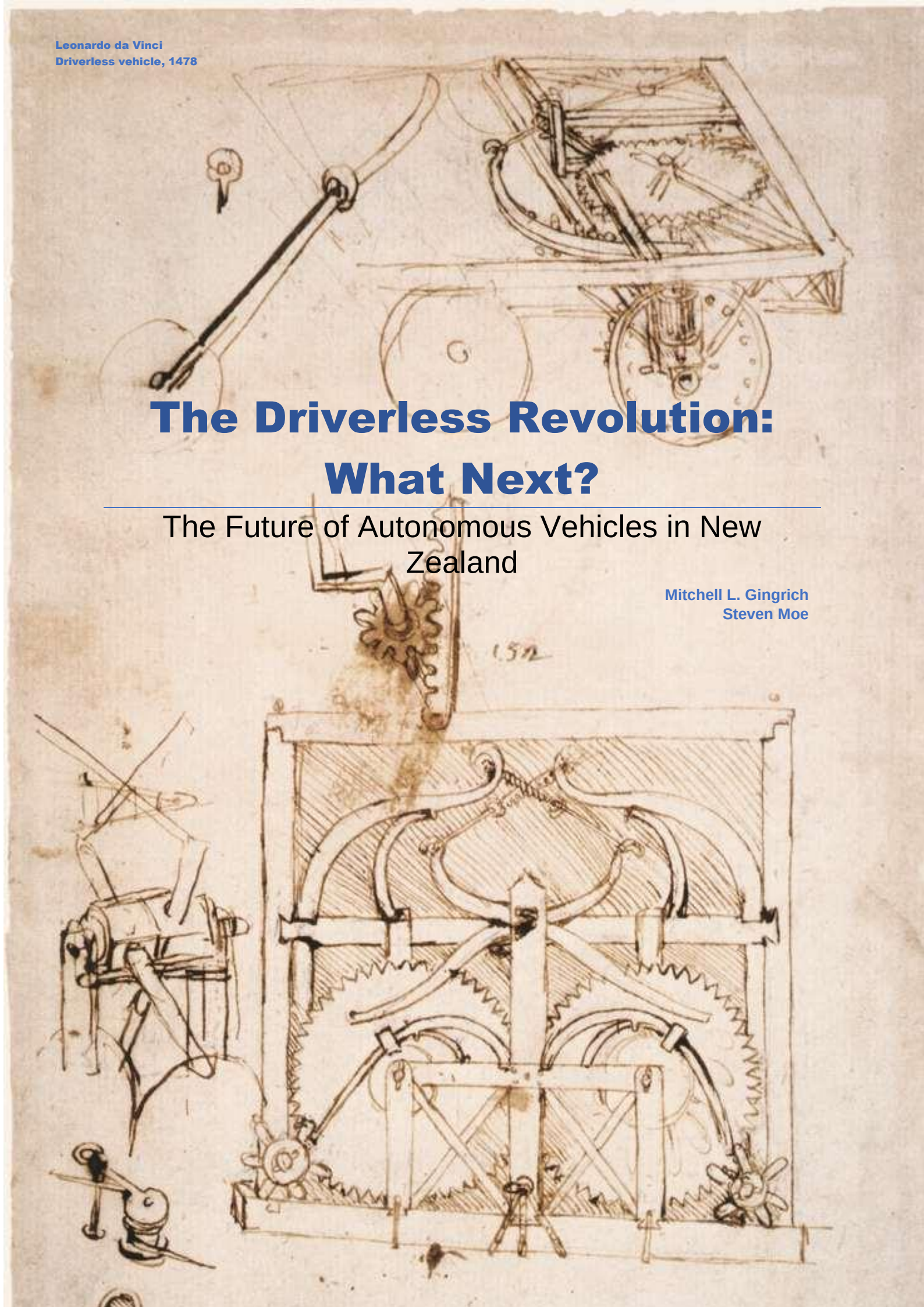

Leonardo da Vinci
Driverless vehicle, 1478

The Driverless Revolution: What Next?

The Future of Autonomous Vehicles in New Zealand

Mitchell L. Gingrich
Steven Moe

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Comments from advance readers of this white paper:

Autonomous vehicles have the potential to change transport, and therefore our neighbourhoods, towns and cities dramatically in the future. We must prepare and plan for them to ensure we end with positive, community and well-being enhancing outcomes.

