



# **DRIVEN TO SAFETY: ROBOT CARS AND THE FUTURE OF LIABILITY**

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# EXECUTIVE SUMMARY

- Robot cars could significantly reduce the number of automobile crashes.
- A robotic revolution would go beyond transportation, and impact insurance and liability.
- The courts have dealt with innovative technologies before.
- While civil justice reform is unnecessary in the short term, a strict liability system may one day prove the most efficient.

Every year, more than 2 million people are injured and more than 30,000 killed in 6 million automobile crashes on U.S. roads. Widespread adoption of robot cars could have a revolutionary impact on these figures, potentially preventing

90 percent of crashes and saving thousands of lives every year.

The impact of such a robotic revolution would go beyond transportation. Robot cars may transform the automobile industry from one based on car ownership to one based on ride-share services. The auto insurance industry may wither, as the idea of personal car ownership slowly disappears. And without human drivers, or insurance policies to match, traditional approaches to liability when there are crashes may have to evolve.

Such uncertainty has led some commentators to propose schemes such as no-fault insurance, or various forms of manufacturer immunity. Most of these concepts have already been tried and found flawed. They also underestimate the ability of the courts to adapt to new technology and guide

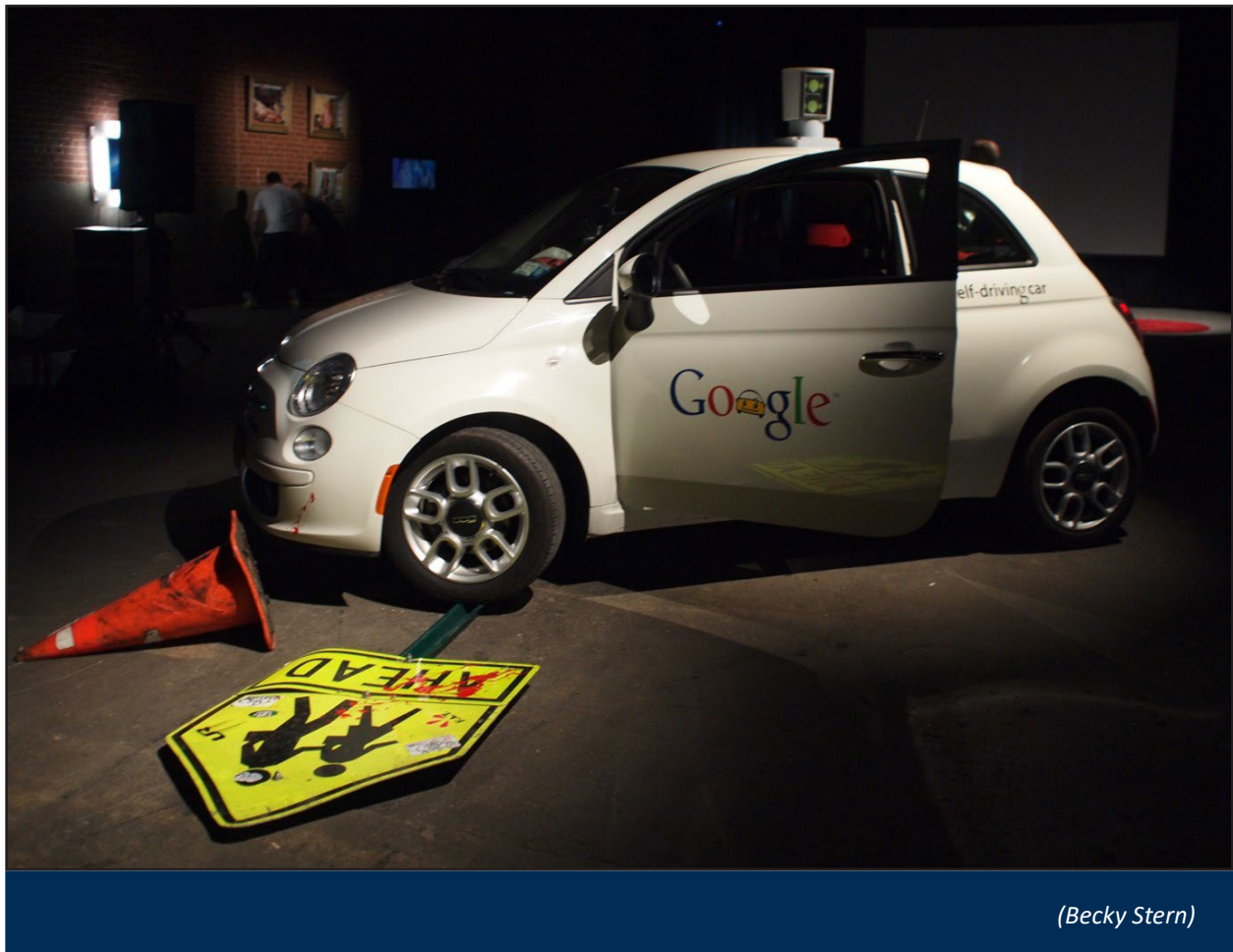


**THE DRIVERLESS FUTURE:** A 1956 advertisement for utility companies imagining future robot cars.

society's beliefs on what is right and wrong. From the earliest passenger airplanes to robotic surgical systems a century later, litigation has served as the most consistent and powerful force in strengthening safety standards, revealing previously concealed defects and deterring manufacturers from cutting corners on safety for the goal of greater profits. The civil justice system is better placed than any other regulatory mechanism to ensure innovations develop in the safest manner possible.

regime, the claimant need only prove the tort occurred and that the defendant is responsible. Holding vehicle makers accountable for crashes will be the only way to guarantee that humans and governments do not end up footing the bill for collisions over which they have no control. A strict liability system would ensure manufacturers have an incentive to make their vehicles as safe as possible, while giving victims meaningful access to justice.

If there is one proposal that might fit in an eventual driverless world it is strict liability. Under a strict liability



(Becky Stern)



# HUMANS AT THE WHEEL

- Humans are causing more crashes than ever, while automated systems are already saving lives.
- There is no consensus of what a robot car world will look like.
- However advanced, robot cars will still crash, raising a multitude of questions over liability.

In 2015, there were 6.3 million automobile crashes on U.S. roads, injuring 2.4 million people, and killing 35,092.<sup>1</sup> Despite design innovations making cars safer than ever, the death tally marked a seven percent increase over the year before, and was the largest jump in 50 years. Increases in so-called “human choice crashes” — driving while distracted or intoxicated, driving without a seatbelt, and speeding — accounted for most of the increase. Distracted driving deaths grew the most of all (by nine percent), killing more people than speeding.

