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General outstanding considerations on legal issues applied to autonomous vehicles

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Abstract

Even if there are many differences between the autonomous vehicles and aviation, we have tried to show that the long history of automation in airplanes can be a source of inspiration to understand some legal aspects necessary to allow autonomous cars on the streets. Independent on the technological evolution, the premise of this work is to ask the questions that must be faced if a fatal accident involving an autonomous vehicle occurs. In this sense, criminal issues will arise and the autonomous vehicles will be put under legal scrutiny.

Keywords: aerial accidents, automated vehicles, criminal liability.

Introduction

The ability of the law to monitor the evolution of society is essential for the commercial deployment of autonomous vehicles (hereinafter AV). In the near future, the AV's embedded technology will join 80 million other light commercial vehicles¹ on the road. This important evolution in individual mobility promises to reduce road accidents, promote social inclusion of elderly and disabled persons, reduce the level of CO₂ emission as well as reduce total fuel consumption.²

Taking into consideration the progress of those new technologies, the changes they are going to bring to our society and the possible legal consequences, this work will focus on the criminal responsibility in the case of a road accident involving autonomous vehicles restrict to public demonstrations³.

¹ L'Observatoire Cetelem 2015.

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³ Notice that vehicles will run with special authorizations.

Very often we hear that the main idea is to develop a system that drives the vehicle in a manner similar to that of autopilot used in airplanes. However, is this assumption correct? What is actually happening when autopilot is turned on in an aircraft?

One of the most stubborn myths in all aviation is this notion that pilots⁴ just sit there while the plane flies itself. Airplanes do not fly themselves but the crew flies it through the different levels of automation. In vehicle language, we can say through different types of Advanced Driver Assistance System (ADAS).

The systems make things easier, but humans control the operation itself. Nowadays, important problems and accidents occur exactly due to failures at the interface between human and automation.

Earl Wiener⁵, a pioneer of human-factors and automation research in aviation, analysed the interplay among automation, pilot error, and accidents. By the early nineteen-eighties, he had concluded that a striking number of innovations designed to address the perceived risk of human error had, in fact, led to accidents.

Thus, we are running in quite similar worlds (aero and terrestrial) but with a completely different environment. Besides the reliability that aeronautic machines are supposed to perform due to the redundancy of systems, the most important differences we can highlight are:

- A complex 3D space that airplanes move is much less crowded and much more simple than the 2D space like streets and highways cars are supposed to evolve;
- The airlines crew is very highly trained for all possible problems that can occur during operation of an aircraft; and
- It is admitted that an airplane can fly with all possible assistance for the pilot (autopilot, radar guiding, radio guiding and so on), but to engage the same level of assistance in autonomous vehicles, laws must evolve.

As we have pointed out, there are many differences between the two systems, but even though, since we are running a series of experimentation of autonomous cars now and then, what's going to happen if severe failures occur or even more, if an important accident happens?

Independent on the technology evolution, the idea of this paper is to discuss the questions that can arise in case of a fatal accident involving an autonomous vehicle in a public demonstration. In this sense, legal issues are analysed and the AVs will be put under criminal law.

The paper is structured as follows: Part 1 shows the autonomous vehicles in the legal world,

⁴ The second author is a private pilot.

⁵ Wiener, 1988.

offering some explanations to make sure that jurists can understand this new technology. Part 2 deals with some questions arising from an aviation accident and the criminal prosecution intended by the Brazilian Federal Prosecution Office⁶. Part 3 demonstrates some general aspects of the investigation and the criminal prosecution. Part 4 presents conclusions and some issues for the next steps.

1. Autonomous vehicles in the legal world

The Merriam-Webster dictionary defines automation as the technique of making an apparatus, process or system by mechanical or electronic devices that take the place of human labor.

In terms of this article, human labor has to be understood as the driving⁷ task. That means the drivers will become passengers of their autonomous vehicles (electric or hybrid), governed by automatic control algorithms that allows improving road security, economy of fuel, and better use of the available infrastructure⁸.