Professor Simon Kingham, Chief Science Advisor to the New Zealand Ministry of Transport

Regulations can be aimed at the known. Regulations seldom anticipate the unknown. Therefore, regulations have to be open to challenge and change.

Christopher C. Kissling, Ph.D., Professor Emeritus of Transport at Lincoln University

The development of air and land-based autonomous technology offers a significant economic opportunity for New Zealand. Trials are already underway in Canterbury, New Zealand, where geographic and industry conditions offer significant advantages as test environments.

Autonomy technologies offer an opportunity to transform sectors of the economy either impacted by disruption or where there is opportunity for significant growth beyond traditional activity. The manufacturing and engineering sectors are two examples where this transition is occurring. This transformation is possible at a regional and national level, proving the opportunity to contribute to economic development in regional centres.

A focus on autonomous technology also leverages existing strengths and capability within tertiary institutes, offering students and staff opportunities to use autonomy to solve challenges facing other industries such as agriculture. Enabling regulations further support the advantages New Zealand already has as a pilot environment.

Joanna Norris, Chief Executive Officer, ChristchurchNZ

Aerospace and future transport is a compelling opportunity for Canterbury. National and international companies are already working in our region to testbed their technology. We can build on existing capabilities to provide a world-class platform for atmospheric and terrestrial R&D into the 2020s and beyond.

Mark Rocket, Chair of the Christchurch Aerospace Centre

The challenges we face with AV regulation are, at a basic level, similar to those arising in the context of any other emerging technology: The key to create a safe yet innovation-friendly regulatory environment is to understand the technology in question, as well as the ethical, economic, and social implications of the legal choices we make.

Dr Olivia J. Erdelyi, Lecturer, Canterbury Law School, Specialising in AI Regulation

Most, if not all, of our current options for transporting goods and people, will be consigned to museums in 50 years and replaced by various forms of AV. These will be complex, technologically 'dense' machines, as they will require advanced engineering, design, and manufacture.

A few of the hurdles preventing mass production and adoption of AVs are technological, but the majority are legal, regulatory and attitudinal. These issues will be overcome in time, but not without a concerted and coordinated plan of action. Steven and Mitchell's paper constitutes a very useful addition to the literature and should be used to catalyse discussions around the future of AVs in Canterbury and New Zealand. We must push hard to be in the global vanguard with respect to the design, manufacture, testing, and adoption of these vehicles.

Neil Hamilton, General Manager, Canterbury Tech

A fascinating and informative examination of the history, current state of play, and future landscape of autonomous vehicles presented in a cogent and concise manner. Written by two experts in their respective fields, this paper sets out the map for a road yet to be travelled, as well as demonstrating how New Zealand is well-positioned to facilitate the growth and development of this technology. A great read for anyone interested in the future.

Tom Pils, LLB, BComm-Accg, The Drone Lawyer

Contents

Introduction

> *"It is not an idle dream to look forward to the passing of the horse and the coming of the new era of motor cars … the horseless cab is now a common sight in London … it is only a matter of a few years when all the world will ride in horseless carriages … the automobile has emerged from the experimental stage … the cost is beginning to fall, and before long it will be as cheap as a good bicycle."*
>
> Quotes from "*The Passing of the Horse*"
> New Zealand Herald, 26 August 1899

It is easy to look back on technology change from the vantage point of our current perspective and smile. But imagine the time when seeing a car was a novelty. What new laws would be needed and changes made to infrastructure as cities adapted to a move from horses to cars? Today we are undergoing a similar revolution that has the same potential for enormous impact when it comes to autonomous vehicles.

This white paper looks at what is changing in the area of autonomous vehicles and asks the question – how do we prepare for that? What might the essential changes be that are needed in order to empower and catalyse the new reality so that New Zealand leads the world in the adoption of autonomous vehicle use?

We are asking these and other questions because we believe that the answers are important to consider now so that we are ready for the future.

Will we be able to embrace autonomous vehicle technology and not be afraid of it, but instead put an infrastructure of regulation in place that releases it to achieve its full potential? Or will we not take a proactive approach? We hope this white paper assists in the ongoing discussion about the future of autonomous vehicles in New Zealand and we recommend 8 things which we think need to be considered.

We welcome your feedback as we all continue on this journey.