DESPITE DESIGN INNOVATIONS MAKING CARS SAFER THAN EVER, THE DEATH TALLY MARKED A 7 PERCENT INCREASE OVER THE YEAR BEFORE, AND THE LARGEST JUMP IN 50 YEARS

At the same time, the development of automated driving technologies accelerated rapidly. In 2010, more than 70 percent of vehicles on the road did not feature electronic stability control

(ESC) — a technology that cuts the risk of a fatal single-vehicle crash by about half and the risk of a fatal rollover by as much as 80 percent — despite the fact that the technology had been available since the mid-1990s.<sup>2</sup> By 2014, ESC was in place in nearly half of all vehicles on the road, and had saved an estimated 4,100 lives.<sup>3</sup> More recent innovations, such as forward collision avoidance systems, lane departure warnings, and adaptive headlights, are already significantly reducing the number of claims insurers see, and are anticipated to eventually prevent as many as 1.8 million crashes and more than 10,000 fatalities annually.<sup>4</sup>

Human drivers then, are increasingly causing fatal crashes, even as automated systems are increasingly saving people. Which is why both vehicle and software manufacturers have been pursuing a vision of full automation — robot cars.

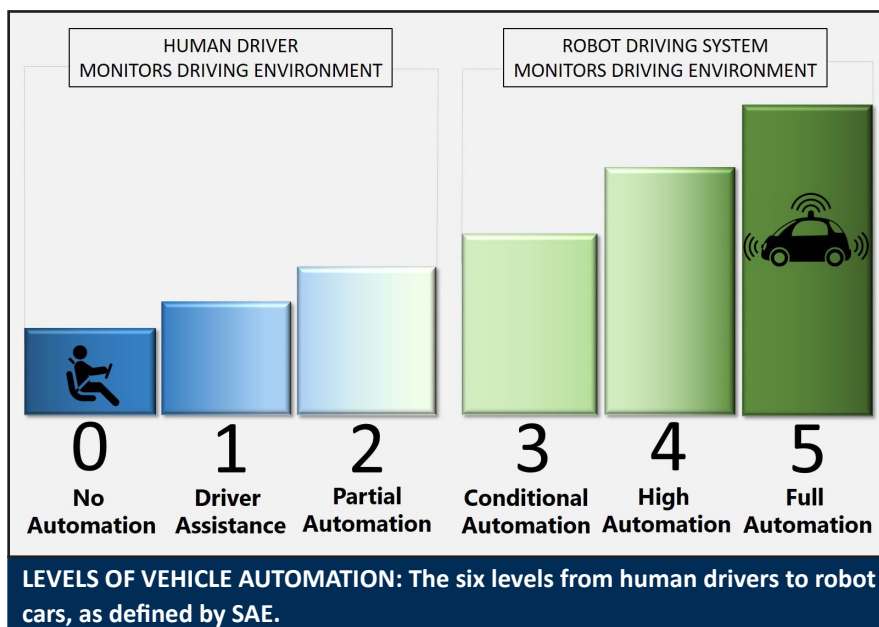
For all the technological innovations in vehicle safety, humans remain the weak link. Human factors — mostly driver error — are the critical reason for 94 percent of crashes.<sup>5</sup> Robot cars remove the human factor, and could, according to some experts, reduce crashes by as much as 90 percent, saving 30,000 lives a year.<sup>6</sup>

It's hard to know what a robot car future will look like, except that it will be significantly different from today. Robot cars may be two years away, or two decades away.<sup>7</sup> Robot ride-sharing services will dramatically reduce the need to own a car and thus reduce vehicle miles overall, or make travel so easy that people will travel more than ever, causing vehicle miles to soar.<sup>8</sup> Such services may also eliminate car ownership and put most of the automobile industry out of business, or perhaps the autonomous revolution won't come from Uber, Google or Silicon Valley at all, but the traditional auto industry giants like Ford and Volvo.<sup>9</sup>

As much as 80 percent of auto insurance premium volume will disappear, resulting in the near elimination of the auto insurance industry as we know it, or robot cars will create new opportunities for insurers in cybersecurity and alliances with car makers.<sup>10</sup> Urban design may evolve as cities reimagine parking lots and road networks, or be suffocated by a growth in urban sprawl.<sup>11</sup> Robot cars may dramatically reduce emissions and create an automotive environmental utopia, or make things worse and hasten an impending environmental crisis.<sup>12</sup>

But while the future of robot cars may be uncertain, the fact that they will still sometimes crash is inevitable. As revolutionary as they are, the current generation of robot cars are still occasionally baffled by situations a human would take for granted. Tumbleweed, clouds of exhaust gases on cold mornings, and the soap-covered brushes of car washes are examples of everyday things

that automated cars tend to misinterpret as impending disaster.<sup>13</sup> Future iterations will be more capable, but they will never be perfect. Robot cars employ machine learning, which is closer to training than it is to traditional programming.<sup>14</sup> Human engineers coach machines rather than code them line by line, and the end result can be unpredictable.<sup>15</sup> Which raises the question, when a driverless car crashes, who is to blame?



# THE QUESTION OF LIABILITY

- There are many questions regarding liability in a robot world.
- The courts have dealt with disruptive technologies before.
- There is a psychological tendency to blame humans when robots cause injury.

## **The question of liability – it seems complicated**

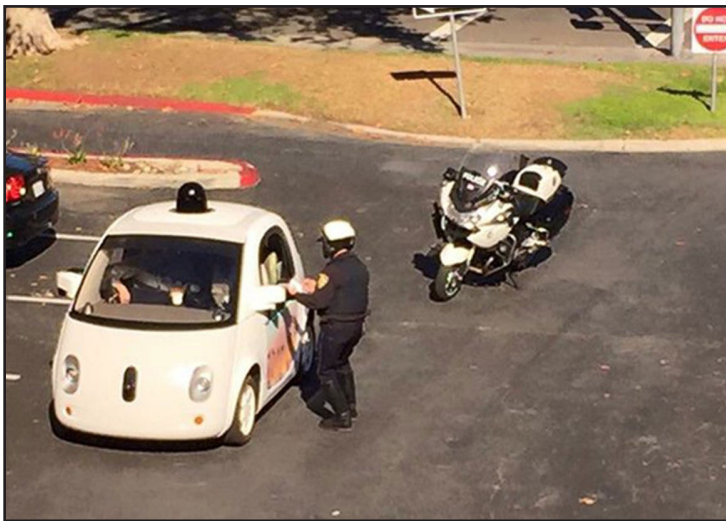
If a robot car crashes, who should take the blame? The human, even if they're not actually driving? The car manufacturer? The software designer?

If a car is conditionally autonomous and alerts the human driver to take over, when is the machine no longer responsible for driving? When it sounds the alert? When the driver actually takes over? Ten seconds

after the driver takes over? Or 20, or 30 seconds? Or never?

