



THE WORLD IN 2040

The future of
healthcare, mobility,
travel and the home

**MOBILITY
OF THE
FUTURE**



Contents

MOBILITY OF THE FUTURE

About the Author	3
Mobility of the Future	4
Government Plans	6
The Trends Shaping The Future of Mobility	7
Self-Driving Vehicles and Smart Roads	11
The Need For Security	14
Charging Ahead	14
Love To Drive?	15
Changing Patterns of Car Ownership	15
The Road To 2040	19

About the Author

Ray Hammond has been researching, writing and speaking about future trends and developments for almost 40 years.

He is the author of 14 books on the future and he has written, consulted and lectured for the world's great corporations, for governments and for many universities in Europe, the USA and in Asia. He is a regular broadcaster on both national and international radio and TV channels.



In 2010, Michal Gorbachev presented him with a medal for his services to futurology which was issued by the Italian Chamber of Deputies on behalf of the United Nations. In the citation, President Gorbachev wrote:

“We are delighted to honour Ray Hammond for his constant commitment to research and for his stunning speculations about the future, enlightened by scientific knowledge and an evident concern for humankind.”

Author's Note

This report represents my own opinions about likely future developments. It does not represent the views of Allianz Partners. When I was asked to research and write this report, I was provided with guidance about the topic areas to research, but I was given a free hand to develop all editorial matter independently. Any errors and omissions are my own responsibility.

Mobility of the Future

By 2040, most city dwellers in developed countries will no longer own private cars. There will be few on-street parking spaces and no public car parks in the centre of towns. In many cities, fossil-fuel vehicles will have been banned completely.

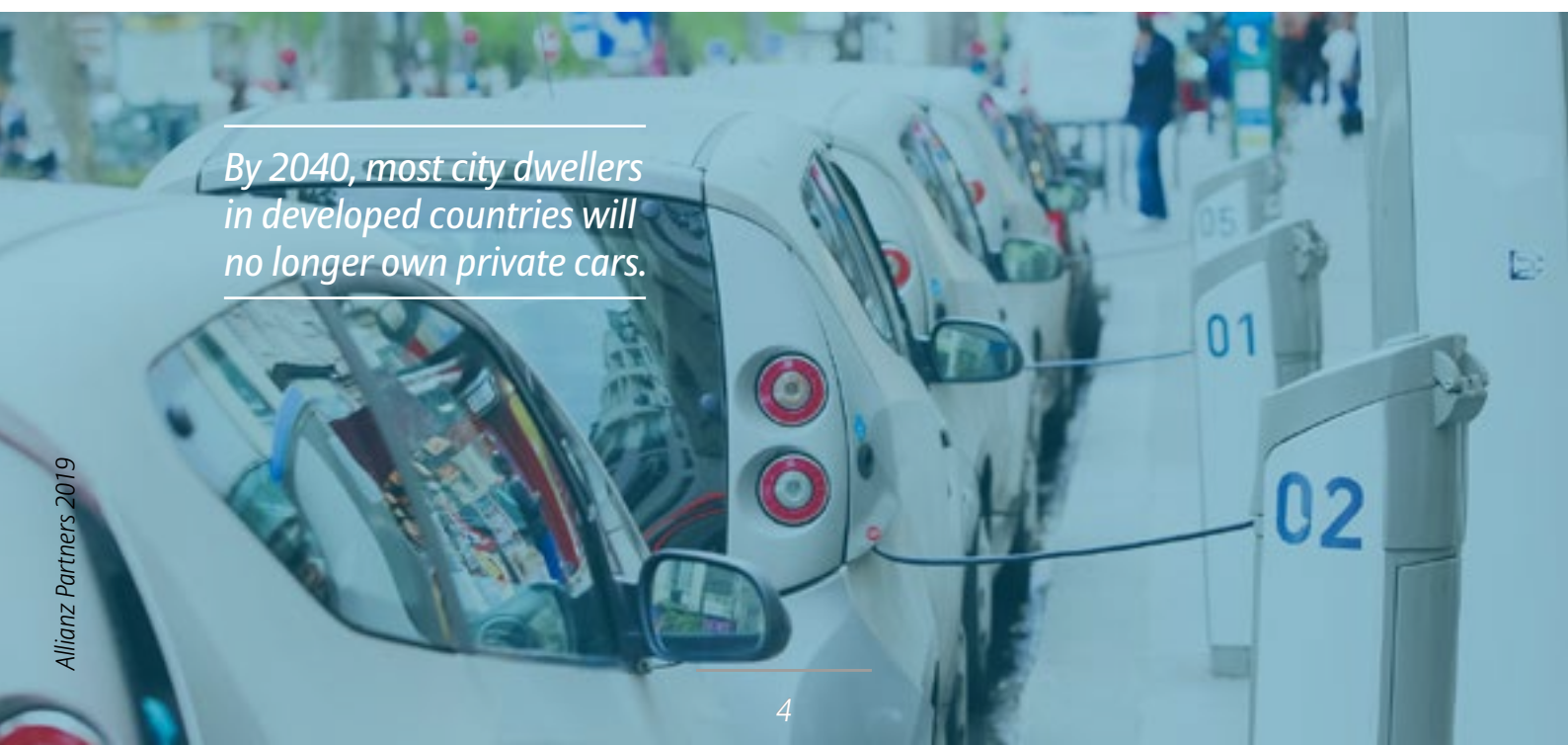
To meet the population's transport needs, driverless electric taxis will arrive within two minutes of being summoned and will transport passengers to their destination for a price equivalent to today's bus fares. For short journeys, some city dwellers will also use electric cycles and scooters supplied via sharing schemes.