In partial automation (SAE level 3), the vehicle's control is shared between the driver and the vehicle and it is useful to consider the driver and the vehicle as a single system because according to legal requirements, a driver assistance system is considered safe⁹ as long as the driver is able to control the vehicle.

This “driver + vehicle” system is also required by the Article 8 of the 1968 United Nations Convention on Road Traffic¹⁰, which states that “every driver shall at all times be able to control his vehicle”.

An amendment to this statement¹¹, agreed to in March 2014 by the United Nation Working

⁶ In Brazil, the Prosecution Service is not part of the Executive, Legislative or Judicial branches, being totally independent. It cannot be terminated and its duties cannot be transferred to other government agencies. Prosecutors have their independence guaranteed by the Brazilian Constitution. Therefore, they are subordinated to an authority for administrative purposes only, but each member of the Prosecution Service is free to act according to their conscience and convictions under the law.

⁷ For Michon (1985), there are three levels in the driving task: strategical (planning the trip, where to go and how to get there), tactical (drivers exercise maneuvers such as obstacles avoidance and turning) and operational (control in the tight timing).

⁸ *Prospectives en Automatique Horizon 2020*.

⁹ European legislation ensures a consistent, high level of protection for the health and safety of consumers. Products placed on the market in the internal market are subject to general safety requirements (Directive 2001/92/EC).

¹⁰ Also known as the Vienna Convention on Road Traffic.

¹¹ The amendment was submitted by the governments of Germany, Italy, France, Belgium and Austria, according to the April 17 U.N. document.

Party on Road Traffic Safety, will allow the vehicle to drive itself, as long as the system “can be overridden or switched off by the driver”.

This amendment shall enter into force after within 18 to 24 months. Only after that can countries - that are party to the Vienna Convention - introduce new rules into intern laws.

This process is necessary because in many countries there is a hierarchical structure of laws in which each inferior norm finds its justification in a superior one, until the vertex of the pyramid¹² is reached. In the French system, international treaties - such as the Convention of Vienna on road traffic - are effective upon ratification, and they have a specific hierarchy, which is higher than domestic laws (*Code de la route*)¹³.

Some systems that help the driver in his task¹⁴ are already known:

- Parking assist system: protects every side of the vehicle and prevents damage when parking by automatically braking; manoeuvres the car into and out of parking spaces automatically;
- Brake assist system: prevents rear-end collisions with stationary or moving vehicles by automatically braking;
- Blind spot warning system: prevents lane-changing collisions (with vehicles in the blind spot or approaching from behind) by automatically braking and/or through steering intervention;
- Junction assistance system: prevents violations of priority by automatically braking;
- Safe distance support system (side): prevents sideswipes by automatically braking and/or through steering intervention;
- Assistance system for pulling out (reversing or forward with warning and intervention): prevents collisions when pulling out into moving traffic by automatically braking; and
- Curve assistance system: detects excessive driving speeds on the approach to bends and automatically brakes to the appropriate speed for the bend.

In these systems, the driver remains in control of the vehicle and must be focused on the task of driving. This is why we understand that the amendment in the Vienna Convention doesn't allow for full autonomous vehicles (SAE level 5) to operate on public streets. However, this surely is a nice beginning, and we definitely should not underestimate the work done in order to enact this amendment.

¹² As we can see at the normative pyramid of Hans Kelsen.

¹³ Article 55 of the Constitution.

¹⁴ Advanced Driver Assistance Systems (HUMMEL, 2011).

In autonomous vehicles, driver assistance features are integrated with connected vehicle technologies for added safety and efficiency¹⁵. These advances lead to an improvement in automated driving which occurs along two dimensions: first, in the context of driving (road type, traffic speed, with or without changing lanes, etc) and secondly, in the depth of delegation, from partial to full automation. In this sense, the delegation of driving will be gradually increased in certain conditions. It will probably be quite restrictive initially, although it can be extended as soon as legal restrictions are lifted¹⁶.