Mitchell L. Gingrich, President, Autonomous Consulting
Steven Moe, Partner, Parry Field Lawyers

December 2019

Part 1: The Past

The Autonomous Vehicle Journey Begins

Riding in an autonomous vehicle ("AV") is already a reality for some, albeit in a very limited context. Currently, AVs deliver humans and small goods through the air or along footpaths or bulk items via large trucks on limited-access highways. Predicting the likelihood of wider AV usage readily compares to asking a seer to tell the future without the aid of a crystal ball.

The software and hardware supporting AVs demonstrate the current viability of travel by this means; however, at present, technology alone cannot deliver on the promise of a future with zero road accidents.

The human transportation journey has gone from two legs to four legs to wheels powered by machines, which have become increasingly complex, automated and, to an increasing extent, self-governing. Unpacking the complexities of autonomy facilitates our present AV reality and develops a foundation for when AV journeys will be commonplace.

The Dream of Autonomy

The idea of AVs have been with us for a long time. Leonardo Da Vinci sketched a self-propelled carriage in 1478 for Renaissance Festivals of his day (the plans for that are the cover image of this white paper). Da Vinci's car became a reality in 2004 when Italian Paulo Galluzzi and his team built a scale model and demonstrated Da Vinci's car successfully. Operating like a wind-up toy, Da Vinci's design even included programmable steering.[1]

Replica of Leonardo Da Vinci's self-propelled cart

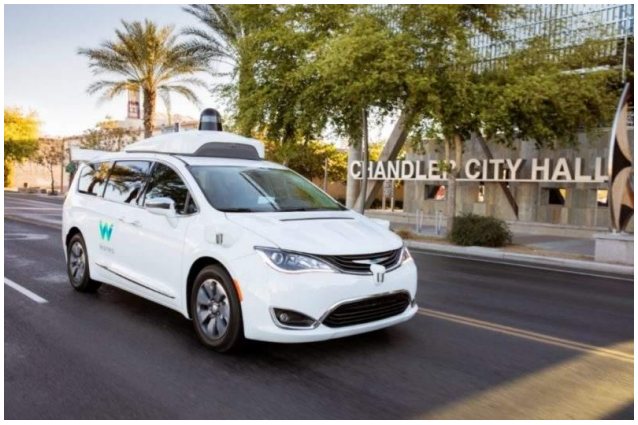
In 1925, Francis Houdina demonstrated a radio-controlled automobile[2], which he demonstrated on the streets of Manhattan without anyone at the steering wheel. The New York Times remarked it was "as if a phantom hand were at the wheel."[3]

Predicting the future is never easy, but humans put in a great amount of effort to do just that. The 1939 New York World's Fair featured Norman Bel Geddes' iteration of modern urban life in a pavilion named, "Futurama," which included a self-driving car. Bel Geddes, a highly regarded designer of his day, predicted that the urban world featured in Futurama could be real, as soon as 1960. Predictions are easy to make and they cause us to marvel at what the future may hold for us; however, the future comes whether we marvel at it or not because engineers, such as Da Vinci, imagine and create the future from the stuff of today.

Part 2: The Present

Our modern fascination with AVs likely derives from the US Defense Advanced Research Projects Agency ("DARPA") competitions in the early 2000s.[4] Over the years, many of the DARPA contestants have established themselves as the titans of the AV industry. Google's Waymo division is considered to be the industry leader with as many as 10 Billion miles driven by its AV simulation software[5] and has provided thousands of passenger rides in the real world,[6] including recent trips without a safety driver.[7] The advance of AV technology combined with the near-ubiquity of smartphones brings us to the conclusion of the 21st Century's second decade. Many predict that AVs will be a daily reality in the 2020s.

In the past, machines weren't driving for us, but human drivers took commands and delivered their riders as directed. Our ancestors barked orders to their coach drivers. This activity evolved to doing the same to the taxi drivers of major urban centres. Today, our app-driven reality follows the same format – command and deliver. In those early years, perhaps the dream was to free up the privileged for other tasks. Today, that dream is being overwhelmed by an obsession with the smartphone screen. The AV industry, along with the government and the insurance industry, however, has a different dream – one of safety for all.



A Waymo AV (photo used with permission from Waymo)

How and when AV users and the AV industry arrive at the same dreamt-of destination, especially where New Zealand is concerned, is what this white paper will explore next.