If people choose ride-hailing services over owning a car, and no longer carry personal auto insurance, who can they make a claim to when something goes wrong?

Can a robot car get a speeding ticket or a parking violation?<sup>16</sup> Can a passenger get a DUI, even if the robot is driving?<sup>17</sup>



**PULLED OVER:** A Google self-driving car is stopped for driving too slowly in Mountain View, California. There was a human in the car. No ticket was issued. (Google)

If a robot car has a defect, the origin of which is so complex that it can't be pinpointed, would the manufacturer get away scot-free when it crashes, because no one can be sure of the cause?

Questions about the future of liability in a robot car world outnumber the answers. But even if we were to figure out the future, what about now? It takes approximately 15 years for the fleet of cars on the road to turn over completely to the next generation, which means the roads are always filled with a mix of technologies. Today in Pittsburgh, Pennsylvania, you



can catch an Uber that drives itself, yet it will take until 2032 before 95 percent of the vehicles on the road are equipped with something as simple as electronic stability control, which has been around for decades.<sup>18</sup> Even the most optimistic robot car advocates believe it will be the mid-2020s before fully automated cars really take hold, and then at least 15 more years before human-operated cars are all but gone. Meaning for at least the next quarter of a century we'll be living in a world where robot cars, partially-automated/human-operated cars, and plain old error-prone human-driven cars are all sharing the road. When a robot car crashes with a human-operated car, who is going to be at fault?

### **The question of liability — it's actually simple**

As uncertain as the future sounds, the civil justice system is well-placed to handle such ambiguity. The courts have faced

disruptive technologies many times before, and proved themselves able to adapt. The peculiarities of each innovation have been worked out by the common law on a case-by-case basis until a legal consensus is reached. While legislative bodies and government agencies often end up playing catch-up to technological change, the law is a living thing and is capable of evolving with technology.

**"JUST LEAVE IT TO THE TORT SYSTEM."**  
- ADAM THIERER, GEORGE MASON

Amongst legal experts there is already widespread agreement that the current liability system is best-placed to handle innovation.

Even those who advocate for tort reform and limiting corporate accountability, and who have proposed manufacturers eventually enjoy immunity, admit that the civil justice system is the best option at present. As Adam Thierer, an advocate of manufacturer immunity at the Mercatus Center at George Mason University, puts it, "*Just leave it to the tort system.*"<sup>19</sup>

### **Historical Innovations and the Civil Justice System**

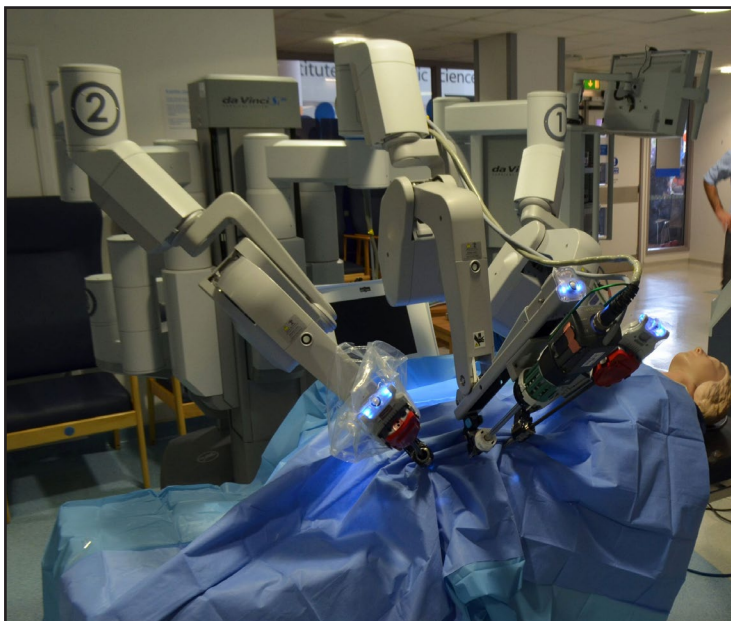
From the introduction of automated elevators in the early 1900s to the development of advanced surgical robots a century later, the courts have wrestled with questions of ethics and fault and through trial (literally) and error, and guided our understanding of responsibility.

***Automatic Elevators*** — Automatic elevators began to replace the existing manual elevators from the 1930s. When the initial technology proved dangerous,



**AUTOMATIC ELEVATORS:** Elevators required operators to function, until technological advances rendered them unnecessary. (*Life*)

states began enacting specific safety requirements for elevators. The insurance industry developed a special “elevator liability” insurance, and courts deemed elevators “common carriers” – meaning an entity that transports people or goods for a fee, like a taxi – which held operators and manufacturers to the highest duty of care under the law.<sup>20</sup> Today, automatic elevators are safe and efficient at least in part because the manufacturers were held to such strict standards.



ROBOT SURGEON: A da Vinci surgical system. (Cmglee)

**Airplane Autopilot** — Like autonomous vehicles, the invention of aviation autopilot systems was lauded as a great advancement in safety — in 1916, the *New York Times* declared one such invention would “make the heavier-than-air machines practically ‘foolproof’.”<sup>21</sup> And like autonomous vehicles, aviation autopilot would be expected to have a significant impact on liability, making it more likely that autopilot manufacturers would be held to account when planes did crash.

However, that didn’t really happen.<sup>22</sup> Pilots tended to take the blame for crashes, and when cases did go to trial, they involved the airlines as defendants, rather than the autopilot manufacturers. Even now, crashes tend to be attributed to human error, even when autopilot has put pilots in impossible situations. Manufacturers fight every case, and when forced to settle do not admit fault.<sup>23</sup>

**Surgical Robots** — Capable of remarkable feats of dexterity, and allowing far less invasive surgeries, surgical robots have been heavily marketed as the future of surgery. However, in 2013, the FDA began surveying surgeons after an increase in reported adverse events, including 70 deaths in five years. By 2014, Intuitive Surgical Inc., the company behind the industry-leading da Vinci surgical system, admitted it knew of as many as 3,000 claims against it, many of which the company had settled.<sup>24</sup> In 2016, two insurance companies sued Intuitive Surgical alleging that the company had hidden more than 700 injury claims when it applied for liability coverage.<sup>25</sup>

