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Preparing For a Driverless Future

Business, Socio-Economic and Legal Perspectives

June 2016

The Automotive Practice Group at Nishith Desai Associates is pleased to present this paper. Hope you enjoy the read and find it useful in shaping the regulatory framework for autonomous vehicles in the world and in India in particular.

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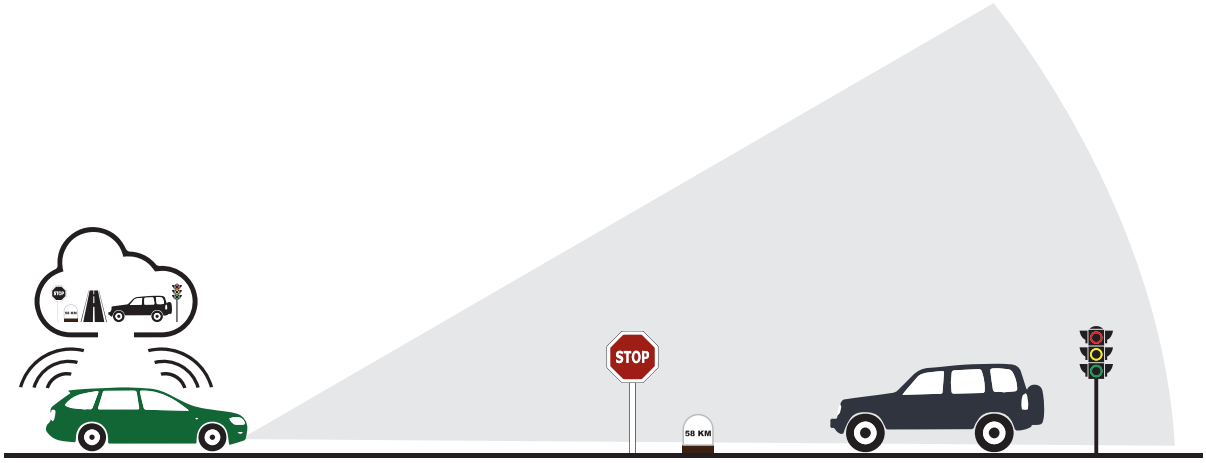
1. Introduction

The automotive industry is on the brink of a technological revolution and has come a long way since Henry Ford debuted his assembly line. Given the rapid pace of technological advancement, what the future has in store for us is limited only by our imagination. One such innovation is that of the fully autonomous vehicle, or, in other words, driverless cars. Such technological innovation promises to be both disruptive and revolutionary in terms of its impact on human autonomy and shaping the societies of tomorrow. The driverless car will most likely join unmanned drones and digital surveillance as one of the advances and controversies that will impact our times.

While some governments have already begun taking necessary policy initiatives in anticipation of the autonomous vehicle as a common mode of transport, only time will tell how others are able to prepare themselves in tackling issues relating to insurance, liability, cyber security, safety and performance standards in a manner that they may not have been able to envisage so far. This paper shall provide some insights into the future with regards to the fully autonomous vehicle and what it has in store for policy makers and society at large.

This paper shall comprehensively analyze the effects of the eventual and undisputed reign of the fully autonomous vehicle and the economic, social, environmental and legal ramifications arising thereof. A detailed analysis of publicly available reports, research studies, and media articles as well as opinions of government organizations and industry leaders, on recent developments in this arena have been taken into account in the writing of this paper.



2. Embracing the Idea

The idea of the autonomous vehicle first gained widespread public exposure at GM's '*Futurama*'[1] exhibit at the 1939 World's fair which envisioned *"abundant sunshine, fresh air [and] fine green parkways upon which cars would drive themselves."*[2] Since then, autonomous vehicular technology has gone through a multitude of innovations and tests. Visionaries have toyed and experimented with this idea for decades. The "DARPA Grand Challenge" organized by The Defense Advanced Research Projects Agency [3] was the first major long distance competition for autonomous vehicles in 2004.[4] In 2009-10, Google introduced its driverless cars under the leadership of Sebastian Thrum, an alumnus of the Grand Challenge.

After having driven around 1.3 million miles since it was first introduced, in February 2016, Google's self-driving car caused its first crash in Mountain View, California when it changed lanes and put itself in the path of an on-coming bus.[5] In March 2016, Daimler obtained special permission from the state of Baden-Württemberg, Germany for a live test of three of its self-driving Mercedes-Benz trucks that were wirelessly connected to each other.[6] The reality of the driverless future, and the issues that it is bound to raise, are closer to us now than ever before. Time Magazine in its March 2016 issue featured the driverless car as its cover story titled "*No traffic. No accidents. No deaths. All you have to do is give up your right to drive.*"

1. Futurama was an exhibit/ride at the 1939 New York World's Fair designed by Norman Bel Geddes that presented a possible model of the world 20 years into the future (1959–60). Sponsored by the General Motors Corporation, the installation was characterized by its automated highways and vast suburbs.
2. "Autonomous Cars through the Ages." Wired.com. Conde Nast Digital. Web. 12 Feb. 2016.
3. DARPA is an agency of the U.S. Department of Defense and is known as a laboratory and an incubator of innovation and provides infrastructural support elements to the transformative ideas that would be potential new realities.
4. In the Grand Challenge, fifteen teams competed but none came close to completing the 150 mile course. Two more Challenges were also organised in 2005 and 2007 respectively, where a great progress was displayed.
5. Dave Lee, Google self-driving car hits a bus, 29 February 2016, available at http://www.bbc.com/news/technology-35692845
6. Daimler's self-driving trucks to hit German roads, 21.08.2015, available at http://www.dw.com/en/daimlers-self-driving-trucks-to-hit-german-roads/a-18665100

3. Industry Leaders

Companies such as Tesla Motors, Google, Apple, TomTom, Baidu, Faraday Future, BMW and Jaguar Land Rover are already looking to become key players in the driverless space. Amongst the automobile companies, Toyota is leading the race with around 1400 patents to its name, followed by Bosch, Denso, Hyundai, and General Motors. Soon enough, there will be no way of distinguishing technology and software companies from automobile companies, as collaborations between the two will blur all boundaries between them. Intellectual property and science analysts at Thomson Reuters, after conducting a thorough analysis of the patent portfolios of Apple and Tesla have predicted that these two could potentially become very effective partners in shaping the driverless future. [7]

Amongst other industry leaders, Tesla's founder, Elon Musk, estimates that true autonomous driving will be achieved in the next 5 to 6 years, by which time one would be able to get into their car, go to sleep and wake up at their respective destinations.[8] In fact, Tesla Motors recently pushed a software update to its vehicles around the world enabling them to coordinate sensors, cameras, GPS and controls already onboard the cars to allow for autonomous driving, albeit requiring humans to be on the driver's seat ready to take over if required. Sergey Brin of Google has made it clear that he intends to have his driverless cars on the road no later than 2018. Uber CEO, Travis Kalanick expects the entire Uber fleet to be driverless by 2030. In fact, Stefan Moser who heads Product and Technology Communications at Audi has announced that the next generation of their A8 limousines will be able to drive itself with full autonomy as early as 2017.[9] It is clear from these estimations that a driverless future is imminent.