Goods vehicles will also be electric self-driving modules which exchange containers with long-distance trucks at the edge of the city.

Vehicle parks will be located in a ring outside of towns and cities and here, travellers will swap their autonomous taxis for electric hire vehicles in which to make inter-city and rural journeys. These long-distance vehicles will also be self-driving, but will also allow for manual control for when a vehicle has to make a rural journey to an area that lacks smart roads and network infrastructure (which driverless vehicles will need to operate at maximum efficiency).

These long-distance, self-driving vehicles will provide sleeping facilities to allow for overnight journeys and the parking areas around towns and cities will include shower facilities, restaurants and other leisure services. Inside their driverless vehicles, passengers will be able to use journey times to work, to play, to socialise (locally and remotely), indulge in virtual travel, chat to famous virtual personalities and, if they so wish, to educate themselves.

By 2040, most city dwellers in developed countries will no longer own private cars.





By 2040, there will be close to zero road deaths in developed nations

In-car virtual entertainment will be so immersive and so compelling, that few will struggle to fill the time that will be saved by the use of self-driving vehicles.

There will be no more traffic jams in cities or on highways, as all traffic movements will be under network control and vehicle access and travel speeds will be managed to keep traffic moving smoothly.

And the best news is that there will be very few major traffic accidents and few severe injuries and deaths on the road. Nearly 1.35 million people die in road crashes each year, on average 3,287 deaths a day.

An additional 20-50 million are injured or disabled and more than half of all road traffic deaths occur among young adults aged 15-44. By 2040, there will be close to zero road deaths in developed nations.

Any accidents that do occur are likely to be minor events – bicycle collisions, scooter crashes – or those caused by mechanical failures and natural events, e.g. bursting tyres or falling tree branches.

The urban landscape will be transformed, cities will be undergoing redesign and regeneration programmes and the century-and-a-half of the urban dominance of the motor vehicle will be over. Many cities in the New World were designed around motor vehicles. Future cities and re-developed cities will be built around people.

Government Plans

The above scenario could be described as fanciful, if not impossibly optimistic, were it not for plans now being laid by governments around the world and the convergence of several powerful trends that are likely to force rapid change on the automotive transport sector.

Although it is true to say that government plans are often subject to change, I think it likely that it is this 'convergence' of trends that will alter the automotive landscape.

Over the 150 years since motorised vehicles first arrived, we have seen successive 'revolutions' occur – for example, when steam power gave way to the internal combustion engine and with the introduction of paved highways – and it's often thought that such revolutions take decades to be fully implemented.

But sometimes, the revolution occurs so quickly, it seems as if everything has changed almost overnight.