**Industrial Robots** — Robots have long been used in manufacturing plants, particularly auto assembly plants and those utilizing die press and molding equipment. In 1979, Robert Williams became the first human to be killed by a robot when he was hit by a robot arm at a Ford assembly line in Flat Rock, Michigan. Williams’ family filed a lawsuit against the robot manufacturer, and a jury agreed that a lack of safety measures caused the incident, awarding the family \$10 million.<sup>26</sup> There have been many more incidents since then, and at least 27 deaths.<sup>27</sup> Human error is

often blamed for such incidents, and when manufacturers are taken to court they are often cleared on the basis that humans have disengaged or ignored safety warnings and devices.<sup>28</sup> The 2015 death of a Volkswagen technician exemplifies this instinct to blame humans not manufacturers. The 21-year-old technician was struck in the chest while installing the machine and later died of his injuries. Artificial Intelligence expert Blay Whitby told the *Financial Times*, “*This unfortunate accident is technically and morally comparable to a machine operator being crushed because he didn’t use the safety guard. In this case it’s more complex and therefore more forgivable because ‘the safety guard’ was provided by computer software and he was in the process of setting it up.*”<sup>29</sup>

**Complex Systems** — Incidents involving automated systems are frequently blamed on a single cause, like human error, when in fact there are complex interacting causes. In the 1980s, the Therac-25, a radiation therapy machine made by Atomic Energy of Canada Ltd (AECL), killed and injured several patients by giving them massive overdoses of radiation. On the surface it appeared the problem was down to technicians who routinely ignored the machine’s warning alerts. But when researchers looked deeper, they found a complex set of causes. Technicians ignored alerts because the machine spat out so many of them, not all of which corresponded to any documentation, meaning they could not be acted upon. Multiple software defects allowed the overdoses to occur, even when technicians thought everything had worked correctly. Hardware fail safes had masked the defects in previous models, but because there was no way to

know they had ever been triggered, AECL copied the defective software over to the new models, but without the fail safes. That also allowed AECL to bypass Food and Drug Administration (FDA) testing, because the company could claim the software was not new. And while multiple users informed the manufacturer of the problems, corporate executives claimed there were no other complaints, and emphasized software patches over a call to stop using the machine.<sup>30</sup>

**Car Automation** — Vehicle automation is already here and has been in some form for half a century. When cruise control was first developed and implemented in luxury cars in the 1950s and 60s, courts dealt with, and rejected, the idea that drivers were no longer in control.<sup>31</sup> Electronic stability control was developed in the mid-1990s, and saved an estimated 4,100 lives between 2010 and 2014.<sup>32</sup>

The increased complexity of such innovations has also increased the possibility of significant product defects. The Toyota sudden acceleration case is a recent example. Whether and why Toyota vehicles suffered from sudden acceleration is, to some, still in dispute, but Toyota accepted liability to the tune of \$1.2 billion. Georgetown University law professor David Vladek suggests the Toyota case may mirror a future scenario where a class of robot vehicles seems to suffer an apparent problem, but the complexity of their manufacture makes it hard to pinpoint the exact defect. “*As the Toyota case makes plain, existing products liability law is well-positioned to address cases where the evidence strongly suggests a defect, but technology cannot isolate the cause.*”<sup>33</sup>

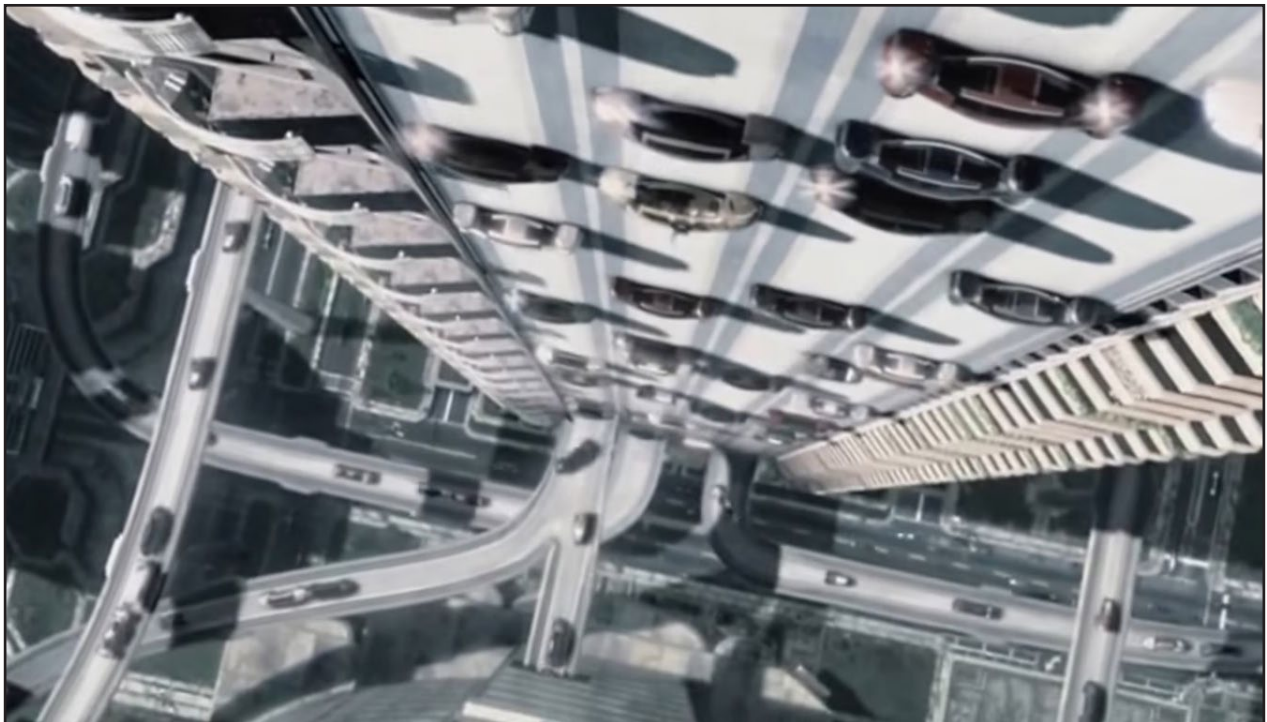


Such systems have been the subject of court cases not only when they prove defective, but when they have not been installed at all.<sup>34</sup> In fact, the civil justice system has been a significant factor in the improved safety of automobiles, prompting such innovations as impact-absorbing dashboards, steering columns, and gas tanks that don't explode in rear-end collisions.<sup>35</sup> Electronic stability control has been standard on all new cars since 2012, in part because of litigation against car makers who had reserved the technology as an option or for luxury models in order to make more money. Similarly, manufacturers are now under pressure to make another life-saving technology — forward collision avoidance, or auto brakes — standard because it could potentially prevent a million crashes a year.<sup>36</sup>

### **Blaming Humans**

Each of these innovations has threatened to shake up traditional understandings of liability, but ultimately did not. The courts have not only been able to adapt to new technology, but have also served to both ensure that innovations are safe, and that they are implemented when available.

