

**Developing the Regulatory Environment for Autonomous Vehicles:
Historical Lessons for the Socio-technical Transition**

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DEDICATION

To Mom, Dad, and Robby
Because I grew up, got in, and got through, all with help from you

I love you with all my heart,
more than you can imagine, y más.

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Mom and Dad, thank you for making it possible for me to come to my dream school. I am at a loss for words and am overcome with emotion and gratitude, crying as I try to write this. I will never be able to repay you for the life you have given me. I think that because I had you as a support system, I didn't question so hard whether I was truly supposed to be admitted into Princeton. I am an extension of you, and you deserve everything, so I knew you deserved Princeton and that made me feel like I could do it. Making you proud has always been my motivation.

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"I'll get it if you need it, I'll search if you can't see it. You're thirsty, I'll be rain, you get hurt I'll take your pain. I know you don't believe it, but I said it and I still mean it, when you heard what I told you, when you get worried, I'll be your soldier." - Soldier, Gavin DeGraw

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Lastly, I want to acknowledge my motivation for studying this topic for my thesis. I have always had a soft spot for children and am interested in policies that promote the wellbeing of children. Injuries sustained from car crashes are amongst the leading causes of death for children,¹ and it is my hope that autonomous technologies will greatly reduce fatalities in crashes.

¹Centers for Disease Control and Prevention. “10 Leading Causes of Death by Age Group Highlighting Unintentional Injury Deaths, United States- 2014” Accessed April 1, 2017. <https://www.cdc.gov/injury/wisqars/leadingcauses.html>

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ABSTRACT

The shift to autonomous vehicles will be as, if not more, revolutionary than the transition from the horse-and-buggy to the personal automobile. By removing human error, which plays a role in 94 percent of automobile crashes, the deployment of autonomous vehicles can save thousands of lives. Our federal and state governments and scholars agree that autonomous vehicle technologies will also save billions of dollars by reducing collision costs and improving fuel economy, and will create social benefits such as reducing traffic congestion and providing mobility to thousands who were previously excluded from personal transportation options, such as the young, the elderly, and the blind. It is not debated whether autonomous technologies should be pursued, but whether technology is safe enough at the moment, and what type of regulatory environment will best promote safe innovation, testing, and commercialization of these technologies. This paper contributes to the regulatory dialogue by studying the major historical shift in transportation, from the horse-and-buggy to the personal automobile, to determine what parallels can be drawn between the historical shift and the current transition to autonomous vehicles. The parallels proved that lessons learned from the previous transition can help scholars and policy makers assess the status of the current transition and future of autonomous vehicle technology. This paper utilizes a multi-level, socio-technical lens to examine the historical transportation transition, placing emphasis on the formation of the regulatory regime for the personal automobile. A comparative analysis of the formation of the historical regulatory environment and developing regulatory environment for autonomous vehicles completes this study. This paper finds that the regulatory environment for autonomous vehicles is in its nascent form, marked by a lack of state-level regulatory uniformity and a lag in federal intervention that also characterized the historical shift in transportation. Lessons learned indicate that the NHTSA should mandate federal vehicle safety regulations for manufacturers of autonomous vehicles before commercialization, and the DOT should promote uniformity of state legislation in order to remove barriers to testing and future commercialization, and should fund autonomous vehicle infrastructures as the need presents itself. The developing regulatory environment for autonomous vehicles is following in the path of its historical counterpart and will become increasingly explicit and expansive as the perceived benefits of autonomous vehicles push government agencies and the public to pursue a new transportation landscape of autonomous vehicles.

INTRODUCTION

The shift to autonomous vehicles will be as, if not more, revolutionary than the transition from the horse and buggy to the personal automobile.² Autonomous vehicles hold the potential to make personal transportation safer by removing human choice and error, which plays a role in 94 percent of the automobile crashes. The National Safety Council estimates that in 2016, around 40,000 people died in automobile crashes, making it the deadliest year on US roadways since 2007. Further estimates conclude that around 4.6 million people required medical attention after car accidents in 2016, generating an estimated cost to society of \$462 billion.³ The deployment of autonomous vehicles can save thousands of lives, create huge economic and social benefits such as saving billions of dollars from reduced crash costs, better fuel economy, and reduced congestion⁴, and provide mobility to thousands more who were previously excluded from personal transportation options, such as the young, the elderly, and the blind.⁵

This paper analyses the first major shift in personal transportation, from the horse-and-buggy to the personal automobile, in order to derive lessons learned that should be taken into consideration in the ongoing research and debate surrounding the future regulatory environment for autonomous vehicles. What parallels can be drawn

² Foxx, Anthony, introductory message to Federal Automated Vehicles Policy 2016. September 2016. 3.

³ “2016 Motor Vehicle Deaths Estimated to be Highest in Nine Years.” National Safety Council. Accessed February 20, 2017. <http://www.nsc.org/learn/NSC-Initiatives/Pages/Fatality-Estimates.aspx>

⁴ Keating, Lauren. “How Safe Are Autonomous Vehicles?” *Tech Times*. July 28, 2015. Accessed March 24. Original source: Eno Center for Transportation.

<http://www.techtimes.com/articles/67253/20150728/driverless-cars-safe.htm>

⁵ Federal Automated Vehicles Policy 2016. Executive Summary. September 2016. 5-6.

between the historical shift in personal transportation and this current transition, and what do they mean for the current status and future of autonomous vehicle technology?

In order to answer these questions, this paper examines the historical transportation transition using a multi-level, socio-technical lens, placing emphasis on the formation of the regulatory regime for the personal automobile. This is followed by a study of current regulatory environment for autonomous vehicles in order to draw parallels between the two transitions. By drawing parallels and noting differences between the historical transportation regime shift and the current regime shift, this paper plots where in transition the automobile industry currently is relative to its historical counterpart and offers insight into how well this transition is fairing.

This paper is organized as follows: Chapter 1 explores scholarship and debate surrounding automated vehicle technologies and explains how this paper will extend the literature on the subject; Chapter 2 examines the history of shifts in transportation regimes, starting in 1886⁶, the year of the first patent filing for a horseless carriage, through the various socio-technical shifts that brought us to the personal automobile; Chapter 3 provides a detailed study of the development of the automotive regulatory environment; Chapter 4 examines the lag in federal intervention and the implications of the gradual expansion of federal regulatory jurisdiction over the automotive industry; Chapter 5 details the current federal and state regulations for automated vehicles in order to draw parallels and highlight differences between the historic transition to the personal automobile and the future transition to the autonomous vehicle, and Chapter 6 concludes,

⁶ Daimler, Gottlieb. MOTOR ENGINE. U.S. Patent US349983 A. Filed May 13, 1865, Issued September 28, 1886.

charting explicit parallels between the historical transition and the present one and presenting lessons learned.

CHAPTER 1: CURRENT DEBATE SURROUNDING AUTONOMOUS VEHICLES

"The question isn't a technological question, it's a regulatory and policy question of how to incorporate vehicles on the roadways while we still have motor vehicles that are operating fully by people behind the wheel."

- Ryan Hagemann, civil liberties policy analyst at the Niskanen Center and fellow on robotics at TechFreedom, in interview with Tech Times⁷

The current issues surrounding the testing and commercialization of autonomous vehicles have been well publicized, and the various arguments put forth will play an important role in shaping public perception around the vehicles, which, in conjunction with the nature of the regulations established, will eventually determine the success of their proliferation. Since President Donald Trump took office and pledged to drastically reduce the amount of regulation imposed by the federal government, there has been an uptick in activity relating to autonomous vehicles.⁸ While the president himself has not yet addressed autonomous technologies, the recently confirmed Transportation Secretary Elaine Chao has promised to leave automakers room to innovate. During her confirmation hearing this January, she said: "We are now seeing the advent of autonomous vehicles, artificial intelligence, smart cars and also drones. While the benefits are very much known, there are also concerns about how they will continue to develop and I will work with this committee and the Congress to address many of these

⁷ As quoted in: Keating, Lauren. "How Safe Are Autonomous Vehicles?" *Tech Times*. July 28, 2015. Accessed March 24, 2017. <http://www.techtimes.com/articles/67253/20150728/driverless-cars-safe.htm>

⁸ Ibid.

concerns, but we need to do so in a way that will not dampen the basic creativity and innovation of our country.”⁹ The views of the executive branch are guaranteed to bolster the position of the automotive manufacturers and others with stakes in the adoption of autonomous technologies, and will without a doubt incite increased debate surrounding this technology as the commercialization of these vehicles seems less far off in the horizon than many previously thought.

This chapter outlines the main concerns about automotive technologies and the existing regulatory system that are being discussed by legislators and the general public and illuminates how this paper will expand upon this debate.

Just today,¹⁰ news headlines flashed that Uber will halt its testing of autonomous vehicles in Arizona, after one of its vehicles was involved in a collision with a non-autonomous vehicle last night. The autonomous vehicle was not at fault, and neither the driver of the vehicle at fault nor the person sitting in the driver’s seat of the vehicle in self-driving mode were injured, but Uber has decided to suspend testing until an investigation into the collision is complete.¹¹ This incident comes at an inopportune time for the company, as they have already clashed with regulators, pushing to allow for testing on public roads. They also fell into trouble in San Francisco for testing without registering for a testing permit. Later they did apply and had their permit revoked,

⁹ Ibid.

¹⁰ March 25, 2017.

¹¹ Isaac, Mike. “Uber Suspends Tests of Self-Driving Vehicles After Arizona Crash”. *New York Times*. Published March 25, 2017. Accessed March 25, 2017.

https://www.nytimes.com/2017/03/25/business/uber-suspends-tests-of-self-driving-vehicles-after-arizona-crash.html?_r=0

causing them to take their testing to Arizona, where they were not required to register to test autonomous technologies on public roads.¹²

Stories like these cast doubt on the safety of these vehicles within the public perception and challenge the notion that the collision avoidance technologies are ready to hit the roads. Amongst legislators and the general public, the safety of this technology is one of the most heavily debated subjects. Safety is invoked on both sides of the debate. Those who favor the proliferation of autonomous technologies and seek to speed along the “road to deployment”¹³ point to the fact that this is a potentially life-saving technology. The testimony that GM vice-president of global strategy Mike Abelson prepared for Congress summarizes the position of this camp:

“With 94 percent of fatal crashes caused by human behavior, there is tremendous potential in deploying technology that can do much better,” the testimony reads. “Self-driving cars won’t drive while impaired by drugs or alcohol, they won’t be distracted by a cell phone, they won’t drive drowsy or recklessly, and their speed will be limited to that of the local laws and conditions.”¹⁴

Those who favor a faster road to proliferation for autonomous vehicles point out that the safety benefits of autonomous vehicles will likely only be realized if the adoption of this technology nears 100 percent.¹⁵

¹² Ibid.

¹³ Laing, Keith. “Congress revs up debate over self-driving cars” Detroit News Washington Bureau. Published Feb. 13, 2017. Accessed March 24, 2017. <http://www.detroitnews.com/story/business/autos/2017/02/13/congress-revs-debate-self-driving-cars/97855966/#>

¹⁴ Ibid.

¹⁵ Ryan Hagemann, quoted in Keating “How Safe Are Autonomous Vehicles.”

Others feel that this technology will advance road safety in the future, but argue that the transition to autonomous vehicles will be dangerous because human drivers won't know how to anticipate the behavior of autonomous vehicles, and thus many of the safety benefits will not appear until the majority of the cars of the road are autonomous. John M. Simpson, director of consumer relations at Consumer Watchdog explained, "the problem with some of the crashes, while technically not Google's fault, they are in fact [at fault] because in some sense people don't understand how to react with a driverless vehicle." I think what may have happened in some of the cases is that it could be that Google cars are not reacting the way that human drivers would."¹⁶

Contributors on both sides of the debate understand that safety benefits may take time to actualize, but other economic and social benefits of autonomous technologies will be more immediate.

Table 3. Estimates of Annual Economic Benefits from Autonomous Vehicles (AVs) in the United States

Assumed adoption rate	10%	50%	90%
Crash cost savings from AVs			
Lives saved (per year)	1,100	9,600	21,700
Fewer crashes	211,000	1,880,000	4,220,000
Economic cost savings	\$5.5 B	\$48.8 B	\$109.7 B
Comprehensive cost savings	\$17.7 B	\$158.1 B	\$355.4 B
Economic cost savings per AV	\$430	\$770	\$960
Comprehensive cost savings per AV	\$1,390	\$2,480	\$3,100
Congestion benefits			
Travel time savings (millions of hours)	756	1680	2772
Fuel savings (millions of gallons)	102	224	724
Total savings	\$16.8 B	\$37.4 B	\$63.0 B
Savings per AV	\$1,320	\$590	\$550
Other AV impacts			
Parking savings	\$3.20	\$15.90	\$28.70
Savings per AV	\$250	\$250	\$250
Vehicle miles traveled increase	2.0%	7.5%	9.0%
Change in total # of vehicles	-4.7%	-23.7%	-42.6%
Annual savings: economic costs only	\$25.5 B	\$102.2 B	\$201.4 B
Annual savings: comprehensive costs	\$37.7 B	\$211.5 B	\$447.1B

Source: Eno Center for Transportation.

¹⁶ As quoted in the Keating, "How Safe Are Autonomous Vehicles."

For example, this table from the Eno Center of Transportation (above)¹⁷ quantifies the expected annual economic benefits of switching to autonomous vehicles in the United States. Note that the values of these benefits are estimated at various levels of adoption, providing a strength to those arguing for the catalyzed commercialization of the technology that is lacking in the safety argument.

While those against rapid commercialization of autonomous vehicle technologies do not argue about the eventual reduction in fatalities and the economic benefits that the technologies will produce, they question the safety of these automobiles from a variety of angles. Just this month¹⁸ in Colorado, the Senate Transportation Committee heard testimony for those arguing both sides of the safety debate. Many felt that the first driverless vehicle bill proposed in Colorado did not do enough to specifically address safety concerns of these vehicles.¹⁹ One representative of a steel company testified that he had witnessed manufacturing accidents involving highly automated equipment before, and that “we are simply not ready for the deadly effects of this new and unproven technology.”²⁰ Another representative of commercial drivers was concerned about the fact that the Colorado bill in particular did not include a provision requiring a fail-safe mechanism, such as a driver in the front seat that could take over the car in a manual mode if the automated technology were to malfunction.²¹ The requirement of having a

¹⁷ Keating, Lauren. “How Safe Are Autonomous Vehicles?” *Tech Times*. July 28, 2015. Original source: Eno Center for Transportation.

¹⁸ March, 2017

¹⁹ Chuang, Tamara. “First driver-less vehicle bill in Colorado headed to Senate debate: Opponents of the “light-touch” bill say it doesn’t go far enough with safety.” March 16, 2017, Updated March 22, 2017. Accessed March 24, 2017.

<http://www.denverpost.com/2017/03/16/driver-less-vehicle-bill-colorado-debate/>

²⁰ Charles Perko, of EVRAZ Rocky Mountain Steel, as quoted in Chuang, *ibid*.

²¹ Kiersten Forseth, of the Colorado AFL-CIO, as quoted in Chuang, *ibid*.

driver in the front seat that is able to turn the vehicle to manual mode currently varies by state.