The transitions from fossil-fuel-powered vehicles to electric vehicles – and then from human-driven vehicles to self-driving forms of transport – are likely to be rapid.

National and local governments in both the developed and the developing world have already decided to act to radically change the future of automotive transport and, in doing so, to transform the urban landscape.

In 2017, the British government announced that the sale of all diesel and petrol cars and vans will be banned from 2040.



And the UK city of Oxford has announced that it is set to be the first British city to ban all petrol and diesel cars and vans – from a handful of central streets by 2020, extending to the entire urban centre by 2030.

France has announced similar intentions and Paris will ban all non-electric cars by 2030, and is now in the habit of announcing car-free days on which drivers have to stay out of its historic heart.

But, it was Hamburg in Germany which acted first. From May 2018, all older diesel-powered vehicles have been banned from the two main road arteries that serve the city.

The complete list of nations and cities with plans to ban fossil fuel vehicles is constantly growing. In the developed world, the death of the internal combustion engine is imminent.

The Trends Shaping The Future Of Mobility

There are four major trends at work which are driving governments to intervene now to abruptly change the future of motoring and road transport and, in turn, the future of cities.

The first of these trends is rapidly-increasing urban air pollution. The air quality in most major cities of the world is currently at unacceptable, dangerous and often illegal levels. Outdoor air pollution has risen by 8 per cent in the last five years and now causes more than 3.3 million deaths a year. Millions more people are hospitalised with respiratory conditions and other diseases caused by pollution.

In many nations, poor air quality has contributed to more deaths than passive smoking, road casualties and drug misuse combined. More than 80 per cent of those who live in world cities with more than 100,000 citizens are exposed to air quality levels that exceed World Health Organization (WHO) limits. In the UK alone, 44 cities have air pollution which far exceeds the safe level recommended by the WHO.

The choked traffic and murderous pollution in developing mega-cities such as São Paulo, Cairo, Delhi, Beijing or Mumbai are themselves problems which will accelerate the switch, first to cleaner electric cars and then to self-driving vehicles which become part of a managed traffic flow.

In Mexico City, for example, the average commuter spends 220 hours per year in traffic jams, with appalling consequences for human health and economic efficiency.

The principal cause of air pollution found in most cities is fossil-fuel emissions from vehicles. Some city authorities are already offering financial incentives (e.g. free parking, zero congestion charge, free electric recharging) to those drivers who use low emissions vehicles. These metropolitan inducements are in addition to government incentives to buy electric vehicles which are now on offer in dozens of countries including China, most of Europe and many states in the USA and in Canada.

For both city and national governments, there are major economic reasons to incentivise the driving public to switch to low-emission forms of transport in cities. Public health is first, and the potential savings to health service budgets will be a major motivator. In improving public health and saving healthcare costs, reducing the number of pollutant-emitting vehicles is 'low-hanging fruit' – easy to do and with a big pay-off. The savings made in public health costs will go some way to offset the fall in fossil fuel taxes that are levied by many governments in developed nations.

In the UK alone, 44 cities have air pollution which far exceeds the safe level recommended by the WHO

The second big trend that will bring about this dramatic change in urban transportation is climate change



By 2030 or thereabouts, we can expect to see the use of fossil fuel vehicles regarded as the social equivalent of cigarette smoking – air pollution will have become the 'new tobacco'. A decade later, there won't be any fossil-fuel vehicles in cities.

The second big trend that will bring about this dramatic change in urban transportation is climate change. The most recent report from the United Nations' Scientific Panel on Climate Change warns that global warming is in danger of running out of control and that there is a strong risk of climate crisis as early as 2040.

Despite President Trump's threat to withdraw the USA from the Paris Climate Accord, almost all responsible world leaders remain signed up to take positive action to reduce greenhouse gas emissions. And one of the major causes of greenhouse gas emissions are vehicles that run on fossil fuels.

When the pressing issue of climate change is taken with the urgent need to reduce air pollution, I think it almost certain that today's incentives offered to drivers to use low emissions forms of transport will increase rapidly and will then be accompanied by the application of penalties on those who persist in using fossil fuels. The most obvious of these will be increasing taxes on petrol and diesel supplies, but governments may also impose direct taxes on the purchase of polluting vehicles and increase annual road licence fees. There are also likely to be government 'scrappage schemes' which will pay vehicle owners to get fossil-fuel vehicles off the roads. But to make sure the clean air targets are met, many governments have simply decided that by 2040 at the latest, the sale of fossil-fuel-powered vehicles will become illegal.