An overview of positives and negatives of AV[8]

Positives	Negatives
• Facilitate ride sharing • Reduce number of vehicles needed • Ease congestion • Reduce emissions • Potential shared resource - efficiencies of vehicles not just being parked all-day • Cars communicate, easing traffic flows • No drunk drivers • Park themselves in unused areas, reducing need for central city parking buildings	• Reductions in congestion may be temporary • Those currently employed as drivers may need to find new occupations • Foot traffic may reduce, affecting businesses • Human error with AVs on roads may result in accidents

Part 3: The Future

What Role Can New Zealand Play?

> *"Whether driverless vehicles end up being a net positive or not may depend on what we do now and whether we can avoid making too many wrong turns. The law will play a critical role, for good or ill."*
>
> *Michael Cameron, "Realising the Potential of Driverless Vehicles", NZ Law Foundation, 2018*

New Zealand is renowned for innovation and making an impact on a global scale. Whether it's Ernest Rutherford splitting the atom, Bill Pickering leading NASA's Jet Propulsion Lab for decades, or Sir Edmund Hillary scaling Mt. Everest, New Zealanders have continually demonstrated their penchant for leadership by handling some of the most significant challenges on the world's stage. Right now, New Zealander Alex Kendall, a co-founder of Wayve, is testing AV software in London.[9]

What other contributions will New Zealand bring to the ongoing AV revolution in the transportation sector? Will it be an innovative algorithm or computer chip that will mark New Zealand's contribution? What contributions can New Zealand make at this stage of the AV revolution?

Since the current AV revolution has been ongoing for a decade or more, the time may have already passed for laying its foundation and for setting its direction. Perhaps, the opportunities for New Zealand to impact AVs on a global scale exist in fine-tuning existing components of AVs or in developing a framework that defines the safe utilisation of AVs on public roads.

The Challenge: Accidents Happen . . .

Perhaps, the most well-known accident involving an AV took place on 18th March 2018 in Tempe, Arizona when an Uber ATG AV hit and killed a woman walking across a road without the aid of a crosswalk. Journalists around the world wrote about this incident and opined about the dire future of AVs in the wake of it. The Tempe Police Department produced a 300-page report on the accident while the National Transportation Safety Board ("NTSB") has produced hundreds of pages supporting its report.[10]

One of the authors of this white paper is a former employee of Uber ATG who was working there at the time of the accident (Mitchell Gingrich). In his view, this AV accident was preventable.[11] Preventing accidents, however, requires foresight, regulatory input and guidance, thoughtful planning and placing safety as the paramount purpose for any transportation project conducted on public streets. This is not implying that these were the specific failings that led to the Uber ATG accident. The reports from the NTSB and the Tempe Police Department reflect the considered opinions of experts in evaluating transportation accidents and certain aspects of their reports remain under consideration, such as whether the AV driver could or should be charged criminally for reportedly paying more attention to her smartphone than the road.[12]

In 2015, Arizona had no regulatory scheme permitting AVs to operate on its public roads and the Arizona Department of Transportation announced in a news release that the absence of regulations incentivised AV testing.[13] Ironically, the Arizona Department of Public Safety published minimal regulations only two weeks before the fatal Uber ATG accident.[14] Arizona went from being known as the "Wild West for AVs" to a 'ghost town' as Uber ATG shuttered its operations two months after the fatality. Uber ATG's fatal accident, however, has not deterred other states from aggressively pursuing the AV dream.[15] A thorough and well-reasoned regulatory framework permitting AVs to operate on the public roads in New Zealand creates a stronger likelihood of preventing AVs, a.k.a., the "Robot cars," from striking pedestrians or inflicting harm on the public roads.

What is the Law in New Zealand?

Already, the AV revolution has landed on the shores of New Zealand. You can see it is the future because right now at the Christchurch airport driverless buses are being trialled. For those travelling in rural areas of mid-Canterbury another trial is taking place – in the skies with Google's Cora Project.[16] But what are the legal rules that apply, and if they are inadequate, then for what should they be providing?