7. IP and Science business of Thomson Reuters, The State of Self-Driving Automotive Innovation. 2016. Web. 17 Feb. 2016.

8. Kaufman, Alexander C. "Elon Musk: We'll Have Driverless Cars By 2023." The Huffington Post. TheHuffingtonPost.com. Web. 14 Feb. 2016.

9. "Next-gen Audi A8 Drives Better than You." Motoring.com.au. 2014. Web. 14 Feb. 2016.

4. The Functioning of Autonomous Vehicles

A vehicle that travels from point A to point B without any human input for a particular duration of time is classified as an autonomous vehicle. Such vehicles employ sensory, control and navigation technologies that respond to the environment accordingly, thereby eliminating the need for human interference.[10] A host of sophisticated, high-end technology provides the autonomous vehicle with an elaborate level of connectivity. The U.S. Department of Transportation's National Highway Traffic Safety Administration ("**NHTSA**") has classified autonomous vehicles as belonging to one of five levels: The Society for Automotive Engineers, India (**"SAE"**)[11] also has similar classifications for automated vehicles.[12] These are as follows;

i. Level 0 (No Automation): The human driver is in constant and complete control of the car.

ii. Level 1 (Assisted Automation): Only one function can be automated at a time such as either electronic stability control or pre-charged brakes, where the vehicle automatically assists with braking, enabling the driver to regain control of the vehicle or stop faster than would be possible if the driver had acted of his own volition. Cruise control, lane keeping and parking assist are other such commonplace features found in autonomous cars of this level.

iii. Level 2 (Partial Automation): More than one function is automated at the same time such as a combination of adaptive cruise control and lane centering. However, the driver must still remain constantly attentive.

iv. Level 3 (High Automation): The functions are sufficiently automated, enabling the driver to safely engage in other work or activities. The driver is expected to be available for occasional control, but will have comfortable transition time. The Google car is an example.

v. Level 4 (Full Automation): The car can completely drive itself without a human operator. The vehicle is designed to perform all driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will only have to provide the destination or navigation input, but is not required to be available for control at any time during the trip.[13]

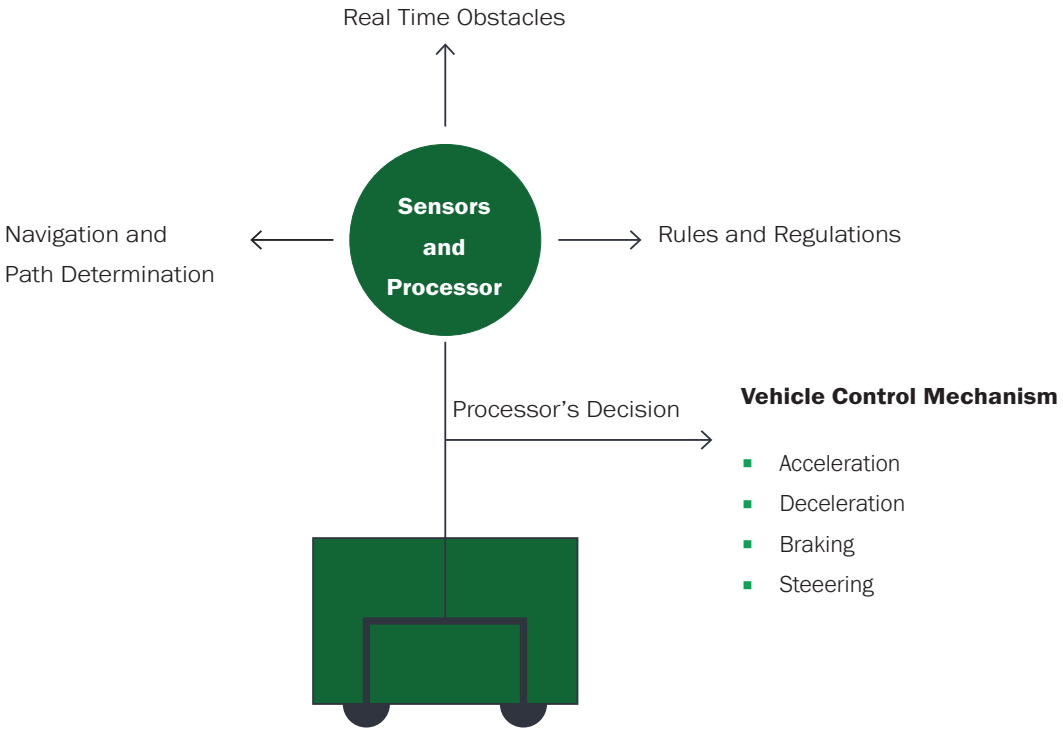
The basic essential features of an autonomous vehicle are as follows:

10. IP and Science business of Thomson Reuters, The State of Self-Driving Automotive Innovation. 2016. Web. 17 Feb. 2016.

11. SAE International, initially established as the Society ofAutomotive Engineers, is a U.S.-based, globally active professional association and standards organization for engineering professionals in various industries ; SAEINDIA is an affiliate society of SAE International registered in India as an Indian nonprofit engineering and scientific society dedicated to the advancement of mobility industry in India.

12. Mobility Engineering: Automotive, aerospace, off-highway, SAE India, Quarterly publication, Volume 3 Issue 1, March 2016 (Available - http://saeindia.org/uploads/10.MARCH%202016.pdf).

13. "U.S. Department of Transportation Releases Policy on Automated Vehicle Development." U.S. Department of Transportation Releases Policy on Automated Vehicle Development. Web. 21 Feb. 2016.



Autonomous Vehicle

GPS (Global Positioning System) works alongside on-board cameras and advanced mapping systems wherein each map is highly detailed, down to identifying the height of the curbs and the dimensions of the lane. **Light Detecting and Ranging (LIDAR) sensors** bounce pulses of light off the surroundings, creating a picture of potential hazards and accurately determining the profile and distance of the surrounding objects. **Four radar sensors**, mounted on the front and the back of the vehicle, monitor the speed of the objects around and help avoid collisions by sending signals to apply brakes or move out of the way, as and when applicable

Cameras provide overlapping images of the surroundings which help detect traffic lights, road signs, track other vehicles, cyclists, pedestrians and other objects on the road and **central computers** which then build a real-time image of the world, thereby manipulating and influencing the functions of the car accordingly. Learning algorithms fed into the central computer enable it to learn from past experiences and act accordingly in future.[14]

It was in the 1970s that automakers initially started turning to electronics for better engine control. To that was added other computerized features such as anti-lock functions, brakes and power steering. Cars these days are already equipped with sensors and cameras aiding drivers in their decision making while their insides are loaded with data-spewing operating systems. Currently, such automated functions are controlled by a central unit called the ECU (engine control unit). The functioning of the fully autonomous vehicle, promises to elevate existing technology to much advanced levels.

