed at a single focus for data collection. By following these three steps, I had the guarantee that my data collection would proceed smoothly.

As I had designed and prepared my case study, I could now start collecting the case study evidence. Robert K. Yin stated six sources of evidence: documentations, archival records, interviews, direct observations, participant observation and physical artifacts. In this particular case, I decided to conduct interviews to collect case study evidence. Case study interviews need to resemble guided conversations rather than structured queries. The stream of questions has to be fluid rather than rigid. Interviews are one of the most important sources of case study evidence. Yin recommends using recording devices when conducting interviews because it provides a more accurate rendition than when you are taking your own notes.

The table below represents the strengths and weaknesses of interviews:

Source of evidence	Strengths	Weaknesses
Interviews	• Targeted can focus directly on case study topics • Insightful provides explanations as well as personal views (e.g., perceptions, attitudes, and meanings)	• Bias to poorly articulated questions • Response bias • Inaccuracies due to poor recall • Reflexivity- e.g., interviewee says what the interviewer wants to hear

Table 4: *Six sources of evidence: strengths and weaknesses. Adapted from "Case study research and applications", Yin, 2018, p.114.*

Once I had collected the information from my interviews I proceeded with a triangulation by using multiple sources of evidence. I combined the information gathered in my focus interview with the information that I had read in documents. That permitted me to increase the scope of my case study and to find a convergence of evidence.

After collecting the case study evidence, I was now able to analyze my data. I decided to follow an explanation building by narrating the information that I had collected. It was a good way to report the opinion of my interviewees about the development of autonomous driving systems.

Case study analysis of Volvo:

Volvo has been the leader in the area of automotive safety since it invented the three-point seat belt in 1959. The vision of Volvo is that by 2020 no one will be killed or seriously injured in a new Volvo car. The company is convinced that the introduction of autonomous driving technology will help them to achieve this goal. Volvo is a pioneer in the development of autonomous driving systems and has developed internally the Intellisafe system, a preventive safety system that helps the driver in his driving. The company has also created the Pilot Assist system, a semi-autonomous system that supports the driver with steering, distance and speed control in situations ranging from slow moving traffic jams to free-flowing long distance driving on motorways at speeds up to 130km/h. These two systems provide a level 2 of autonomous driving and are already embedded in each Volvo 90 series and 60 series cars.

In addition, the Swedish carmaker has also developed the system Drive me, the world's most ambitious and advanced public autonomous driving that provides a level 4 of autonomous driving. This system was created with the collaboration of a number of public and private sector participants, including: Volvo Cars, Autoliv, the Swedish Transport Administration, the Swedish Transport Agency, Chalmers University of Technology, Lindholmen Science Park and the City of Gothenburg.

They have equipped the Volvo XC90 SUV with this system to carry out tests on public roads in Gothenburg (Sweden). At Volvo cars, they have always approached product development from a human-centric perspective and that is why they have decided to put people first in the development of their autonomous cars. Håkan Samuelsson, president and chief executive of Volvo Cars, said: "Our main focus has always been on people and making their lives easier. Technology should improve the consumer experience making mobility safer, sustainable and more convenient."
That is the reason why rather than relying only on their own engineers, they also selected families to test the car on a daily basis. The purpose of this project was to focus on how to improve people's lives and to have a positive impact on society.

However, to go further in the development of autonomous cars, Volvo had to collaborate with another bigger partner. In 2016, the Swedish premium carmaker decided to join its forces with Uber, the world's leading ride-sharing company, to develop the next generation of autonomous driving cars. This collaboration has helped Volvo to have an access to some knowledge that it did not master until then. Håkan Samuelsson, said: "The automotive industry is being disrupted by technology and Volvo cars chooses to be an active part of that disruption."
Both Volvo cars and Uber signed an agreement and are contributing a combined 300 million $ to their joint project which will allow, on the one hand, Volvo to manufacture base vehicles, and, on the other hand, Uber to embed its own self-developed autonomous driving system to them. The contract stipulated the sale of 10,000 autonomous driving compatible base vehicles between 2019 and 2021 to Uber. We can clearly see the strategic direction Volvo wants to take for the future.

