Chapter

The Long Journey of the Driverless Car

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Abstract

There has been considerable hype about the expectations around driverless cars but tests and trials have shown that the concept is far more difficult to bring to fruition than expected. Since around 2010, there have been predictions of the imminent arrival of driverless cars. All these predictions have proved to be over optimistic and none of the goals have been achieved. Companies like Waymo, who are most advanced in the field, are beginning to admit that the task they faced is far more difficult than originally envidaged. This chapter will examine the obstacles to the achievement of the driverless car concept and assess whether the models of shared use driverless vehicle posited by the auto manufacturers and tech companies are realistic.

Keywords: autonomous vehicles, driverless cars

1. Introduction

For more than a decade, a group of auto manufacturers (OEMs, or Original Equipment Manufacturers) and technology companies have been working on the development of autonomous vehicles. There had, in fact, been work on the concept stretching back to the 1930s but it was only towards the end of the first decade of the 21st century that there was widespread interest in the concept. This seems to have been stimulated by the need for the tech companies, which had generated huge surpluses, to find projects in which to invest their money combined with the desperate fear of motor manufacturers that autonomy would be an essential part of the offer within a few years.

Throughout this period, the claims for this new technology have been ambitious. One of the earliest presentations by a senior motor industry figure was at the Shanghai Expo held in 2010. With a backdrop of a film showing a blind girl being raced through canyons of Shanghai's tower blocks in her driverless pod and a pregnant mother being rushed to hospital in an autonomous ambulance, Kevin Wale, the then boss of General Motors set out his prediction for 2030: 'Our vision for the future is free from petroleum, free form emissions, free from accidents, free from congestion and at the same time fun and fashionable' [1]. The key was for cars to be autonomous. This would ensure, he said, that there would be no traffic jams, no accidents and no emissions since all the vehicles would be electric.

This optimistic view set the tone for much of the subsequent coverage. The presentation of the concept of autonomy has been relentlessly positive emphasising a series of potential advantages. The aspect that is stressed most often is safety.

Protagonists of the new technology point to the fact that about 1.25 million people are killed on roads annually, including around 40,000 in the US. Since more than 90 per cent of these are the result of human error, the claim is that this number could be dramatically reduced. Take out the drivers, and the errors will go with them. Autonomous cars do not get drunk or fall asleep at the wheel, so the argument goes, and therefore they are will undoubtedly be safer. The National Highway Traffic Safety Administration suggested that 'automated vehicles' potential to save lives and reduce injuries is rooted in one critical and tragic fact: 94 per cent of serious crashes are due to human error. Automated vehicles have the potential to remove human error from the crash equation, which will help protect drivers and passengers, as well as bicyclists and pedestrians' [2].

A second key argument is convenience. Regular daily commutes of an hour or more in each direction are commonplace and that time will become available again to the drivers who can use it to answer emails, make calls or even just read a book. There is too, the potential for the technology to enable many more people to use cars, such as blind people or dementia sufferers. This idea was a key part of the presentation by Google's then head of its autonomous car project at to a congressional committee, Chris Urmson who cited the example of 'Justin Harford, a man who is legally blind' who had told him 'what this is really about is who gets to access transportation and commerce and who doesn't' [3]. These comments were met with great enthusiasm by campaigners for people with disabilities such as, for example, Parnell Diggs, the Director of Government Affairs for the National Federation of the Blind, who told the committee 'we anxiously anticipate the day that all blind people will have the opportunity to driver independently, and we believe that autonomous vehicles will make this day possible'.

A third major advantage claimed for the technology is that people will no longer need to own their own cars. The idea is that vehicles will be shared use, ready to be called up at a moment's notice through an app. This, in turn, will enable vast swathes of parking areas to be repurposed since once at their destination people will be able to despatch their vehicle to its next user or to distant car parks.

With reduced car ownership, there will be more road space available as cars will no longer be parked on kerbs. Moreover, because autonomous cars will be driven in a controlled way, without the vagaries of human control, there will be a much more efficient use of highways as the well-known wave effect will be eliminated. Zenzic, the organisation which coordinates the UK's research programme claimed in a press release that connected autonomous vehicles could reduce transport emissions by between 5 to 20 per cent by reducing congestion and was 'the key to becoming climate neutral' [4].