Despite some similarities with a human driver fatal car crash, there are a number of aspects that will make the criminal prosecution, in case of autonomous vehicles, unique and requiring special attention. Prosecutors normally file criminal charges when they believe that they can prove a suspect's guilty beyond a reasonable doubt. A machine or a system cannot currently be held responsible for a crime, only individuals and, in some cases, corporations¹⁷.

How are prosecutors going to charge someone of a crime if this person is only a passenger and does not have control of the driving? Isn't it true that personal liability guarantees that each offender will be criminally liable and punished for his own behavior only? In this sense, which person may commit, participate in or otherwise be found responsible if an autonomous vehicle hits and kills someone? Who is to be held criminally liable for this kind of offense - the manufacturer, the programmer, the user, the autonomous vehicle itself, or anyone else?

This discussion has a huge importance because we understand that criminal liability is the strongest formal censure that society can inflict to someone, and it also may result in a legal sentence, which would amount to a severe deprivation of the ordinary liberties of the offender¹⁸.

2. Aviation accident and criminal liability

In 2007, almost 200 people were killed in an aviation accident at the airport of Congonhas in São Paulo (Brazil).

¹⁵ Like eCall, a real-time alarm system that has to be installed in European new cars after October 2015. See at <http://ec.europa.eu>.

¹⁶ Recent developments: General Motors will offer a super cruise system with hands-free automated driving on freeways that have proper lane markings by 2016. However, drivers will have to be ready to take over control of the vehicle and cars will be fitted with a device designed to alert the driver to pay attention even during highway driving. Toyota said it plans to offer crash-avoidance technology in Toyota and Lexus models by 2017. Daimler is now offering a system on certain models that allows a car to brake, accelerate and remain in its lane without human intervention at speeds of under 16 miles an hour (Insurance Information Institute, September, 2014).

¹⁷ A business entity having a separate legal personality from the [natural persons](#) that manage its activities or individuals acting on behalf of a corporation or other business entity.

¹⁸ Ashworth, 2013.

Shortly thereafter, it was determined that the refurbished runway in addition to a wrong interpretation of the crew about a complex and unclear auto-thrust system that controls the engines during landing are pointed as the main causes of the accident¹⁹.

The aircraft landed on a rain-soaked runway that did not have proper grooves to ensure the water flow. In addition, one thrust reverse - used to reduce speed on landing airplanes – had been deactivated due to defect. Official audits determined that botched landing was partly due to an incorrect positioning of the plane's throttle controls, which was blamed on pilot error and lack of training by the airline.

Although the pilots did not survive the accident, ten people have been implicated in the civil police report for contributing to the aircraft accident, and three of them, a former director of the Brazilian Civil Aviation Agency (ANAC) and two of the senior employees of the Brazilian airline, have been charged of neglecting air transport safety by allowing the jet to land in heavy rain on the recently resurfaced runway²⁰. The process is still running, but as they are all accused of violating national aviation security, they could face prison terms of up to 6 years.

The prosecution argues that it was unsafe for the plane to land on the notoriously short runway, along with the fact that the grooves, to channel away excess rainwater, had not been completed. It also states that the alarm system failed in the few crucial moments before the crash, and the pilots had not been properly trained to deal with emergency landings.

The defense attorneys tried to thwart the criminal procedure with a writ of *habeas corpus* arguing their clients could not be held responsible for the accident; however, the Superior Court of Justice denied the writ stating that the substantive issues should be analyzed in a proper place, meaning, in the course of criminal proceedings.

In fact, the narrow procedure of the writ does not allow for the review of the whole investigation. It was determined that the evidence described in the criminal complaint should be produced and contradicted in the instruction procedure, allowing the prosecution the opportunity to complete the evidence that supports the accusation²¹.