What such past histories also reveal is society's instinct to blame humans when things go wrong. From airline pilots to assembly plant workers, humans are consistently held responsible for incidents even when actual causes are complex and interrelated. This is a particular concern with robot cars, which threaten to saddle humans with responsibility for problems they cannot control.



**A DRIVERLESS WORLD:** The 2002 film *Minority Report* imagined a world of robot cars. Lexus designed a custom driverless prototype (though not truly operational), the Lexus 2054, for the film.

# BLAMING HUMANS: THE HANDOVER PROBLEM

- Humans are not well adapted to taking over control of a robot car mid-drive.
- Rival manufacturers think Tesla's Autopilot is dangerous.
- Autopilot systems that make drivers take over in an emergency allows companies to blame drivers for crashes.

Already, automated car makers are pushing to shift responsibility for collisions away from themselves. Tesla has responded to a variety of crash reports by emphasizing that the cars in question were not operating under Autopilot at the time of the crash, even though research has shown that humans find it very hard to take over a complex task like driving midway through. When an autonomous Nissan, run by Cruise Automation, crashed in downtown San Francisco, the company blamed the human driver, though he had only taken

control a few seconds before to correct the robot car's error.<sup>37</sup>

Even Google, which has proactively said it would accept liability for crashes caused by its cars, was reluctant to accept full responsibility when one did indeed cause a crash, instead trying to pin some of the blame on the bus hit by the car (the local Santa Clara Transportation Authority disagreed, absolving the bus driver of any blame — See *Timeline to Robot Cars*, page 34).<sup>38</sup>



**GOOGLE BUS CRASH:** A Google self-driving car pulled in front of a bus causing a collision in Santa Clara, California, in February, 2016. (YouTube)

The desire to blame everything on human operators also follows historical precedent. As previously noted, incidents involving aviation autopilot systems and automated surgical devices have tended to blame human error. Even Takata, maker of deadly airbags, has tried to shift blame to drivers who may have missed recall notices.<sup>39</sup> Santa Clara University Law Professor Kyle Graham highlights a 1904 article that sought to blame drivers for what was clearly



one of the first examples of a recurring product defect in early automobiles — pins falling out of the steering gear:

*“Now, while a mishap to the steering gear is very likely to cause a serious accident, it is hard to believe that the steering gears of so many cars are so carelessly constructed that they break or drop to pieces on the road... we are rather inclined to think that the greater portion of these accidents are simply the result of reckless driving, mostly by comparative novices.”*<sup>40</sup>

### The Handover Problem

Perhaps the biggest challenge when it comes to liability is the “handover problem.” Discussion of robotic car liability often conjures up a scenario where manufacturers are liable for crashes that occur under autonomous control, while humans remain liable for crashes that occur when they are operating the vehicle. However, the reality is not as clear cut.

IT TAKES 17 SECONDS TO REGAIN CONTROL OF A VEHICLE — ENOUGH TIME FOR A CAR MOVING AT 60 MILES PER HOUR TO TRAVEL A QUARTER OF A MILE.

Research shows that humans are not well adapted to re-engaging with complex tasks, like driving a vehicle in an emergency situation, once their attention has been allowed to wander. A 2015 study by the National Highway Traffic Safety Administration (NHTSA) found that it took test subjects an average of 17 seconds to respond to a request to regain control of their vehicle. That’s enough time for a car traveling at 60 miles per hour to travel a quarter of a mile.<sup>41</sup>

A comprehensive review of studies by British researchers concluded that planning for a human driver to take over in an emergency was more dangerous than planning for no driver at all:

*“[I]t is a substantial technical challenge for a vehicle in autonomous mode to be brought to a halt, before any collision arises, and after the control system has sought to engage a human driver, and failed, and for it to achieve this in every conceivable crisis event. This is a greater challenge than would be faced by a fully autonomous control system which does not attempt to pass control back to human driver before safe failing.”*<sup>42</sup>

### Humans as “Moral Crumple Zones”

Manufacturers may prefer a situation where humans, though only incidental to operation of robot cars, retain responsibility. If the complicated system of hardware and software collaboration somehow fails, the human who happens

to be in the car takes the blame, becoming what anthropologist M.C. Elish calls “a moral crumple zone.”

*“If there’s an accident, we intuitively—and*

*our laws, in practice—want someone to take the blame. The result of this ambiguity is that humans may emerge as “moral crumple zones.” Just as the crumple zone in a car is designed to absorb the force of impact in a crash, the human in a robotic system may become simply a component—accidentally or intentionally—that is intended to bear the brunt of the moral and legal penalties when the overall system fails.”*<sup>43</sup>

Tesla, for instance, has been vigilant in rejecting responsibility for many crashes involving its cars by pointing out that its Autopilot was not engaged. Even when Autopilot was implicated in the death of Joshua Brown — Tesla's first Autopilot-operated fatality — Tesla responded with a blog post emphasizing human responsibility: *"When drivers activate Autopilot, the acknowledgment box explains, among other things, that Autopilot 'is an assist feature that requires you to keep your hands on the steering wheel at all times,' and that 'you need to maintain control and responsibility for your vehicle' while using it."*<sup>44</sup>



**TESLA'S AUTOPILOT FATALITY:** Joshua Brown, a former Navy Seal, was an avid fan of Tesla. He died in May 2016, when his Tesla Model S crashed into a tractor trailer without applying the brakes.

Experts have long known that autopilot systems in aviation cause human pilot skills to atrophy and awareness to decrease. When things go wrong, pilots are left to take control at the worst possible time — an emergency situation, the build-up to which they have not been involved. Elish cites the example of the 2009 Air

France 447 crash, in which 228 people were killed. When problems occurred, the autopilot disconnected, however, the pilots could not properly understand the many warning alerts, and the plane crashed into the Atlantic Ocean:

*"Regulators, in addition to the engineers and managers of aviation systems, have created a schizophrenic dynamic in which automation is seen as safer and superior in most instances, unless something goes wrong, at which point humans are regarded as safer and superior. Unfortunately, creating this kind of role for humans, who must jump into an emergency situation at the last minute, is something humans do not do well."*<sup>45</sup>

### Some Automakers Recognize the Danger

While Tesla defends its approach, other companies making robot vehicles have suggested that Autopilot makes crashes inevitable.<sup>46</sup> Volvo's senior technical leader of crash avoidance, Trent Victor, described Autopilot as a *"wannabe,"* and said, *"It gives you the impression that it's doing more than it is."*<sup>47</sup> Ford is planning on skipping Level 3 automation and going straight to a Level 4 vehicle with no driver operation at all. *"We're not going to ask the driver to instantaneously intervene,"* Ford driverless vehicles expert Jim McBride has said, *"that's not a fair proposition."*<sup>48</sup>