Arguments looped into the safety debate include issues surrounding ethical decision making and the possibility of hacking. One of the classic ethical appeals uses the hypothetical, yet highly possible, situation in which a child chases a ball into the street. Would a driverless car swerve into oncoming traffic, risking a head-on collision that endangers the driver and the car but saves the child?²² Would the car brake immediately, risking an accident with a car behind it? This question has yet to be consistently answered by manufacturers testing autonomous technologies. Nevertheless, these split second decisions, some argue, would not be perfect coming from a human driver nor from an algorithm, and they are only necessary in rare circumstances.²³

The other main safety worry from the camp critical of autonomous technologies is the possibility of autonomous technologies being hacked by terrorists. In July 2015, it was reported that hackers were able to remotely disable a Jeep Grand Cherokee, resulting in a massive recall as Fiat worked to strengthen its software against cyber attacks. That same month, two senators proposed the SPY Car Act,²⁴ which would mandate increased precautions on the part of manufacturers to ensure that the autonomous software was less vulnerable to cyber attack. The act would also require the Federal Trade Commission to rate the different cars in terms of their vulnerability to cyber attack, and the cars would receive stickers that allow consumers to evaluate their safety, just like they evaluate gas

²² John M. Simpson, director of consumer relations at Consumer Watchdog, quoted in: Keating, “How Safe Are Autonomous Vehicles?”

²³ Ryan Hagemann, quoted in Keating, *ibid.*

²⁴ Security and Privacy in your Car Act of 2015. S.1806. 114th Congress.

mileage.²⁵ To date, this act has yet to pass,²⁶ but this aspect of the safety debate remains at the forefront of the public and policymakers' minds. The DOT and NHTSA's Federal Automated Vehicles Policy included vehicle cybersecurity as one of the performance areas which they want manufacturers to voluntarily report on in a Safety Assessment Letter to the NHTSA.²⁷ While software security is a worthy consideration, Hagemann pointed out that "all the cars on the roadways right now can already be hacked through Wi-Fi signals."²⁸ Therefore, hacking by terrorists is a possibility, but is not a new challenge that is particular to autonomous vehicle technology.

While the safety debate is ongoing, even those who fear the technology in its current state do not argue against the idea that autonomous vehicles are the future of transportation. Thus, the second main debate within scholarly and public discussion surrounding autonomous vehicles addresses the question of how this technology should be regulated. The two sides of the argument can be grouped into those who feel that premature regulations could hinder innovation and slow the adoption of the technology²⁹ and those who contend that federal regulators need to aim to keep pace with this rapidly evolving technology, regulating it before it is commercialized.^{30 31}

²⁵Keating, Lauren. "How Safe Are Autonomous Vehicles?"

²⁶All Bill Information (Except Text) for S.1806 - SPY Car Act of 2015. Accessed March 26, 2017. <https://www.congress.gov/bill/114th-congress/senate-bill/1806/all-info>

²⁷Department of Transportation and National Highway Traffic Safety Administration, "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety," September 2016. 13-14.

²⁸ As quoted in the Keating, "How Safe Are Autonomous Vehicles?"

²⁹ Thierer, Adam and Hagemann, Ryan. "Removing Roadblocks to Intelligent Vehicles and Driverless Cars" (Mercatus Working Paper, George Mason University, 2016) 10-12. Accessed March 26, 2017. <https://www.mercatus.org/system/files/Thierer-Intelligent-Vehicles.pdf>

³⁰ Department of Transportation and National Highway Traffic Safety Administration, "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety," September 2016. Accessed February 21, 2017. 5-6.

³¹Laing, Keith. "Congress revs up debate over self-driving cars" Detroit News Washington Bureau. Published Feb. 13, 2017. Accessed March 24, 2017.

The extent of the federal government's jurisdiction over the regulation of the operation of autonomous vehicles is arguably a gray area. Currently, the NHTSA regulates automobiles and the states regulate drivers. In a situation where the automobile becomes the driver, the various roles of the federal and state-level regulators could be re-evaluated.³² The various voices in the regulatory debate promote different levels and different areas of involvement for federal agencies.

The federal regulatory agencies and their supporters, which include some states, former President Barack Obama, and those who fall on the wary side of the safety debate discussed above, favor the view expressed by President Obama in an opinion editorial that he wrote for the *Pittsburgh Post-Gazette*. He championed the guidelines issued in the Federal Automated Vehicles Policy, writing, "We're also giving guidance to states on how to wisely regulate these new technologies, so that when a self-driving car crosses from Ohio into Pennsylvania, its passengers can be confident that other vehicles will be just as responsibly deployed and just as safe."³³ Aside from pointing out the benefit to creating a uniform regulatory environment across states for manufacturers and consumers of autonomous technologies, he also assured readers that the government understands that over-regulation could hinder innovation. "Regulation can go too far. Government sometimes gets it wrong when it comes to rapidly changing technologies.

<http://www.detroitnews.com/story/business/autos/2017/02/13/congress-revs-debate-self-driving-cars/97855966/#>

³² Vock, Daniel. "The Gray Area of Driverless Car Regulation." September 28, 2016. Accessed March 24, 2017. <http://www.govtech.com/fs/The-Gray-Area-of-Driverless-Car-Regulation.html>

³³ As quoted in Vock, *ibid*.

That's why this new policy is flexible and designed to evolve with new advances," he added.³⁴

Others believe the federal government should focus their efforts on removing barriers to commercialization and helping increase public confidence in autonomous technologies.³⁵ Some automotive manufacturers have called upon federal regulators to help pave the way for the introduction of autonomous vehicles, stating that current federal regulations assume that there is always a human driver and therefore are not equipped to regulate autonomous vehicles.³⁶

Scholars, states, and manufacturers on the flip side of the coin argue for "permissionless innovation"³⁷ at the most extreme and at the very least precaution against the creation of a complex pre-emptive regulatory environment for autonomous vehicles. Permissionless innovation refers to the idea that "experimentation with new technologies and business models should generally be permitted by default."³⁸ Scholars that promote permissionless innovation believe that innovation should be allowed to continue as long as it does not pose a serious and imminent threat to the public well-being, and that problems should be addressed after they arise rather than proactively.³⁹ They argue that this notion drives entrepreneurialism and is a primary reason for economic growth in many sectors, and cite the Internet as a powerful modern example of the social and

³⁴ Ibid.

³⁵ Anders Karrberg, vice president government affairs for Volvo, testimony to Congress as quoted in Laing, "Congress revs up debate over self-driving cars."

³⁶ Mike Abelson, GM vice-president of global strategy, testimony to Congress as quoted in Laing, *ibid.*

³⁷ Thierer, Adam and Hagemann, Ryan. "Removing Roadblocks to Intelligent Vehicles and Driverless Cars" (Mercatus Working Paper, George Mason University, 2016) 10-12. Accessed March 26, 2017. <https://www.mercatus.org/system/files/Thierer-Intelligent-Vehicles.pdf>

³⁸ Ibid.

³⁹ Ibid.

economic benefits that can arise by letting innovation flourish without being impeded by heavy regulation.⁴⁰

States show their general alignment with this stance when they do not follow the more restrictive suggestions of the federal guidance that was issued in 2016. It is expected that the states that are viewed as more “industry-friendly,” such as Florida, Michigan, and Texas, will ignore the more restrictive suggestions and may even market their relatively lax regulatory regimes to manufacturers wishing to test autonomous vehicles.⁴¹ As one sponsor of the Colorado bill on autonomous vehicles warned: “When we start putting too many specifics in these bills, in these regulations, we risk regulating an industry out of existence before it has a chance to prove itself. That’s why we focused in our bill that you have to coordinate with CDOT and state patrol if you can’t show that you are safe and can follow the rules of the road.”⁴²

A middle ground will likely be found, as the federal government is aware of its responsibility to allow this potentially life-saving technology to develop as quickly and efficiently as possible, and those advocating for a lighter regulatory environment during the development and introduction of autonomous vehicles understand regulatory intervention as permissible in cases where the safety of the public is at risk.

To date, scholarship and debate surrounding current and future autonomous vehicle regulation does not include any thorough analysis of, nor invoke, lessons learned

⁴⁰ *ibid.*

⁴¹ Vock, Daniel. “The Gray Area of Driverless Car Regulation.” September 28, 2016. Accessed March 24, 2017. <http://www.govtech.com/fs/The-Gray-Area-of-Driverless-Car-Regulation.html>

⁴² Owen Hill, as quoted in the Chuang, “First driver-less vehicle bill in Colorado headed to Senate debate: Opponents of the “light-touch” bill say it doesn’t go far enough with safety.”.

from the only historical example of a massive shift in personal transportation that we have to call upon, the transition from the horse-and-buggy to the personal automobile. This paper extends current scholarship by contributing another lens through which one can monitor and understand the current transition occurring within our transportation regime. This paper utilizes a historical, socio-technical lens to examine how the regulatory environment around personal automobiles formed at the state and federal level with the purpose of gaining insights that can be applied to the current shift in personal transportation. This paper does not make regulatory policy recommendations, but aims to further the conversation about the state and federal government's roles as regulatory bodies at various stages of the development of this technology.

CHAPTER 2: MULTI-LEVEL ANALYSIS OF SOCIO-TECHNICAL TRANSITIONS IN THE TRANSPORTATION INDUSTRY

*"The remains of the old must be decently laid away; the path of the new prepared. That is the difference between Revolution and Progress."*⁴³

-Henry Ford

By analyzing the transitions that brought America from horse and buggies to automobiles from a multi-level perspective, we seek to understand the how each socio-technical system in the transportation industry was created and then embedded into society over time. While we often think of disruptive technologies as “revolutionizing” a market, Ford’s quote rings true for the technological advances of the automotive industry. The path of the new must be prepared before a switch, and in the transportation industry this occurs by way of niche markets and intermediate technologies. This paper utilizes multi-level analysis because, unlike the substitution method of analyzing technological transitions, the multi-level perspective emphasizes the importance of niche markets and intermediate technologies and their role in socio-technical transitions and also includes analysis of how policies and regulations, user preferences, infrastructures, and cultural viewpoints affect transitions.⁴⁴ This chapter is informed by the multi-level analysis completed by Dr. Frank Geels on the transition from the horse and buggy to the

⁴³ Ford, Henry. *Ford News*. May 5, 1922. 2. Accessed January 19, 2017.

<https://www.thehenryford.org/collections-and-research/digital-resources/popular-topics/henry-ford-quotes/>

⁴⁴ Geels, Frank W. "The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930)." *Technology analysis & strategic management* 17.4 (2005): 445-476. <http://dx.doi.org/10.1080/09537320500357319>

automobile from 1860 to 1930, and the history explored here is used to draw parallels to the current socio-technical shift occurring within our modern transportation regime.

Explanation of Multi-Level Analysis

A brief description of the multi-level perspective proposed by Geels is offered here. There are three conceptual levels: niche, socio-technical regime, and socio-technical landscape. Within these levels, the study of the sociology of technology examines three interrelated dimensions: socio-technical systems, social groups, and rules (in the form of regulatory regimes). The socio-technical systems are the tangible elements which perform the societal functions, for example, the automobile. The social groups are responsible for maintaining and reproducing the elements of the socio-technical systems, and the rules regulate the behaviors of the social groups.

A key function of the multi-level perspective is to look past simple causality in the realm of socio-technical transitions and examine the “circular causality” of the transitions, that is, to examine the processes that occur at different levels simultaneously. When these processes link up and reinforce each other, the transition occurs. There isn’t simply one causal factor that causes a socio-technical shift. New technologies can remain stuck in their niche market for decades if processes within the current regime are misaligned. As long as processes at the regime level remain stable, it will remain difficult for a niche technology to diffuse.⁴⁵ Thus, examining the systems, groups, and

⁴⁵ Ibid, 445-543.

rules at the various conceptual levels offers a clearer picture of socio-technical transitions.

Socio-technical Transitions from the Horse-and-Buggy to the Personal Automobile 1860–1885⁴⁶

The landscape change towards urbanization is what created the need for an urban transit regime. Travelling by foot would no longer be effective in the larger cities, and thus the horse-based transport regime was created. The groups involved in this regime were largely the middle and upper classes, with the middle class riding horse-drawn omnibuses that had a capacity of 15 to 25 people, and the upper class utilizing horse-drawn taxis or their own private carriages. As early as 1830, New York had 70 omnibuses, but by the 1850s, the omnibuses were replaced by the innovation of the horse tram, a horse-drawn carriage that operated on railroads, that increased capacity by 100 percent and speed by 30 percent. The horse-tram became the first urban mass transportation mode, and the horse-based transportation regime expanded until the end of the 1800s.⁴⁷

The horse-based transit hit a literal bump in the road as cobblestones became problematic, damaging the carriages' wheels. Efforts to smooth the roads began after the Civil War during the first half of the 1860s, but by the 1870s, the work stalled as funds ran out and locals, who saw traffic as a hindrance and felt this change in infrastructure

⁴⁶ The analyses are broken down temporally by Geels. This paper does not change the time frames he proposed in his analysis.

⁴⁷ Geels, Frank W. "The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930)." *Technology analysis & strategic management* 17.4 (2005): 455-456. <http://dx.doi.org/10.1080/09537320500357319>

inequitably benefitted the wealthy, resisted. Meanwhile, other forms of transportation were developing niches, but did not threaten the current transport regime. Bicycles, electric vehicles, and steam automobiles were novelties that were utilized as forms of entertainment during this time, but they were not reliable enough for practical transport. Bicycles were seen as toys as the wealthy and were raced on tracks, and electric vehicles suffered from heavy batteries and weak motors. Steam automobiles showed more potential as steel made a lighter and smaller design possible. Steam automobiles were shown at racetracks and circus parades in the 1860s and 1870s, but despite the technical improvements made up until the 1880s, the steam automobile did not diffuse outside of the entertainment niche because regulators responded to the public's resistance to the exhaust, speed, and potential for explosion that defined the steam automobile.⁴⁸ Summarily, up until the 1880s, the socio-technical landscape was one of increasing urbanization, which spurred the development of a horse-drawn transportation regime. Technological developments led to radical niche transport options that did not threaten the current regime. The regime however, began to destabilize as cobblestone roads proved damaging, improving infrastructure proved difficult, and horse trams were costly.

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1885-1903

The new landscape development of the 1880s and 1890s was immigration. Within these two decades, over 60,000 immigrants entered the United States. Urbanization continued as immigrants and the working class flooded into urban areas, but

⁴⁸ Ibid, 455-456.