In the "*Intelligent Transport Systems Technology Action Plan 2014-2018*" issued in May 2014 here (which already seems a very long time ago), there is a section called "Promoting New Zealand internationally as a test-bed for new technologies" which states:[17]

> *Internationally there is a great deal of thought being given to what laws will be necessary for the general operation of driverless vehicles. Their widespread operation will pose complex legal challenges, especially to determine liability in the event of any accident. It is not proposed that the New Zealand government will explicitly look at these legal issues at this time. Rather, the government will continue to monitor international developments and draw on this knowledge once international thinking has developed further and it is clearer if or when these vehicles will be commercially available.*

That may have been the position. How about more recent developments? The Ministry of Transport has issued guidance in October 2019 here which includes a section about the legal issues:[18]

> *"Autonomous vehicles will present a range of new legal issues. The Ministry of Transport has started to look at legal issues associated with testing such vehicles. There are no obvious legal barriers to the deployment of autonomous vehicles for testing in New Zealand. Unlike some countries, NZ law has no explicit requirement for a driver to be present. However, autonomous vehicles could raise issues about who is at fault if they were to crash. In addition to the issues of liability in the event of an accident or offence, the Government's key concern is to ensure public safety of testing or use of autonomous vehicles. The Ministry considers that, between the Police's general powers to ensure public safety, and the specific powers of the New Zealand Transport Agency to place conditions on the operation of vehicles (when the vehicles need permits to operate on our roads), there are sufficient controls in New Zealand to ensure the safety of testing of autonomous vehicles on public roads."*

It is fascinating to think that our law has "no explicit requirement for a driver to be present". If you look at the New Zealand Road Code[19] and the Land Transport Act 1998 s 6,[20] the requirements for a vehicle boil down to having the right equipment in good working order, not overloading the car and displaying:

- A current warrant of fitness
- A current licence label
- A road user charges licence if required (e.g. if the car runs on diesel)
- A clearly visible number plate on the front and back of the car

In other countries, changes have been made to the legal position – for example, the United Kingdom has taken its first legislative step by passing the Automated and Electric Vehicles Act 2018.[21] While the Act has received its royal assent, the majority of its provisions do not come into force until the Secretary of State appoints its commencement date. Essentially, the Act states that when an insured AV causes an accident, the insurer is liable for the damage. If the vehicle is uninsured, the owner is liable. However, if the person in control of the vehicle was negligent by allowing the AV to drive itself at an inappropriate time, the insurer/owner is not responsible for this person's injuries.

So, the question in New Zealand is, what might the law be like in 10 years – and how do we go about amending our regulatory framework now to foster an ecosystem where public safety is paramount and new technology like this is embraced?

Innovating in the Regulatory Space

Anyone paying attention to the AV sector recognises the transformative power of technology. Arguably, AVs began centuries ago with Da Vinci's self-driving car and technology's rapid advance in the post-industrial world demonstrates the determination of the automotive industry to bring AVs to your neighbourhood soon. Otherwise, the multi-billions of dollars invested in AV technology will have failed to produce a return on investment. It has been noted that:

> *"The presence of autonomous vehicles in your city will increasingly depend on the speed of local legislators in changing laws, as well as the availability of local investors and expected demand for exploitation. If you live in a large and modern city, where mapping is relatively straightforward, you will soon be seeing these vehicles on the roads."*[22]

In the past, government decisions followed industrial innovations. This led to infrastructure that facilitated the advance of a culture built around the automobile. As a consequence, cities emptied into suburbs replete with multi-lane motorways, and public transit fell into disfavour. It is incumbent upon the government to prepare legislation and infrastructure to address the transformation being brought about by AVs.[23] The example of Boeing's troubles with its 737 Max aeroplane demonstrates why the FAA wants greater involvement in the development of future Boeing planes and provides insight as to why it is incumbent on the government to address emerging technologies, especially when the safety of the travelling public is at stake.[24] Taking a moment to think collectively and deliberately on the future of overall transport and not just AVs represents a history lesson for all of us.[25]

Often overlooked in analysing the bumps in the road to the future utilisation of AVs' is a coherent and technologically savvy regulatory framework.[26] Christopher C. Kissling, Ph.D., Professor Emeritus of Transport at Lincoln University, notes:

> *"Regulations can be aimed at the known. Regulations seldom anticipate the unknown. Therefore, regulations have to be open to challenge and change."*

As discussed earlier, governments at various levels from a governor's executive order to proposed national laws are reaching for answers to permitting and regulating the operation of AVs on our public roads. At the public hearing concerning the Uber ATG fatal accident, one of the members of the National Transportation Safety Board criticised the overall lack of AV regulations and lamented that governments lack the skillset to address the legal issues arising in the AV sector.[27]

Conclusion: Our 8 Recommendations

With change, there is always opportunity. In our view, this opportunity is to offer New Zealand a way to smooth out the legal bumps in the road for AVs and deliver a regulatory framework, which not only is coherent but also technologically savvy – combining law **and** AV technology. There is also the opportunity for New Zealand to be truly world-leading in this area and an example to other nations.