14. "How Self-Driving Cars Work: The Nuts and Bolts behind Google's Autonomous Car Program." MakeUseOf. Web. 13 Feb. 2016.

5. Triple Bottom Line

Autonomous vehicular technology aims to bring about a paradigm shift in transportation. It will reduce the number of accidents, increase mobility and safety, create a healthier environment, reduce congestion, and dramatically improve productivity. This section will evaluate autonomous vehicles' potential against the triple bottom line framework, an accounting framework that incorporates three dimensions of performance: social, environmental and economic. This differs from traditional reporting frameworks as it includes environmental and social measures that can be difficult to assign appropriate means of measurement.[15]

I. Economic

Insurance companies have provided cover to drivers in respect of road accidents that are caused due to human error. The same principle may be applied to driverless cars. Manufacturers and infrastructure providers will now become the subject of liability, rather than the direct consumers (drivers). According to a report by KPMG,[16] it would lead to a fall in premiums, change underwriting models which earlier depended on driver behavior, and might even eliminate the need for car insurance for the drivers. The insurance sector will have to adapt their business models accordingly.

Automakers will also have to adopt new business models of car sharing, rental, or taxi services rather than car ownership or retail. If cars can be summoned for, whenever required, ownership of cars may become an idea that is obsolete. This would also lead to an equal opportunity to all for use and people will not have to be dependent on drivers anymore for their commute. Even the handicapped and the elderly would have equal access and the ability to get from place to place, making them self-reliant.

Another industry to be impacted by autonomous vehicular technology would be the telecommunications sector. There is bound to be considerable growth in data consumption as autonomous vehicles will communicate over mobile networks. The Society for Automotive Engineering has brought up important issues of access to telecommunication networks for the functioning of these cars – an electrical grid blackout, or a weather disruption at a busy intersection might have fatal consequences for autonomous cars.[17] This would require the industry to build higher quality capacity products and services in order to cash in on the increase in data traffic.[18] Park Associates, an internationally recognized market research and consulting company specializing in emerging consumer technology products, has, through research, estimated that mobile networks such as AT&T and Verizon will be making nearly $ 1 billion each year in connected-car revenue by 2018.

As mentioned earlier, Uber expects to replace its fleet with self-driving cars, thus making their services more economical as one would be paying only for the vehicle and not the driver anymore.[19] Uber and other taxi-hailing apps have led to an explosion of business creation and job opportunities where currently, the number of people opting to become drivers is increasing by the day. If, by 2030, transportation service providers become driverless, a massive rise in the unemployment numbers of persons currently working as drivers will result. Also, services like Pay and Park would lose their parking revenues as proximate parking will no longer be necessary in case of autonomous vehicles.

While on the one hand, a lot of jobs and businesses are bound to be rendered obsolete, the loss of business in some sectors will be counteracted by a host of other employment and business opportunities in related sectors. According to a survey by the Open Roboethics Initiative (**"ORI"**) [20], there will be increasing employ-

15. "The Triple Bottom Line: What Is It and How Does It Work?" Timothy F. Slaper, Ph.D. http://www.ibrc.indiana.edu/ibr/2011/spring/article2.html
16. KPMG LLP, Self-Driving Cars: The Next Revolution. 2012. Web. 15 Feb. 2016
17. *Id.*
18. KPMG LLP, Connected and Autonomous Vehicles – The UK Opportunity. 2015. Web. 18 Feb. 2016.
19. "Uber Will Eventually Replace All Its Drivers with Self-driving Cars." The Verge. 2014. Web. 21 Feb. 2016.
20. Open Roboethics initiative (ORi) is a roboethics think tank that

ment opportunities, mainly in automobile and technology industries. The ORI is of the opinion that the anticipated benefits of the technology may just be big enough to compensate for the negative impact that it may have on the job market. New kinds of jobs in insurance, services and other sectors will be available; a higher number of auto mechanics will be required; and as demand grows, more autonomous car developers will be required.[21] According to a study by KPMG, autonomous vehicles will create an additional three hundred thousand jobs in the UK by 2030. Industries like telecom, digital, and media will also offer additional jobs as the inter-connected and autonomous vehicles open up new markets.[22]

II. Social

The fundamental reason for the autonomous vehicle having the backing of all major industry players is that it holds the key to a better and cleaner transportation ecosystem and a better human experience. Autonomous vehicles aim to achieve reduction in road congestion, improvement in road design as more cars in seamless coordination with each other can be added onto the same amount of real estate on the road, safer transportation, and increased mobility.
It will also result in a hassle-free travel experience for cyclists and pedestrians as well as for the ones travelling in cars.[23] It promises to bring about a huge cultural change to the point that the idea of someone driving themselves would cease to be the norm.
It is also believed that autonomous vehicles shall greatly improve the safety of our roads. According to a report by McKinsey, self-driving cars will reduce road accidents by as much as 90%. Automation will make for safer driving, with savings of up to $190 billion a year, mostly from reduced health care costs.[24]

Human error has been one of the biggest contributing element to road accidents; drivers distracted by their phones, drinking and driving, lack of skill, and road rage to name a few prevalent accident- inducing errors. Driverless cars would eliminate the chance of human error while driving.

This futuristic technology can also improve human productivity by a great measure, as people will be able to utilize the time that is spent driving on other more productive activities. According to a McKinsey report, it is said that a driverless future will result in persons having an extra 50 minutes per day for work or relaxation, and would also provide for billions of extra square feet of parking space, partly because of the enhanced parking skills of the Autonomous Vehicles.[25]

III. Environmental

The introduction of autonomous vehicles and the consequent availability of a portfolio of transport options, rather than ownership, promises to enhance safety and convenience by finding the quickest routes, minimizing the extra time taken driving in search of parking, and discarding pointless acceleration and honking. By eliminating unnecessary driving, we can attain a greater degree of fuel efficiency of up to 50% and reduction in associated carbon emissions by more than 90%.[26] Due to a reduction in road congestion, additional roads needn't be constructed which would help maintain green spaces. The need for traffic lights and street lighting will also be eliminated. Presently, roadways and supporting infrastructure are made keeping in mind the human need for visual input to navigate safely.[27]

aims to foster active discussions of ethical, legal, and societal issues of robotics (roboethics). Headquartered in Vancouver, Canada, ORi is an interdisciplinary, international group of people passionate about roboethics in general.