By 2030, I think it likely that the percentage of 'legacy vehicles' (old vehicles still running on fossil fuels) in use will be much smaller and will be mainly limited to rural areas in which there is a poor electric charging infrastructure. By 2040, vehicles powered by fossil fuels will be museum pieces with only a few vintage and classic vehicles being owned by enthusiastic collectors. Drivers who would still like to drive at high speeds and in cars that are not under the management of traffic control will, of course, be free to do so at specialist driving tracks.

The third trend that is converging to make this radical vision of a new urban landscape a reality, is the rapid improvements being made in vehicle battery technology.

Until very recently, it has been 'range anxiety' that has stopped drivers from buying, leasing or hiring electric vehicles. Just a few years ago, the most efficient electric cars on the market could only offer a range of 150 – 200 kilometres (90 – 120 miles) without needing to 'rest' for lengthy recharging, and this meant that such vehicles weren't suitable for anything but inner-city use.

A lack of recharging infrastructure exacerbated the problem. Of course, fossil-fuel/electric hybrids eliminated the range concern, but they didn't eliminate emissions. These hybrids, too, will have mostly disappeared by 2040.

But today's best all-electric cars and vans are offering 300-500-kilometre ranges (185 – 310 miles) from a single charge and are also capable of rapid re-charging (although, in reality, most vehicles are used for journeys of less than 100 kilometres and are mostly kept in a permanent state of semi-full charge).

Heavy goods vehicles are also becoming available with better than 805 kilometres (500 mile) range options and by 2030, it is almost certain that electric trucks, vans and family cars will offer ranges of more than 1,000 kilometres (620 miles) with rapid recharging. And by then, vehicle batteries are likely to become capable of being charged and discharged many thousands of times without degradation.



Yet another major trend that will propel electric cars into automotive dominance is the rapidly-falling cost of renewable energy generation. It goes without saying that charging electric cars with electricity generated from fossil fuels is self-defeating. This does not help to reduce global warming.

But the falling cost of renewable power generation has been dramatic. Over the last eight years, the price of solar voltaic panels which capture sunlight and convert it into electricity has fallen by 86 per cent and the cost of energy from wind turbines had dropped by 23 per cent. This is a dramatic reduction and it makes renewable energy directly competitive with even the cheapest and dirtiest fossil fuel – coal. And from 2020 onwards, the cost of energy generated from renewable sources will be consistently lower than that which comes from fossil fuels.

This trend in the reduction of the cost in generating power from solar and wind sources is likely to continue (although perhaps at not the same rate) and by 2030, it is forecast that renewable power will be providing more than 60 per cent of Europe's energy needs.

Globally, by mid-century, renewable sources are likely to be producing more than 50 per cent of the power we consume (even though our overall power consumption is likely to increase by 30 per cent in the next 20 years).

Another important factor that will drive the deployment of renewable power is the improvement in battery storage technology. Just as batteries for vehicle propulsion are improving in efficiency while dropping in cost, so large storage batteries that can store grid power generated from renewable sources are also becoming practical for the first time.



This smooths out the 'intermittent' supply problems for renewable energy generation when the wind does not blow, or the sun does not shine.

Today, however, the percentage of electricity generated from renewable sources is only around 8.5 per cent worldwide. But even if the majority of the power for today's electric vehicles is generated by power stations burning fossil fuels, the reduction in street-level air pollution in cities when electric vehicles replace fossil-fuel vehicles becomes a dramatic and immediate win. Because most power stations are situated away from urban areas, the harmful gases and particulates emitted as power is generated do not contribute directly to air pollution when measured at the level of city streets.



Self-Driving Vehicles and Smart Roads

Self-driving cars have been imagined and talked about for almost a century. But such speculation remained imaginary. Then, in 1957 Daimler produced an advertisement suggesting that the self-driving future was almost at hand.