This project illustrates perfectly the situation of innovation ecosystems where a car manufacturer joins forces with a new Silicon Valley-based entrant to the car industry. This highlights the way in which the global automotive industry is evolving in response to the advent of new technologies. And in this particular case, we can assume it is just the beginning of a very long-term industrial partnership.

Uber decided to collaborate with Volvo because the new base vehicle will be developed on Volvo cars' fully modular Scalable Product Architecture (SPA), one of the most advanced car architectures in the world. It is currently used on Volvo XC90 SUV, S90 premium sedan and V90 premium estate. This platform started its development in 2010 and has been preparing for the latest autonomous driving technologies as well as the next generation electrification and connectivity developments. Travis Kalanick, Uber's chief executive, said: "Over one million people die in car accidents every year. These are tragedies that self-driving technology can help solve, but we can't do this alone. That's why our partnership with a great manufacturer like Volvo is so important. Volvo is a leader in vehicle development and best-in-class when it comes to safety. By combining

the capabilities of Uber and Volvo we will get to the future faster, together."

This collaboration will be conducted by both Volvo and Uber engineers in order to add on the SPA platform all needed safety, redundancy and new features required to have autonomous vehicles on the road.

Håkan Samuelsson also pointed out the importance this collaboration had by saying: "Volvo is a world leader in the development of active safety and autonomous drive technology and possesses an unrivaled safety credibility. We are very proud to be the partner of choice for Uber, one of the world's leading technology companies. This alliance places Volvo at the heart of the current technological revolution in the automotive industry."

In addition to this collaboration with Uber, Volvo should also start to work with other car manufacturers. The ultimate goal of carmakers is to create a network between all cars on the road where cars will be able to communicate with each other. For example a Volvo could communicate with a BMW to inform it about a potential danger on the road. That would increase safety on the roads. Carmakers have already developed the technology to achieve this thanks to a bigger connectivity embedded in new cars but, for the moment, no one yet has proposed to create such an ecosystem.

Volvo is also conscious that the customers' needs are changing and that they now want to use their cars more efficiently. For that reason, Volvo has already started to find new tracks to generate new revenue streams. The company has also started to collaborate with a renting company in Sweden. This project consists in renting cars instead of selling them. In practice, this means that from a traditional carmaker, Volvo would become a mobility service provider with, of course, all the changes that this involves on its business model.

Based on the above, we can conclude Volvo has fully understood the interests at stake and is actively preparing the ground for the challenges in the future. It is not trusting on

its laurels; it does not want to become the new Nokia or Kodak of the car industry and has already implemented an innovative ecosystem. Moreover, to achieve its goals, it is focusing simultaneously on several fronts: connectivity, electrification and autonomous driving, the three pillars of the new car industry. And, finally, Volvo seems to be willing to adapt its business model to the new needs of its customers.

Additional information provided by Damien Ernst:

Damien Ernst, professor at the University of Liège and specialized in electricity and artificial intelligence, is absolutely in favor of the development of driverless cars. According to him they will improve our lives and our way of moving and reduce considerably the number of accidents on roads. He points out each carmaker is now developing its system of driverless cars by making partnerships or by working internally, as Tesla, VW or Renault for example. The driverless technology is already now fully acquired and will not evolve much more in the years to come.
Carmakers have therefore to take the first-mover advantage of driverless cars before these become a commodity in the automobile sector. He also predicts that the growth of driverless cars will be significant. Maybe in the future, fully autonomous cars will become the norm and it will not be allowed to drive in certain areas anymore. But before it gets to that stage, the legislation has first of all to be adapted.

According to him, it is very difficult to determine who will be the biggest winner of the driverless car technology. It is not yet clear which, between the software or the hardware, will take the advantage. He might be tempted to say that carmakers will not be the big winners of this ecosystem because of the apparition of a lot of new entrants on the market, for example, new car manufacturers, IT companies and mobility providers. The competition will be tough. However, IT companies will gain many advantages as autonomous cars will be embedded with technology that they have developed.