There have been numerous attempts to quantify all the gains from the introduction of autonomous vehicles. A study [5] by KPMG, for example, suggested that British drivers would save £5bn per year in reduced insurance, car parking and running costs. A report by Rand [6] argued that the increase in lane capacity on highways might amount to 500 per cent and that autonomous cars would lead to an improvement in fuel use of between 4 to 10 per cent. Ohio University's Future of Driving report [7] stated that harmful emissions would be reduced by 60 per cent by the introduction of autonomous vehicles. Zenzic claims that the industry will be worth £52 billion in the UK and £907 billion worldwide by 2035 [8].

All this, however, is rather mundane and to make it more exciting the promoters of the technology is that they wrap up these ideas with language that represents a radical and exciting vision for the future such as in the speech by Kevin Wale of GM. There is talk of 'life-changing' experience, of 'freeing up large amounts of time', of clean air and 'emptier roads'.

While the various manufacturers and tech companies have different conceptions of what this new driverless world may look like, the long term vision converges around a triple revolution: in the future vehicles will be driverless, electric and shared used. This is the Holy Grail for the industry as in this scenario driverless vehicles would dominated the transport landscape, taking over not just the existing privately driven car market but also making deep inroads into public transit and expanding the use of cars by enabling, as mentioned above, many people with disabilities or without a licence to 'drive'.

2. The triple revolution

This is based on a variety of assumptions around very profound and radical societal changes. Yet, neither the breadth of these changes nor the huge number of obstacles that need to be overcome before this vision can become a reality are examined by those putting out this vision. Quite apart from the depiction of a transport world completely different from the one in which we live today, the very long period during which there would be a mix of driverless and conventionally-driven vehicles is given little attention.

Indeed, the idea that a totally driverless world is possible stretches credulity. The very example given at the Shanghai Expo of an ambulance carrying a pregnant woman is an unlikely scenario for a driverless vehicle as emergency vehicles are allowed to break the rules precisely because they must have priority. Even in a near driverless world, emergency vehicles, VIP limos, other urgent transport and various other types of vehicle are likely to remain conventionally driven.

The scenario presented by the concept's enthusiasts is, in fact, three separate revolutions bundled into one. The least innovatory and radical of these assumptions is that vehicles will increasingly be electric. That is highly likely but upscaling the production and sale of electric cars beyond the current minority market has proved difficult because of the high initial cost, the short range (or more pertinently fears about the range) and the slow rate of development of new models. Currently sales represent around 2.6 per cent of the global market [9]. This is growing but only slowly and there are concerns that the biggest constraint will be the production of sufficient batteries to support a rapid expansion in the electric and hybrid share of the market. The availability of charging points, the difficulties many flat dwellers would have in charging their vehicles overnight and the various issues around the sustainability of batteries all point to a relatively slow take-up of electric vehicles.

Setting these difficulties aside, the second assumption is an even bigger obstacle, The notion that drivers will happily dispense with their own cars once driverless models become widely available and rely on Uber type services to call up vehicles when they are needed has very little evidence to support it. There are indeed a minority of Millenials living in urban areas who are happy to dispense with car ownership. For people who at the moment live in a city served by good private hire and taxi services including Uber, the option of not owning a car is perfectly feasible. However, once they move to the suburbs, or have children, they tend to purchase their own vehicles. For the past century or so, people have bought their own cars, despite the high cost, for a whole host of reasons: convenience, choice of type of vehicle, accessibility, enjoyment and, for many, keeping up or bettering the Joneses. In fact, driving is still considered by many to be a pleasure. The idea that suddenly this will all be abandoned because vehicles will no longer be driven but will be autonomous has little logic and no research to back it up. Indeed, on the contrary, the providers of shared use vehicles accept that 'car clubs are not for everyone and

there are many who still aspire to car ownership, even Millenials. I don't see a time when all vehicles will be shared [10].' People like the convenience of having, say, baby seats, golf clubs or tools in the car and moreover, the guarantee that the car is outside the home for immediate use. Relying on a shared use vehicle accessed through an app when they have to get to work at a particular time or take the kids to school will never be able to replace that flexibility.

There is another practical objection to the model here. At the moment services such as Uber and Lyft are available principally in large urban conurbations. If the world were genuinely to become dominated by share use vehicles, they would have to serve small towns and even villages. There is simply no feasible business model in which such areas would have access to a pool of shared use vehicles at short notice. Even if the shared use model might be widely accepted in central urban areas, it is difficult to envisage it taking off in more sparsely populated suburbs let alone small towns, villages or rural areas. The provision of sufficient cars would simply not be cost effective as no supplier would take the financial risk.