⁴⁹ Ibid, 455-456.

urban dwelling came to be associated with crowding, unsanitary conditions, and danger. As a result, middle and upper class citizens began to spread to suburban areas. At the social level, the middle class became larger and more people became salaried employees. This increased disposable income and leisure time within the middle class, and as a result, led to the development of popular culture. Emphasis on entertainment, active lifestyles, and movement away from cities catalyzed the formation of new socio-technical systems that would start to apply pressure to the horse-drawn transport regime. Four broader socio-technical landscape issues led to the breakdown of the horse-drawn transit regime during this period. The cost of feeding and stabling horses pushed tram companies to become interested in finding other ways to propel trams. Horses also posed safety risks of kicking, biting, or running people over. The third and fourth problems were congestion and pollution. The city roads did not accommodate heavy traffic well and the horse trams took up much of the width of the road. The pollution issue was due to the horse manure, which housed bacteria that could produce respiratory infections. Giving strength to the pollution issue was the growing cultural predilection for practicing better hygiene. As health and hygiene garnered more attention in the public discourse, horses fell from the graces of the public. Thus, from cultural, economic, and technical standpoints, the horse began to cripple the horse-drawn transport regime, making room for the diffusion of transportation options that had once only been utilized in niches.⁵⁰

Electric trams replaced horse trams within the next fourteen years, creating a new transport regime. From the technological and economic standpoints, the tram was twice

⁵⁰ Ibid, 456-463.

as fast as the horse tram and the operational costs were lower, despite the initial high switch costs that came from the need to build up electrical infrastructure. Horse tram companies wanted to make the switch, and just needed to be able to overcome the switch costs. The switch cost is where the cultural dimension made the difference. Powerful social groups supported the switch to the electric tram and were willing to invest in the infrastructure. Electric companies welcomed the new electric market, real estate developers invested in tram cables to raise the value of their properties, and local authorities voiced their support of the electric tram as a means to support suburbanization. Another cultural layer that added to the regime change was a general enthusiasm surrounding the use of electricity. This “hype” around electricity made investors all the more ready to help tram companies make the switch.⁵¹

The switch to electric trams caused greater socio-technical ripple effects that paved the way for personal automobile. The trams, or “trolleys” catalyzed suburbanization by providing a cheap mass transit system and made it possible for the less wealthy to engage in tourism to the countryside. Both suburbanization and tourism created travel patterns that would later be supported by automobiles. Aside from these changes in physical behaviors, the trolleys also changed cultural perceptions surrounding transport. Streets, previously understood as gathering places and markets, became increasingly viewed as travel arteries, and residents became used to high speed vehicles overtaking the streets. Of course, these perceptions did not shift smoothly nor overnight. Trolleys faced protests in the first few years of their use because of accidents and

⁵¹ Ibid, 456-463.

fatalities they caused. Additionally, local residents who still viewed streets as social forums resisted road improvements in the 1890s until increased street traffic diminished their authority and transferred power to public authorities, who in turn had hundreds of miles of roads paved with asphalt and similar materials by 1900.⁵²

In this time frame, automobiles emerged as a radical innovation, but remained in niches marked more by societal enthusiasm than actual practicality. By 1900, cars were utilized as toys for the wealthy. Gasoline cars were used for sport and touring, while electric cars were used as luxury transport within cities. The separation between the two types of cars persisted while cars remained in their market niches.⁵³

1903-1914

Within this period, the socio-technical car regime solidified and horse-drawn transportation receded into a niche market before disappearing. Up until World War II, horses were used to transport freight. From a social standpoint, this niche market quelled social unrest by reducing the unemployment shock for social groups tied to horse transport. Gasoline cars increased in numbers because touring the countryside gained popularity as a leisurely activity from 1902 to 1907. Electric cars did not penetrate this niche as their need to recharge limited their range, and were mainly utilized as luxury toys for promenading and attending tea parties. While it was unclear which niche steam cars targeted, as the craftsmen focused more on the beauty of the machine than any customer base, both electric and steam vehicles maintained their shares of their market

⁵² Ibid, 463-465.

⁵³ Ibid, 463-465.

niches in the early 1900s, but gasoline cars shot up in sales within their niche. The chart below⁵⁴ shows that both electric cars and steamers decreased in sales by less 10 percent in the first half of the 1900s, but the sale of gasoline cars increased by close to 1,900 percent.

Table 1. Annual car sales in the USA

	1900	1905
Electric cars	1575	1425
Steamers	1681	1568
Gasoline cars	936	18,699
<i>Total</i>	4192	21,692

Source: Based on data from Kirsch (Ref. 72), and Mom (Ref. 42).

Gasoline cars got there utilitarian start in the taxi niche before winning out over electric cars and becoming a mainstream method of transport. This was preceded by a fleet of electric urban taxis operated by the Electric Vehicle Company (EVC) that enjoyed popularity from 1899 to 1902, but the batteries proved unstable, the cars suffered frequent breakdowns, and the EVC went bankrupt in 1903.⁵⁵ The electric taxis were generally viewed as a failed experiment and gasoline taxis were introduced by 1907.⁵⁶ The chart below⁵⁷ shows how quickly gasoline taxi cabs were adopted and proliferated in

⁵⁴ Ibid, 464.

⁵⁵ Ibid, 463-465.

⁵⁶ Salazar, Cristian. "NYC taxis through the years: from horse-drawn cabs to hybrids and beyond." amNewYork, Transit. June 29, 2016. Accessed February 20, 2017. <http://www.amny.com/transit/nyc-taxis-through-the-years-from-horse-drawn-cabs-to-hybrids-and-beyond-1.10037203>

⁵⁷ "The New York City Taxicab Fact Book" Schaller Consulting. March 2006. 30. Accessed February 20, 2017. <http://www.schallerconsult.com/taxi/taxifb.pdf>

New York City. In the first 30 years of the usage of the gasoline taxi, total taxi and livery numbers increased by over 20,000 percent in New York City alone.

Table 3. Growth of taxi and livery industries, 1907-2006

	Total Taxi and Livery*	Taxicabs	Car services	Black cars	Limousines	"Gypsy cabs"
1907	65	65				
1912	2,800	2,800				
1923	15,000	15,000				
1931	21,000	21,000				
1933	15,500	15,500				
1934	14,000	14,000				
1937	13,595	13,595				
During WW II	7,500	7,500				
1947	11,414	11,414				
1964	14,300	11,787	2,500			
1966	15,800	11,787	4,000			
1971	21,100	11,787	9,300			4,400
1973	25,500	11,787	13,700			
1983	34,200	11,787	21,300	1,080		14,000
1992	39,400	11,787	19,600	8,000	1,600	
May 1996		11,920				
Oct. 1996		12,053				
Sept. 1997		12,187				
2000	54,000	12,187	30,800	11,000	3,100	
2002	50,900	12,187	27,400	11,300	4,500	
2004	47,900	12,487	25,500	9,900	3,600	
2006	46,000	12,779	22,900	10,400	4,200	

Additionally, no dominant design emerged for electric cars. For a variety of technical and engineering reasons, Ford's Model T, a gasoline car, became the dominant design for the car industry once the luxury car market became saturated and sales dropped in 1907, signalling to other manufacturers that they should follow Ford's lead and head down-market. Electric cars faded from relevance as the lack of standardization

meant the design could not benefit from economies of scale and thus could not compete with the price of a Model T.⁵⁸

1914-1930s

The automobile increased in popularity in the 1910s by proving useful in two market niches. Farmers increasingly utilized cars instead of trains to transport their produce to avoid expensive fees, and the suburban middle class bought cars to commute to work in the city. At the same time, trolley companies were amassing large amounts of debt due to hikes in material prices that resulted from World War I. The public had come to view trolley companies unfavorably when they raked in profits in the years prior, and so the public authorities were not inclined to help out the dying industry. In fact, they taxed the trolley companies while subsidizing automobiles and motor buses.⁵⁹

The subsidy was just one legislative action taken to entrench the automobile's socio-technical regime. In this time period, new regulations helped promote the adoption of automobiles as the main method of transportation. Speed limits were relaxed to accommodate the faster technology, educational campaigns in schools taught pedestrians how to safely cross the street, traffic was organized in order to reduce congestion. Public authorities also worked to reduce child pedestrian fatalities by building playgrounds to keep them from playing in the roads, an early example of automobiles shaping both the cultural and physical landscape. Despite early safety efforts to reduce the number of

⁵⁸ Geels, Frank W. "The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930)." *Technology analysis & strategic management* 17.4 (2005): 463-465. <http://dx.doi.org/10.1080/09537320500357319>

⁵⁹ *Ibid*, 465-468.

pedestrian fatalities, the number of accidents did increase. Seventy-five percent of the victims were pedestrians, and most were children.⁶⁰

While the transition was not smooth, it certainly was successful in changing the socio-technical transportation landscape. By the 1930s, a “car culture” had emerged, further transforming the landscape into what it is today. Fast-food restaurants with drive through windows, drive-in movies, and strip malls on the outskirts of cities ensured that, even though not everyone owned one at this point, the automobile would be the way forward.⁶¹

Framing Thoughts

The multi-level perspective of the socio-technical transitions from the horse-and-buggy to the personal automobile provides a foundation from which we can begin to draw parallels to the transition that will occur from the automobile to the autonomous vehicle. The following chapter provides a closer examination of the formation of the automotive regulatory environment in early 20th century. By understanding how regulations formed, shaping and being shaped by the changing socio-technical landscape, we can gain insight into what may be appropriate behavior for policy makers in the transition to autonomous vehicles.

⁶⁰ Ibid, 465-568.

⁶¹ Ibid, 465-468.

CHAPTER 3: DEVELOPING THE REGULATORY ENVIRONMENT FOR AUTOMOBILES: 1906-1924

Of the three interrelated dimensions examined in the previous chapter: socio-technical systems, social groups, and rules (in the form of regulatory regimes), we can view these socio-technical systems and social groups as the components that inform the creation of the rules- the regulatory regime for automobiles that developed at the state, and later federal, level. This chapter examines three editions of *The Law of Automobiles* by Xenophon P. Huddy, an expansive encyclopedia that not only enumerates new automobile laws in each edition, but illuminates how the transition from horse-and-buggy to automobile slowly took shape via a combination of state legislation, expansions of existing legal paradigms, and thousands of court rulings. Both the content of these regulations and evidence of how they formed can be used to draw parallels to the current socio-technical transition to autonomous vehicles and to gain insight into issues that may arise further down the road of this transition.

Beginnings of a Regulatory Environment: 1906 to 1912

The first edition of *The Law of Automobiles* was published by lawyer Xenophon P. Huddy in 1906, and by 1912 he had published a third edition. We use these two volumes to explore the first decade of automobile regulations in America. In 1906, 37 states had passed some form of automobile legislation.⁶² The federal government had not

⁶² Huddy, Xenophon P. *The Law of Automobiles*. 1st ed. Matthew Bender & Co. Albany, N.Y., 1906. (University of Michigan, Hathi Trust) Accessed March 1, 2017. <https://babel.hathitrust.org/cgi/pt?id=mdp.35112104143559;view=1up;seq=21>

yet established itself as a regulatory body in the automotive realm, and only had jurisdiction over interstate travel, the reasoning being that the federal government had constitutional power over interstate commerce, and interstate travel by automobile arguable fell into under this umbrella.⁶³ At the state level, the statutes passed were so brief and uncomplicated in nature that Huddy was able to discuss each state individually in his first edition, whereas the third edition required the meticulous arrangement of chapters based on type of statute which was necessitated by the third edition. For the sake of brevity, we will discuss tendencies within the early legislation rather than mirror Huddy's state by state approach, as there were similarities that spanned across almost all of the states. As one will note, legislation across states is largely similar, with slight variations. Huddy advocated for uniformity in automobile legislation, arguing that both the motorist and the state would benefit from it. In his view, too much variation existed in state automobile legislation up until 1906⁶⁴, but this section highlights provisions that the majority of the states passed.

Almost every state that passed automobile legislation included provisions about registration, licensing and fees, speed regulations, some rudimentary "rules of the road", and penalties for violation of the statutes. Many states also required chauffeurs, manufacturers, and dealers to register with the state and prohibited municipalities from passing local ordinances that conflicted with the state-level legislation. Non-resident exemption clauses allowed drivers and cars from other states on public roads, as long as they had a tag that showed that the car was registered in the driver's home state, but the

⁶³ Huddy, Xenophon P. "Interstate Motoring," in *The Law of Automobiles*. 1st ed. 115.

⁶⁴ Huddy, Xenophon P. "Uniformity of Automobile Legislation," in *The Law of Automobiles*. 1st ed. 112.

lengths of time at which a non-resident car was allowed to do so varied in the early 1900s. One state only allowed non-resident automobiles on public roads for 48 hours, lest the driver need to register in the new state.⁶⁵

Speed regulations varied. Some states gave specific miles per hour limits, while other states simply noted that drivers should not drive about speeds that are “reasonable and proper.”⁶⁶ Many states included special speed provisions for cars approaching bridges and for turning sharp corners, as cars taking corners too quickly often “turned turtle,” the term used for cars flipping onto their backs.⁶⁷ Rules of the road sought to organize traffic, and were largely standardized across the states. Automobiles were to keep right and pass other vehicles on the left, and were to exercise caution so as to not frighten horses. Duties included signalling one’s approach with a bell and slowing down. Some states even required mufflers, along with other required equipment such as brakes and lamps, so as to reduce the overall noise of automobiles in an effort to avoid frightening horses.

Aside from the fear surrounding injuries caused by horses, states also took measures to minimize pedestrian deaths caused by automobiles. The only exception made for the legality of local ordinances occurred where some states deemed that certain locales could create specific speed limits in order to protect the public. Many states

⁶⁵ Huddy, Xenophon P. *The Law of Automobiles*. 1st ed. Matthew Bender & Co. Albany, N.Y., 1906. (University of Michigan, Hathi Trust) Accessed March 1, 2017.

<https://babel.hathitrust.org/cgi/pt?id=mdp.35112104143559;view=1up;seq=21>

⁶⁶ Huddy, Xenophon P. “South Dakota Section 8. Regulations,” in *The Law of Automobiles*. 1st ed. 294.

⁶⁷ Loomis, Bill. 1900-1930: The years of driving dangerously. *The Detroit News*. April 26, 2015. Accessed March 6, 2017.

<http://www.detroitnews.com/story/news/local/michigan-history/2015/04/26/auto-traffic-history-detroit/26312107/>

included provisions for municipalities to be able to regulate the speed of automobiles passing through parks, parkways, and cemeteries.⁶⁸ Nevertheless, pedestrian, and more specifically child deaths, became a massive issue and soared in numbers in later years as automobiles became more widely adopted.⁶⁹

Finally, most states legislated penalties for failure to comply with the new regulatory environment. Penalties included small fines or short prison sentences. This was an extremely simple legal environment compared to what is described in Huddy's third volume, published only six years later.

By 1912, the regulatory schema surrounding automobiles had become fairly complex, and legal experts had their sights set on the future of automotive innovation. In his third edition of *The Law of Automobiles*, Huddy quoted a ruling by Judge Cooley from 1876 to make a case for the proliferation of this new means of transportation,⁷⁰ showing that the legal field maintained Cooley's view decades later:

*“When the highway is not restricted in its dedication to some particular mode of use, it is open to all suitable methods, and it cannot be assumed that these will be the same from age to age, or that the new means of making the way useful must be excluded merely because their introduction may tend to the inconvenience or even to the injury of those who continue to use the road after the same manner as formerly.”*⁷¹

⁶⁸ Huddy, Xenophon P. “Parks, parkways, cemeteries excepted” in *The Law of Automobiles*. 1st ed. 257.

⁶⁹ Loomis, Bill. “1900-1930: The years of driving dangerously.”

⁷⁰ Huddy, Xenophon P. (Xenophon Pearce). *The law of automobiles*. 3rd ed. / by Howard C. Joyce. Albany, N.Y., 1912. *The Making of Modern Law*. Gale. 2017. Gale, Cengage Learning. Accessed March 1, 2017. <<http://galenet.galegroup.com/servlet/MOML?af=RN&ae=F152066871&srcht=a&ste=14>>

⁷¹ Huddy, Xenophon P. “Highways open to new uses,” in *The Law of Automobiles*. 3rd ed. 21.

The most pertinent part of this quote is the argument that a new technology should not be excluded from the roads just because it inconveniences, or even injures, those who use old technologies. Surely the threshold of permissible inconvenience and injury has changed over the decades, but this argument remains relevant in the current transition to autonomous vehicles.