21. "Results: Will Autonomous Cars Create More Jobs?" Open Roboethics Initiative. 2014. Web. 16 Feb. 2016.
22. KPMG LLP,. Connected and Autonomous Vehicles – The UK Opportunity. 2015. Web. 18 Feb. 2016.
23. Atkins Ltd., Connected and Autonomous Vehicles. 2016. Web. 19 Feb. 2016. Introducing the Future of Mobility
24. "Ten Ways Autonomous Driving Could Redefine the Automotive World." McKinsey & Company. Web. 17 Feb. 2016.
25. Matthew Claudel and Carlo Ratti, Full speed ahead: How the driverless car could transform cities, August 2015, available at http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/full-speed-ahead-how-the-driverless-car-could-transform-cities
26. "Are Self-driving Cars a Good Thing for the Environment?" GreenBiz. Web. 18 Feb. 2016.
27. KPMG LLP, Self-Driving Cars: The Next Revolution. 2012. Web. 15 Feb. 2016.

6. Status of Autonomous Vehicles around the Globe

Different countries are at different stages, both technologically as well as in the legal and regulatory context in coming to terms with the autonomous vehicle concept. There's still time for autonomous vehicles to be available on public roads in a full-fledged manner, while they are already very much a reality in controlled environments. [28]

Various countries around the world had adopted the Vienna Convention on Road Traffic 1968 (**"Convention"**)[29] which required a driver to be in control of his/her vehicle at all times. This prevented Governments from allowing test drives on autonomous vehicles or marketing them for public use.[30] In May 2014 however, an amendment was made to Article 8 [31] of the Convention[32], allowing the car to drive itself as long as the system *"can be overridden or switched off by the driver"*, albeit requiring a driver to be present.[33] As a result, various countries across the World have now begun taking measures to confront the inevitable reign of the autonomous vehicle, some of which are discussed below.

I. United Kingdom

Heathrow Airport has been using electric driverless pods since 2011 to shuttle passengers to and from the terminal to their cars in the parking lot. In the latter half of 2016, trials are to take place where driverless cars resembling the shuttles at Heathrow, will also be employed at Greenwich, Bristol, Coventry and Milton Keynes.[34] Jaguar Land Rover, as part of a UK Connected Intelligent Transport Environment (CITE) initiative is undertaking a project worth £5.5 million to create a highly advanced environment for testing connected and autonomous vehicles [35], and will soon also be testing autonomous vehicles on public roads across the UK.[36]

II. United States of America

In June 2011, Nevada became the first state in the world to allow autonomous vehicles on public roads.[37] Nevada law defines an autonomous vehicle as *"a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator."* The law also acknowledges that the operator will not need to pay attention while the car is operating itself.[38] California recently passed regulations allowing the routine use

28. "Driverless Vehicles - TechAlliance." TechAlliance. Web. 21 Feb. 2016.
29. Vienna Convention on Road Traffic, 1968 is an international treaty designed to facilitate international road traffic and to increase road safety by establishing standard traffic rules among the contracting parties. Amongst other aspects related to traffic and safety on road, it also laid down guidelines regarding drivers' responsibilities.
30. Convention on Road Traffic Vienna, 8 November 1968, available at https://treaties.un.org/Pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XI-B-19&chapter=11&Temp=mtdsg3&lang=en
31. Article 8 of the Vienna Convention on Road Traffic, 1968 -Drivers (1) Every moving vehicle or combination of vehicles shall have a driver available at http://www.unece.org/fileadmin/DAM/trans/conventn/Conv_road_traffic_EN.pdf
32. The Convention covers European countries, Mexico, Chile, Brazil and Russia, although not the United States, Japan or China. Provided the amendment clears all bureaucratic hurdles, all 72 countries that are party to the convention would have to work the new rules into their laws.
33. "Cars Could Drive Themselves Sooner than Expected after European Push." Reuters. Thomson Reuters, 2014. Web. 21 Feb. 2016.
34. "London's First Driverless Cars Based on Heathrow 'pods' - BBC News." BBC News. Web. 21 Feb. 2016.
35. "Driverless Cars Technology Receives £20 Million Boost." - Press Releases. Web. 21 Feb. 2016.
36. "Jaguar Land Rover to Test Autonomous Vehicles on UK Roads." Jaguar Land Rover to Test Autonomous Vehicles on UK Roads. Web. 21 Feb. 2016.
37. Assembly Bill No. 511–Committee on Transportation for Nevada
38. "Nevada Passes Law Allowing Self-Driving Cars." Motor Authority. Web. 16 Feb. 2016.

of autonomous cars on public roads but has mandated that human operators would be required, in case there is a need to take control.[39] Nevada, California, Florida, Michigan and Washington D.C. have successfully enacted laws with respect to autonomous vehicles.[40]

III. Germany

A section of the A9 Autobahn in Bavaria has already been designated for automated vehicle testing.[41] Currently each Federal state can grant exemptions from the German road traffic licensing regulations allowing the testing of automated vehicles, provided that there is a driver in the driver's seat who has full legal responsibility for the safe operation of the vehicle.[42] As already mentioned earlier, Daimler has obtained special permission from the state of Baden-Württemberg, Germany for a live test of its wirelessly connected driverless Mercedes-Benz trucks.

IV. Sweden

Sweden has already permitted testing of highly automated vehicles on public roads as part of the Volvo 'Drive Me' project which aims at making self-driving cars synonymous with safety [43], in restricted areas in and around Gothenburg.[44]Volvo also plans on putting 100 autonomous cars on Germany's streets by 2017.[45]

V. France

France published its roadmap for automated vehicles in July 2014 indicating pilot zones for testing, changes to driver training, and research and development projects running till 2018, with the authorization of experimental on-road testing of highly automated vehicles.[46] In October 2015, at the Intelligent Transport Systems (**"ITS"**) World Congress, on receiving authorization to carry out the testing of autonomous vehicles, four self-driving cars traveled 360 miles between Paris and Bordeaux on open roads in France.[47]

VI. Singapore

In August 2014, the Land Transport Authority (LTA) in Singapore announced it was setting up the Singapore Autonomous Vehicle Initiative (SAVI) with public road testing beginning January 2015[48]

In an ongoing effort to help Singapore develop innovative transport solutions, the Singapore-MIT Alliance for Research and Technology (SMART) launched Singapore's very first locally-developed driverless car designed for operations on public roads.[49] Further, driverless buggies were deployed in the Chinese and Japanese gardens in the Jurong Lake District and the system featured an online booking system and vehicle-to-vehicle communications.[50]