Whether delivering people or products, AVs must be safe for all users of public spaces. One way to accomplish this safety goal is by attending to the following issues, which we propose as a road map for the future of AVs in New Zealand:

1. **A full-fledged permitting process** allowing companies to test AVs on the public roads in a limited manner, such as a geo-fenced area.[28] Regulations could require:

    a. AV operating companies to report on AV on-road operations.
    b. One-time and on-going certification of AV Safety Drivers.
    c. Warrants of Fitness (WOF) for AVs reviewing the vehicle, hardware and software systems.
    d. AV operating companies to have two safety drivers at all times.
    e. AV Agency, under the Ministry of Transport, is granted oversight of software utilised in AV.
    f. X kilometres of AV simulation completed prior to on-road testing.
    g. Safety redundancies in place.
    h. Effective monitoring to diminish "automation complacency."[29]
    i. AV operating companies to divulge data ("Black Box") in the event of an incident.
    j. IT security measures to be in place and routinely monitored.
    k. Mandatory insurance and/or the lodging of a bond.

2. **Upgrading New Zealand motor vehicle standards** so that AVs are in compliance. For example, regulations permitting a vehicle without a steering wheel or pedals for a human driver. These upgraded standards should also reflect the adoption of the SAE taxonomy for levels of vehicle autonomy.

3. **Establish an AV Agency** under the authority of the Ministry of Transport/NZTA to provide oversight concerning the AV regulatory framework and approvals for AV certification and testing. We recommend that such an agency be agile and set parameters that welcome innovation and investment in the AV sector, as well as foster safety for all users of public areas. In this way, the AV Agency can have a voice in the maturing global AV sector. At a bare minimum, governing agencies need to upskill regarding AVs by learning from those who have been actively participating in the AV sector.

4. **Updating street signs**, pedestrian walkways, cycle lanes, lane markings, and footpaths.

5. **Establishing "autonomy zones"** where geo-fenced AVs may operate for testing, initially, and then full-fledged operations.

6. **Address privacy** and carefully navigate the concerns of AV users, and in fact, all users of the public roads as tremendous amounts of data will be stored by the AV owner/operators.[30] Encourage "white hat" hacking to establish a robust data privacy scheme.

7. **Clarify legal liability** and update New Zealand law to address the liability for an AV accident. Such considerations are:

    a. In the event of an accident/incident, with whom does civil and/or criminal liability vest? For example, if an AV was undergoing testing with AV Safety Drivers, was the AV Safety Driver negligent? If so, is there criminal liability?
    b. Were the algorithms operating properly? For example, as in the Uber ATG accident, was the AV incorrectly classifying objects? If yes, does liability vest with the software programmer, the manager of the software development team, or higher up the executive ladder? Does product liability vest? If so, with whom?
    c. Did the AV owner/operator have the latest version of operating software in the AV at the time of the accident? If not, with whom does responsibility and therefore liability vest?
    d. Was there an IT security event that preceded the AV accident?
    e. Was there a lapse in V2V or V2X communications?[31]
    f. Did something else fail - the hardware? A vehicle component? Where does the liability vest?
    g. Did the AV owner/operator faithfully maintain the AV and document its maintenance?[32] What standards should be in place to hold owners/operators liable?
    h. Is it best to establish a liability scheme similar to ACC where those injured by AVs are compensated through levies paid into the fund by AV fleet owners/operators, as well as by the AV software and AV hardware companies? If so, what changes are needed?

8. **For fully autonomous Level 5 AVs** operating on New Zealand's public roads in the near future, we suggest a variety of considerations. These include the need to establish whether AVs may be owned or operated by individual owners or only by fleet operators, Public Road Testing Standards, software standards, vehicle and computer hardware maintenance standards, testing simulation standards, reporting requirements for AV owner/operators that deliver meaningful AV metrics, as opposed to the disengagement rules utilised in California, IT security standards, privacy standards regarding AV data, post-incident data sharing requirements, initial registration and on-going certification process for AV safety drivers, initial registration and on-going certification process for those remotely observing and operating the AVs. Others have put forward recommendations for legal reform which should also be considered.[33]

Conclusion

New Zealand can be agile and prescient in these technologically transformative times. Doing so will foster an environment of safety and security for the travelling public, as well as foster innovation and investment. Not doing so reflects the habits of a by-gone era where we reacted to the whims of industry and played a game of catch-up with the developing world. This is not the day or hour for playing games or for waiting for others to lead the way. Our new era should reflect an ongoing partnership between government and technology so that no one is left behind.