The themes that arose with frequency in this volume included state police powers, negligence in operating automobiles, general education about what is to be expected in the automobile transportation regime, and liability and litigation. The power to legislate remained largely in the hands of the states, and “police powers” were on the forefront of legal experts’ minds, as they questioned which state-level regulations were permissible or unconstitutional. The concept of police powers arose out from the 10th Amendment, which reserves all powers not left to the federal government to the states and to the people. Police powers allow states to create and enforce laws that protect the safety, health, and welfare of the public.⁷² One of the biggest debates on the use of state police powers was whether the states had the right to gain revenue from the licensing of automobiles. In many cases the fees were put towards enhancing travel infrastructure, but Huddy believes that police powers did not encompass a right of taxation. The public also questioned the extent of police powers in lawsuits claiming that automobile legislation, such as those requiring licensing fees, was class legislation that singled out automobile drivers because it did not pertain to horse and buggy drivers. It was decided by the courts that states were within their constitutional rights to require certain behaviors

⁷² Legal Information Institute. Cornell University Law School. “Police Powers.” https://www.law.cornell.edu/wex/police_powers

or fees from automobile drivers and that this was not discriminatory, as drivers are not a “class” of people.⁷³ In general, however, the courts in this period tended to expand the rights of the motorist, promoting the idea that the automobile was not inherently an evil machine, but that negligence on the part of the driver was the source of the danger associated with automobiles.⁷⁴

Based on the frequency with which the subject of negligence arose in this volume (there were thirteen sub-sections that discussed various forms of negligence), one can infer that negligence on the part of the driver was one of the biggest issues affecting the safety of automobile travel, and educating the public about their duties as drivers, as well as creating a legal system that deals with various forms of negligence, were top priorities in the early years of the automobile. Even the status of the passenger was called into question, and it was made explicit that a passenger could not contribute to or be blamed for the negligence of the driver or chauffeur.⁷⁵ While this seems obvious to us within our current automotive socio-technical regime, the status of the passenger may realistically be called back into question with the introduction of autonomous vehicles that do not require human drivers. The duties of pedestrians were also addressed,⁷⁶ as pedestrians were used to walking where they pleased and often did not correctly anticipate the speed at which they would need to get out of the way of an approaching automobile. While today’s pedestrians utilize crosswalks and sidewalks and can gauge the speed of oncoming cars,

⁷³ Huddy, Xenophon P. “Constitutional Law, Class Legislation” in *The Law of Automobiles*. 3rd ed. 75-79.

⁷⁴ Huddy, Xenophon P. “Tendencies in Judicial Decisions,” in *The Law of Automobiles*. 3rd ed. 23.

⁷⁵ Huddy, Xenophon P. “Liability of Passenger for Negligence,” in *The Law of Automobiles*. 3rd ed. 342-343.

⁷⁶ Huddy, Xenophon P. “Pedestrians crossing street-duty to stop, look, and listen,” in *The Law of Automobiles*. 3rd ed. 182-183.

they may need to be educated on how to approach autonomous vehicles, especially if they one day operate without any human driver that has manual override capabilities. As one can see, the general concepts behind the laws that formed during the historic transportation shift parallel many issues that need to be addressed and are being debated in the current socio-technical transportation shift. When so many parallels between the first years of the adoption of the personal automobile and the first years of discourse and testing surrounding autonomous vehicles can be drawn, one must wonder what other parallels can and should be drawn that have simply not been addressed yet in the current regime shift.

Aside from the education that inherently arises out of the incorporation of the many rules surrounding negligence, the regulatory environment grew immensely more complex between 1906 and 1912. Since the 1912 volume was not organized by state but rather by subjects of regulation, we can assume that these new rules were adopted by the majority of the states in the exact or a highly similar fashion as explained by this legal text. Thus, within six years time, we see a framework develop around every aspect of the automobile. The right of automobiles on the streets, licensing and registration, operations on highways, and the rights, duties, and liabilities of drivers were each treated in extensive chapters, and four chapters were dedicated to the rules of the road such as turning, overtaking, passing, approaching horses, and stopping.

In summary, from the introduction of the automobile up until the publication of Huddy's first edition, there was a scarce and piecemeal regulatory environment, in which states adopted similar yet varied basic regulations regarding vehicle registration,

licensing, safety, and some preliminary rules of the road. Between 1906 and 1912, state power over the transportation socio-technical regime was established, and with this power, the states largely aimed to expand the rights of the motorist rather than limit them. State regulation became more extensive and standardized, and a variety of statutes on rules of the road point to the fact that drivers and pedestrians became more educated about their newly developing automotive socio-technical regime during this timeframe.

Evolution of Regulations: 1912-1924

Xenophon Huddy's continued studies and publications of *The Law of Automobiles* allow us to gain understanding of how the legal and regulatory environment surrounding the automobile took shape from the moment the motor vehicle gained popularity to its widespread adoption. The seventh edition, published in 1924, is "in reality a new work"⁷⁷ even though the sixth edition was published just two years prior. Since the publication of the sixth edition (1922), the Appellate Courts had gone through thousands of cases, many involving new applications of automobile laws, new problems encountered with state statutes, and new experiments done by states to protect the public from reckless driving and other dangers. By this point, automotive law was the most actively litigated branch of the law, and the development of the law was so rapid that even though the seventh edition was published just two years after the sixth, it contains four new chapters and an average of 15% more material on the pages.⁷⁸

⁷⁷ Curtis, Arthur F. Preface to *The Law of Automobiles* by Xenophon P Huddy. 7th ed. / by Howard C. Joyce. Albany, N.Y., 1912. ." The Making of Modern Law. Gale. 2017. Gale, Cengage Learning. 4. Accessed March 18, 2017.

<<http://galenet.galegroup.com/servlet/MOML?af=RN&ae=F152415578&srchtp=a&ste=14>>

⁷⁸ Ibid.

The seventh edition includes many verbatim passages from the third edition, but some concepts are not simply restated, they are reinforced by rulings that have readdressed the subject and arrived at the same conclusion. Most relevant to our study of the regulatory environment of the automobile are the status of the automobilist, the federal government, and the municipalities within this regulatory regime. One quote by Huddy sums up the court's perception of the automobilist: "As between the inanimate chattel, the automobile, and the automobilist, the latter constitutes a more appropriate subject of legal regulation."⁷⁹ While this seems self-evident today, this was a revelation for the generation new to the automobile. They had to arrive at the conclusion that it was driver negligence, rather than the automotive technology, that was the primary source of the dangers of automotive transportation.⁸⁰ This decade solidified the concept that the driver would be responsible for the actions of the car and liable for damages inflicted by the car, in most scenarios. This is but one of the legal concepts that could change with the introduction of autonomous vehicles.

The scope of the powers of the federal government and municipal authorities was also reaffirmed, and in the case of municipalities, restricted. In this edition, Huddy emphasizes that Congress has no power to pass legislation regarding transportation within states, as this arena of regulation is explicitly left to the states in the form of police powers. He argues that it is questionable whether Congress has the right to legislate or tax interstate travel, stating that it is dubious whether interstate travel should fall under the definition of interstate commerce. However, given the fact that we now have the

⁷⁹ Huddy, Xenophon P. "Status of the Automobilist" in *The Law of Automobiles*. 7th ed. 69.

⁸⁰ Huddy, Xenophon P. "Automobile as a dangerous machine." in *The Law of Automobiles*. 7th ed. 23-26.

NHTSA and the DOT, we know that government intervention into automotive regulation arose well after the widespread adoption of motor vehicles. Municipal powers became more limited in this period, and municipal ordinances could not come in conflict with state legislation or the Constitution. Municipalities could only have powers handed to them by the states, and the only such power uniformly handed to municipalities across states was the police power to ensure the safe use of roads. In some states, this power did not extend to speed limits and only referenced the city's ability control traffic by means such as putting up traffic signs and designating pedestrian crosswalks.⁸¹ This signals a step towards uniformity in automotive laws, which Huddy had advocated for since he wrote the first edition of *The Law of Automobiles*.

It is worth noting that the federal government did pass two pieces of legislation within this period that related to the automotive industry; however, these were not regulations but rather aid packages. The Federal Road Aid Act of 1916 put federal aid for highways on the national agenda, and the Bureau of Public Roads was placed in charge of allocating funding to the states for construction. The states chose which roads to improve, and they would bare future maintenance costs. By 1920, every state had their own road organization, but these groups did not coordinate. The "Good Roads Movement," a national lobbyist group, advocated for a system of national roads that would join large cities and increase economic activity, and this was addressed in the Federal Aid Highway Act of 1921, requiring the states to designate state highways, which the federal government would help fund.⁸² Thus, the federal government inserted itself as

⁸¹ Huddy, Xenophon P. "Chapter VI Municipal Regulations" in *The Law of Automobiles*. 7th ed. 98-112.

⁸² Encyclopedia Britannica, "Roads in the Age of the Automobile." Accessed March 20, 2017. <https://www.britannica.com/technology/road#ref592080>.

an influencer in the automotive socio-technical regime, but it left decisions largely in the hands of the states. The gradual increase in federal regulatory intervention will be discussed in the following chapter.

One particularly useful facet of the exploration of Huddy's editions is that, while pinpointing areas of regulation that may change with the introduction of autonomous vehicles, we also gain insight into how these regulations formed in the first place. One trend that stands out in the period from 1912 to 1924 is the fact that many rules and regulations did not arise out of state legislature, but were formed by the rulings of state courts after automotive issues that had never been addressed before were brought before the courts. Thus, instead of proactive regulation, this socio-technical regime shift was characterized by a "wait and see" approach.

This "wait and see approach" demonstrates that in cases where one cannot predict all possible scenarios that will warrant legislative action, allowing for permissionless innovation promotes early adoption of a technology and simultaneously creates an environment where issues arise that can then be solved by the legal system or legislators. In line with this notion, the section that discusses the general right to the use of highways reaffirmed that the newness of the automobile is immaterial and that they are allowed on highways absent the passage of peculiar legislation, so long as drivers exercise reasonable care and follow any statutes that have already been put in place.⁸³ This idea that automotive actions are legal before deemed illegal by state legislation is being questioned in the current day transition to autonomous vehicles. The Federal Automated

⁸³ Huddy, Xenophon P. "Right of automobilist to use highways" in *The Law of Automobiles*. 7th ed. 36.

Vehicles Policy seems to presume that testing autonomous vehicles is illegal unless specifically authorized by state or federal laws; thus, companies wishing to test autonomous vehicles on state roads must ascertain whether the state also believes that a lack of legislation on the subject means the practice is illegal.⁸⁴

Aside from determining the driver to be the subject of regulation, solidifying the power of the states to regulate transportation, and reaffirming the right of the automobile to operate on public roads, this edition demonstrates how regulations arose out of a substantial increase in economic activity involving the automobile. Multiple chapters outline extensive licensing and liability schemas for public carriages (such as taxis), private motor vehicles for hire, and chauffeurs. An examination of the citations reveal that these regulations were institutionalized by case law rather than by the passage of state legislation, as court cases, rather than statutes, were cited as the source of the rules. Some rules are an extension of previously existing contract law that could easily be interpreted as extending to contracts within the taxi, private hire, and chauffeur enterprises, but the main finding is that the overwhelming majority of these new rules were not statutes passed proactively in the anticipation of new occupations created by the proliferation of the automobile; these rules took shape after incidents or disagreements brought issues into deliberation in a court of law.⁸⁵

Efforts to increase safety on the roads expanded in this period as well. This edition includes updated laws of the road and the duties established for the driver and

⁸⁴ Kohler, William J. and Colbert-Taylor, Alex, "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles" January 2015. 110. Accessed February 21, 2017. <http://digitalcommons.law.scu.edu/cgi/viewcontent.cgi?article=1590&context=chtlj>

⁸⁵ Huddy, Xenophon P. *The Law of Automobiles*. 7th ed. 1924.

pedestrian, some of which may be of paralleled importance after the introduction of the autonomous vehicle. For example, at this point in time, there were valid excuses for failing to follow the rules of the road. Various sections on excuses outlined acceptable reasons for failing to stay on the correct side of the road. Turning to avoid a collision was acceptable, even if the turn would have been illegal under normal circumstances. Perhaps more questionable, an automobilist could swerve to avoid an obstacle in the road and would not be held liable for hitting an oncoming motorist.⁸⁶ In an autonomous vehicle transportation regime, where autonomous technologies will make decisions on how to minimize damages in an accident scenario, it remains unclear as to whether the technology and the law will initially favor the safety of the driver and passengers or favor an overall reduction of collateral damage, even at the possible endangerment of those in the vehicle. Whether these scenarios will be treated on a case by case basis, paralleling the historical approach to solidifying a new transportation regime, remains to be seen.

Within this period, the duties of the driver became explicit, with chapters on dangerous driving, the duty to avoid injury to pedestrians, and frightening horses describing the “degree of care required by automobilists”⁸⁷ in a plethora of situations. Duties to avoid injury to pedestrians spanned 63 pages,⁸⁸ indicating that hitting pedestrians was still a rampant problem, and courts were ruling on these cases with extreme frequency. On the other hand, the chapter on frightening horses begins by stating that these rules aren’t of the same importance as they were a few years ago,

⁸⁶ Huddy, Xenophon P. “Chapter XIV Law of the Road” in *The Law of Automobiles*. 7th ed. 306-357.

⁸⁷ Huddy, Xenophon P. “Chapter XV Negligence in Operation of Motor Vehicles, in General. Sec. 339-344,” in *The Law of Automobiles*. 7th ed. 359-371.

⁸⁸ Huddy, Xenophon P. “Chapter XIX Duty to Avoid Injury to Pedestrians” in *The Law of Automobiles*. 7th ed. 521-584.

signalling the decline of horse-and-buggies on the road. By 1924, there was scarcely one case involving horses per year, compared to the hundreds of cases that occurred during the first few years of use of motor vehicles.⁸⁹ As horse-and-buggies became a rarity on the roads, those who continued to use of this old form of transportation undoubtedly experienced increased danger and inconvenience as increased traffic frightened horses and infrastructure changed to favor automobiles. Late adopters of new autonomous technologies will likely experience increased inconvenience in the current transportation shift as well. Once the majority of cars on the road are driven by algorithms rather than humans and operate using advanced automated collision technologies, cars with human drivers will be dangerous by comparison, as these cars are likely to be the liable party in any crash. Higher liability will cause an increase in insurance costs for those who do not adopt the autonomous technology.⁹⁰

In brief, the period between 1912 and 1924 revealed trends regarding how the regulatory side of the socio-technical automotive regime formed in the face of the increased adoption of automobiles. First, despite automotive law becoming the most heavily litigated branch of law, with thousands of rulings setting precedent and shaping the rules and regulations of the automotive regime moving forward, the states and state courts maintained power over the automotive regulatory environment. Municipal powers were restricted in order to promote continuity of expectations for drivers within the states, and the federal government was kept from intervening based on the constitutional

⁸⁹ Huddy, Xenophon P. “ Chapter XXII Frightening Horses” in *The Law of Automobiles*. 7th ed. 677-708.

⁹⁰ Alain Kornhauser, Director of Transportation Program and Faculty Advisor of Princeton Autonomous Vehicle Engineering, in discussion with the author, Princeton University, Princeton, NJ. March 28, 2017.

interpretation of the time that held that automotive regulation fell within the realm of police powers granted to the states. Secondly, the development of extensive licensing and liability schemas for taxis, chauffeurs, and private vehicles for hire indicate that some rules and regulations arose as a result of increased economic activity within the new automotive socio-technical regime. Most new rules arose from rulings in the state courts rather than stemming from proactive state legislation. In the following chapter, we examine how federal regulatory intervention, post-introduction of the automobile, helped or hindered the entrenchment of the new socio-technical automotive regime.

CHAPTER 4: FEDERAL REGULATORY INTERVENTION IN THE AUTOMOTIVE INDUSTRY

The historical analysis in the previous chapter demonstrated that, in the early years of automobile adoption:

- 1) States held all regulatory power over transportation and sought to extend rights to motorists,
- 2) regulations and rules largely emerged from case law, meaning they came "after the fact", and infrequently had their roots in proactive legislation,
- 3) many regulations arose as a result of increased economic activity concerning the automobile, such as taxi services and chauffeurs, but state regulation did not occur until after rudimentary forms of these economies developed; and,
- 4) driver education was seen as a necessary campaign for shifting to the new transportation regime.

