

1 WHAT IS AN AUTONOMOUS VEHICLE?

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A vehicle performing a complex mission in interaction with its environment and with no intervention of a human driver was long seen as belonging to the realm of science-fiction or that of artists' imagination. And yet, driving automation, whereby parts or all of the driving tasks are delegated to an automated system, has now become a reality, gaining public attention through the experimentations of Google's automated vehicle (in 2010).

The word "autonomy" comes from the Greek roots "Auto" for self and "Nomos" for rules. An autonomous vehicle should therefore be able to react by itself based on pre-defined rules. In order to perform the tasks assigned to it, such a vehicle should be able to perceive the environment and understand it, decide on a manoeuvre and plan how to undertake it.

To this end, it is equipped with various sensing technologies (laser scan, radar and camera). The signals captured by the sensors are then translated by algorithms into data liable to be processed by the machines and essential to the driving operations (road markings, signalling, buildings, vehicles, pedestrians, etc.).

In this respect, SAE³ suggests several levels of automation and autonomy, reflecting these systems' respective impact on the driving function.

Autonomous vehicles will allow us to tackle a number of societal challenges such as road safety, traffic fluidity, energy savings and mobility for all. This latter point is crucial in the context of our ageing societies and for disabled persons, for indeed such mobility is an enabling factor and allows the people concerned to recover part of their autonomy.

First a collective experience to start with

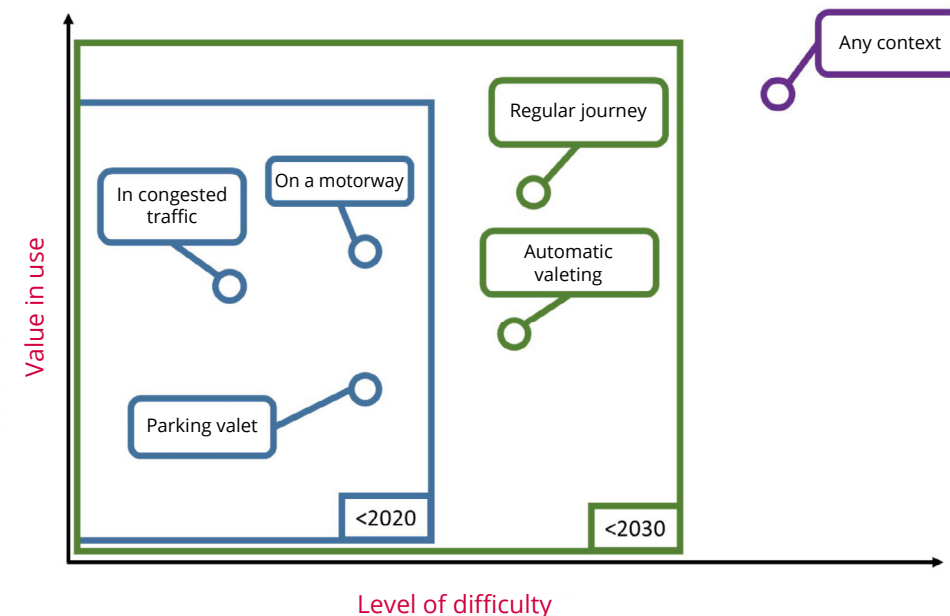
With the new mobility capabilities now within reach, self-driving cars are often likened to mobile phones and the revolution they brought about. If the autonomous transport object is primarily seen from the angle of the vehicle, then it may benefit many other areas such as freight transport, autonomous taxis or collective transportation.

In this latter case, a number of experimentations, or even integrations, have already been performed (driverless shuttles serving airports such as OrlyVal and Navya Arma, or automated metros). The common feature of these transport modes remains the context within which the vehicle is operating: it is highly protected. The environment perception step indeed remains a complex aspect and requires being performed with a great level of performance and reliability. Thus, to simplify the decision-making and planning step, the vehicle's reactions should remain limited: lateral control is thus constrained (by rails or by walls strongly restraining the guidance system) and only longitudinal control may vary within extensive ranges.

Motorways, the way forward for individual vehicles

Stakeholders have thus replicated this roadmap for individual cars. First to be targeted will be the motorway network, with two main applications: high-speed driving over long distances and low-speed driving in congested traffic situations.

The motorway environment shares many similarities with the above-mentioned protected environments: guidance is simplified (standard markings available), limited interactions with other users (few pedestrians and obstacles, trajectory of other vehicles both comprehensible and easily predictable), and potential reactions are constrained.



▲ Excerpts from the research objectives of *Nouvelle France Industrielle* (new industrial France) for autonomous vehicles – usage roadmap of the autonomous vehicle, case of the passenger car.
<http://pole-moveo.org/appels/plan-nfi-objectifs-de-recherche-vehicule-autonome/>



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WHAT IS AN AUTONOMOUS VEHICLE? (END)

This development also echoes one of the major demands of drivers concerning high-speed motorway driving. Today, Tesla and high-end automakers promote automated systems for this type of usage, which is very popular among users.

A matter of implication

Driving delegation is nevertheless still quite limited thus far. First from a technical point of view, the functions available, or soon to be, are only found at level 2 of the SAE³ ranking. The driver still is under the obligation to supervise the system and the environment and to take immediate action in the event of a failure.

Besides, misuses have already been identified, in particular as the driver builds up confidence in the system and starts indulging in other activities, as was the case with the TESLA accident. Thus, what we would need as from now is a level-4 system capable of supervising itself, the vehicle's environment, and of taking self-prompted action in case of a failure.

The autonomous vehicle, such as we can imagine it, will take a few more years before it becomes a reality. Until then it will have to position itself precisely with respect to its environment and learn to make decisions in order to plan its trajectories while minimising constraints for other users.

1. COSYS: Components and systems Department
2. LIVIC: Laboratory for Vehicle Infrastructure Driver Interactions
3. SAE International is a worldwide association of over 128,000 engineers and technical experts working together with the aerospace, automotive and commercial vehicles industries. <https://www.sae.org/>
4. VEDECOM: French Institute for Public-Private Partnership Research and Training dedicated to individual, carbon-free and sustainable mobility.



Animation



Usecase driving delegation, VEDECOM⁴



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