The recent pandemic leads to other difficulties. Who would guarantee that these cars were clean and not full of the previous occupants' litter or, worse, germs? There are a myriad other reasons why this scenario is implausible such as the lack of any business model: the costs of maintaining a service as these vehicles would need supervision and a back-up service; the initial investment required to set up such a business given the cost of the technology; and the reluctance of the public to part with their own vehicles and effectively replace them with an app. This model is, on the face of it, a very strange basis for the massive investment programmes by the tech and auto manufacturers given the lack of evidence that people are prepared to buy into this model. So why has this shared use concept become so important for the autonomous car protagonists?

The reason, in fact, points to their Achilles Heel and demonstrates that the extent to which this triple revolution is an impossible dream that more sensible advocates now see as being 'decades away' [11]. The supporters of autonomous cars have been forced to put forward this shared use scenario because of their fear of the criticism that the advent of driverless cars will lead to an increase in cars on the road and consequently greater congestion. They argue that since cars are in use for only around 5 per cent of their time, having autonomous cars which are shared will lead to a massive reduction in the number of vehicles on the road. There are obvious logical objections to this. Most people want their cars at peak times in the morning and evening, and very few use them at 3 am in the morning. Therefore the parc of vehicles would have to be far higher than the 5 per cent figure which this scenario implies even if all were shared use and driverless. Moreover, no clear business model has been set out for how such a massive business as providing vehicles for, literally, millions of people in a city would work. The practicalities of essentially making available hundreds of thousands of vehicles that would need to be centrally owned by a single entity (competition would add another layer of complexity) has never been set out. This is not an evolutionary process but a revolutionary one. In reality, the prompt for this scenario is the auto manufacturers' concern about understandable concerns that mass autonomy would lead to an increase, not a reduction, in congestion. There is much logic in that argument. If autonomy makes it easier for people to access individual cars rather than public transport, then it is highly likely there will be an increase in demand. Moreover, in a world dominated by autonomous vehicles, there would be considerable mileage undertaken by completely empty cars travelling between users. Uber presently has an average passenger occupancy rate of 0.6 (in addition to the driver) which means their vehicles are been driven for nearly half the time without a passenger. This emphasis on shared use is therefore borne of the necessity to argue that the spread of autonomy will lead

to a reduction in congestion when the opposite has much more logic. It is a defence to a criticism, not a presentation of a realistic scenario.

The third element of this triple revolution, the widespread use of cars that are entirely capable of driving without human intervention is an even tougher obstacle to overcome. At present, the technology is at what has been called level 3. Cars can perform routine driving tasks such as on highways, even selecting routes and not requiring human input for steering but they still require constant attention from the driver. There have been countless tests and trials, and millions of miles have been driven by vehicles that have many features that allow them to be computer-controlled but despite the investment of an estimated $100bn [12], the technology is nowhere close to delivering a car that can be driven anywhere in any weather conditions with complete safety which is defined at Level 5.

Waymo's 'robo taxi' service in Phoenix, Arizona, and Silicon Valley (for employees only) started operating in December 2018 but has been beset with problems. In fact, all the cars still have safety drivers, except for a minority which are 'geo-fenced' and all are monitored - and sometimes controlled – remotely. Passengers have complained of being dropped off in the wrong place, experiencing unexplained stops sometimes so sudden that they have caused whiplash and near collisions with cyclists: 'In about 2.5 per cent of Phoenix rides and 6.5per cent of Silicon Valley rides, Waymo vehicles stood still for a long period of time before either the human driver took over or a Waymo representative monitoring the vehicle from a remote location helped the car figure out how to start moving again. One Waymo rider *The Information* that during three trips in one week this summer, the Waymo vehicle got stuck each time' [13].

Most of the testing in the US has been carried out by cars monitored by an operator who is supposed to intervene when things are about to go wrong – something that clearly did not happen when the unfortunate woman wheeling a bike which had bags on its handlebars in Arizona was killed because the car failed to recognise her as human. It identified her initially as a plastic bag and then as a cyclist who was not on a collision course and only too late as a human being. This accident, which caused the death of Elaine Herzberg in Tempe Arizona in March 2018 was a key demonstration of the inability of even the most sophisticated computers to recognise 'outlier' situations. The fact that Herzberg was pushing a bicycle which had bags on its handlebars clearly was not a situation that the on board computer had been programmed to recognise. This is proving to be the biggest single obstacle to progress in the development of the autonomy aspect of these vehicles. However many millions of miles have been covered on the road, they will never be sufficient for the vehicles to learn about all eventualities and therefore the ability to reach full driverlessness must be in doubt. Indeed, despite the large amount of testing that has already taken place, most of the cars still cannot operate in heavy rain, snow or off road.