Biographies

Mitchell L. Gingrich

Launching accurately reflects the professional experience that Mitch brings to everything that he does. This was first evidenced in building a solo law practice into a well-regarded law firm in Akron, Ohio, USA where he shepherded clients through the complexities of launching businesses and non-profit organizations looking to improve the lives of those within their communities.

An entrepreneurial bent led to him wearing multiple hats as a co-founder of Mims Motors Corporation, an electric vehicle company based in Las Vegas, Nevada, USA, and to participating in the development of autonomous vehicles with Uber ATG in Tempe, Arizona, USA. In relocating to New Zealand in 2018, Mitch is launching a consulting business where he assists the government and industry in developing policies relating to the testing and use of autonomous vehicles in public areas.

He holds a Bachelor of Arts from The University of Akron (1985) and a Juris Doctor from The University of Akron School of Law (1988).

Steven Moe

Steven is a partner at Parry Field Lawyers and host of the podcast seeds. He works across the country to help establish and provide advice to companies, investors, social enterprises and not for profits. He is from Christchurch and after 3 years working at a national law firm in Wellington, Steven spent 11 years overseas working for an international law firm in Tokyo (4 years), London (3 years) and Sydney (4 years) before returning to New Zealand at the start of 2016. He has a unique focus on empowering impact and published the book: "*Social Enterprises in New Zealand: A Legal Handbook*". To educate and grow the impact ecosystem he hosts the popular weekly podcast seeds interviewing inspiring people with more than 150 interviews and more than 50,000 listens.

Endnotes

[1] https://auto.howstuffworks.com/da-vinci-car1.htm
[2] Houdina used a Chandler automobile for his demonstration. Interestingly, Waymo operates a fleet of robo-taxis in the Phoenix suburb of Chandler, Arizona.
[3] https://www.digitaltrends.com/cars/history-of-self-driving-cars-milestones/
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[11] https://www.forbes.com/sites/bradtempleton/2019/11/19/ntsb-hearing-blames-humans-software-and-policy-for-fatal-uber-robocar-crash/#3fa181de4c6d The National Transportation Safety Board determined that the inattentiveness of the Uber ATG safety driver was a factor in the accident (NTSB Findings #s 9 and 10).
[12] https://www.azcentral.com/story/news/local/tempe/2019/03/17/one-year-after-self-driving-uber-rafaela-vasquez-behind-wheel-crash-death-elaine-herzberg-tempe/1296676002/
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[26] https://www.cnbc.com/2019/11/18/self-driving-cars-still-face-many-hurdles-says-chinese-automaker.html
[27] https://www.forbes.com/sites/bradtempleton/2019/11/19/ntsb-hearing-blames-humans-software-and-policy-for-fatal-uber-robocar-crash/#3fa181de4c6d The recent spate of articles concerning the need for AV regulation buttresses our position that regulation not only is needed but also a significant aspect in inviting innovation and investment in the AV sector.
[28] Geofencing involves digitally limiting the active range of an AV, much like fencing a paddock.
[29] Automation complacency refers to drivers of vehicles with automated safety features, such as lane keep assist or adaptive cruise control, which are common in many modern vehicles, growing complacent with the task of driving. In the AV context, the risk of automation complacency is higher due to the higher degree of automation in AVs operating at SAE Levels 2-4, which are the kind of AVs currently being tested. Automation Complacency does not exist when AVs operate at SAE Level 5.
[30] Intel estimates that each AV may accumulate and store at least 4,000 GB of data daily.

[31] V2V stands for “Vehicle to Vehicle” wireless communications. V2X stands for “Vehicle to Everything” wireless communications. Needless to say, 5G Networks are essential to the effectiveness of V2V and V2X communications in the AV sector.

[32] This would be similar to the aviation industry where the need for aircraft maintenance and its documentation is obvious.

[33] See Michael Cameron’s report, “Realising the Potential of Driverless Vehicles”, The New Zealand Law Foundation, 2018