The apparition of level 5 autonomous driving system will push carmakers to adapt the conception of their vehicles but also their business models to satisfy the new needs of the customers. Firstly, as human intervention will no longer be needed, the full interior of the cars will have to be redesigned to provide an atmosphere where the passengers can relax and feel comfortable. Secondly, since the way of using cars will change completely, carmakers cannot afford to act merely as manufacturers. They will also have to become service mobility providers and to create sharing services for their customers.

Mr. Ernst is convinced the apparition of driverless cars will significantly disrupt the car industry and this disruption will be more radical than the change brought about by car electrification.
Driverless cars will be successful. All the car industry is shifting in that direction but we are now waiting for governmental agreements.

Conclusion

"Ford started as a manufacturing company, became a manufacturing and technology firm, and now needs to become an organization that is a manufacturing, technology and information company" (Mark Fields, CEO Ford, 2016).

This sentence summarizes perfectly well the situation in which car manufacturers are currently involved. The automotive industry is in a new shifting phase, expected to be rapid and fundamental as its products are changing significantly. It is obvious autonomous cars of level 4 and 5 will be considerably different from what we have had until now. The transformation has been made possible thanks to the convergence of four disruptive technology-driven trends: connectivity, autonomous driving, electrification and shared mobility. They represent the new pillars of the car industry.

To find an answer to my research question, which was "How the introduction of driverless cars is disrupting the car industry?", I had firstly to answer important sub-questions. For that purpose, I collected information by making desk research and I asked four experts their opinions, two of them even agreed for an interview.

The first question was "In which ecosystem do car industries need to evolve in order to develop driverless cars?" The answer is now clear that carmakers have to be part of an ecosystem with an IT company or a mobility provider if they want to develop a driverless car technology. The list of firms involved in innovation ecosystems provided in this report, even if it is not exhaustive, tends to indicate it. The case study about Volvo and Uber is also a good example of a situation where a car manufacturer joins force with a new Silicon Valley-based industry to form an innovative ecosystem that works well. All this highlights the way in which the global automotive industry is evolving in response to the advent of the driverless car technology. This technology is so complex that huge human and financial resources are necessary. Partners absolutely need to exchange ideas and join their knowledge and skills.

Ecosystems are based on trust and communication and members need to collaborate if they want to evolve positively. Their creation is not an easy task and requires a good coordination and organization between the different partners involved in the innovation process. If they all participate in the well-being of their ecosystems, ecosystems will become more efficient and that will have positive impacts on all partners.

It is therefore really important for carmakers to establish consolidate ecosystems with the right partners if they want to launch a successful product and revolutionize the automobile industrial market.

Then the questions arose as who could lead these ecosystems and who could benefit from the creation of driverless cars. The leader company of an ecosystem is a key element. It will contribute to success if it manages to give positive impulsions to its partners to stimulate and motivate them. The leader has to create a blueprint that generates value for the end user and, in the meanwhile it has to make sure that all its partners get enough surplus to warrant their participation in the process. On the other hand, it has to leave enough value in the end to see its own efforts rewarded. In the case of driverless cars, when we look at examples of ecosystems, we notice that the leaders could be carmakers, IT companies or Mobility providers. This new technology represents large opportunities for them all, and if they cannot be part of a good ecosystem, they risk loosing a lot. All of them are therefore motivated to stimulate and lead ecosystems.

The next step was to determine who could be the biggest winners of the creation of driverless cars.
It was not easy to establish the surplus each partner would gain. To find an answer to this issue, I also included importers, retailers and end-customers as partners of the developers of driverless cars. These three additional partners are also really important contributors to the success of driverless cars. Here I asked the points of view of four

experts to indicate me paths for reflection. By combining their answers, I could establish that all partners would gain surplus from the creation of driverless cars and that is really promising for the future of the technology. I could also establish a ranking of the partners.