In our opinion, the position of the Brazilian's Court means that criminal cases involving autonomous vehicles will need accurate evidence analyzes.

3. Autonomous vehicles under criminal prosecution

Why does this particular accident inspire us to write about autonomous vehicles? The answer is that it involves three different aspects - infrastructure, human machine interface (HMI) and

¹⁹ CENIPA, 2009.

²⁰ The six-year investigation has also looked into possible pilot error and mechanical failure.

²¹ In the Brazilian system, any doubt in this phase is resolved in favor of the society, owner of a legitimate interest in the investigation of a crime and punishing the perpetrators.

human errors - which will be faced in the AVs environment.

Assuming that demonstrations of different kind²² of autonomous vehicles are going to be held in public streets and parking areas, and that those vehicles may be involved in car accidents, the question of criminal liability promptly arises²³.

Initially, here are some introductory notes for the non-jurists²⁴:

- Individuals are punished under criminal law when their conduct jeopardizes foundational elements of society;
- An individual's criminal responsibility is subordinated to the existence of a specific norm or statute in accordance with the principle of legality²⁵;
- A person commits an offense if he or she voluntarily engages in conduct, including an act, an omission or possession²⁶. There is no punishment for merely thinking about a criminal act;
- Conduct is the objective and external expression of the commission of the offense, but it's necessary to note that the conduct requirement of some offenses can be satisfied by inaction²⁷. Modern society does not punish accidental, thoughtless or random events;
- Culpability relates to the mental state of the offender and reflects the subjective-internal intention of the commission of the offense²⁸;
- Personal liability guarantees that each offender would be liable and punished only for his own part.

Considering the professional experience from the first author in the Brazilian Federal Prosecution Service in criminal cases and the fact that it is impossible to analyze the criminal law of each country, we are focusing on general terms of a prosecution, especially on the

²² *Navettes électriques*, prototypes, regular cars modified in some systems (e.g. breaking, steering and engine controls).

²³ This won't be a simple problem. "How do you apportion blame between a human driver and a car's automated systems? How do you apportion blame within those systems? Was it the software? Or the way the software was or wasn't tested? Or maybe it was the hardware. Or perhaps it was due to the software and hardware interacting in unforeseen ways (Villasenor, 2014).

²⁴ See Pigallo, 2013, Hallevy, 2013 and Hallevy, 2014.

²⁵ *Nullum crimen nulla poena sine lege*.

²⁶ *Nullum crimen nulla poena sine actu*.

²⁷ The photographers at the scene of Lady Diana's fatal car collision were investigated for violation of the French law of "non-assistance à personne en danger" (deliberately failing to provide assistance to a person in danger), which can be punished by up to 5 years imprisonment and a fine of up to \$100,000.

²⁸ *Nullum crimen nulla poena sine culpa*.

offender²⁹.

In criminal cases, society has a vested interest in preventing crime and, therefore, does not wish wrongdoers³⁰ to go unpunished.

Prosecutors have to answer seven main questions concerning the facts of the criminal case: when?, where?, who?, with whom?, what?, why?, and how? Let's consider an example of a formal criminal charge of vehicular homicide³¹ in Brazil:

“In October, 17th, 2014, at 10 a.m., at 1520 Visconde de Guarapuava Avenue, in Curitiba, state of Paraná, [*name of the offender*], driving an Honda Civic, plaques AMC3015, killed [*name of victim*] when, driving under the influence of alcohol and texting while driving, failed to stop at the red light.”

In terms of vehicle full automation, determining the “name of offender” can be quite a problem. In public demonstrations, assuming that there will be at least one³² person, with a valid driver's license, responsible for the control of the car at any time - as statute in the Vienna Convention on road traffic, and as required by local traffic authorities, there is probably sufficient evidence to conclude that this person will be seen as the offender.