39. "California Opens Road to Public Use of Autonomous Cars." CIO India. Web. 18 Feb. 2016.
40. National Conference of State Legislatures, Self- driving vehicles legislation- http://www.ncsl.org/research/transportation/autonomous-vehicles-legislation.aspx
41. Jon Martindale, Germany creates its driverless car legislation, February 6, 2015, available at http://www.telematics.com/germany-creates-its-driverless-car-legislation/
42. Department of transport, The Pathway to Driverless Cars Summary report and action plan, February 2015, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401562/pathway-driverless-cars-summary.pdf
43. Driving Change: Volvo's 'Drive Me' Project to Make Self-Driving Cars Synonymous with Safety, https://blogs.nvidia.com/blog/2016/04/06/volvo-safety-self-driving/
44. *Supra* note 38
45. Daniel Johnson, UK to be 'driverless car world leader', 05 Dec 2013, available at http://www.telegraph.co.uk/technology/news/10497814/UK-to-be-driverless-car-world-leader.html
46. *Supra* note 36
47. "4 Self-driving French Cars Successfully Made a 360-mile Trip with No Test Driver." Tech Insider. Web. 20 Feb. 2016.
48. *Supra* note 38
49. SMART launches first Singapore-developed driverless car designed for operations on public roads, available at http://smart.mit.edu/news-a-events/press-room/article/42-smart-launches-first-singapore-developed-driverless-car-designed-for-operations-on-public-roads-.html
50. Michael Fitzgerald, Singapore Wants a Driverless Version of Uber, December 23, 2014, available at https://www.technologyreview.com/s/533601/singapore-wants-a-driverless-version-of-uber/

VII. Japan

Japan's Ministry of Land, Infrastructure, Transport and Tourism discussed advanced technologies with domestic automakers in June, 2013. The ministry also issued the first license for automated driving to Nissan in September 2013. Backed by the government, Japan is making great progress in this field. Public testing is expected to begin in March, 2016.[51] Japan has already evolved as a leader of autonomous vehicular technology with Toyota, Bosch, Nissan, Denso, and Honda being among the top 20 autonomous innovators.[52]

VIII. India

Novus Drive, a driverless shuttle, was the first of its kind to debut in the country [53], and was seen carrying visitors from one dome center to another during its showcase at the Defexpo 2016 held in Delhi.[54] India has been developing it at par with other more developed nations by carrying out tests, running a driverless metro in Delhi, and plans to introduce driverless pod taxis in Gurgaon.[55]

Mahindra Reva, an 'electric car' subsidiary of the eminent automaker Mahindra and Mahindra, has submitted proof of concepts for driverless cars in the UK and Singapore and has already begun experiments in its R&D facility in Bengaluru. It plans on testing these cars on roads abroad, once they have obtained the requisite permissions.[56] Robert Bosch, the German electrical and engineering company, considers India to be a potentially strong market for autonomous vehicles.[57] Earlier this year, news reports arose of Dr. Roshy Joan, head of the Robotics and Cognitive Systems division at Tata Consultancy, who has developed his own self driving car by adding the requisite technology to a Tata Nano.[58] All that he requires is permission from the traffic police for the test 'drive'.

51. Boyd, John. "Japan's Plan to Speed Self-Driving Cars." Web. 16 Feb. 2016.
52. IP and Science business of Thomson Reuters, The State of Self-Driving Automotive Innovation. 2016. Web. 17 Feb. 2016.
53. Novus-Drive is the first driverless shuttle in the country. The vehicle seats 14 people and can autonomously navigate on its own with its high fidelity sensors and robust algorithms for path planning and navigation. The vehicle is indigenously manufactured. Among other features is its battery run mechanism i.e. the vehicle is 100% environment friendly and runs 150 kms per charge. It uses 3d lidars, GPS/INS and stereo vision cameras for its external world perception and is controlled with deeply integrated drive by wire system and is environment friendly - THRSL receives huge applause for Novus-drive, the driverless vehicle, available at http://www.motorindiaonline.in/applications/hi-tech-demonstrates-driverless-vehicle-capability-with-novus-drive/
54. Defexpo India 2016,wasthe ninth in the series of biennial Land, Naval and Internal Homeland Security Systems Exhibitions. Defexpo India is clearly steering the path of steady growth and has been receiving overwhelming and unprecedented international response with each edition.
55. BHOOMIKA, India's step in TEVs (Technology Enabled Vehicles, APRIL 22, 2016, available at http://businesswolf.org/indias-step-tevs-technology-enabled-vehicles/
56. "Mahindra Dabbling in Driverless Cars? - News - NDTV CarAndBike.com." CarAndBike. Web. 17 Feb. 2016.
57. "India Will Be a Market for Autonomous Driving: Bosch." Www.autocarpro.in. Web. 15 Feb. 2016.
58. Nash David, "Indian techie builds self-driving Tata Nano; could retrofit any car in one hour!" Firstpost, 16 March, 2016 (Available - http://tech.firstpost.com/news-analysis/indian-techie-builds-self-driving-tata-nano-could-retrofit-any-car-in-one-hour-301971.html).

7. Legal Ramifications

I. Liability and Insurance

A driverless car was recently pulled over in California by a cop for driving too slow, but there was no driver in the car that could be penalized. This is just one of the examples of the uniquely new issues relating to the use of autonomous vehicles. When autonomous vehicles become involved in accidents, the issue of liability may get complicated as resolving the question of fault will indeed require consideration of novel and challenging questions[59] The extant test is to determine the driver's liability and adjudicate accordingly, but in cases where there is no driver, and the car runs entirely with software assist, there needs to be different parameters of consideration.

The dynamics of the insurance industry would change. 'Compensation' as defined under the Motor Vehicles Act, 1988, requires all vehicles operating in public places to be insured in order to cover third party liability and provide for compensation by way of the same. This should remain even in the case of autonomous vehicles. The issue of liability will be critical in determining whether any personal cover is warranted by the driver.[60] In fact, given that autonomous vehicles promise to improve safety standards manifold, one may have to pay a much higher premium if one chooses to drive cars on their own rather than let the computers take over.

II. Standard of performance and care

Laws and regulations will have to be enacted accordingly, setting standards of performance for autonomous vehicles to abide by. Everything from speed, the requirement of a human operator in case of emergencies, licensing, roads, permissible infrastructure, penalties, and liabilities in case of damage to third parties or otherwise, level of automation permissible, *inter alia*, shall have to be accounted for in addition to ethical issues

The issue of liability in a situation where there is a collision between two driverless cars also needs to be determined as it would involve all parties involved in assembling and manufacturing the two cars, thereby warranting a long list of plaintiffs and defendants in a potentially ensuing litigation.

III. Privacy, Data Protection, and Cyber Security

The safety and security of personal information in autonomous vehicles, interconnected through a central server, is of utmost importance. Unauthorized parties such as hackers and terrorists could illegally access a person's regular travel route, alter records, instigate attacks on the systems, or invade privacy by tracking individual vehicles.[61] From a hacker's perspective, as more and more cars are connecting to the internet, the potential surface area for a cyber-attack increases drastically.[62] There is immense potential for intrusion into the personal lives of people. User data could be utilized by parties to personalize advertisements displayed in the car, or even to adjust a vehicle's route so that it passes retail outlets which may match a user's imputed preferences.[63] Furthermore, user data acquired by insurance and telecom sectors shall also have to be adequately protected.