And the 1960s and 1970s films starring an anthropomorphic, self-driving VW Beetle called 'Herbie' made the concept familiar to all Western Baby Boomers. Later, the 1980s U.S. TV series 'Knight Rider' made a more serious stab at guessing what autonomous cars might be like.

But industry didn't get serious about making autonomous vehicles until the first few years of the 21st Century – and then it was the software industry, not the automotive sector, which led the development. In 2004, the US Defense agency DARPA, launched a Grand Challenge.

This offered a prize of \$1 million to the team that could build a driverless car able to travel 150 miles (241km) without a human on-board and without remote control. The prize was won in 2005. That was the start of the race to develop driverless cars that could eventually take to public roads.

When Google's first self-driving cars ventured onto public roads back in 2009 (very much under human supervision), it was imagined that as soon as the technology had developed sufficiently, such vehicles would be allowed out unsupervised to navigate through other traffic driven by humans, just as if there was a robot driver with human-level consciousness at the wheel. We now know this is not going to happen in most parts of the world.

Fully-autonomous vehicles can't be allowed out onto roads on their own as they cannot anticipate the many unexpected things the human drivers around them are likely to do.

And they cannot interpret road rules and conditions when the signs are missing (e.g. when traffic lights are broken, in snow storms, or after an accident). Humans can interpret the unknown and act accordingly, but such intuitive understanding by machine intelligence is still many decades away.

In order to ensure that today's unsupervised driverless cars would remain safe on existing public highways, they would have to be programmed to proceed at very slow speeds and with the sort of caution that a new student driver would exhibit. Such vehicles would cause chaos on today's public roads because of the delays and frustrations they would cause for human drivers.

The answer is to see driverless cars not as stand-alone pieces of technology, but to see each one of them as a single node within a co-operative, self-learning transport network; an ecosystem of smart vehicles and smart roads that will work together as if it were one.

In the meantime – 'driver-assist' technology – e.g. automatic braking, pedestrian sensing, forward collision warning, lane departure warnings, blind spot detection and driver alertness monitoring – will be of great help in keeping human drivers safer and reducing accident and injury. These assistance technologies will be the way in which the general public starts to learn about the developing phases of self-driving automation.

Over the coming decades, humans who today are distrustful of the idea of a car that can drive itself will learn to accept the idea that autonomous vehicles will actually be far safer than cars driven by humans. But such driver-assist technologies are just stepping stones towards smart roads and vehicles that can safely drive themselves.

In the next ten years or so, roads themselves will start to become smart as it is better understood that for really safe and reliable operation, driverless cars will not be stand-alone independent vehicles. The future road network will be a single self-learning 'transport system' in which one vehicle's discovery of an icy patch on a road means that all other vehicles and the road system itself also knows instantly about the location, the slipperiness level and extent of the ice patch (as well as knowing and updating the weather forecast).

Driverless cars will not be standalone pieces of technology, but part of an ecosystem of smart vehicles and smart roads that will work together as if it were one

Initially, road furniture and signage will be made smart. This is already happening in experimental urban communities and such signs and fittings (e.g. traffic lights, speed limit signs, lamp posts and pedestrian crossings) will communicate their existence and condition to road vehicles wirelessly using the ultra-fast, high-bandwidth wireless networks (at least 7G by 2040) with local communications redundancy built-in just in case of network failure.

Smart streets and highways will become the first major implementation of the much touted 'Internet of Things' (IoT). Because electrical power is an integral part of city and suburban streets and highway design, power will be available to supply the many sensors that will create the smart road network of 2040.

These traffic signs and sensors will include cameras, radar, lidar, speed sensors, weather sensors, visibility sensors, number plate recognition systems, emergency warning sensors and many other sensors yet to be imagined. Much of the information being transmitted by road signs and street furniture will be real-time 'map updates' and location-checking, all of which are vital for the safe operation of driverless vehicles. These systems will need to work reliably in poor weather conditions, when wireless connectivity is intermittent and across a range of dynamic driving conditions.

That means signs, markings and lines will themselves need to provide self-powered digital information as guaranteed back-up systems. Smart signs and pavement markings coated in 'digital paint' will need to communicate directly with cars equipped to recognise these new intelligent transport materials, improving roadway safety.