3. Public acceptance

All of this has helped increase scepticism about the concept. Almost half of Americans say they would not get in a self-driving taxi, according to a poll by the advocacy group Partners for Automated Vehicle Education [14]. The poll, carried out at the beginning of 2020, found that 48 per cent of the 1200 adults surveyed would 'never get in a taxi or ride-share vehicle that was being driven autonomously', while a further 21 per cent said they were unsure about doing so. While a fifth of respondents said that autonomous vehicles would never be safe, another fifth stated, incorrectly, that it is possible 'to own a completely driverless vehicle today',

highlighting the confusion that still remains over how far the technology has already developed. On the other side of the coin, people want to continue driving. A post-pandemic lockdown survey in *Le Monde* [15] found that half of all car owners actually missed driving while they were unable to travel.

> *The fact that so many people believe that the driverless car is already a reality is the product of the tremendous hype that has accompanies the investment. enti-ties. In an article for the online academic magazine Transportation Research Interdisciplinary Perspectives [16], Liza Dixon argues that much of the material put out by the companies developing autonomous vehicles is misleading as it fails to distinguish between autonomy and driving aids. She defines autonowashing as making unverified or misleading claims that misrepresent the appropriate level of human supervision required by a partially or semi-autonomous product, service or technology. This is, in fact, a characteristic of much of the PR output of the industry.*
>
> *She cites the use of vague language and the failure to prove claims as being charac-teristics of autonowashing, and she highlights the media's culpability in relation to its 'utopian' reporting and exaggeration of the level of autonomy. Indeed, there are numerous examples of articles whose headlines suggest they are about 'driverless' vehicles but that go on to reveal that there is a safety driver at the wheel.*

Dixon points out, the phenomenon is somewhat self-defeating for the industry, which depends on building trust among potential users. By exaggerating claims and failing to consider disadvantages, the industry is weakening its own case. She writes: 'Autonowashing leads to overtrust, which leads to misuse. If a driver man-agement system is unable to assist the user in error prevention, accident, injury or death may occur. This results in negative media coverage which can then stir public distrust in vehicle automation, threatening the return on investment'.

The extraordinary level of hype is, in fact, a key part of the current business model which appear to more about attracting investment funds than actually developing a fully autonomous vehicle. Given the clear and obvious obstacles facing the industry, the reasons to justify the vast level of investment are surprisingly unclear. Yet it continues unabated. Waymo managed to raise $3bn in the market in the Spring of 2020 while survey of the top thirty companies in the field published in *The Information* [17] revealed that $16 billion was spent on autonomous vehicle R&D in 2019: 'Just three companies spent half of that money – Alphabet's Waymo, GM's Cruise and Uber... Four other companies, including Apple, Baidu, Ford and Toyota, spent most of the rest.' According to a Fortune magazine article of 7 January 2020, while Waymo remains the market leader after eleven years of research, the company 'remains an expensive science project in search of a business'.

The benefits of removing the driver from cars have been heavily promoted by these companies but as we have seen do not stand up to close scrutiny. Since clearly the model of the triple revolution is unlikely ever to be realised, which means that the notion of blind or infirm people being able to regain autonomous mobility is a myth, what of the other purported benefits of a move to driverless vehicles?

The safety benefits are far less marked than suggested by the industry. The Insurance Institution for Highway Safety has calculated [18] that just a third of accidents would be prevented by the use of autonomous vehicles. This is because only accidents that are what the researchers call 'sensing and perception' errors, such as driver distraction or failure to spot a hazard, will be prevented. The technol-ogy cannot prevent the majority of accidents, which the IIHS believes are caused by 'prediction errors', such as misjudging the speed of other vehicles, excessive speed

when road conditions are treacherous, and mistaken driver efforts to avoid a crash. One example is when a cyclist swerves into the path of an autonomous car. The vehicle may have seen the cyclist but it cannot manoeuvre quickly enough to avoid hitting them.

These doubts make the motivation of those seeking to promote this technology unclear. There seems to be no short or medium term prospect of making a return on this capital. One driver of the high levels of investment is the assumption that the first to develop full autonomy will make super profits by establishing a monopoly. However even Waymo is now suggesting that the full driverless model is not achievable. An article on CNET [19] in November 2018 quoted the CEO of Waymo, John Krafcik, as expressing doubts over whether autonomous cars would ever become ubiquitous:

'It'll be decades before autonomous cars are widespread on the roads – and even then, they won't be able to drive themselves in certain conditions. Autonomy always will have some constraints'.

While this suggests that there is a need for a model that is very different from the ones previously proposed, there is no sign at this stage of what it is.

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