The biggest winners are indisputably the end-customers because of their high total benefit and their low total costs.
Importers are also going to gain a lot because they will take advantage of the success of driverless cars without investing too much in them.
Then we have car manufacturers and mobility providers. Car manufacturers will be the ones that will gain the maximum of benefits but will also invest the most in the new technology. Driverless cars will also create a lot of benefits and opportunities for mobility providers because they are the best prepared to provide new kinds of services to satisfy the new needs of customers.
And finally IT companies and retailers will be the two partners that will gain the lowest surplus. IT companies injected a lot of money in R&D but the expected returns on investments will not be so high. And retailers are the ones that will gain the lowest benefits and moreover their functions will have to be adapted to the new products sold.
The introduction of driverless cars will be beneficial for the whole car industry. However, carmakers will have to modify their business model in order to adapt to this change.

This raised another issue: “What business model will become the new source of revenues for car manufacturers?”
Entrepreneurs need to continually invent, design and implement new business models to be successful. As regards autonomous system, connectivity and ridesharing will create new opportunities for carmakers. The latter will now be in direct contact with their end-customers and this will reduce the interventions of intermediaries. So the role of the retailers will be more limited. Carmakers will subsequently have to modify their business model. For them, there is no more money to be made from building cars in the

future. Collecting data and renting mobility services will become their new sources of revenues. What might work would be the creation of mobility services, but in no way the monetization of the data because of existing limitations on private data.
Carmakers will also have to move their value proposition from “hardware provider” to “integrated service provider”. They will build direct relationship with customers by selling them miles rather than vehicles. With this new paradigm they will have to develop expertise in areas out of their core competencies. They will not only build physical cars, they will also have to deal with software and data to provide services, ride management and autonomous functionality.

In conclusion, carmakers have no other choice but to adapt their business model and value proposition if they do not want to be washed away by the wave of new technology as Kodak or Nokia were.

Thanks to all these developments, I was now able to answer the main question of this report: “How the introduction of driverless cars is disrupting the car industry?”
The apparition of driverless cars will definitely disrupt the car industry. The way of moving and using a car will considerably change in the future. Carmakers will, of course, have to modify the design of their cars but they will have first and foremost adapt their business model to satisfy the new expectations of their customers. Besides, it is vital for carmakers and new entrants to pool their resources and skills to come up with a successful strategy. We can talk of an unprecedented revolution since the advent of the car.

I totally agree with Chris Hawken (group marketing director of IM Group, which distributes Subaru and Isuzu in the UK) when he says: « We are at a transitional stage between generations. We do not know exactly how the landscape will look but one thing is for sure: it will change radically and if you are not planning for it, you are in danger ».

Limitation and direction for further research

The focus of my research was to determine the impact of the introduction of driverless cars in the car industry.

One limitation of my work is that I did not develop the issues of data privacy and cyber security that will occur with the apparition of driverless cars. But, of course, car manufacturers have to take into account these two elements in the future.

Moreover, my research does not consider the impacts of driverless cars on mobility while this new technology will considerably change our way of moving and force us to adapt to it.

These three parameters could be taken into account to investigate a deeper analysis of this subject.

A third limitation could be the number of case studies that I made. I managed to get only one and so I had not the chance to make a cross case analysis.

These limitations open up new research avenues and could give prospective researchers the opportunity to go a step further, which will provide additional information about the advent of driverless cars.

However, despite these limitations, I think my report offers a good overview of how driverless cars will disrupt the car industry.

This new technology has numerous advantages. Everybody without exception will be able to use them even if they do not have a driving license (children, elderly and disabled people) or have temporary incapacities to drive (drunk people) and that will reduce the number of accidents. Nonetheless, one down-to-earth question remains: “Are people ready to trust robots?”

