WAVESTONE

THE DRIVERLESS CAR
A REALITY IN THE MAKING

The autonomous car will certainly be one of the greatest innovations of the 21st century. Having revolutionized the transport sector, this breakthrough is set to have a profound impact on the daily lives of millions of people in a few years.

How can we be so sure? Because of the increasing maturity of this technology, as illustrated by the multiple announcements on the subject. Alliances forged between long-standing carmakers and IT giants, as well as increasingly conclusive feedback on autonomous-vehicle trials underscore the shift towards driverless cars; a change that all players in the ecosystem must be prepared for. However, technology is not the only facet of the self-driving car: beyond technological innovation, many other challenges need to be addressed. Mobility will have to undergo transformation, regardless of the obstacles involved.

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AUTONOMOUS TECHNOLOGY: A LEVER FOR MOBILITY TRANSFORMATION

The emergence of new technologies has already triggered a series of in-depth changes in the transportation sector at several levels, ranging from passenger services to operations and maintenance.

This has also given rise to changes in the automobile and road transport sectors. Given the mobile tools and applications on offer, players employing disruptive strategies are already strongly calling existing models into question and, as such, paving the way for the emergence of numerous services.

However, in addition to these new trends which are already having an impact on society, technology is set to take road transport to another level. Vehicles are becoming increasingly autonomous and connected. Many initiatives have been implemented and considerable progress made in the field of connected, automated and autonomous vehicles. Some mediatized examples include but are not limited to, the Google and Tesla driverless cars.

Long-standing carmakers have also shown a lot of interest in the autonomous car.

Trends in automation, initiated several decades ago gave rise to functionalities, such as anti-lock breaking systems (ABS) that are now known to and used by the general public. Automatic technologies are therefore already integrated, even in car control functions.

In addition, vehicles are becoming increasingly connected with the outside world, be it with other vehicles, infrastructures or platforms.

Technological progress is being made at several levels:

- **Data:** Data storage capacity and multiple information sources (sensors, user information, etc.) exponentially enrich the reservoir of available data, as well as that of geographical and traffic data.
- **Analysis capacity:** With processes such as data mining and predictive algorithms, technology is making it possible to go beyond simple data collection thanks to computing power and storage capacity.
- **Automation and artificial intelligence:** In addition to data analysis, robotization can be used to make vehicles act in accordance with the information processed, a trend that is making vehicles increasingly intelligent.

The combination of innovative technologies is therefore gradually paving the way for the autonomous vehicle. This trend is set to gain momentum thanks to the hybrid nature of these cars in which the driver can still take back control of the vehicle, on the motorway and in traffic jams for example. On the other hand, fully autonomous vehicle usage has already been tested and solutions rolled out, although these are generally limited to specific stretches (short-distance shuttles and low-density roads). The different levels of autonomy, defined by the Society of Automotive Engineers (SAE), will give rise to several development models. Despite their differences, these models are not mutually exclusive and will be developed simultaneously to offer greater autonomous mobility.

A movement now underway!

2011

ASSESSMENT OF CITYMOBIL 1
European R&D autonomous transport project

2013

NISSAN TEST IN JAPAN
Autonomous vehicle motorway test

2014

French launch of
PROJET SCOOP@F

2015

GOOGLE CIRCULATES FIRST PROTOTYPE
of its autonomous car on public roads

TELSA launches its
AUTOMATIC PILOT

IMPLEMENTATION OF M-CITY
A 13-HECTARE ARTIFICAL MOCK CITY
designed to test autonomous vehicles

2016

RENAULT-NISSAN/MICROSOFT ALLIANCE

FCA/GOOGLE ALLIANCE

Tesla launches its Master Plan Part 2

Mercedes unveils its Van of the future for
LAST MILE MANAGMENT

UBER to launch 4-AV FLEET

Launch of the HONGQI HQ3 car in Asia
Product of research carried out by the University of Defense and the FaW group.