Thus, it can be said that state regulation lagged the introduction and early adoption of automotive technology, and federal regulation followed after state regulation. While it cannot be proven that a state-level regulatory environment with minimal federal government intervention benefitted the widespread adoption of the automobile, a discussion of the current transition from automobiles to autonomous vehicles would benefit from understanding why the federal government hesitated in becoming a regulatory body with jurisdiction over the transition from the horse-and-buggy to the automotive socio-technical regime.

This chapter explores the increase in federal involvement in the automotive industry, aiming to illuminate why federal entities may have waited to assert themselves as a regulatory body, and analysing whether their steady increase in regulatory activity was a benefit or detriment to the automotive regime. First, it explores possible reasons why the federal government lagged behind state-level regulation in the automotive industry. Then, a brief timeline of federal interventions is provided, and quantitative and qualitative evidence is included to support the efficacy or ineffectiveness of these actions. The goal of this chapter is to use historical lessons learned in order to determine which types of federal regulations may be beneficial to the safe proliferation of automotive technologies and to uncover which federal regulations may be better left to the states or omitted during the early adoption of automated vehicles.

Lessons from the Federal Lag in Automobile Regulation

In the study of the history of automobile legislation, case law, and regulation in the chapter prior, lawyers throughout the years emphasized that the regulation of automobiles fell within state police powers and that the federal government did not have the constitutional authority to intervene in these matters. However, the federal government did slowly begin to assert itself as a regulatory body in the automotive domain with the Highway Acts of 1916 and 1924. If the federal government had the intention of expanding its regulatory power over automobiles and the surrounding aspects of the socio-technical regime within which the automobile is situated, then why did federal regulatory action lag behind the introduction of the technology and behind state-level regulations? Was the federal government truly only interested in the interstate

aspect of personal mobility, wishing to remain relatively uninvolved in regulating automobiles themselves? They arguably had jurisdiction over interstate travel if one considers this to fall under interstate commerce, and they did get involved with regulating trains and trucks that carried goods and travelled between states. Alternatively, could they have simply lacked the expertise in the automotive industry and manpower in office to get involved in research and regulation at the onset of the testing and commercialization of automotive technology? Understanding why federal regulation lagged in the socio-technical transition to the personal automobile can offer a lens through which to judge the initial federal regulatory actions beginning to take shape in the transition to autonomous vehicles.

The timeline explored below gives some insight into one possible answer. The development of federal regulations with regards to the personal automobile focused mainly on giving grants to state-level initiatives. Yet, they intervened quite heavily into the arenas of railroad transportation and urban mass-transit. This restraint from intervening in state-level decision making regarding the personal automobile, coupled with the evidence that the legal scholars of the time largely agreed that personal automobile regulation was a power reserved for the states,⁹¹ point to a federal decision to remain largely uninvolved in the regulation of the personal automobile. It wasn't until the late 1960s and early 1970s, when the DOT and NHTSA, two federal regulatory bodies with the missions of making personal transit more efficient and personal automobiles safer, were established, that the federal government formalized its role

⁹¹ Huddy, Xenophon P. "Power of Federal government" in *The Law of Automobiles*. 7th ed. 74.

automobile regulation. These regulatory bodies ensured that the federal government would keep up with the technological advances of automobiles, analyse their safety, and give recommendations surrounding automotive innovations. Therefore, the federal government's understanding of its position within the automotive socio-technical regime had slowly changed over the greater portion of the 20th century. If we view the federal government's increased intervention as a change in the "rules" (the rules in this paper always meaning the current regulatory regime), then we question how the other two dimensions in our multi-level analysis, social groups and socio-technical systems, influenced the change in the rules.

National lobbying groups played a key part in shifting the federal government's attention towards the regulation of the personal automobile. Groups advocating for increased highway safety measures organized in the 1930s, supporting government highway acts and funding and administering various highway safety programs. Their compelling research into automotive safety, coupled with the fact that they helped fund various programs, likely ensured that their interests, backed by the public outcry over traffic fatalities,⁹² increased federal intervention into various aspects of the automotive socio-technical regime, including the creation of safer interstate highways and research into the automotive technologies.

Both the National Highway Users Conference (NHUC), founded by the President of General Motors and other industry leaders, and the Automotive Safety Foundation, formed by automobile and allied industries, developed in the 1930s.⁹³ Through the

⁹²American Highway Users' Alliance. *Historical Milestones: Celebrating 75 Years of Advocacy*. 2007. Accessed March 21, 2017. http://www.highways.org/wp-content/uploads/2010/10/historical_milestones.pdf

⁹³Ibid.

1940s, these interest groups gained access to the President's ear. In 1946, the NHUC conducted its first Highway Transportation Conference in Washington, D.C., and President Truman, inspired from an idea by the Automotive Safety Foundation, organized the first President's Highway Safety Conference, which birthed an "Action Program" for traffic safety.⁹⁴ Thus, interest groups directed the executive branch's attention to highway safety and the federal government expanded its power, no longer simply funding the construction of more highway infrastructure, but engaging in discussions about personal transportation and eventually committing to research how the federal government could further shape automotive regulations. In 1954, President Eisenhower worked with the Automotive Safety Foundation to launch a full-scale study of highway laws enacted in all of the states,⁹⁵ signalling the shift towards our current automotive regulatory environment. However, this shift in the federal regulatory paradigm still focused on the safety of highways, so the federal government had yet to truly step out of its "wheelhouse." The step from funding highway construction to regulating highway safety was perhaps not as large as the step from regulating highway safety to regulating the automotive technologies themselves.

How did automotive technologies, the socio-technical systems within this multi-level analysis, influence federal government intervention? In the section above, this paper argues that national lobbying groups and the public, as social groups, pushed the federal government, itself another social group, to change the "rules" by which they previously operated. The federal government then changed the regulatory regime by

⁹⁴Ibid.

⁹⁵Ibid.

acting *upon* socio-technical systems. More simply, social groups pushed for federal intervention, which changed the rules of state-level governance over personal automobiles to include federal regulation, and the federal government did this by taking control of the regulation of the safety of automobile technologies.

Americans were slow to understand that the design of the automobile had enormous implications for safety.⁹⁶ As demonstrated by the various editions of *The Law of Automobiles*, it was determined that the car was not “inherently evil” and the primary source of danger on the roads was the negligence of the driver. Thus, the first safety solutions offered in the 1910s and 1920s were social responses that focused on improving driver behavior. It wasn’t until the late 1920s that manufacturers realized that flaws in car designs compromised safety and offered technological responses to mitigate the dangers of the road. By the 1930s, cars were equipped with shatter-resistant windshields, all-steel bodies, and hydraulic brakes. Seat belts had already been invented by the 1930s, but they weren’t installed in cars.⁹⁷ They were not commonly used until the NHTSA included seat belts in the Federal Motor Vehicle Safety Standards in the 1960s, and states began requiring the usage of seat belts in the 1980s.⁹⁸ Thus, national lobbying groups pushed to emphasize highway safety on the national agenda. As a result, the federal government created the NHTSA and commissioned it with the responsibility of reducing deaths, injuries, and economic losses resulting from highway crashes.⁹⁹ The

⁹⁶White, Roger (curator). “Auto Safety History.” America On the Move. National Museum of American History Online. Accessed March 21, 2017. http://amhistory.si.edu/onthemove/themes/story_86_1.html

⁹⁷Ibid.

⁹⁸Timeline of Federal Motor Vehicle Standards- NHTSA. Accessed March 20, 2017. <https://www.nhtsa.gov/staticfiles/communications/pdf/Lives-Saved-Tech-Timeline.pdf>

⁹⁹Federal Register: National Highway Traffic Safety Administration. Accessed March 20, 2017. <https://www.federalregister.gov/agencies/national-highway-traffic-safety-administration>

NHTSA achieved this mission by expanding the government's role from keeping highways safe to also ensuring that the automobiles themselves were safe.

In summary, federal regulation lagged behind state regulation because the federal government did not view its role as encompassing the regulation of the personal automobile until they were compelled to do so based on national lobbying groups pushing for highway infrastructure and safety and public outcry over the dangers of automobiles. Initial interventions included the development of safe highway infrastructure and researching highway safety. Eventually, with the creation of the NHTSA, the federal government expanded its role to include the regulation of vehicle safety standards. Since the seat belt, amongst other safety technologies, were invented in the 1930s but not implemented until the NHTSA required them to be installed decades later, one can argue that earlier federal intervention into personal automobile safety would have been beneficial to the automotive industry. What is concerning is that, without federal intervention, manufacturers did not take it upon themselves to install certain safety technologies. It is imperative that federal regulatory bodies ensure that something similar does not occur in the current technological transition. The following section departs from the multi-level analysis of the socio-technical shift and provides a timeline of federal regulatory interventions, coupled with analysis of their beneficiality or detriment to the automotive industry.

Timeline of Federal Interventions and Analysis of Implications

Having already discussed the first Highway Acts of 1916 and 1921 in the previous chapter, we begin in 1932, when the federal government enacted a gasoline tax

of one cent on the gallon under the condition that it would be repealed within the next year. This was supposed to be a temporary tax to shrink the budget deficit during the Depression, but the gas tax became permanent and has risen over time, despite a recommendation by the 1933 Senate Finance Committee to repeal it.¹⁰⁰ Despite going back on their commitment to repeal the tax, there isn't evidence that the federal tax on gasoline damaged the automotive industry in a quantifiable way. Increasing gas taxes makes consumer goods transported via trucks more costly and makes the commute to work more costly, so arguably the gas tax hurts middle-income families the most. Additionally, research on the effect of gasoline taxes on work shows that the incentive to work does not decrease as gas prices increase, but this may be because people continue commuting to work and cut back on non-work related travel, which causes them to dedicate more time to work.¹⁰¹ This could therefore cause other areas of the economy to take a hit, but this is true of all taxes. Thus, the federal government's first intervention, into the automotive regime, outside of grants, did not harm the proliferation of the personal automobile, and in fact contributed to the new automotive landscape, as some of the revenue from the tax did go towards the construction of highways.¹⁰²

In 1956, the Federal Highway Act authorized a budget of \$25 billion to be spent on the interstate highway system over the next 10 years. State highway development

¹⁰⁰Edwards, Chris. Downsizing the Federal Government. Your Guide to Cutting Federal Spending. "Department of Transportation Timeline" Accessed March 20, 2017. <https://www.downsizinggovernment.org/transportation/timeline>

¹⁰¹Picker, Les. "The Effect of Gasoline Taxes on Work Effort." The National Bureau of Economic Research. Accessed March 22, 2017. <http://www.nber.org/digest/jul04/w10330.html>

¹⁰²Edwards, Chris. Downsizing the Federal Government. Your Guide to Cutting Federal Spending. "Department of Transportation Timeline" Accessed March 20, 2017. <https://www.downsizinggovernment.org/transportation/timeline>

efforts were already booming, so this Act largely just federalized these efforts, allowing the federal government to impose regulations on the construction of these highways.¹⁰³ While some aspects of the Highway Act, including the Davis Bacon Act which required that all sub-contracted mechanics and laborers working on interstate highways be paid at the same wage rate as those who are “doing the same type of work on similar construction in the immediate locality,”¹⁰⁴ arguably raised the cost of building highway infrastructure in the states,¹⁰⁵ it catalysed the development of infrastructure that was necessary for the success of the new automotive landscape, and it also helped the economy by spurring entrepreneurship and creating jobs. The construction of the interstate highways lead to the growth of roadside businesses such as restaurants and fast food chains, hotels, and amusement parks, and by the 1960s, it was estimated that one in seven Americans was employed directly or indirectly by the automobile industry.¹⁰⁶

The federal government then expanded its regulatory grip to both aviation and public transportation. Aviation is outside of the scope of this paper, but public transportation was historically and remains closely tied to the automotive transportation regime and its regulation will therefore be included in this timeline. In 1964, the Urban Mass Transit Act was passed, which subsidized public transportation agencies but not private ones. This Act is argued to have destroyed the private transit industry in the

¹⁰³Ibid.

¹⁰⁴Federal Highway Act of 1956. Section 115. “Prevailing Rate of Wage.” Government Publishing Office. 385. Accessed March 21, 2017.

<https://www.gpo.gov/fdsys/pkg/STATUTE-70/pdf/STATUTE-70-Pg374.pdf>

¹⁰⁵Edwards, Chris. Downsizing the Federal Government. Your Guide to Cutting Federal Spending. “Department of Transportation Timeline” Accessed March 20.

<https://www.downsizinggovernment.org/transportation/timeline>

¹⁰⁶“1956: Congress Approves Federal Highway Act” This Day in History| Automotive. History. Accessed March 29, 2017. <http://www.history.com/this-day-in-history/congress-approves-federal-highway-act>

United States,¹⁰⁷ signalling a large expansion of federal power over transportation that wouldn't be reined in until the Carter presidency in the 1980s. Research into the socio-technical transportation landscape from the 1950s to the 1970s does show, however, that the decline of public transportation was more complicated than just resulting from the passage of this Act. Mass-transit ridership peaked during World War II but was steadily declining as the personal automobile gained popularity and residential living sprawled further away from the mass-transit routes. Between the late 50s and early 70s, over 170 transit corporations had shut down.¹⁰⁸ Therefore, one view is that mass-transit was already experiencing swift decline, and the Act sought to reinvigorate urban transportation. Despite massive federal aid efforts, mass transit could not compete with the car, and ridership continued to fall. It wasn't until the 1990s that mass transit started making a comeback, due to the transit-and-growth oriented choices of city planners, but the question remains whether transit will truly regain popularity due to the traffic congestion in American streets.¹⁰⁹ The opposing view maintains that transit funding is not an appropriate function of the federal government, as the funding distorts state policymakers' decision making, pushing them to pursue transit solutions that are higher cost and less efficient than what a competitive market would produce.¹¹⁰ As the proliferation of autonomous vehicles is predicted to decrease traffic congestion, this may draw ridership away from mass transit once again. Since the success of the historic

¹⁰⁷Ibid.

¹⁰⁸America on the Move. Cities and Suburbs. Chicago and Park Forest, Illinois. "What Happened to Public Transit" Accessed March 21, 2017. http://amhistory.si.edu/onthemove/exhibition/exhibition_15_6.html

¹⁰⁹Ibid.