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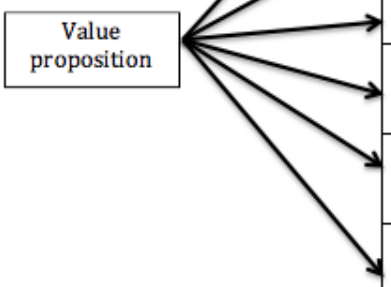
Appendices

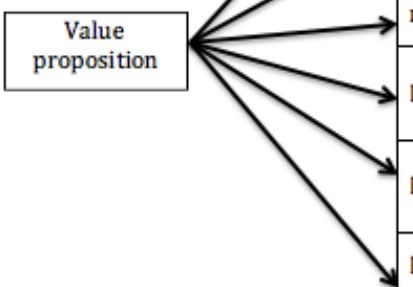
Appendix 1: Leadership prisms:

From Bart Pyl (Volvo):



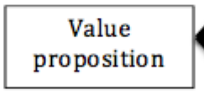
Partners	Relative benefits	- Total costs	= Surplus
Tech companies	2	4	-2
Mobility providers	2	2	0
Car manufacturers	5	3	2
Importers	4	3	1
Retailers	3	2	1
End customers	5	1	4

From Damien Ernst (University of Liège):



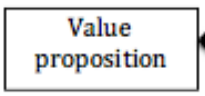
Partners	Relative benefits	- Total costs	= Surplus
Tech companies	5	0	5
Mobility providers	5	0	5
Car manufacturers	5	3	2
Importers	5	1	4
Retailers	3	3	0
End customers	5	0	5

From Dries Vanmarsenille (Toyota):



Partners	Relative benefits	- Total costs	= Surplus
Tech companies	4	4	0
Mobility providers	4	4	0
Car manufacturers	5	3	2
Importers	3	0	3
Retailers	3	0	3
End customers	5	3	2

From Xavier Winnepenninxks (BMW):



Partners	Relative benefits	- Total costs	= Surplus
Tech companies	5	3	2
Mobility providers	5	1	4
Car manufacturers	4	3	1
Importers	3	1	2
Retailers	2	1	1
End customers	5	2	3

Appendix 2: Full transcripts of the interviews.

Interview 1: Damien Ernst

1) Can you introduce yourself?

   My name is Damien Ernst and I am a Professor at the University of Liège, specialized in electricity and artificial intelligence.

2) In which ecosystem do car industries need to evolve in order to develop driverless cars?

   Companies can collaborate with some specialized equipment manufacturers in order to develop driverless cars. But some companies like Tesla, VW or Renault have developed their autonomous technology by themselves.
   For the moment there is still a competitive advantage for car manufacturers to develop their own technology but in the future the creation of driverless cars will become a commodity in the automobile sector. Carmakers need therefore to gain the first mover advantage on the driverless cars market.

3) How can the automotive industry take advantage of the capabilities coming from the industry 4.0?

   The car industry is already in the industry 4.0 because the production chains are fully automated and it was the first industry sector to take advantage of this new revolution.

4) According to you, who will win out the creation of driverless cars?

It is really difficult to determine who will be the biggest winners because we have to see between hardware and software, which one will take the advantage on the other.

I am not sure that car manufacturers will be the big winner of this development because we will see the apparition of many new entrants on the car industry market that will increase the competition. New jobs will appear like mobility providers, which can gain a lot from the development of driverless cars because it will be easier and cheaper to share cars.

On the other hand IT companies will gain many advantages because autonomous cars will be embedded with a lot of technology that they will develop.

5) Because of the high connectivity of the cars what about the data collection? How will carmakers deal with the privacy of their customers?

For the moment cars collect already a lot of info about their customers via the GPS. Customers are also always traceable with their smartphones. The way of collecting data will remain the same but because of the greater connectivity, carmakers will have to deal with more data.

6) Do you think that the apparition of driverless cars will accelerate the shift from combustion cars to electric cars?

It is easier to develop driverless cars on electrical cars than on engine combustion ones because the technological base is more similar. The importance of electric cars will increase in the next years because we will be able to create cheaper ones thanks to mass production. In the future combustion cars will tend to disappear.

7) In a report of MCKinsey, a statement stipulates that 15% of new cars sold in 2030 could be fully autonomous? Do you agree with that? Is it feasible?