2017

RATP, STIF and the city of Paris test
AUTONOMOUS INTER-STATION SHUTTLE

French launch of
AUTOPILOT PROJECT

IBM files patent
FOR A COGNITIVE SYSTEM
enabling switch between driving and autonomous modes

IBM/ INTEL/MOBILEYE ALLIANCE
to test 40 AV models

MERCEDES/NVIDIA ALLIANCE
AV launch

2018

PSA
to propose
autonomous vehicles

2020

RENAULT-NISSAN
to launch autonomous vehicles

TOYOTA
to test its autonomous car
AT THE TOKYO OLYMPIC GAMES

AUDI / NVIDIA ALLIANCE
to launch its autonomous car

2021

FORD
announces
MASS AV PRODUCTION

2025

ASIAN CARMAKER CHANG'AN
present its
to present entire AV fleet

2035

GOOGLE
expects AVs to represent
9% OF THE GLOBAL FLEET

2060

According to the University of Sanford, BETWEEN
70 - 90% OF TAXIS WILL BE AUTONOMOUS

ALLIANCES, PARTENRSHIPS, ACQUISITIONS, AND RECRUITMENT...
ENCOUNTERS THAT REVEAL FUTURE TECHNOLOGICAL CHALLENGES

PRECISE 3D MAPPING

The **BMW**, **Audi** and **Daimler Consortium** acquire the HERE cartography and navigational software platform (now known as HERE We Go) in August 2015

SENSORS, PERCEPTION AND ADVANCED DETECTION SYSTEMS

Volkswagen and **Mobileye** forge partnership to implement new optical sensor systems

SYSTEM SECURITY

In April 2017, the **Zoox start-up announced the appointment of Mark Roseline**, former Director of the NHTSA (National Highway Traffic Safety Administration) as ***Chief Safety Innovation Officer***

INTEGRATED PLATFORMS

Nvidia and Internet giant **Baaidu** join forces to set up « ***cloud-to-car*** » AV platform

NEEDS BECOMING CRITICAL

By 2050, it is estimated that 70% of the population will be living in urban areas and that there will be **27 megacities** each with a population of **between 10 and 20 million people**. As such, current transport models will not suffice to ensure mobility transformation. This will require advances in areas such as traffic management, road safety and security, car-park capacity and the environmental footprint. Transport is **the biggest generator of CO^2 emissions** in France and the car the major source of emissions per km per capita. Although autonomous mobility is not the only development axis, it is an opportunity to benefit from new technologies to change vehicle usage trends. How? In several ways; by taking into account the emergence of new car-ownership models and the increase in transport services. The following points highlight several autonomous vehicle opportunities:

- Higher vehicle occupancy rates, which will **reduce the amount of private vehicles on the roads. Occupation rates** of cars could be a parameter that is taken into account in mobility services and even a regulatory obligation for transport services.
- More efficient **traffic management**. Adjusting automobile itineraries to meet traffic constraints and posting drivers' points of departure and destinations could optimize the number of vehicles in circulation, and help avoid bottlenecks. In addition to urban and peripheral traffic flows, optimizing truck traffic management by grouping vehicles into platoons could reduce truck fuel consumption by 25% and therefore the level of greenhouse gas emissions. The «European Truck Platooning Challenge» has been launched in Europe to test this traffic-flow solution.
- Better car **park management** with the possibility of parking vehicles in dedicated car parks that are not necessarily in close proximity to the driver's destination.

Although needs are the same in the traditional and autonomous mobility segments, driverless cars immediately evoke obstacles that could prevent us from envisaging a future without drivers.

OBSTACLES SHOULD TRIGGER ACTION

Any changes, especially major, could remove obstacles facing the players concerned; whether they are involved in the change or the targets impacted by this change.

These obstacles must not hamper reflection and idea generation. They must not be masked, but rather anticipated. In order to best prepare for this change, it is essential to remember the values targeted. Examples illustrating this stance are three-fold:

1 **Car hacking and road safety.** New technologies can be vulnerable: the surface of IT vulnerability (attack surface) in cars is increasing and driving functions can even be exposed to tampering. In 2016, the team of researchers of the Chinese company, Keen Security demonstrated that these weak points can be exploited by malicious hackers. Clearly, hijacking vehicles can cause serious accidents. However, the connected car and the autonomous vehicle offer numerous opportunities in terms of road safety and security. The idea is therefore not to limit the exercise to detecting the vehicle's initial risk potential but rather to examine the solutions available and address cyber risk upstream by thinking Cyber Security "By Design".

2 **Job loss versus labor-market momentum**

A 2014 study carried out by Stanford University shows that autonomous cars could account for between 70% and 90% of taxis on the roads by 2060. At first glance, the advent of the self-driving car suggests job loss. On the contrary, this trend will give rise to the emergence of new professions in different fields, such as production, maintenance and new services. There is therefore an increasing need to anticipate these new professions both at the corporate level, to pave the way for the upcoming changes, and in the field of education, to ensure that graduates and job seekers alike are qualified.

3 **High-tech AV inaccessibility versus new cheaper innovation models**

New technologies tend to be expensive before reaching the mass marketing stage. However, given expected changes in traditional car buying and ownership models, vehicle transport could become less expensive over time and open to new segments of the population. For instance, seamless mobility solutions could be offered to persons with reduced mobility.