Google initially tested cars that relied on humans to occasionally take control, and eventually deemed it a failure. The employee volunteers the company used indulged in *"silly behavior,"* including turning around and looking for a laptop while traveling at 65 mph. So Google

gave up on the L3 level of automation and made truly driverless cars its goal.<sup>49</sup>

### Regulators See the Danger Too

In September 2016, NHTSA issued its guidelines on robot cars, and addressed the overlapping issue of “fall back” — namely what a robot car should do to facilitate safe operation if it malfunctioned or faced a problem it could not handle.<sup>50</sup>

At higher levels of automation, NHTSA recommended the car be able to put itself into a position of minimal risk, for instance by pulling over. But when a human driver was present, NHTSA noted that, *“human drivers may be inattentive, under the influence of alcohol or other substances, drowsy, or physically impaired in some other manner... Such fall back actions should also minimize the effects of errors in human driver recognition*

*and decision-making during and after transitions to manual control.”*<sup>51</sup>

In addition, NHTSA recognized that there may be “some circumstances” where “liability for a crash involving a human driver of an HAV should be assigned to the manufacturer” — a clear nod to the danger that Level 3 vehicles pose.<sup>52</sup>

Finally, California regulators have proposed regulations that would prohibit Tesla (and other automakers) from advertising a vehicle as an autonomous vehicle unless it meets certain requirements, effectively prohibiting Tesla from advertising their system as “auto-pilot.”<sup>53</sup> This echoes calls from *Consumer Reports* made in July 2016 that using the term auto-pilot was “misleading and potentially dangerous.”<sup>54</sup>



**HUMAN IN ANY FORM:** A Google car learning to recognize children in costume for Halloween. Google cars are programmed to be more cautious around children. (Google)

# ALTERNATIVE FORMS OF LIABILITY

- No-fault insurance has turned out to be a costly mistake wherever it has been tried.
- The auto industry has a long history of cover-ups, and cannot be trusted to self-regulate.
- Corporate immunity models would slow innovation and harm consumers.

Despite consensus that the civil justice system is best-placed to handle robot cars, some commentators have argued that liability might one day become an obstacle to their continued development, and have advocated that corporations be granted some level of immunity. For instance, if robot cars save 15,000 lives but kill 20,000, they would still be safer than humans (35,000 people died in car crashes in 2015). Manufacturers, some suggest, should get credit for the people they save, and immunity for the ones they kill. These alternative immunity schemes have tended to come in the form of:

- a no-fault insurance system;
- industry self-regulation;
- manufacturer immunity;
- preemption of state laws.<sup>55</sup>

What each has in common is some level of escape from accountability for

manufacturers, on the basis that this will spur innovation. The reality is that liability has already proven no obstacle to innovation in vehicle automation, which has proceeded in astonishing leaps and bounds. As of 2016, 19 major manufacturers, from Audi to Uber, are planning to push out some kind of autonomous or near-autonomous vehicles within the next few years.<sup>56</sup> Far from citing liability as an obstacle, three of them – Google, Volvo, and Mercedes Benz—have proactively pledged to accept full liability.<sup>57</sup> Clearly, the industry does not need immunity to foster innovation.

Each of the alternatives also assume innovation and accountability are incompatible. But this is not the case. The civil justice system's obvious goal is to provide compensation to those injured by negligence and wrongdoing. But a further goal is to, as University of South Carolina law professor F. Patrick Hubbard puts it, “*create market incentives that internalize the costs of wrongdoing to the wrongdoer.*”<sup>58</sup>



Google, Volvo, and Mercedes Benz are examples of corporations that have embraced this incentive to make safer products.

Putting the impact on innovation aside, there are other compelling reasons why such corporate immunity provided by these alternative scenarios would be either impractical or unjustified.

### **The Argument for No Fault**

The argument for no-fault insurance for robot cars typically follows these assumptions: liability in car crashes will fundamentally shift from personal injury liability to product liability. There will be

no drivers, and no insurance policies to recover from. Suits against manufacturers for product defects will be the only way to obtain compensation. Because those suits won't have to worry about policy limits, the amount of dollars at stake in liability claims will grow, even if the overall number of accidents drop. Verdicts against manufacturers will grow so large, investment in robot cars will wither. Therefore, an alternative compensation system must be introduced to cover the costs of accidents, and to take corporations off the hook — no-fault insurance.<sup>59</sup>

Such an argument rests on the idea that product defect litigation, which already exists, will somehow increase dramatically even as crashes become more and more rare.<sup>60</sup> There is no evidence at all to support this. However, there is evidence that no-fault insurance systems themselves are costly, ineffective and unjust.

### **No-Fault's Failure**

No-fault insurance was first implemented in Massachusetts in 1971, and by the end of the decade 27 states had enacted it. Since then it has fallen out of favor, with many states repealing their no-fault law and returning to traditional liability. No state operates a pure no-fault system anymore, although 15 do have some form of modified system in which drivers can still sue for non-economic damages.<sup>61</sup>

The big problem with no-fault? It didn't work. Despite claims it would reduce costs and insurance premiums, in fact it did the opposite, raising medical costs and drivers' premiums. Researchers at the RAND Corporation found that over a 20-year period, insurance premiums in no-



**NO FAULT PROTEST:** Michigan car crash victims and their family members protesting proposed cuts on medical care and caps on reimbursement under the state's no-fault system in May, 2015. Michigan drivers pay more than double the national average in premiums. (CAPP)



fault states rose faster than in traditional tort states, until premiums were a full 50 percent higher.<sup>62</sup> While the first years of no-fault resulted in lower costs, after a while those costs increased. Insurers found they were paying for a larger number of medical services, and paying more for them.

OVER A 20-YEAR PERIOD, INSURANCE PREMIUMS IN NO-FAULT STATES ROSE QUICKER THAN IN TRADITIONAL TORT STATES, UNTIL PREMIUMS WERE A FULL 50 PERCENT HIGHER.

Aside from the increased costs and insurance rates, there were other reasons why no-fault became widely considered a no-go:

❑ **Bad drivers were protected.** Because they could not be sued, bad drivers were never singled out, and there was no reward for good driving. Instead, good drivers were forced to pay for the costs of bad drivers' negligence;

❑ **Serious damages were not adequately compensated.** Arbitrary limits meant that non-economic damages like pain and suffering received no, or little, compensation;

❑ **Even economic damages weren't always compensated.** Because no-fault implemented limits on liability, even basic economic damages like medical bills and lost income were sometimes only partially compensated.