Yes, and the percentage could be much higher. Carmakers could produce maybe only fully autonomous driving cars and it would be no more allowed to drive without an autonomous mode in certain cities. For the moment, systems of autopilot are not yet authorized on our roads but the legislation will change because we can see that there are fewer accidents thanks to these systems. These systems are more efficient than humans and make fewer accidents.

8) Do you agree that car manufacturers have to modify their value proposition in order to better understand the customers' new needs?

A car in the future will become like a living room. Therefore carmakers will have to redesign the whole interior of the cars. They have to create an atmosphere where the driver can relax and feel comfortable. The needs of customers will definitely change, so carmakers have to follow this new trend if they want to survive.

9) And what business model will become the new source of revenues for car manufacturers?

From a level 5 of autonomous driving, we can start the creation of car sharing systems because we will be able to control our car via our smartphone and ask it to come to pick us up. With this full autonomous driving system, it will be easier to share the car with someone else and that will increase the utilization of the car. Thus, carmakers have to adapt their business models to develop new services. They have to become service mobility providers in addition to manufacturers.

10) How the introduction of driverless cars is disrupting the car industry?

The apparition of driverless cars will change significantly the car industry. For many years we had no real change in the conception of a car but in this case everything will change. The revolution will be more radical that the one with the electrification.

The success of driverless cars is sure because all car manufacturers have already developed their self-driving systems, but we are just waiting for the legislation part. The driverless technology is already fully acquired and will not evolve much more in the next years.

Interview 2: Bart Pyl

1) Can I ask you to introduce your company and your personal business position and responsibilities?

My name is Bart Pyl and I am the senior product manager of Volvo car Belux. I work in the marketing sector and I am in charge of the launching of each new Volvo model in the Belux.

2) What is the current position of Volvo in the development of driverless cars?

Volvo has developed the Intellisafe system, which is a preventive safety system that helps the driver in his driving, and a semi-autonomous system called the Pilot Assist that supports the driver with steering, distance and speed control in situations ranging from slow moving traffic jams to free-flowing long distance driving on motorways at speeds up to 130km/h. These two systems provide a level 2 of autonomous driving and are embedded in each Volvo 90 series and 60 series cars.

But in 2016, we also developed internally the system Drive me, which is one of

the world's most ambitious and advanced public autonomous driving that provides a level 4 of autonomous driving. We have equipped the Volvo XC90 SUV with this system in order to realize tests on public roads in Gothenburg (Sweden). Instead of relying only on our own engineers, we selected families to test the car in their everyday lives. That helped us to collect important feedbacks about the reliability of the car.

3) Are you familiar with the term "ecosystem" and do you think it is useful for your industry area?

Yes, and this is essential for us. Being part of an ecosystem will bring more advantage to our company because we will be able to develop new technology faster and we will have access to new knowledge. For example, our partnership with Uber helps us to learn more about car sharing in order to develop our next generation of autonomous driving cars.

4) In which ecosystem do car industries need to evolve in order to develop driverless cars?

We are actively engaged in strategic partnerships in the area of autonomous drive technology. We need to collaborate with partners that will bring new technology that we do not completely master. Working with a mobility provider such as Uber is for us a perfect example of successful innovation ecosystem. This collaboration is really important for the development of level 4 and 5 autonomous driving systems. The collaboration with Uber helps us to go further than the project Drive me, which was developed internally. The advantage of Uber is that it has an important network of users and it has already identified the majority of the streets.

We need also to work with our end-customers because we need to create the car that will best fit their needs. If they do not want to buy our products, there is no business to make.

We have also to collaborate with other car manufacturers because the ultimate goal of driverless cars is to make possible the communication between each car no matter the brand. In the future a Volvo car should be able to communicate with a BMW which it already does with another Volvo. But for the moment no carmaker has already managed to develop such a technology.

5) With which partners is Volvo collaborating?

In 2016, we launched a partnership with Uber to jointly develop the next generation of autonomous driving cars. This joint project will help us to create the new base vehicles that will be able to incorporate the latest development in autonomous driving technologies, up to and including fully autonomous driverless cars.