59. John Villasenor, Products Liability and Driverless Cars: Issues and Guiding Principles for Legislation, April 24, 2014, available at http://www.brookings.edu/research/papers/2014/04/products-liability-driverless-cars-villasenor

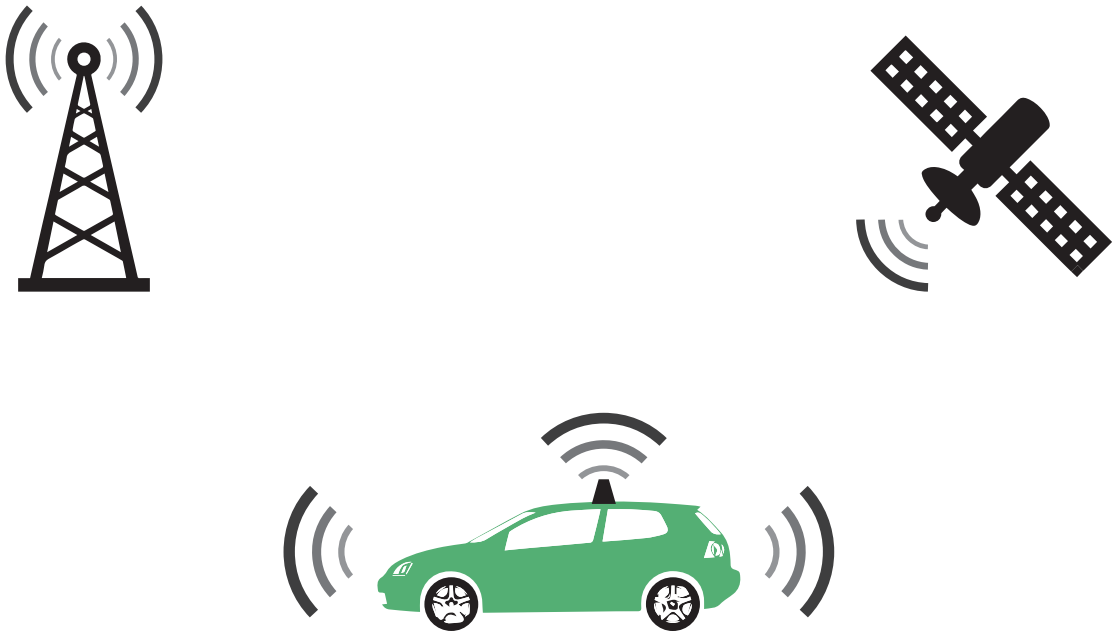
60. Atkins Ltd., Connected and Autonomous Vehicles. 2016. Web. 19 Feb. 2016. Introducing the Future of Mobility

61. KPMG LLP,. Self-Driving Cars: The Next Revolution. 2012. Web. 15 Feb. 2016.

62. Security Nightmare of Driverless Cars, October 25, 2015, available at http://www.tripwire.com/state-of-security/security-data-protection/cyber-security/security-nightmare-of-driverless-cars/

63. "Self-driving Cars: A Spy on Every Street?" World Economic Forum. Web. 17 Feb. 2016.

The "Grow America" Act in Congress [64] is intended to make hacking a vehicle, a criminal offense. NHTSA is already working on security protocols, trying to ensure that vehicles can send and receive trusted messages and instructions and has also welcomed the move of automakers in taking responsibility for accidents involving their automobiles. Volvo, Mercedes, and Google have already taken the onus of the liability for their vehicles.[65] To avoid scenarios where hackers may be able to render utter chaos on a six-lane high way full of autonomous vehicles, the car industry will have to come together to create a security consortium that will share information about potential threats without sharing trade secrets. In the same manner, other governments too will have to enact appropriate legislations in order to ensure that user data is not abused in any manner. Industry leaders will have to come forward and work together in order to ensure that the transition into the driverless age is as smooth as possible.



64. A transportation funding bill supported by the Obama administration

65. Risen, Tom. U.S. News. 8 Oct. 2015. How safe is a Self-Driving Car?

8. Existing Laws in India

The Motor Vehicles Act, 1939 (**"MV Act"**), mandates that a motor vehicle may not be driven without a driving license.[66] Secondly, no person under the age of 18 is allowed to drive a motor vehicle. The MV Act places the responsibility on the owner of the vehicle to ensure that the above mentioned provisions are complied with. The question that arises is whether such responsibilities of the 'owner' of the vehicle would still exist in the age of autonomous cars. Appropriate amendments would have to be made to the MV Act allowing for a special sort of license for autonomous vehicles or none at all. Given that most of the functions of an autonomous vehicle, if not all, would be controlled by internal processors, the question also arises whether people below the age of 18 would be allowed to 'operate' the said vehicle.

Another issue that requires attention pertains to the requirement of registration of cars as provided for in the MV Act,[67] in the procedure as provided for in *Section 41*. Importantly, the State Government, by virtue of the MV Act currently holds the power to restrict the use of vehicles 'in the interest of public safety',[68] as well as 'make regulations for the driving of motor vehicles'.[69] It is therefore a possibility that states might differ on the regulations that govern autonomous cars. Further, provisions of the law that ban driving when mentally or physically unfit,[70] under the influence of substances,[71] would possibly be redundant in the case of autonomous cars.

The MV Act initially provided for the award of compensation on the principle of "fault" only. The Supreme Court in *Manushri Raha v. B.L. Gupta* [72] as well as the Law Commission of India had recommended the introduction of "no fault" liability which was subsequently not incorporated.[73] In the amended MV Act of 1988, *Sections 140 to 144* provide for award of compensation resulting from an accident arising out of the use of motor vehicles. *Section 144* attaches strict liability to the owner or on their behalf to the insurance company. In case of award of compensation it will based on the principle of "No Fault" [74]

In the case of a driverless car getting into an accident, the issue of liability may lead to legal complexities initially. Manufacturers will be held to a higher standard of responsibility than they are currently. Issues pertaining to negligence, manufacturing defects, design defects, failure to warn, misrepresentation, unfair trade practices, breach of warranty and strict liability will fall under the Consumer Protection Act, 1986 (**"CPA"**).[75] The **CPA** also establishes the right to consumer education. The consumer will have to be educated accordingly, on how the driverless cars operate and how not to panic and take control in case of emergencies. Since driverless technology discounts the possibility of human error, the liability would lie either with the manufacturer or the technology provider, as the case may be, for a defect in goods or deficiency in services, respectively. Considering that consumer concerns about liability could represent a roadblock to acceptance of driverless cars, Volvo, Google and Daimler AG's Mercedes-Benz have all pledged to accept liability in the event that their vehicles were to cause an accident.[76]