¹¹⁰O'Toole, Randal. Downsizing the Federal Government. Your Guide to Cutting Federal Spending. "Urban Transit" January 4, 2017. Accessed March 20, 2017. <https://www.downsizinggovernment.org/transportation/timeline>

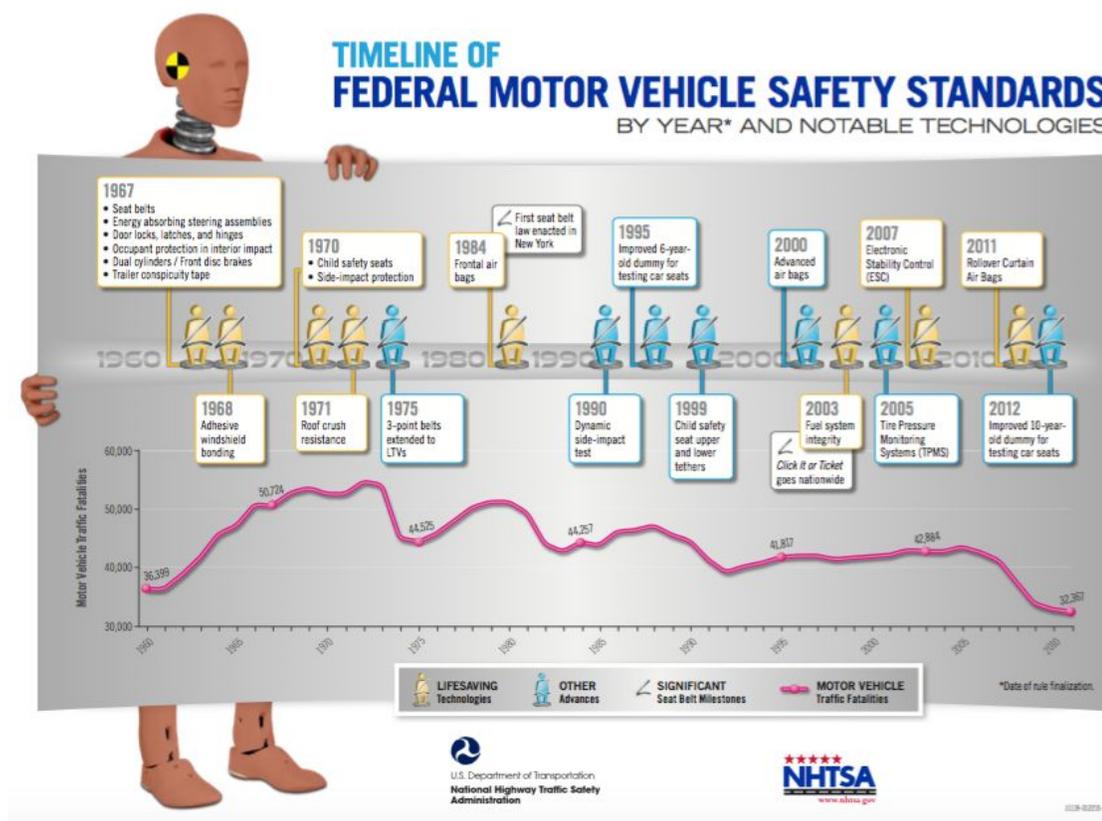
federal attempt at the reinvigoration of mass transit is ambiguous, it is up for debate whether the federal government should attempt something similar in the case of autonomous vehicles causing a reduce in mass transit ridership.

Federal influence over the automotive socio-technical regime became entrenched with the establishment of the Department of Transportation (DOT) in 1964 and the National Highway Traffic Safety Administration (NHTSA) in 1970.¹¹¹ The DOT aims to “serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future,”¹¹² while the NHTSA was established with the mission of helping “reduce the number of deaths, injuries, and economic losses resulting from motor vehicle crashes on the Nation's highways.”¹¹³ The DOT takes more of an oversight role, and is shaping up to behave the same way in regulating autonomous vehicles, while the NHTSA engages in a laundry list of regulatory activities, and their programs to promote and enforce safety technologies and behaviors have been largely successful in reducing highway fatalities.

¹¹¹ *National Highway Safety Act of 1970*. (23 U.S.C. 401)

¹¹²Department of Transportation. “About Us” Accessed March 21, 2017.
<https://www.transportation.gov/mission/about-us>

¹¹³Federal Register: National Highway Traffic Safety Administration. Accessed March 20, 2017.
<https://www.federalregister.gov/agencies/national-highway-traffic-safety-administration>



The NHTSA timeline (above)¹¹⁴ of the development and enforcement of new safety technologies against a timeline of motor vehicle traffic fatalities demonstrates the beneficial effects of nationalizing safety standards. For example, one can note a sharp decline in fatalities around 1984, within the same year that the first seat belt law was enacted in New York and frontal air bags became a life-saving technology. The NHTSA has already begun publishing safety requirements for autonomous vehicle technologies, showing that in this next socio-technical transportation shift, the federal government is attempting to establish power both by establishing a regulatory environment that precedes

¹¹⁴ Timeline of Federal Motor Vehicle Standards- NHTSA. Accessed March 20, 2017. <https://www.nhtsa.gov/staticfiles/communications/pdf/Lives-Saved-Tech-Timeline.pdf>

the introduction of the technology and shapes the regulatory environments created at the state level.

The 1980s contain examples of federal restraint and federal usurpation. In 1980, President Jimmy Carter signed the Railroad Regulatory Act, which removed federal restraints on railroads, enabling them to tailor rates and services to market conditions. Since deregulation, the industry's financial health has improved and railways have become safer.¹¹⁵ Additionally, ridership increased by over 20 percent in the last decade, reaching its highest numbers of passengers since 1957.¹¹⁶ While transit companies that receive funding from the Federal Transit Administration (FTA) are still required to report to the FTA, this is to populate the National Transit Database (NTD) with information, and the NTD helps the companies analyse multi-year trends¹¹⁷ without imposing centralized planning from Washington.¹¹⁸

While the Railroad Regulatory Act demonstrated positive effects of the federal deregulation of transit, the federal government encroached on state powers in 1984 when the Highway Improvement Act stipulated that it would cut funding from states if they did not raise their drinking age to 21.¹¹⁹ This is concerning because the 21st Amendment specifically grants the power to regulate alcohol to the states, yet the Supreme Court sided with the federal government in 1987 and the law was approved.¹²⁰ This "aid

¹¹⁵ Edwards, Chris. Downsizing the Federal Government. Your Guide to Cutting Federal Spending. "Department of Transportation Timeline" Accessed March 20, 2017. <https://www.downsizinggovernment.org/transportation/timeline>

¹¹⁶ Federal Transit Administration. The National Transit Database. Updated February 22, 2017. Accessed March 21, 2017. <https://www.transit.dot.gov/ntd>

¹¹⁷ Ibid.

¹¹⁸ Edwards, Chris. "Department of Transportation Timeline."

¹¹⁹ Ibid.

¹²⁰ Ibid.

conditionality” is a common federal tactic used in foreign affairs, but domestic aid conditionality, and encroachment on state rights, can and has proven to be damaging to the socio-technical automotive regime. For example, Congress imposed a national speed limit of 55 miles per hour in 1974, threatening to cut aid from states that did not institute the limit. The law was passed in response to an oil crisis, under the misinformed notion that regulating miles per hour would save large amounts of fuel. Interstate truckers complained that the law drove up the cost of transporting goods, saying that the useless and costly delays constituted an unwarranted and ill-advised intrusion of the federal government into an area of regulation previously reserved to the states. This limit wasn’t repealed until 1995, after over a decade of complaints from truckers and vacationing Americans, who felt as if they were travelling at a glacial pace.¹²¹

In these few examples, one can note trends in the types of federal government intervention that are beneficial and those that have proven to be harmful when put into practice at the state level. First, federal funding of state transportation infrastructure was the medium by which the federal government began to increase their influence over the transportation regulatory environment. Naturally the funding of infrastructure lagged behind the introduction of the automotive technology, as the need for infrastructure had to be established by the widespread adoption of the personal automobile. Federal funding catalyzed the large-scale project, and other economic benefits such as increased entrepreneurship and employment opportunities resulted from the project. Secondly, federal level motor safety solutions and campaigns, undertaken by the NHTSA, proved

¹²¹ “The High Cost of the 55 MPH Speed Limit.” *The Heritage Foundation*. September 9, 1986. Accessed March 21, 2017. <http://www.heritage.org/report/the-high-cost-the-55-mph-speed-limit>

beneficial to the automotive regime. Lastly, failures in federal regulation occurred when funding was conditional upon the adoption of certain regulations that proved to not be the most cost-effective or sensible solutions when applied across the states. Each of these historical findings can be applied to the developing regulatory environment for autonomous vehicles.

The historical lessons learned described in this chapter show that, as we shift to the autonomous vehicle regime, early NHTSA oversight and research into the safety features of autonomous vehicle technologies would be more beneficial than a lag in federal safety standards for autonomous vehicles. Additionally, federal funding of infrastructures supporting autonomous technologies will help solidify the autonomous transportation landscape, but massive funding projects can wait until the demand for infrastructure is apparent. Finally, while historical research from prior chapters show that increasing uniformity across state regulatory environments is beneficial for the entrenchment of a new socio-technical transportation landscape, the federal government should avoid tying funding to the forced adoption of certain regulatory conditions that are not closely tied to ensuring highway safety and efficiency.

CHAPTER 5: THE CURRENT REGULATORY ENVIRONMENT FOR AUTONOMOUS VEHICLES

In their quest towards automation, vehicle manufacturers currently face a regulatory hodgepodge.¹²² Federal and state regulators struggle to keep up with the rapid pace of automotive innovation, create guidelines to ensure safe production and usage of these vehicles, and predict and address the impact of the commercialization of these vehicles.¹²³ The DOT and the NHTSA have remained largely deferential to state legislators up to this point, and so far twelve states have passed laws regarding automated vehicles.¹²⁴ The state laws have some similarities but vary enough to require significant changes in corporate or driver behavior as they cross state borders¹²⁵, and to date there is no case law regarding automated vehicles from which courts can draw precedent. This chapter examines the existing regulatory framework for automated vehicles at the federal and state level in order to draw parallels to the historical lessons learned presented in prior chapters.

¹²² Greenblatt, Nathan, “Self Driving Cars Will Be Ready Before Our Laws Are,” January 19, 2016. Accessed February 21, 2017.

<http://spectrum.ieee.org/transportation/advanced-cars/selfdriving-cars-will-be-ready-before-our-laws-are>

¹²³ National Conference of State Legislatures. “AUTONOMOUS | SELF-DRIVING VEHICLES LEGISLATION” December 16, 2016. Accessed January 23, 2017.

<http://www.ncsl.org/research/transportation/autonomous-vehicles-legislation.aspx>

¹²⁴ Ibid.

¹²⁵ Kohler, William J. & Colbert-Taylor, Alex, “Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles” January 2015. Accessed February 21, 2017.

<http://digitalcommons.law.scu.edu/cgi/viewcontent.cgi?article=1590&context=chtlj>

Preemptive Federal Regulatory Guidelines

At the federal level, the DOT, in collaboration with NHTSA, released updated guidelines for the safe development of highly autonomous vehicles (HAVs) in 2016. The NHTSA updated four policy areas within their guidelines for HAVs: vehicle performance guidelines, model state policy, NHTSA's current regulatory tools, and possible new regulatory actions.¹²⁶ It is worth noting that HAVs are not fully autonomous. The 2016 federal guidelines did not address regulation of fully autonomous vehicles, although many companies are working on and testing this technology.¹²⁷ Within the next year, the NHTSA is expected to expand their 2016 guidance by issuing further guidelines for the development and deployment of *fully* automated vehicles.¹²⁸

The current guidelines issued in February 2016 in “Federal Automated Vehicles Policy” includes suggestions for manufacturers (Vehicle Performance Guidelines) and states (Model State Policy) but does not bind corporations or states to a specific standard of regulation of HAVs. However, the NHTSA reserves the right to do so in the future.¹²⁹ In the Vehicle Performance Guidelines, the DOT encourages manufacturers to designate the level of automation of their systems in conformity with SAE International's published definitions, and states that the NHTSA will evaluate whether they agree with the

¹²⁶ Department of Transportation and National Highway and Transportation Safety Agency, “Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety,” September 2016. 6. Accessed February 21, 2017.

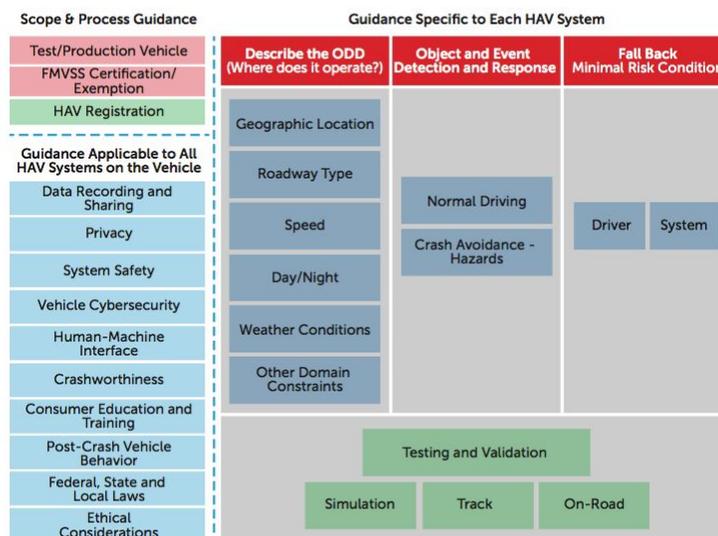
¹²⁷ State of California. Department of Motor Vehicles. “Testing of Autonomous Vehicles.” Released March 7, 2017. Accessed March 20, 2017. <https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing>

¹²⁸ Department of Transportation and National Highway and Transportation Safety Agency, “Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety,” September 2016. 8. Accessed February 21, 2017.

¹²⁹ *Ibid*, 11.

designations. They also provide a framework (depicted below) which they suggest manufacturers use to evaluate their systems.¹³⁰

Figure I: Framework for Vehicle Performance Guidance



The DOT then requests that manufacturers voluntarily provide a Safety Assessment Letter to the NHTSA that addresses all of the factors listed in the figure above under “Guidance Applicable to All HAV Systems on the Vehicle.” The DOT states that such letters may become mandatory through the passage of future legislation, as they will help the NHTSA and the public determine whether the safety of the HAVs has been thoroughly assessed before these vehicles are released onto the roads. The DOT envisions that manufacturers will eventually enable remote software updates, and therefore includes a provision to guide manufacturers to submit a new Safety Assessment Letter any time a software or hardware update changes how the HAV complies with the elements outlined in the framework above. Most notably, the Vehicle Performance

¹³⁰ Ibid, 9-14.

Guidelines section concludes with next steps for the DOT and NHTSA to “expand and oversee the guidance.” Such steps include making the Safety Assessment mandatory, requiring HAV registration, and updating Federal Motor Vehicle Safety Standards (FMVSS) to account for fully autonomous vehicles that do not accommodate human drivers at all, for example, vehicles that do not have steering wheels or brakes.¹³¹

The Model State Policy section aims to promote consistency of regulations at the state level, as differing state regulations and laws could delay the deployment of these potentially lifesaving technologies. The DOT strongly recommends that states leave performance evaluation of HAVs under the jurisdiction of the DOT, stating that under the Vehicle Safety Act, states currently cannot pass their own vehicle performance legislation unless it is identical to a federal FMVSS regulation. They do, however, outline areas in which federal and state automotive regulatory bodies should collaborate, such as in driver education and HAV maintenance education, and prompt states to extend their regulatory framework to include coordination with law enforcement. The DOT worries that automation will lead to increased driver distraction and calls upon the states to develop methodologies for law enforcement to educate the public on how to behave in a HAV. States are also responsible for determining who is liable in crashes involving HAVs, deciding whether the owner, operator, passenger, or manufacturer must be insured, and making future decisions on other currently unforeseen liability issues. The DOT also generally advises that states update their vehicle laws in ways that will remove barriers

¹³¹ Department of Transportation and National Highway and Transportation Safety Agency, “Vehicle Performance Guidance for Automated Vehicles” in “Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety,” September 2016. 11-36.

for the deployment of HAVs, such as changing the definition of a driver to include non-human drivers, if necessary.¹³² While the introduction to the Model State Policy section warns against inconsistent regulations across states, the DOT leaves nine HAV policy areas in the hands of the states, and this paper finds that state-level autonomous vehicle legislation contains many variations in laws and regulations that could impede the speed of adoption of HAVs.

The Current Regulatory Tools section of the federal guidelines solidified the NHTSA's ability to recall automated technologies, addressing their concern that semi-autonomous technologies could lead to increased distracted driving. This federal recall ability complicates the question of whether the use of automated vehicles is inherently legal or illegal in areas that have no state legislation addressing their operation. Other tools that the NHTSA uses to address new automotive technologies include letters of interpretation regarding current regulations, short-term exemptions from existing standards, and rulemakings to amend standards or create new ones. The regulatory body states that applying their regulatory tools to aid new technologies usually takes a couple of years, but it has pledged to prioritize inquiries from manufacturers regarding HAVs in an effort to catalyse testing and commercialization.¹³³

Lastly, the DOT submits potential new tools and authorities which the NHTSA might utilize to regulate HAVs. New authorities would have to be granted by Congress,

¹³² Department of Transportation and National Highway and Transportation Safety Agency, "Model State Policy" in "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety," September 2016. 37-47.