Nevada became the first state to repeal its no-fault law in 1980 (after only six years in

place), and other states soon followed suit. States that repealed their no-fault laws saw premiums drop by 10 to 30 percent.<sup>63</sup>

### Self-Regulation

Car makers have suggested they should be allowed to regulate themselves, and have warned state government agencies not to establish safety standards.<sup>64</sup> Car makers know the technology best, they argue, and should decide what safety measures a robot car needs. Some companies have gone one step further, suggesting they should be allowed to "self-certify," which might eventually create a certification standard that could be used as a preemptive defense against liability.<sup>65</sup> In such a scenario, car makers would set individual standards, then certify that they met their own standards, for which they would be granted immunity in the courts.

This is essentially car makers saying, "trust us," which is not confidence-inspiring given recent automotive manufacturing scandals such as:

❑ GM's 10-year-long cover-up of an ignition switch defect, which killed at least 124 people;<sup>66</sup>

❑ Toyota's sudden acceleration problem, which resulted in as many as 89 deaths;<sup>67</sup>

❑ Takata's cover-up of lethal air bags, which have killed at least 14 people and are still installed in tens of millions of cars.<sup>68</sup>

These examples involve design defects that the manufacturer chose not to reveal. The Takata problem is particularly instructive. Nearly 70 million Takata airbags have

been recalled because they have a tendency to explode and imbed metal shrapnel into drivers and front seat passengers. Takata's own engineers raised concerns about the airbags — made more cheaply than competitors by using ammonium nitrate, a compound that other manufacturers deemed too risky to use — in the late 1990s, but went unheeded.

## FOUR CARMAKERS ARE CONTINUING TO SELL NEW CARS WITH THE DEFECTIVE AIRBAGS, TAKING ADVANTAGE OF A LOOPHOLE THAT SAYS THE AIRBAGS DON'T HAVE TO BE COMPLETELY RECALLED UNTIL 2018.

Honda, Takata's biggest customer, was allegedly aware of the problem as early as 2004, but neither company alerted the public, until 2008, when a recall was issued covering just 4,000 cars.<sup>69</sup> When federal regulators finally took notice, their investigation was so short that it was closed before Takata had fully responded. Meanwhile, the recall grew in size, as Takata slowly admitted just how many cars were affected. By 2016, the recall had extended to the cars of 16 different manufacturers.<sup>70</sup>

If one needed further evidence that corporations regularly put profits before people, consider that four carmakers (Toyota, Fiat Chrysler, Volkswagen and Mitsubishi) continue to sell new cars with the defective airbags, taking advantage of a loophole that says the airbags don't have to be completely recalled until 2018, while Takata itself has been found replacing the defective, potentially lethal airbags *with the same defective airbags*.<sup>71</sup>

### Immunity

Self-regulation may be immunity in sheep's clothing, but a few commentators go further, and advocate for outright immunity, claiming that it would boost innovation and lower production costs for carmakers, who would no longer have to concern themselves with liability.<sup>72</sup>

The model for such a scenario is usually vaccine immunity.<sup>73</sup> The National Childhood Vaccine Injury Act of 1986 was enacted to respond to vaccine shortages, and gave immunity to vaccine manufacturers. It

also created a compensation fund for the small subset of patients who might be injured, which was in effect another version of a no-fault system.

However, unlike vaccines at the time, there is no shortage of innovation in the area of robot cars. As previously mentioned, 19 major manufacturers, from Audi to Uber, are planning to push out some kind of autonomous or near-autonomous vehicles within the next few years.<sup>74</sup>

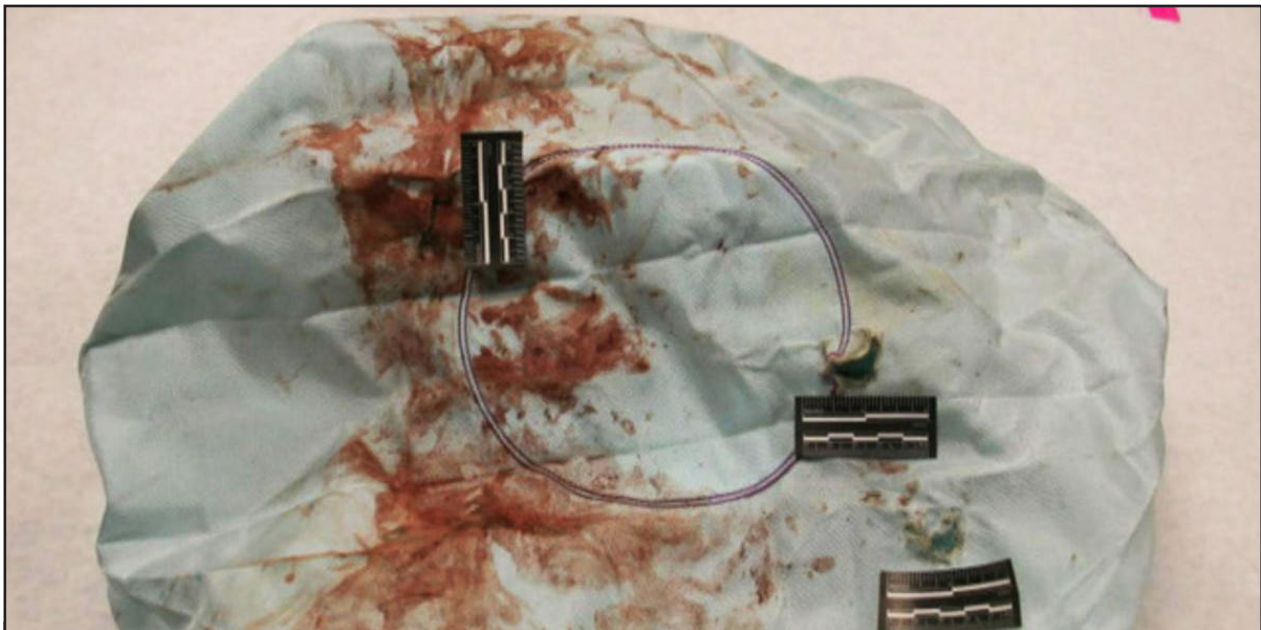
Even if innovation was a concern, the vaccine industry is an example of how immunity actually removes the incentive to innovate. In 2011, the U.S. Supreme Court agreed to expand the scope of vaccine immunity, barring design-defect claims that cropped up when manufacturers failed to update their vaccines to reflect scientific advances.<sup>75</sup>

The case, *Bruesewitz v. Wyeth*, centered on a vaccine that had not been updated in more than half a century, and which was

associated with an unusually high number of adverse events.<sup>76</sup> Justice Sotomayor's dissent highlighted the negative impact on innovation such broadened immunity would bring, writing that the decision, *"leaves a regulatory vacuum in which no one ensures that vaccine manufacturers adequately take account of scientific and technological advancements when designing and distributing their products."*<sup>77</sup>

Meanwhile, the vaccine industry has reaped tremendous profits. In 2013, industry revenues reached \$24 billion, with profit margins as high as 40 percent.<sup>78</sup> Consumers, however, paid a price.