The stance to be adopted here, therefore, is to consider the driverless car as an opportunity to create value. This does not mean ignoring the negative impacts of autonomous vehicles, or users' apprehensions; both of these factors should be taken into account in a forward-looking strategy. An innovative approach must fix its objectives and the value targeted in order to set the stage for reflection and debate, and to anticipate and address risks upstream so as to reassure stakeholders.

The diagram on page 6 gives a non-exclusive list of some of the aims of the driverless car.

Expectations regarding autonomous vehicles

EMPLOYMENT

Value creation should be analyzed from the point of view of job creation: trends in professional career paths are set to change and trigger the emergence of new professions.

ROAD SAFETY & SECURITY

Autonomous mobility is a major factor underpinning the reduction in risks. Clear examples of this include optimizing speed management and avoiding driving with blood alcohol levels that are over the legal limit.

ENVIRONNEMENT

Combine and streamline transport thanks to ecological cornerstones such as smart usage, vehicle itinerary optimization and speed management, etc.

TRAINING AND RESEARCH

Such a structural change will be underpinned by the momentum and change in the teaching and research approaches putting it at the forefront of this domain with multiple facets and applications.

ECONOMY

The implementation of new services and industries, as well as open data will inject a new economic dynamic underpinned by new alliances forged between long-standing market players and young start-ups.

NEW USER-SERVICES

Increase of a wide range of AV applications such as mobility as a service, car sharing, simplified logistics and accessibility for people with reduced mobility.

REGULATORY FRAMEWORK MUST GRADUALLY ADAPT TO STAY ABREAST OF PROGRESS

In addition to the initiatives taken by automobile manufacturers, IT players and research institutes, etc., work groups and public authorities have implemented the regulatory measures needed to meet expected security and legal liability requirements. In Europe, the United Nations Economic Commission for Europe (UNECE) reviewed the Convention of Vienna in 2016 for the purposes of authorizing autonomous car traffic flows.

> « As of that date, automated driving technologies, transferring driving tasks to the vehicle, will be authorized on the roads on condition they comply with the United Nations vehicle regulations and can be overridden or deactivated by the driver. »

In August 2016, the French Council of Ministers authorized the circulation of autonomous vehicles on public roads for the purpose of testing driverless automobiles and vehicles fitted with driver-assistance systems. As of March 2017, the US Department of Motor Vehicles authorized 27 California-based companies to test self-driving vehicles on the roads.

The authorities are currently monitoring autonomous mobility in order to pave the way, and prepare society for this in-depth innovation. To do this, however, the framework will have to be adapted to address future mobility trends at all levels. These include responsibility issues, road safety and security, technical standardization, interoperability, economic policy, job market trends, as well as societal support with future structural changes. To stay abreast of technological progress, regulations will be progressively adapted for the arrival of the driverless vehicle.