66. Section 3(1)
67. Section 39 & 40.
68. Section 115.
69. Section 118.
70. Section 186.
71. Section 185.
72. 1977 AIR 1158
73. No Fault liability, available at http://www.ebc-india.com/lawyer/articles/98v6a4.htm on 30/10/2011
74. Section 140 of the MV Act, 1988 – Liability to pay compensation in certain cases on the principle of no fault; Section 141 - Provisions as to other right to claim compensation for death or permanent disablement; Section 142 - Permanent disablement; Section 143 - Applicability of Chapter to certain claims under Act 8 of 1923; Section 144 - The provisions of this Chapter shall have effect notwithstanding anything contained in any other provision of this Act or of any other law for the time being in force.
75. *Supra* note 54
76. Mark Harris, Why You Shouldn't Worry About Liability for Self-Driving Car Accidents, 12 Oct 2015 available at http://spectrum.ieee.org/cars-that-think/transportation/self-driving/why-you-shouldnt-worry-about-liability-for-selfdriving-car-accidents

Privacy and data protection would primarily come under the Information Technology Act, 2000 (**"IT Act"**) and Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011. (**"IT Rules"**) which *inter alia*, lay down provisions for the protection of Sensitive Data and Personal Information (**"SDPI"**). Section 66 of the IT Act classifies hacking as the situation where someone who, with the *intent* to cause wrongful loss or damage, or *knowledge* of the same – *destroys*, *deletes* or *alters* any information in a computer resource, or *diminishes its value*, or *affects it injuriously*. The scope of such provisions will have to be enlarged accordingly to account for scenarios where a hacker may take over complete control of a vehicle, by hacking into a computer or a central processor operating driverless cars and coordinating traffic. Laws will also have to incorporate necessary provisions dealing with protection and responsible utilization of passenger data, along with increasing threat of hackers, cyber espionage and warfare.

Driverless cars would require enhanced mapping technology and increased investment in satellite infrastructure in order to ensure that such cars are provided a detailed and highly accurate global positioning system, not only to autonomously and accurately arrive at its destination, but to also circumvent the various obstacles en-route. The recently released draft Geospatial Information Regulation Bill, 2016, introduced to regulate the acquisition, dissemination, publication and distribution of geospatial information[77] of India, will bring the driverless car under its ambit. While the said bill is still in discussion stage, the driverless future ought to be kept in mind, so as to enhance and not diminish the positive externalities that a driverless future promises to have upon society at large.

77. Geospatial information, in common parlance, refers to information relating to the position of things on the Earth's surface, or any information that has a geographical component.

9. Challenges to Implementation

India is bound to have its own unique challenges in the effective implementation of the driverless era. Infrastructure and legislation will have to keep pace with more developed nations if India is to tap into the potential of the driverless future. Standardization of supporting infrastructure, roads and an improvement in support technology such as mapping & GPS will have to be fast tracked. Low-tech cars, lack of adequate infrastructure for the handicapped, poor road discipline, lack of strict regulations, poor enforcement of traffic rules, inexperienced and first-time drivers are some of the immediate issues that come to mind.

Such issues are not limited to India. Even Europe is faced with issues such as the complexity of roads, streets, tunnels, contraband, human smuggling, and societal resistance to the idea. There is also a regulatory lacuna due to the lack of a pan-European legislation governing the use of autonomous cars.[78] Even in some parts of the United States of America, inadequate infrastructure has posed a major roadblock and has vexed engineers as well as added to the time and cost of the process. Poor road markings and uneven signage on paved roads in the United States is now forcing automakers to develop more sophisticated sensors and maps.[79] Such issues will have to be similarly tackled in India. Some of the challenges and some possible measures to tackle them are discussed in further detail below;

I. Cultural nuances

Given India's cultural diversity, the computer operating the driverless car will have to adapt to localized graphical representations, informative signs, traffic symbols and language barriers. Furthermore, the tendency of Indians to rely on landmarks for navigation as opposed to directions or addresses and street names means that there aren't many road signs or registered street names, especially in the more rural parts of India. This could pose a challenge. GPS mapping would have to be made absolutely accurate, and the car would have to be equipped with adequate software as well as hardware to overcome such barriers. Furthermore, the cars would have to detect and decipher visual cues such as hand signals for turns or stops, to overtake, or flashing lights indicating a variety of meanings. Employing visual means to signal and convey messages and instructions is a common practice for drivers and traffic policemen alike in India which would have to be taken into account by the on-board computers in the car.

II. Local infrastructure

The cars would need to be customized keeping in mind the nature of Indian roads. Information about speed limits, height and width restrictions, types of road traversed, common or restricted use for a particular type of transportation such as bullock-carts, cyclists, two wheelers, trucks, animal crossings would have to be fed into the systems and algorithms accordingly tweaked. Potholes, speed breakers, road dividers dangerously placed on highways by the police, gravel and tar left by road repair crews, open drainages, supplemented with uniquely Indian traffic obstructions such as religious festivals being celebrated on the roads would mean that driverless cars would have to be especially smarter if they are to take over Indian roads. There is already a shortage of servicing centers even for normal cars in rural India. Driverless cars are going to face similar issues. Investments in adequate servicing infrastructure will have to accordingly increase.

78. Carl Fenger, International Eye - Driverless Cars: The View from Europe, Apr/May 2015, available at: http://connectedworld.com/driverless-cars-the-view-from-europe/

79. Alexandria Sage, Where's the lane? Self-driving cars confused by shabby U.S. roadways, Mar 31, 2016, available at http://www.reuters.com/article/us-autos-autonomous-infrastructure-insig-idUSKCN-0WX131

III. Perception of Surroundings

Auto rickshaws, scooters, mopeds, hand carts, ox carts, cycle rickshaws, tractors and other such vehicles of varying shapes and sizes plying on Indian roads, would require the driverless cars to be equipped with extra sensitive sensors. The cars would also have to discern a variety of life forms of different compositions including stray animals and people sleeping on the streets in order to detect and avoid such obstacles.