One huge payoff for society will be the savings in hospital admissions and the cost of follow-up care for those millions who would previously have been injured in motor accidents. Today, 20 per cent of trauma admissions in UK hospitals are as a result of road traffic accidents, and the percentage is much higher in developing countries. Reducing or eliminating this cause of accidents will provide a major incentive for governments to provide the money needed to build a smart road network for self-driving vehicles.



The Need For Security

Of course, it will be vital that strong cyber security systems must be built into the road traffic networks of 2040 to prevent vehicles and roads being hijacked or disrupted.

It's likely that in 2040, today's traffic police forces will largely have been replaced by traffic cyber security forces intent on keeping our roads and all forms of automotive transport safe from malicious or criminal interference. We can only hope that the quantum encryption of 2040 proves as hacker-proof as is currently being claimed.

The cyber-criminal poses even larger threats to society as a whole. A successful cyber-attack aimed at the smart road networks could potentially bring millions of vehicles to a sudden standstill. It could cripple a city and, perhaps, a nation.

Charging Ahead

Governments are now rolling out networks of electric vehicle charging points, and this programme will accelerate over the next decade. By 2040, it is likely that charging points will be ubiquitous in all but remote areas.

Also likely by 2040 will be under-road ambient charging systems on highways that enable users of electric vehicles to top up their batteries as they travel. Road users are likely to pay both for consuming this power, and for using the highways themselves – a road charge – which will help governments to replace tax revenue lost as the sale of fossil fuels for road propulsion falls to zero.

The self-driving fleet of vehicles that will be providing transport in city centres in 2040 will, of course, be integrated with other forms of transport.



I foresee that train companies will provide their own fleets of self-driving taxis to take passengers 'the last mile' and to provide passenger pick-up services. Train companies will become 'mobility companies' providing door-to-door transport. Airlines will also provide similar door-to-door services for premium class passengers

I also think there will be a wide range of alternative options in the self-driving taxi fleet; there will be VIP limo-style vehicles complete with beverages, snacks and entertainment systems which will cost rather more than the equivalent of a bus fare to hire. There will be low-cost, shared-ride vehicles which several passengers will use together, there will be larger self-driving buses and there will also be 'exclusively-owned' self-driving vehicles for those who can provide private off-street parking. And robot cars will provide mobility to those currently denied it: the young, elderly and disabled. This may turn out to be a major blessing of the autonomous vehicle age.

Love To Drive?

Of course, I am aware that a large section of today's public likes the idea of owning a car. It provides a status symbol as well as independent mobility. For many, it is something to aspire to.

And, in some areas of the world, millions of people are still saving to buy their very first car. The desire for car ownership is not going to disappear because cars become electric and then self-driving. But these desires will become modified as urban transport options improve – first, by ride-sharing and cab-hailing (Didi, Uber, etc.) and then, by the arrival of the autonomous taxi fleets.

And some humans simply love to drive cars for the pleasure of controlling a vehicle – especially fast vehicles on demanding roads. This form of sports driving will become a leisure pursuit limited to remote rural areas and to dedicated tracks. It will have no place on the public roads or highways of 2040.

Even today, drivers in developed nations know that their opportunities to exceed the speed limit, to drive dangerously or to park illegally are becoming fewer by the day. Traffic management systems such as speed cameras, average speed measuring systems, number plate identification systems and CCTV systems have already removed most of our motoring 'freedoms'.

By 2040, our public roads will finally be safe and free-style manual driving will have become an extreme sport pursued far away from the general public.

Changing Patterns Of Car Ownership – A 'Perfect Storm' For The Automotive Industry

One of the defining features of the 21st Century so far has been successive waves of technological disruption. Industry after industry has been upended as new technologies provide new ways to solve problems and deliver goods and services in more efficient and more cost-effective ways. Technological disruption is sweeping through all industries and is a global phenomenon.

Business sectors feeling waves of massive disruption caused by digital technology include retailing, manufacturing, logistics, travel, legal services, banking and financial services. Other sectors feeling the effects include healthcare, higher education, aviation, entertainment, car manufacturing, travel and hospitality, and energy and energy distribution.