¹³³ Department of Transportation and National Highway and Transportation Safety Agency, "NHTSA's Current Regulatory Tools" in "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety," September 2016. 48-67.

and this has been done in the past in order to update the Vehicle Safety Act as new technologies change transportation. Possible new authorities include safety assurance authority over HAVs, pre-market approval authority, cease-and-desist authority, expanded exemption authorities for HAVs, and post-sale authority to regulate software changes.¹³⁴ The most radical new authority would be the pre-market approval authority, which would replace the current self-certification system in which manufacturers are in charge of ensuring that their vehicles comply with the FMVSS, and the DOT tests compliance by purchasing vehicles from new dealerships to sample from the vehicles that are sold to consumers.

The DOT then lists five possible new tools that the NHTSA could utilize and references the authorities they believe the NHTSA has that allow them to use said tools. In some cases, they suggest Congress explicitly grant them authorities to remove doubt from the commercial sector that they are able to exercise these powers. The tools are better described as further requirements for HAV manufacturers and more oversight power for the NHTSA. New requirements imposed on HAV manufacturers would include the creation of more variable test procedures, additional record keeping and reporting to the NHTSA pre and post-commercialization, and enhancing data collection tools and reporting crash information. Additionally, the NHTSA wants to revisit Agency testing protocols more frequently to make them more iterative and “forward-looking.” They posit that the more detailed the protocols are, the more likely they are to limit the exploration of future technologies. Establishing an iterative process for updating

¹³⁴ Department of Transportation and National Highway and Transportation Safety Agency, “Modern Regulatory Tools” in “Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety,” September 2016. 68-82.

protocols shows the NHTSA's commitment to removing regulatory barriers to innovation when appropriate.¹³⁵

Overall, the Federal Automated Vehicle Policy guidelines aim to create a regulatory environment that is welcoming of autonomous vehicle innovations. Anthony Foxx, Secretary of the Department of Transportation has pledged to allocate nearly \$4 billion dollars of government funding over the next decade to catalyzing and encouraging the development and utilization of autonomous vehicle technologies.¹³⁶ As historical federal intervention showed, federal funding was an integral part to expanding the infrastructure necessary for entrenching the new transportation landscape centered around the personal automobile. The Vehicle Performance Guidelines and Modern Regulatory Tools sections hint towards a highly regulated future for HAVs that requires increased paperwork for manufacturers and monitoring by the NHTSA. While some would argue that this could slow the testing and commercialization of these vehicles, the historic transportation shift proved that federal oversight was necessary in order to mandate safety standards that manufacturers were not imposing on themselves. Federal regulatory intervention can be considered to be in its nascent stage with regards to the autonomous vehicle. Pledges of funding, federal research into the private automotive industry, and a focus on ensuring the safety of the technology reflect the first steps of the federal government into the regulation of the personal automobile.

¹³⁵ Ibid.

¹³⁶ Vlasic, Bill. "US Proposes Spending \$4 Billion on Self-Driving Cars." *New York Times*. January 14, 2016. Accessed March 16, 2017. https://www.nytimes.com/2016/01/15/business/us-proposes-spending-4-billion-on-self-driving-cars.html?_r=0

Piecemeal State Regulations

In 2011, Nevada was the first state to pass legislation surrounding autonomous vehicles and authorize their operation.¹³⁷ Since then, Florida, California, Washington D.C., Michigan, Alabama, Virginia, Pennsylvania, North Dakota, Tennessee, Utah, and Louisiana have passed legislation regarding autonomous vehicles, and governors in Arizona and Massachusetts have issued executive orders about autonomous vehicles. From 2012 to 2016, at least 34 states have at least discussed legislation about autonomous vehicles.¹³⁸ This section highlights the congruences and differences between state regulations in order to show how states have approached the adoption of federal guidelines and to point out the differences in the legal frameworks within which HAVs must operate in each state.

Nevada

Nevada's definition of an autonomous vehicle has become the standard across most state legislatures that have adopted autonomous vehicle legislation.¹³⁹ Nevada defines an autonomous vehicle as a vehicle equipped with autonomous technology that is able to drive the vehicle without active control or monitoring by a human operator.¹⁴⁰

¹³⁷Kohler, William J. & Colbert-Taylor, Alex. Act of June 16, 2011, ch. 472, §§ 2, 8, [2011] Nev. Stat. 2,873, 2,876 cited in "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles" January 2015. 112.

¹³⁸ National Conference of State Legislatures. "AUTONOMOUS | SELF-DRIVING VEHICLES LEGISLATION" December 16, 2016. Accessed January 23, 2017. <http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx>

¹³⁹ *ibid.*

¹⁴⁰Kohler, William J. & Colbert-Taylor, Alex. NEV. REV. STAT. §§ 482A.025, .030 (2014) (defining "autonomous technology" and "autonomous vehicle"); NEV. ADMIN. CODE § 482A.010 (2014) cited in "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles" January 2015. 112.

Requirements for testing on state highways include insurance and licensing requirements for the operator, and safety requirements for the vehicle.¹⁴¹ The operator must demonstrate proof of insurance for five million dollars or post another form of security for the same amount,¹⁴² and will only be licensed to test in specific geographic zones.¹⁴³ While testing, the human operator needs to be seated in a way that allows him to monitor the autonomous technology and take over the vehicle manually if necessary.¹⁴⁴ Additionally, Nevada is the only state that requires a second person who is capable of operating the vehicle to ride along for testing.¹⁴⁵ Safety regulations require that the vehicle has an easy way for the driver to engage and disengage autonomous technology, and a visual indicator must show when the autonomous technology is in operation and alert the operator if the technology fails and she needs to take control of the vehicle.¹⁴⁶ This indicator is not yet mandated across states, and different software and hardware requirements across states could pose an issue for manufacturers if not standardized before the vehicles are ready for commercialization.

Regarding commercialization, Nevada is unique in that its legislation explicitly allows manufacturers to sell autonomous vehicles to the public.¹⁴⁷ For a vehicle to be sold, an independent manufacturer or licensed technology certification facility needs to issue both a certificate of compliance for the vehicle and a certificate that deems the

¹⁴¹Kohler, William J. & Colbert-Taylor, Alex. “Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles” January 2015. 112.

¹⁴²Ibid. “NEV. REV. STAT. § 482A.060.” cited on 112.

¹⁴³Ibid. “NEV. REV. STAT. § 482A.120.” cited on 112.

¹⁴⁴Ibid. “NEV. REV. STAT. § 482A.070.” cited on 113.

¹⁴⁵Ibid. “NEV. ADMIN. CODE § 482A.130.” cited on 113.

¹⁴⁶Ibid. “NEV. REV. STAT. § 482A.080(2)(a)–(c).” cited on 112.

¹⁴⁷ Ibid. “NEV. ADMIN. CODE § 482A.190.” cited on 113.

driver is capable of operating the technology.¹⁴⁸ These regulations allow for the development of a privatized certification market and are an explicit step towards the commercialization of automated vehicles.¹⁴⁹

Florida

Florida's legislation retains Nevada's definition of an autonomous vehicle as well as its insurance and vehicle safety requirements.¹⁵⁰ The human operator must be a licensed driver affiliated with the company conducting the test, but the Act also states that "the Legislature finds that the state does not prohibit or specifically regulate the testing or operation of autonomous technology in motor vehicles on public roads."¹⁵¹ The Act did, however, compel the Florida Department of Highway Safety and Motor Vehicles to prepare a report recommending additional regulatory action by February 2014,¹⁵² and the report issued in 2014 concluded that there shouldn't be any additional changes made to Florida legislation at the time being, including their reasoning that- "In order to encourage innovation and foster a positive business environment toward that end, the Department proposes no changes to existing Florida laws and rules at this time."¹⁵³ Thus, commercialization in Florida seems possible due to the fact that the legislature is aware that it is not expressly outlawed and did not seek to change that, but the uncertainty of

¹⁴⁸Ibid. "NEV. REV. STAT.. § 482A.190." cited on 113.

¹⁴⁹ Kohler, William J. & Colbert-Taylor, Alex. "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles." January 2015. 113-114.

¹⁵⁰ Ibid, "Vehicles with Autonomous Technology Act, ch. 2012-111, [2012] Fla. Laws 1223." cited on 114.

¹⁵¹ Ibid, "Vehicles with Autonomous Technology Act, ch. 2012-111, § 1(2), [2012] Fla. Laws 1223." cited on 114.

¹⁵²Ibid, "Vehicles with Autonomous Technology Act, ch. 2012-111,§ 5(3), [2012] Fla. Laws 1223." cited on 114.

¹⁵³Ibid, "JULIUS L. JONES, FLA. DEP'T OF HIGH. SAFETY AND MOTOR VEH., HSMV NO. 13-008, AUTONOMOUS VEHICLE REPORT (2014), at 7." cited on 114.

future regulations surrounding the commercialization of autonomous vehicles may still slow the commercialization process.

California

California has passed the most recent legislation regarding the testing of autonomous vehicles on public roads. On March 7, 2017, California passed regulations that established an Autonomous Vehicle Tester Program, run by the Occupational Licensing Branch of the Department of Motor Vehicles (DMV), that manufacturers must apply to in order to be allowed to test their vehicles in California. As of March 8, California has admitted 27 manufacturers into the program, from behemoths such as Google, Tesla, and China's research giant Baidu, to smaller manufacturers. Once testing within the program, additional requirements include the provision of Autonomous Vehicle Accident reports within 10 days of any incident, and the submission of an annual Autonomous Vehicle Disengagement report, both to the DMV.¹⁵⁴ The DMV defines disengagements as deactivations of the autonomous mode for two possible reasons:

- 1) "Failure of the autonomous technology is detected"; or,
- 2) "safe operation of the vehicle requires that the autonomous vehicle test driver disengage the autonomous mode and take immediate manual control of the vehicle."¹⁵⁵

The definition of manufacturer is what sets California legislation apart from Nevada and Florida; it defines the manufacturer as the party that installs the autonomous

¹⁵⁴State of California. Department of Motor Vehicles. "Testing of Autonomous Vehicles. Released March 7, 2017. Accessed March 20, 2017. <https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing>

¹⁵⁵California DMV "Final statement of reasons" 2-3. March 7, 2017. Accessed March 20, 2017. https://www.dmv.ca.gov/portal/wcm/connect/70791ede-d798-4628-b3a9-764acebcb881/final_sor.pdf?MOD=AJPERES

technology, regardless of who manufactured the underlying vehicle.¹⁵⁶ This could become pertinent for liability issues. California's rules for testing automated vehicles on public roads are similar to Florida's, requiring the operator be personnel of the testing company and requiring proof of five million dollars of insurance coverage.¹⁵⁷ However, California's legislation most closely mirrors that of Nevada, because it more explicitly provides a path towards commercialization than Florida does. The legislation allows manufacturers to apply to for permission to utilize autonomous vehicles in scenarios outside of testing, and is less stringent than Nevada regarding geographical limits on testing within the state. However, California did not legislate for privatized licensing corporations to approve vehicles for sale, so it seems Nevada is still the trailblazer towards the commercialization of automated vehicles.¹⁵⁸

District of Columbia

Unlike other states that have enacted legislation, Washington D.C.'s legislation, which was enacted for the purpose of allowing autonomous vehicles to operate on D.C. roadways,¹⁵⁹ indicates that the District viewed the operation of autonomous vehicles as illegal prior to the passage of the legislation.¹⁶⁰ The legislation placed further rulemaking in the hands of the Mayor, who promptly shifted this power to the Director of the DMV.

¹⁵⁶Kohler, William J. & Colbert-Taylor, Alex. "CAL. VEH. CODE § 38750(a)(5)." cited in "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles." January 2015. 115

¹⁵⁷ Ibid, "CAL. VEH. CODE 38750(b)(3)." cited on 115.

¹⁵⁸ Ibid, "*Compare* CAL. CODE REGS. § 38750 (2014); *with* NEV. ADMIN. CODE ch. 482A (2014)" cited on 116.

¹⁵⁹ Ibid, "Autonomous Vehicle Act of 2012, D.C. Law No. 19-278, 20 D.C. Stat. 906 (2013)(codified at D.C. CODE §§ 50-2351 to -2354 (LexisNexis 2014))" cited on 116.

¹⁶⁰ Kohler, William J. & Colbert-Taylor, Alex. "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles." January 2015. Accessed February 21, 2017. 116.

The Department committed to creating regulations surrounding the registration, titling, and issuing permits to operate autonomous vehicles.¹⁶¹

Michigan

Michigan is unique in that it is the only state that has passed legislation that bans the commercialization of autonomous vehicles,¹⁶² and this has been publicly criticized by Google.¹⁶³ The legislation allows automated vehicles to operate on public roads for testing purposes only.¹⁶⁴

Pennsylvania

The Pennsylvania Senate has pledged to allocate up to forty million dollars to municipalities starting in the 2016-17 fiscal year and each year following, for the purpose of upgrading transportation infrastructure, including “intelligent transportation system applications, such as autonomous and connected vehicle-related technology.”¹⁶⁵

Virginia and Tennessee

Both states passed legislation allowing for visual displays, such as television or communication interfaces, to be active while a vehicle is in autonomous driving mode, as long as the functionalities are stopped when the vehicle is in a manual driving mode.^{166 167}

¹⁶¹Ibid, “Notice of Proposed Rule Amending Title 18 of the D.C. Municipal Regulations,61 D.C. REG. 3,587 (Apr. 4, 2014)” cited on 117.

¹⁶² Ibid, “See MICH. COMP. LAWS §§ 257.663, 665 (2014)” cited on 117.

¹⁶³ Ibid, “Melissa Anders, Autonomous Vehicle Testing Now Allowed Under Michigan Law, MLIVE.COM (Dec. 27, 2013), http://www.mlive.com/politics/index.ssf/2013/12/autonomous_vehicle_testing_now.html.” cited on 117.

¹⁶⁴Ibid, “Act of Dec. 20, 2013, Pub. Act No. 231, [2013] Mich. Pub. Acts (codified at MICH. COMP. LAWS §§ 257.2b, 35a, 36, 244, 602b, 663, 665–66, 817 (2014))” cited on 117.

¹⁶⁵ P.L. 861, No. 101, TRANSPORTATION CODE (74 PA.C.S) AND VEHICLE CODE (75 PA.C.S) - OMNIBUS AMENDMENTS. Act of Jul. 20, 2016. <http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2016&sessInd=0&act=101>

¹⁶⁶HB No. 454. State of Virginia (2016)

<http://lis.virginia.gov/cgi-bin/legp604.exe?ses=161&typ=bil&val=hb454&submit=GO>

¹⁶⁷HB No. 2333. State of Tennessee (2016) <http://www.capitol.tn.gov/Bills/109/Bill/SB2333.pdf>

Tennessee also passed legislation protecting the legality of autonomous vehicle technology, stating, “No political subdivision may by ordinance, resolution, or any other means prohibit the use of a motor vehicle within the jurisdictional boundaries of the political subdivision solely on the basis of being equipped with autonomous technology.”