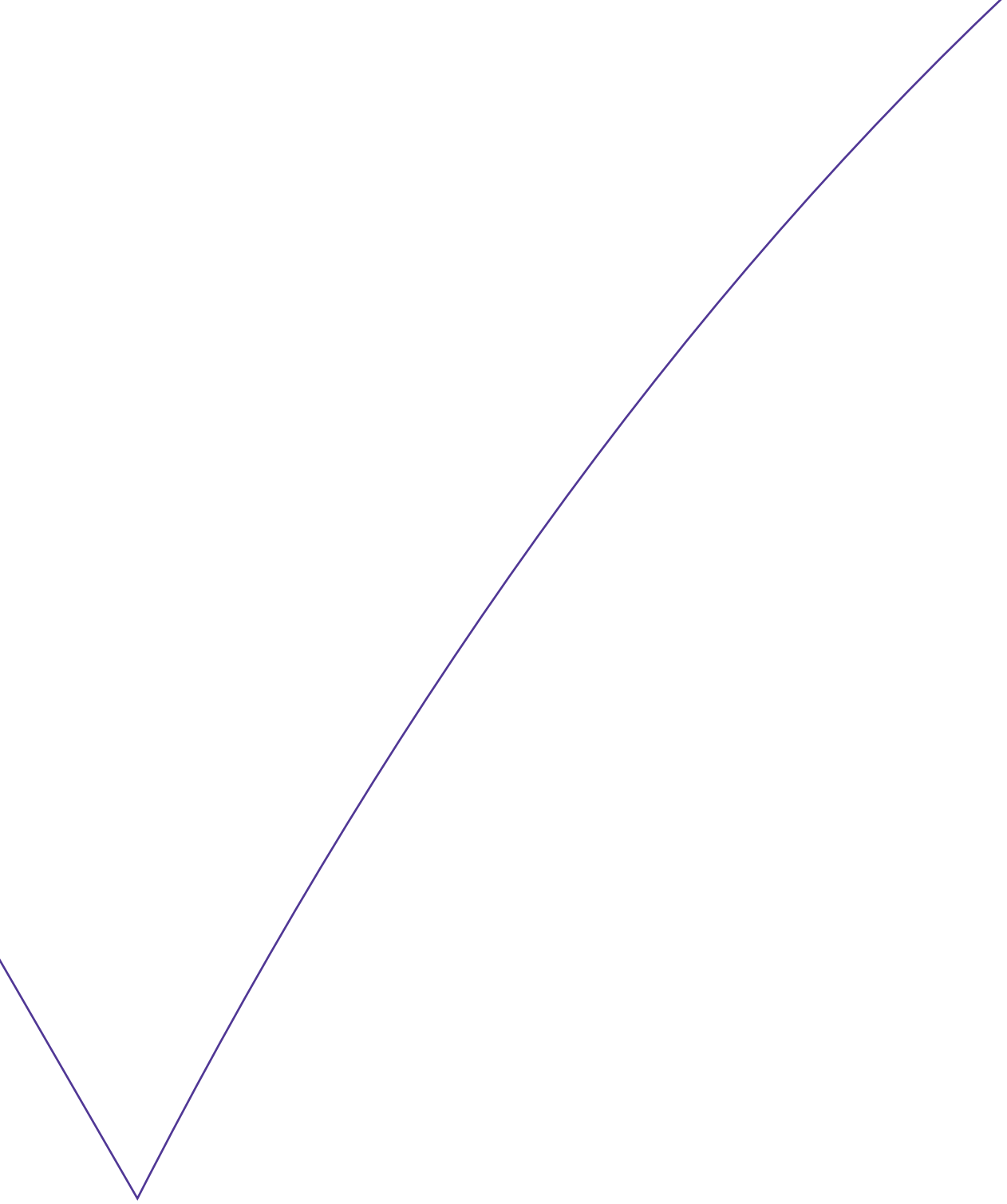
It should be noted that, in addition to autonomous vehicle testing regulations, public authorities are promoting efforts to step up progress by fixing objectives related to the different issues concerning the self-driving car. The legal framework in the US, for instance, the NHTSA (National Highway Traffic Safety Administration) proposed making Vehicle-to-Vehicle (V2V) system installation compulsory for all cars by 2023 in order to reduce the number of accidents that can be anticipated via inter-vehicle data communication (related, for example, to breaking).

THE AUTONOMOUS VEHICLE BY 2020: IS IT A POSSIBILITY?

Having gone beyond the fledgling stages, this technology is beginning to show tangible results: according to the international IT technology research firm, Gartner, 10% of vehicles will be fitted with an autonomous driving system by 2025, compared with less than 1% at present. The autonomous vehicle is therefore set to become a reality by 2020.

However, the widespread use of self-driving cars will come about gradually, later on in the 21st century. But why the delay? Because specific standards applying to these cars must be finalized; the technology will require further improvement and public transport services will have to increase the number of autonomous vehicles in their fleets. With public authority help and incentives, testing will become increasingly widespread, enabling continuous improvement and the preparation of the society as a whole to build up trust in a vehicle that is resolutely set to revolutionize 21st century transport. Tests, as well as trials carried out under limited and supervised conditions will allow the build-up of knowledge, not only of the technology itself, but also of the roads and their environment, and the behavior patterns of pedestrians and drivers of traditional vehicles since both of these technologies and usages will coexist for some time to come. Moreover, the gradual introduction of the autonomous vehicle will make it possible to confirm the advantages (and shortcomings) of this technology. At this stage, AVs notch up considerably less kilometers during test runs than the traditional cars of today, which does not offer an adequate basis of comparison.

Overall, the question is not whether cars will become autonomous, but rather how the progressive shift towards driverless vehicles will come about, how they will coexist alongside traditional vehicles and how they will steer the change. With this technology verging on the brink of maturity, mobility is being seriously called into question. Who will be concerned by, and have to prepare themselves for this change? A large panel of organizations including: car makers and suppliers, insurance companies, transport operators, infrastructure managers, authorities, research institutes and start-ups.



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Wavestone's mission is to enlighten and guide their clients in their most critical decisions, drawing on functional, sectoral and technological expertise.

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