6) According to you, who will win out the creation of driverless cars? Car manufacturers, tech companies or mobility providers?

Our clients will be the biggest winners of this technology because they will gain an “additional quality time per year”. They will be able to gain time by working on the road.
But also car manufacturers because we will have to continually improve our technology for not becoming the new Kodak or Nokia of the car industry.
Mobility providers and tech companies not so much. They will of course benefit from the creation of driverless cars because of the connectivity and all the electronics embedded in cars but their return on investment will not be so high.

7) Do you agree with the statement: “There is no money to be made from building cars in the future. »? This is one of the statements made in the 2017 Global Automotive Executive Survey of KPMG released in January 2017.

Yes and no, but it is not only linked with autonomous cars. With electric cars, there is already less maintenance to be made on the cars and lower pieces need to be changed.
We will still continue to generate revenues from developing and manufacturing cars but we will have to adapt our revenue stream in order to catch new revenues by renting cars for example.
The Drive me project and the Uber project are for us necessary investments to develop new revenues in the future.

8) What business model will become the new source of revenues for car manufacturers?

Inside Volvo we have developed a value chain system where we sell and rent cars. Turning into a mobility service provider could be an interesting solution for us because customers from 30 to 35 years favor better the fact of utilizing a car than owning it. There is still a passion about cars but not a wish to own them. Because customers want to have something more practical, it is important to develop autonomous driving and car-sharing systems in order to satisfy their needs. As a car manufacturer, it is complicated to be a manufacturer as well as a renter or a mobility provider. Therefore we need to collaborate with other companies to guarantee the best service.

9) Do you agree that cars have to modify their value proposition in order to understand the customers' new needs?

We have to follow the new tendency if we do not want to become the new Kodak or Nokia. As car manufacturers, we really need to be focused on connectivity, electrification and autonomous driving. These are the 3 pillars for the future of the car industry. Customers always want to have the smartphone with the latest technology and it is the same for cars.

10) Because of the high connectivity of the cars, what about the data collection? How will you deal with the privacy of your customers?

The GDPR is a new European law for the protection of the privacy and that will limit the utilization of private information. Until now it was possible already to collect info in the black box of a car but now with this new law, the utilization of that information will be limited. Guarantying the privacy of our customers is really important for us.

11) Do you think that car companies will not be anymore simply car manufacturers but that they will become information companies?

With this new law (GDPR) it will become more complicated to deal with private data. So dealing with personal data will not become a part of our core business model.

12) In a report of MC Kinsey, a statement stipulates that 15% of new cars sold in 2030 could be fully autonomous. Do you agree with that? Is it feasible?

Yes, that is absolutely possible because with Volvo we want to launch our full autonomous system by 2022. But this objective will also depend on governments

because they need to create better roads infrastructures. If governments do not follow the trend, that risks to slow down the development of driverless cars.

13) Do you think that in the future we will still need car retailers?

Yes, we believe in the e-commerce and about its importance but we also believe in the importance of car retailers. We cannot create a positive environment if we do not have retailers. They are the connection between the brand and the end-customers, but in the future customers will need to go fewer times to their retailers because they will be able to make some updates for their cars from home and their cars will need less maintenance.

14) Do you think that the apparition of driverless cars will accelerate the shift from combustion cars to electric cars?

There are no connection between the electric and the autonomous system of a car. They are completely independent systems. Of course in the future we will see a tendency to use more electric cars but we do not have to link electrification and autonomous driving system. These are two different projects that evolve at different speeds.

15) How the introduction of driverless cars is disrupting the car industry?

What will really change is the equipment and that will revolutionize the car industry. Driving is no more a pleasure, so we will have to find another way to move people and to transport things.
Disrupting yes because it is important for a carmaker to be in the first position in the development of electrification and autonomous driving systems. We need to manage these technologies if we want to be successful. We will still need cars and trucks in the future but the way of using them will change.

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Datum: **30/05/2018**