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Alabama, North Dakota, Utah, and Louisiana

These states have only enacted legislation that serves the purpose of evaluating the effects of and researching the development of autonomous technologies, so this paper groups them together here as the “study states.” Alabama established a joint legislative committee to study autonomous vehicles, especially “the issues of public safety and state and local economic impact regarding such vehicles.” The committee will also assess whether current statutes stand in the way of autonomous vehicle testing in Alabama, before reporting findings and possible legislation propositions in 2017.¹⁶⁹ North Dakota also passed a house bill that charged legislative management with considering whether current laws need to be changed to allow for the testing and introduction of automated vehicles. The study will also assess the possible benefits of utilizing automated vehicles, such as minimizing collisions, reducing traffic congestion, and improving fuel economy.¹⁷⁰ Utah will study the federal NHTSA guidelines and evaluate regulatory strategies and safety standards before crafting and submitting legislation.¹⁷¹ Lastly, Louisiana takes a

¹⁶⁸HB No. 598. State of Tennessee (2016) <http://www.capitol.tn.gov/Bills/109/Bill/SB0598.pdf>

¹⁶⁹SJR 81, “Establishing the Joint Legislative Committee to Study Self-Driving Vehicles.” April. 7, 2016. <http://alisondb.legislature.state.al.us/ALISON/SearchableInstruments/2016RS/PrintFiles/SJR81-enr.pdf>

¹⁷⁰HB No. 1065, 64th Legislative Assembly of North Dakota. Jan. 6, 2016. <http://www.legis.nd.gov/assembly/64-2015/documents/15-0167-03000.pdf>

¹⁷¹HB No. 280, “Autonomous Vehicle Study.” State of Utah, General Session (2016). <https://le.utah.gov/~2016/bills/static/HB0280.html>

“wait and see” approach, and has only enacted a formalized definition of autonomous technology,¹⁷² in line with the definitions enacted by other states, in order to establish how these vehicles are treated within the framework of the Highway Safety Act.¹⁷³

Summary

The regulatory environment surrounding autonomous vehicles is in its nascent form. At the federal level, DOT and NHTSA regulatory guidance mirrors the initial steps towards federal regulation that were taken during the transition to the personal automobile. Funding for infrastructure, increased federal research into safety and technology, and recommendations to the states aim to help create a cohesive and safe regulatory environment across all states. However, the DOT and NHTSA currently leave the majority of regulation decisions to state legislatures, as their guidance has not yet become law. Examining state legislation, this paper finds that the state-level regulatory environment most closely parallels the regulatory environment outlined in the first edition of *The Law of Automobiles*. While the states seem to agree on the definition of autonomous technology, the legality of their use on public roadways vary from state to state, and only Nevada has taken a definitive step towards removing barriers that remain in the way of commercialization. While historically the piecemeal state-level regulatory environment took during the early adoption phase of the proliferation of the personal

¹⁷²HB No. 318. Regular Session, State of Louisiana (2016)

<http://www.legis.la.gov/legis/ViewDocument.aspx?d=1009651>

¹⁷³ National Conference of State Legislatures. “AUTONOMOUS | SELF-DRIVING VEHICLES LEGISLATION” December 16, 2016. Accessed January 23, 2017.

<http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx>

automobile. This current regulatory environment is forming before the commercialization of the autonomous vehicle. Depending on the timeliness with which the federal government mandates its guidelines, state regulations may become more uniform before the mass commercialization of autonomous vehicles. Currently, the variation in state legislature and the ambiguous future surrounding the enforcement of the Federal Automated Vehicles Policy could possibly slow the trajectory towards commercialization for these vehicles.

CHAPTER 6: CONCLUSION

This final chapter explicitly charts the parallels between the historical socio-technical transition from the horse-and-buggy to the personal automobile and the current shift occurring from the personal automobile transportation regime to a future where autonomous vehicle technologies replace human drivers. These parallels serve to prove that, because the socio-technical transportation shifts are characterized by many commonalities, policy makers can utilize lessons learned from the previous socio-technical shift in order to inform future policy decisions within the current shift.

For the sake of clarity and brevity, the chart of parallels included in this chapter is organized as follows: the first column briefly explains the historical issue; the second column outlines its current counterpart; and, the third column includes reference pages where the historical and current issues are mentioned within this paper, in case the reader wishes to return to the passage for more context. In some cases, specific issues from the historic or current context were not explicitly mentioned in the paper due to the scope of the paper and its focus on federal and state regulatory issues. In such cases, footnotes are included in the chart in case the reader desires more background into the parallels that were found during research and are briefly outlined in the chart but are not treated within the body of the paper.

Table of Parallels

Historical Issue	Current Issue	Pages
Intermediate technologies such as the electric tram paved the way for the diffusion of the personal automobile. The gasoline car took hold in a niche market as a toy for the wealthy before breaking into the taxi market and becoming widely adopted for personal use.	Intermediate autonomous technologies have already been implemented in personal automobiles with success. Examples include front crash prevention systems, blind spot detection, park assist, and adaptive cruise control. ¹⁷⁴	27-29
Pedestrians needed to be educated on how to safely coexist with personal automobiles, and their mental representation of roads as gathering places did not shift overnight. They had to learn new behaviors, such as using crosswalks.	There is concern that pedestrians will exploit the fact that autonomous vehicles are programmed to stop to avoid hitting people. ¹⁷⁵ Thus, pedestrian behavior towards autonomous vehicles will need to be regulated.	31, 38-40, 45, 46
The costliness of maintaining horse-based transportation systems made the public more willing to switch to the electric tram, which was an intermediate technology that paved the way for the personal automobile.	The possible economic savings from crash savings, fuel savings, and parking savings associated with a switch to autonomous vehicles bolsters the argument of those hoping to catalyse the testing and commercialization of autonomous technology.	14, 15, 26, 27

¹⁷⁴ Kohler, William J. & Colbert-Taylor, Alex, "Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles" 100. January 2015. Accessed February 21, 2017. <http://digitalcommons.law.scu.edu/cgi/viewcontent.cgi?article=1590&context=chtlj>

¹⁷⁵ Hurley, Karina. "How Pedestrians Will Defeat Driverless Vehicles" Scientific American. March 7, 2017. Accessed April 1, 2017.

<https://www.scientificamerican.com/article/how-pedestrians-will-defeat-autonomous-vehicles/>

<p>Cultural shifts towards suburbanization, increased focus on sanitation and hygiene, and increased leisure travel spurred the diffusion of the new technology, putting pressure on the horse-drawn transit regime and allowing the personal automobile to break out of its niche market.</p>	<p>The cultural shift towards the “sharing economy” in the transportation industry¹⁷⁶ has already developed a niche for testing autonomous technologies, as companies like Uber and Lyft seek to commercialize fleets of autonomous vehicles for their ride-share services.¹⁷⁷</p>	<p>12, 26</p>
<p>The legal field argued that new technologies should not be excluded from the roads just because it inconveniences, or even injures, those who use old technologies.</p>	<p>Proponents of “permissionless innovation” argue that autonomous vehicle innovation should be allowed to flourish as long as it doesn’t pose imminent threat to the public well-being.</p> <p>DOT Secretary Anthony Foxx introduced the Federal Automated Vehicles Policy by stating that the emergence of new technologies is inevitable, but that safety can be improved by early federal guidance.¹⁷⁸</p>	<p>19, 36, 37, 47</p>

¹⁷⁶ Choe, Ted. “The Rise of the Sharing Economy: Impact on the Transportation Space.” Deloitte. Accessed April 1, 2017.

<https://www2.deloitte.com/us/en/pages/consumer-business/articles/the-rise-of-the-sharing-economy-impact-on-the-transportation-space.html>

¹⁷⁷ “Lyft, GM Teaming Up To Create Fleet of Driverless Cars.” NPR. January 4, 2016. Accessed April 1, 2017.

<http://www.npr.org/sections/thetwo-way/2016/01/04/461922098/lyft-gm-teaming-up-to-create-fleet-of-driverless-cars>

¹⁷⁸ Foxx, Anthony, introductory message to Federal Automated Vehicles Policy 2016. September 2016. 3.

<p>Automobile drivers filed class action lawsuits arguing that taxation on automobile registration was discriminatory, as drivers of horse-and-buggies were not taxed. Courts ruled that automobile drivers were not a class of people and that the legislation was not discriminatory.</p>	<p>One socioeconomic impact of the proliferation of autonomous vehicles will be the creation of two driving classes during the technological shift. Safety will depend on the quality of the driver and the quality of autonomous technology.¹⁷⁹ Human drivers will be more likely to be found at fault in a collision with an automated vehicle, decreasing insurance costs for those who have autonomous vehicles¹⁸⁰ and increasing liability, and likely insurance costs, for those who do not switch to the new technology.¹⁸¹</p>	<p>37, 38</p>
<p>Between 1912 and 1924, the status of the passenger was determined by the legal field. It was determined that the passenger could not be blamed for the negligence of the driver or chauffeur.</p>	<p>Autonomous technologies will blur the line between driver and passenger, and the legal field and regulatory agencies will shape the new expectations for driver liability. State laws currently vary regarding the requirements for human drivers testing autonomous vehicles.</p>	<p>38, 70-74</p>
<p>Between 1912 and 1924, the majority of rules established came from case law. This evidences that the regulatory environment was characterised by a “wait-and-see” approach.</p>	<p>Scholars believe that litigators and courts will play a large role in shaping the common law’s approach to automated driving because they believe commercialization will occur before an extensive legal schema is developed around autonomous driving. Also, DOT Secretary Anthony</p>	<p>44, 48</p>

¹⁷⁹ Alain Kornhauser, Director of Transportation Program and Faculty Advisor of Princeton Autonomous Vehicle Engineering, in discussion with the author, Princeton University, Princeton, NJ. March 28, 2017.

¹⁸⁰ Peltz, James F. “Self-driving cars could flip the auto insurance industry on its head” *Los Angeles Times*. April 2, 2017. Accessed April 2, 2017.

<http://www.latimes.com/business/la-fi-agenda-driverless-insurance-20160620-snap-story.html>

¹⁸¹ Alain Kornhauser, Director of Transportation Program and Faculty Advisor of Princeton Autonomous Vehicle Engineering, in discussion with the author, Princeton University, Princeton, NJ. March 28, 2017.

	<p>Foxx introduced the Federal Automated Vehicles Policy, stating, "...the "unknowns" of today will become "knowns" tomorrow. We do not intend to write the final word on highly automated vehicles here."¹⁸² This signals a similar "wait-and-see" approach.</p>	
<p>Courts decided that the car was not inherently dangerous and that driver negligence was the primary source of danger on the roads. By the late 1920s, manufacturers understood that some dangers threatening driver and passenger safety stemmed from design flaws.</p>	<p>Consumers now understand that design flaws can be inherently dangerous. To increase public trust in new technologies, manufacturers must ensure the safety of autonomous software before it's commercialized. For example, Uber halted testing when one of its vehicles was in a collision in order to ensure that their technology was not at fault before resuming testing.</p>	<p>12, 41, 53</p>
<p>The legal field determined that the general right of the use to highways extended to new technologies so long if there was no specific state legislation stating otherwise.</p>	<p>The idea that new automotive technologies are legal before deemed illegal by state legislation is questioned. The Federal Automated Vehicles Policy, and some states, presume that testing autonomous vehicles is illegal unless authorized. Federal Policy does acknowledge that autonomous vehicles can be sold, absent federal law stating otherwise, but the NHTSA retains the right to recall these technologies.¹⁸³</p>	<p>43, 44, 67, 74</p>

¹⁸² Foxx, Anthony, introductory message to Federal Automated Vehicles Policy 2016. September 2016. 3.

¹⁸³ Department of Transportation and National Highway and Transportation Safety Agency, "Vehicle Performance Guidance for Automated Vehicles" in "Federal Automated Vehicles Policy 2016. September 2016 11. Accessed February 21, 2017.

<p>Rules of the road included valid excuses for driving on the incorrect side of the road, including avoiding obstacles and avoiding another car that was not following the rules of the road.</p>	<p>The public is concerned about how autonomous vehicle algorithms will handle unforeseen circumstances on the road. Will they swerve, stop, or calculate how to minimize damage? Rules for autonomous vehicles need to be understood by human drivers so they can predict how autonomous vehicles will act.</p>	<p>16, 45</p>
<p>Federal regulation lagged behind state level regulatory intervention into the automotive industry.</p>	<p>Federal regulation is currently lagging, as the DOT and NHTSA have not yet mandated their guidelines and leave many decisions to the states.</p>	<p>48, 49, 63, 64, 67</p>
<p>The first federal interventions into the automotive regulatory environment came in the form of grants dedicated to the development of automotive infrastructure.</p>	<p>DOT Secretary Anthony Foxx has pledged 4 billion dollars over the next decade to catalyze the proliferation of autonomous vehicle technologies.</p>	<p>42, 43, 55, 56, 69</p>
<p>State, and later federal, interventions increasingly focused on driver education as an effort to reduce highway fatalities.</p>	<p>Human drivers will need to be educated about autonomous vehicle operation. The Model State Policy section of the Federal Automated Vehicles Policy suggests federal and state legislatures work together on driver education.</p>	<p>31, 37, 66</p>

The following table charts historical issues in the first column, and the second column offers considerations regarding possible future parallels in the transportation shift. The third column provides page numbers referencing where the historical issue was discussed in more depth in this paper.

Table of Considerations

Historical Issue	Future Consideration	Pages
Horse-drawn carriages receded into a niche market before disappearing from the transportation industry. This quelled social unrest by decreasing unemployment shock for those who drove the carriages.	Will taxi drivers and employees of ride-sharing services like Uber and Lyft have a niche market to operate within once these companies switch to fleets of autonomous vehicles?	28
The gasoline car settled in a dominant design with the development of Ford's Model T. Gasoline cars proliferated much more quickly after stabilizing in a dominant design, as manufacturers benefitted from economies of scale and prices dropped as a result.	Will autonomous technologies settle into a dominant design or will each manufacturer have its own proprietary software? What will the implications of this be for oversight agencies like the NHTSA?	30
By 1924, there was only about one court case involving horse-and-buggies per year, signalling their disappearance from the roads.	How rapidly will human drivers vanish from the roads? Will there be numerous court cases involving human drivers and autonomous vehicles during this transition, causing human drivers to feel that manually operating a vehicle becomes an increasingly heavy liability?	46
Manufacturers did not universally install life-saving technologies into their cars until the NHTSA mandated it in their federal safety standards.	If manufacturers historically did not install potentially life-saving technologies that had already been invented, how will they prioritize safety in the current transition? The NHTSA should regulate autonomous vehicle safety standards from the beginning of autonomous technology testing; they should mandate their Vehicle Performance Guidance, which does not currently bind manufacturers to the recommended safety assessment frameworks.	58, 59

Final Thoughts

This paper finds that the regulatory environment for autonomous vehicles is in its nascent form, mirroring the formation of the regulatory environment for personal automobiles outlined in Huddy's first edition of *The Law of Automobiles*. Intermediate autonomous technologies have been successfully implemented, but for the socio-technical shift to be successful, consumers must trust that highly and fully autonomous vehicle technologies are safe. Since consumers from the personal automobile transportation regime have come to understand that design flaws make driving dangerous, manufacturers in this technological transition must prove that their technologies are ready for commercial use through extensive testing. Historically, manufacturers did not implement certain safety features until mandated to do so, so it is imperative that the NHTSA mandate autonomous vehicle safety standards as quickly as possible.

Similar to the early stages of the previous socio-technical transportation transition, federal regulation is lagging behind state regulatory actions. The federal government has pledged funds to catalyse the proliferation of autonomous vehicles, and should coordinate with state legislatures to standardize state regulations for autonomous vehicles, and to educate not only drivers, but pedestrians, on how to behave in relation to autonomous vehicles once they are sold. While early in its development, the regulatory environment is following the path of its historical counterpart and will become increasingly explicit and expansive as the perceived benefits of autonomous vehicles

push government agencies and the public to pursue a new transportation landscape of autonomous vehicles.

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