However, the ability to withstand the punishment of the perpetrator is subject to basic conditions³³. Injuries or deadly accidents caused by a vehicle malfunction³⁴ may include the punishment of the manufacturer of the vehicle and a third party or even more, not be attributable to any person due to force majeure or causes beyond the will of the people³⁵, because an autonomous vehicle may be involved in a pedestrian suicide, for example.

²⁹ One can be considered a party to and guilty of an offence if he or she actually commits the offence; or does or omits an act for the purpose of aiding any person to commit the offence; or abets any person in the commission of the offence; or incites, counsels, or procures any person to commit the offence.

³⁰ For this analyzes, we will not consider that the person able to take the control of the car – called driver - practices a murder, as an intentional act, with a guilty mind.

³¹ Also known as vehicular manslaughter in the United States, is a crime that, in general, involves the death of an individual as a result of the negligent operation of a vehicle. It is comparable to the offense of dangerous driving causing death in some countries (Wikipedia).

³² Maybe two, one driver and one supervisor (system), in a similar way as the crew airline.

³³ If the prosecutor lacks evidence of a defendant's guilt, he must drop the charges or decline to press charges. Moreover, if a prosecutor discovers evidence that puts the defendant's guilt in doubt or relieves the defendant of criminal liability, he must turn that evidence over to the defendant. Once the prosecutor decides what crimes a suspect will be charged with, he makes a formal criminal charge (Principles of Federal Prosecution, US Attorneys).

³⁴ In our opinion, judges may be sensible to recognize technical defects as a ground excluding criminal responsibility.

³⁵ See EGHBALI M. et al (2015).

We should also consider that the accident may have been caused by a set of technical decisions, in conjunction to the state authority's choices and decisions, thus, referring to the case of the aviation accident reported above and the criminal responsibility assigned by the Federal Prosecutor.

If we consider that the principal purpose of the investigation in the criminal act is to develop sufficient factual information to enable the prosecution to make a fair and objective determination of whether and what charges should be brought³⁶, prosecutors will depend heavily on this important evidence. As we are facing an intelligent vehicle, whose performance is ensured by an automated driving system, we shall address evidence determined by the expert and the investigative hearing of witnesses.

Although a machine cannot be criminally prosecuted or be put in jail, it may be subject to search and seizure³⁷. The truth is, in a digital society, in which people interact through systems and interfaces, our main "witness" is a machine.

If prosecution asks experts "*was the system settled on with the option to avoid a frontal collision with another vehicle coming in a colliding trajectory, by maneuvering right or left?*", the possible answers are "0" (not) or "1" (yes).

The system will never answer "*yes, but there was no intention to kill anyone with this maneuver*". The machine is literal and it is surely implacable.

In this case, if computer evidence presumes intention it will be up to defendant to prove otherwise.

4. Conclusion

In this paper, the circumstances and nature of responsibility for legal crimes were determined by enactments and decisions made by the Brazilian Civil Aviation Agency in addition to decisions made by the airline company. The occurrence of a fatal aviation accident caused by a combination of infrastructure, human machine interface and human errors points toward some juridical liability in the special framework of experimentation with autonomous vehicles. In a hypothetical car crash, it should be considered new inputs like the notion of degree of automation and the actions of driver and supervisor, in an analogy with pilot and co-pilot in an airplane. It appears that the relationship between autonomous vehicles and criminal procedures is to set the determining factor of each actor's responsibility in the chain of events, including the person able to take the control of the car at any time, the entity responsible for the vehicle's systems changes, the responsible for the AV road demonstration and state authorities, which includes those involved in traffic authorizations and those responsible for

³⁶ See Standards on Prosecutorial Investigations.

³⁷ A warrant may be issued for an evidence of a crime (persons or property).

the civil infrastructure of roads and driving areas. The final results conclude that more in depth research, investigation and expertise will be required in order to determine the exact nature of an accident involving an autonomous vehicle. It also appears difficult to ignore the vehicle data parameter recorder (e.g. black box) in this context.

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