The vehicle manufacturing industry now faces challenges on several fronts: the first is the shift from fossil-fuel powertrains to electric propulsion; the second is the development of autonomous vehicles and smart roads; and the third area of disruption is the changing patterns of car ownership.

Every vehicle manufacturer, from Ford to Ferrari, is now producing a limited number of electric vehicles in the hope of being able to navigate through the turbulence that will be encountered as the internal combustion engine enters its death throes.

By 2040, our public roads will finally be safe and free-style manual driving will have become an extreme sport

And most major vehicle manufacturers have at least one experimental self-driving vehicle programme hoping to be ready for the time when drivers start to become passengers. Ford, GM, Toyota, Fiat, Mercedes-Benz, BMW, Volkswagen and many other major automotive manufacturers are all showing concept self-driving vehicles and are entering into development partnerships with each other, with universities, with AI developers and small, specialist start-ups.

But it is outsiders who are showing the way. Companies such as Waymo, Apple and Uber seem to be much further ahead in the development of autonomous vehicles than traditional auto manufacturers.

This disruption in mobility also points to a wider change occurring in the pattern of car ownership and operation. With increased online communication and with ride-hailing and ride-sharing apps in widespread use in many cities, car ownership is falling amongst the millennial generation (those aged 18 – 35). Between 2010 and 2014, only 37 per cent of 17 to 29-year-olds reported driving a car in a typical week whilst the figure was 46 per cent between 1995 and 1999.

But it isn't just the percentage of young people driving cars that is changing – there are changing patterns of ownership and usage for all car drivers. Until the beginning of this century, most car drivers bought their vehicles, new or second-hand, either with cash or with finance (hire-purchase). These expensive purchases then sat idle and unused for 95 per cent of their life.

But in recent years, car makers haven't been trying to sell their cars to drivers, they have wanted drivers to 'subscribe' to the experience of driving a Mercedes, Ford or Volvo. In an era of ultra-low interest rates, finance has been pouring into car-leasing deals which allow drivers to lease new cars for three or four years and then hand them back before taking out a new lease. In the USA, 25 per cent of new cars are now leased rather than purchased, and this is a trend that is continuing to grow. Drivers are becoming subscribers to mobility rather than owners of cars.

But even the lease model of car finance still sees these expensive assets very under-used. This gross wastage lies behind the growth of Uber and other taxi and ride-sharing schemes.



If you live in a city and do not make frequent long journeys out of town, it now makes little sense to own or lease a car that sits idle for most of the time. Tapping your smartphone will bring a ride to your door in a few minutes.

On top of the initial cost, car ownership comes with added headaches. The vehicle must be maintained even while depreciating in value. Then, depending on where you live, there are added extras such as parking permit charges, plus charges for driving in certain inner-city zones. Why own a car – whatever the deal – when it is so much easier to use an app to hail a vehicle?

This classic ‘win-win’ solution to personal mobility for city dwellers marks the beginning of the end of traditional car ownership. For too long, private cars have been a commodity which is wasted as frequently and as extravagantly as mustard (only cars are so much more expensive than table condiments). It now seems inevitable that the future pattern of car usage will involve a major shift as spending moves away from the big hunks of steel that, for nearly all of the time, just sit on a street or in a driveway.

But there is both good news and bad news for vehicle manufacturers: the good news is that the world’s entire vehicle fleet has to be replaced over the next few decades (today, 499 out of every 500 cars on the road is powered by fossil fuels). The bad news is that it is not at all clear whether today’s main vehicle manufacturers will still be the big names in the automotive industry of 2040. The death of the internal combustion engine will bring huge disruption to vehicle manufacturers.



As a battery engineer in the automotive trade told the [Financial Times](#) recently: “For the European auto companies to change over to electric vehicles is like turning a battleship. And it’s a battleship with a mutinous crew.”

However, some car makers are already starting to adapt. General Motors is planning to roll out a robo-taxi service that will let urbanites hail a driverless Chevrolet Bolt.

Ford is currently overhauling a dilapidated Detroit train station to become a tech hub aimed at attracting software superstars. Daimler wants to merge one of its divisions with arch-rival [BMW](#) to create a juggernaut for services like ride hailing and car sharing, and Volkswagen has announced a [\\$34 billion](#) investment in creating a new ‘platform’ (chassis) for a range of electric vehicles.