IV. Legislative & Regulatory Hurdles

India is yet to acknowledge the possibility of, and need to legislate in respect of, autonomous vehicles. The country however, has already begun experimenting with the concept. As already discussed earlier, the Novus Drive is slated to re-invent the internal transport system for universities, college campuses, hospitals, senior citizen's clubs, theme parks and other such institutions where internal commuting poses an issue.[80] Furthermore, driverless pod cars are set to run on dedicated double-decker roadway around Amritsar by mid-2016, according to Ultra Fairwood, a tie-up between a U.K-based and an Indian company, which is developing the cars for the city.[81]

The Indian Government, however, very recently rejected Google's plans to map Indian cities, tourist spots, hills and rivers in an application where one could explore through 360-degree, panoramic and street level imagery. Notably, security establishments have grown vary of allowing enhanced levels of image capturing ever since the 2008 terrorists attacks revealed how photographic reconnaissance aided the perpetrators of the attack in their mission. As discussed earlier, the Geospatial Information Regulation, Bill, 2016 prescribes hefty penalties and jail sentences for persons in breach of it. Google's driverless car for example relies on information from GPS satellites. Such geospatial information acquired through space and aerial platforms would perhaps require the owner, manufacturer or the passenger of a driverless car disseminating such information to obtain a license. The bill does not provide an exact definition with regards to the scope of "dissemination" and what it entails. Given the hefty penalties prescribed, if such a bill is to become the law, without adequate clarifications, autonomous vehicles may be faced with unnecessary regulatory hurdles which may dissuade investors.

Given the general parliamentary impasse prevalent in our nation, one hopes that adequate legislation will keep pace with the global driverless revolution as India looks to become a dominant and influential world economy in the 21st century.

80. John Greenough, BI Intelligence, 10 million self-driving cars will be on the road by 2020, Jul. 29, 2015 available at http://www.businessinsider.com/report-10-million-self-driving-cars-will-be-on-the-road-by-2020-2015-5-6?IR=T

81. Saptarishi Dutta, Driverless Cars to the Golden Temple, Jun 10, 2013, available at http://blogs.wsj.com/indiarealtime/2013/06/10/driverless-cars-to-the-golden-temple/

10. The Road Ahead

Autonomous vehicles have traversed thousands of kilometers already, albeit in controlled environments. Heavy investments are being made into this intelligent transport system by governments and private companies alike. The Boston Consulting Group has predicted 13% penetration in the market by 2025 by the autonomous vehicle, representing a market of around $42 billion.[82]

The success of the autonomous vehicle and the benefits reaped as a consequence thereof is both a necessity as well as an eventuality if human progress is to be sustained in the 21st century. It is a fact that the transition into a driverless society is not going to be smooth sailing at all times. Cultural norms and legislations will have to keep pace with the rapid advancements in autonomous vehicular technology in Countries and companies will need to anticipate these in advance and prepare accordingly.

A collaborative approach adopted by automobile and technology companies, along with other sectors that may look to cash in and supplement the widespread emergence and usage of this technology is the need of the hour. At the same time, it is crucial that environmental benefits, improved quality of life and standard of living for human society is at the heart of the agenda as driverless cars become the norm. With appropriate localization and better road infrastructure, driverless, or even flying cars should also be hitting Indian roads in the near future.[83]

The next chapter in mobility is soon to be written. It is time to start preparing!

82. "BMW Eyes New Business Opportunities with Autonomous Cars." Reuters India. 2015. Web. 19 Feb. 2016.

83. "'Localised' Driverless Cars May Become Reality for India in Few Years." 'Localised' Driverless Cars May Become Reality for India in Few Years. Web. 17 Feb. 2016.

11. Epilogue

For more than a century man has dreamt of flying cars, the ultimate vehicle to go wherever and whenever you want to, easily overcoming all sorts of barriers. "Flying cars", so far only a figment of futuristic romanticism, is now closer to reality than ever before.

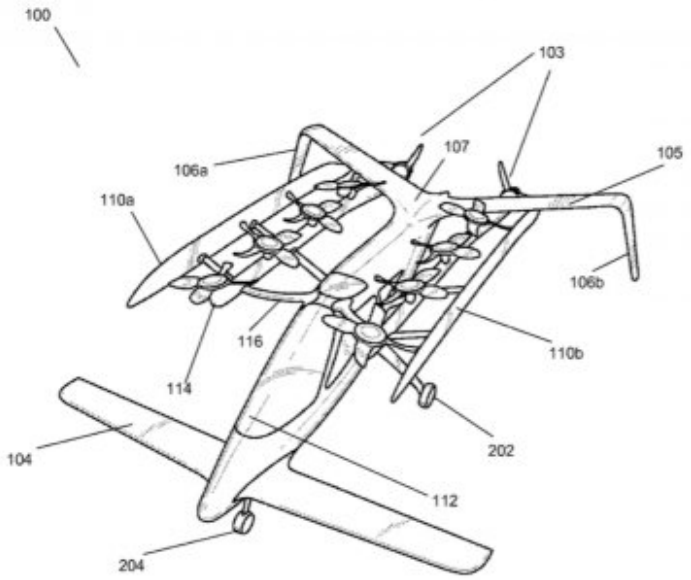
Larry Page, co-founder of Google, has been reportedly working on a prototype of a flying car, at his startup 'Zee. Aero'.[84] Designed by Ilan Kroo, aeronautics professor and NASA scientist, who is listed as the inventor on the patent applications,[85] These cars are however, not the first of their kind.

Earlier this year, Ehang, a Chinese Tech company, released a driverless flying car, or a drone which could hold people, if you will – the first 'Autonomous Aerial Vehicle'.[86] India isn't far from seeing its first flying car either. PAL-V[87] of Europe is soon to launch its flying car which it has been working on since as early as 2001.

Times are exciting. It is indeed prudent to plan ahead and prepare accordingly, given the lightening speed of inovation and technological advancement.

A detailed study on flying cars shall follow.

Zee. Aero's patent diagram[88]



84. *Id.*

85. Francis X Grovers III, "Zee.Aero's flying car concept would fit in a standard parking lot" Gizmag, November 21, 2013 (Available - http://www.gizmag.com/flying-car-zee-aero/29890/).

86. Lynsey Barber, The Ehang 184 Jetsons-style drone can carry people in ambtious plans for driverless flying cars, CityAM, January 7, 2016 (Available - http://www.cityam.com/231892/the-ehang-184-jetsons-style-drone-can-carry-people-in-ambtious-plans-for-driverless-flying-cars).

87. Pal –V Europe NV started in 2001 to design a roadable aircraft by evaluating many potential technologies and creating numerous concepts in cooperation with well known research institutes. The most important breakthrough was the maturing of the DVC tilting technology in 2005. This brought within reach the reality of a flying car. The said technology allows for safe driving without compromises while having a high centre of gravity and a narrow aerodynamic shape necessary for flying. The first real "flying car" concept was born.

88. Source: http://www.businessinsider.in/Larry-Page-has-secretly-spent-100-million-building-flying-cars-here-is-a-patent-diagram-of-one/articleshow/52672211.cms.

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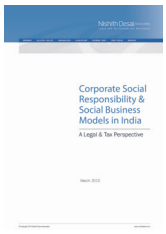

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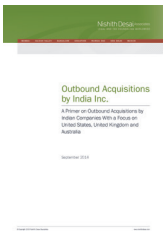

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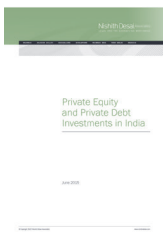

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