And Toyota says it's evolving into an entirely different company, one that focuses more on services that move people around. "It's a matter of surviving or dying," Toyota's chief executive said recently.

Toyota's \$650 investment into self-driving cars for Uber's taxi network is one early example of the company's changing strategy. This agreement will see the initial development of a so-called Autono-MaaS (autonomous-mobility as a service) fleet based on the Toyota Sienna minivan, where Uber's Autonomous Driving System and the Toyota Guardian automated safety support system will both be integrated into the Autono-MaaS vehicles.

Taken with the switch from fossil-fuel propulsion, the imminent arrival of autonomous vehicles and the changing patterns in car ownership and usage this suggests that a 'perfect storm' of disruption and change lies ahead for the entire automotive industry.

Some industry analysts have suggested that the future of personal mobility may not lie with the incumbent car makers, but with completely new entrants. As the car becomes more of a software platform and network node – rather than a stand-alone vehicle – newcomers such as Apple, Google and Uber may drive the future of transport. In essence, information technology will no longer be added to cars as they are constructed; cars will be built around information technology.

Data collection and analysis will become a vital economic factor for tomorrow's makers and operators of autonomous vehicles.

Analysing where passengers want to go – and when – will provide valuable insights into individual and social behaviour. Understanding how passengers want to spend their time in driverless vehicles – working, playing games, shopping, etc. – will also prove very valuable. Mobility data will probably be the most valuable commodity in the automotive industry of the future.

But car making is a capital-intensive, complex and, compared to software, low-margin business and I think

it is most likely that today's big-name auto manufacturers will partner with digital companies to create the new types of vehicle which will be providing personal mobility in 2040. Many such fledgling partnerships have already been established.

What car makers already know is that the vehicle of the future is electric and self-driving, and the industry has now realised

that the huge power of the rapidly-growing Chinese market will also have a major influence upon vehicle design and development.

It also needs to be pointed out that the rapid introduction of network-controlled, self-driving vehicles will bring destructive disruption to the many service industries that serve today's mobility market. Tow trucks, body shop repair services, driving schools, taxi drivers, truck drivers, emergency services (for traffic accidents), meter maids (parking wardens) and parking lot attendants will all be on their way towards becoming redundant.

Some industry analysts have suggested that the future of personal mobility may not lie with the incumbent car makers, but with completely new entrants

The Road To 2040

As successive waves of new technology have washed over society in recent decades, we have learned that the “the future is already here — it’s just not very evenly distributed”. By 2040, some cities in China, Arizona, Canada, Australia and elsewhere may indeed resemble the utopian models of clean-air urban planning I describe in the opening paragraphs of this section.

But I am aware that many other cities will only partly resemble the transport paradise I envision. Some governments and city authorities will embrace the move to self-driving, clean forms of transport and will powerfully incentivise populations to make the necessary adjustments. Other governments and authorities will be slower to do so and there may even be some cities that will still not have rejected the internal combustion engine by 2040.

But the speed at which towns, cities and nations adopt clean, self-driving forms of road transport will depend more on political will and cultural considerations than on economic constraints or technological problems.

It is already becoming clear that the savings to be made by reducing pollution and eliminating damage, death and injuries suffered in road traffic accidents will partly offset the cost of building smart road infrastructure and incentivising the travelling population to switch to cleaner forms of road transport. It is also clear that the introduction of electric self-driving vehicles in major cities will improve a nation’s prosperity and international competitiveness (not least because there will be no time lost in traffic jams and because some of the time people spend in autonomous vehicles will be used for work).



Once these gains are fully realised, it is likely that almost every nation will rush to join the revolution.

But this only works when governments and authorities think holistically and do joined-up thinking. All too often, different departments – e.g. the environment agency and the health authority – operate entirely independently and do not recognise that costs to one department may be creating greater savings in another. Such management failings are all too common in democratic societies.

But it is clear that we are heading into an automotive future that will be cleaner, safer and more efficient. Personal mobility will continue to grow rapidly as the world develops, but this growth will no longer be at the cost of lost human lives, disease-causing pollution and the health of the planet.