Without the civil justice system's incentives towards safety, less safe products enter the market, and individuals absorb the costs in the form of medical bills, lost income and increased insurance premiums.<sup>79</sup> The Vaccine Injury Compensation fund created in 1986 has disintegrated into an administrative and bureaucratic nightmare. Though it was established as a no-fault program, less than one in three injured claimants are compensated.<sup>80</sup> The end result has been to expose "immunity" for what it is — a policy to take away constitutional rights and force citizens to pay the costs of corporate negligence.



**DEADLY AIRBAGS:** Takata airbags can explode, propelling shrapnel into drivers and passengers. Despite their recall, some automakers are still selling cars with the defective airbags. (CBS)

# FEDERAL PREEMPTION

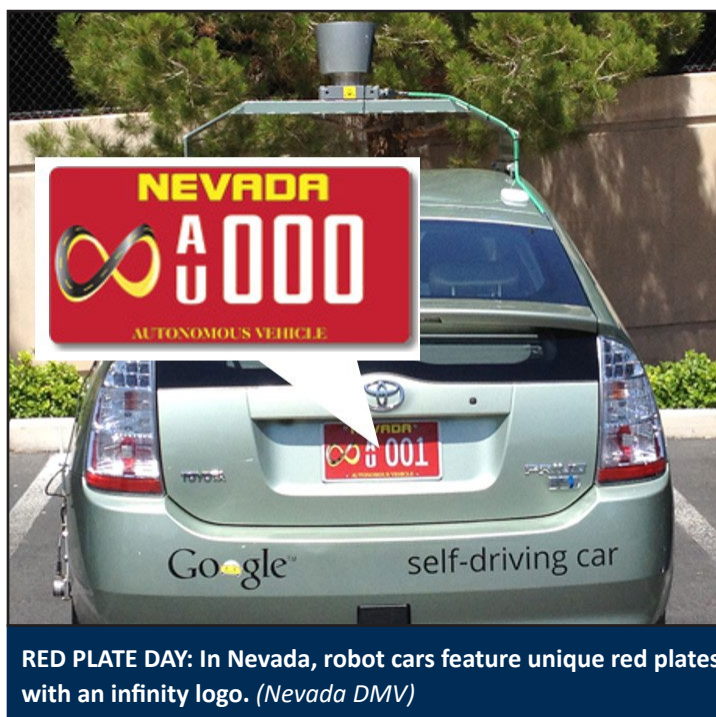
- Preemption of state laws without Congressional intent would be unconstitutional.
- Federal regulation is too slow to keep up with the problems of robot innovations.
- Even advocates of immunity schemes want to keep robot car liability in court for now.

Already it appears robot car makers are looking at federal regulations as a way of avoiding the accountability of state laws.

Over the past few decades, the United States Supreme Court has established a doctrine of federal preemption that favors corporations and leaves injured consumers and their families without recourse.

Federal rules, standards, guidance, and even commentary have been used to curtail cases involving everything from airbags to cigarettes to medical devices. Under a scenario of federal preemption, NHTSA would demand robot cars have certain autonomous technological capabilities, and manufacturers claim that meeting such standards renders them no longer liable in state courts – the primary venue for such claims. When there are crashes, the public are left without recourse.

In 2011, Nevada became the first state to pass robot car legislation, allowing Google to begin testing self-driving cars within the state. Since then, many others have enacted some form of autonomous vehicle regulation.<sup>81</sup> Different states have taken different approaches to regulating robot cars: California initially proposed self-driving vehicles would only be allowed for test purposes, and would be required to retain a human operator, while Florida decided to allow anyone with a driver's license to operate such a car, even remotely, and gave the original





makers of cars being converted into self-driving vehicles immunity from liability.<sup>82</sup>

Car makers and their lobby groups are pushing for voluntary federal guidelines that would override state laws. Consumer protection regulations like those proposed by California would “*create significant barriers to the full-scale deployment of an autonomous fleet.*”<sup>83</sup> The effect of such federal preemption of state laws would be to establish a precedent that allows car makers to escape accountability and externalize costs to consumers.

Since the initial burst of state legislation, federal authorities have made it clear that they believe they are the leading authority when it comes to robot cars. In September 2016, NHTSA and the Department of Transportation (DOT) jointly issued the Federal Automated Vehicles Policy, covering such matters as data recording, crashworthiness, and cybersecurity.<sup>84</sup>

The NHTSA/DOT policy specifically left issues of licensing and liability to the states. However, over the last three decades, corporations have been increasingly successful in using federal statutes and regulations as an escape clause from state laws that would otherwise hold them accountable — a fact the NHTSA/DOT policy notes briefly.<sup>85</sup>

The doctrine of federal preemption was developed by the U.S. Supreme Court, despite its supposed concern with federalism and dedication to states’ rights. The Court consistently sided with businesses, claiming federal preemption of state laws, including cases such as:

□ *Geier v. American Honda Motor Co.* (2000), in which the Supreme Court found that a state tort claim against an automobile manufacturer for not installing airbags was preempted by a federal law concerning seat belts, and which specifically declared that it was not meant to preclude any other redress.

□ *Lorillard Tobacco Co. v. Reilly* (2001), in which the Court found that a Massachusetts law regulating the location of cigarette advertisements was preempted by a federal statute regulating the content of warning labels.

□ *Riegel v. Medtronic, Inc.* (2008), in which the Court ruled the FDA’s premarket approval process preempted state tort claims against a medical device manufacturer.

The RAND Corporation has already signaled how corporations could use federal preemption to their advantage. Imagining a future where personal liability (through drivers’ insurance policies) has been largely replaced by product liability (through manufacturers), RAND suggested that under regulatory preemption, “*it is likely that state tort law claims that were found to be inconsistent with the objective of the regulation would be held preempted under the analysis used in Geier.*”<sup>86</sup>

But while preemption might suit the corporations, it would have significant repercussions for consumers and society as a whole:

□ **Federal regulation is slow and difficult.** While federal agencies may



have expertise, they are not built to offer the kind of vigilance that the civil justice system provides. NHTSA, for instance, issued a “Coordinated Remedy Order” to accelerate recall of Takata’s lethal airbags, but appears to have taken no action against manufacturers that violated the order.<sup>87</sup> Only 8 million of the 70 million recalled airbags have actually been replaced, and consumers have found themselves unable to obtain replacements meaning the prospect of more deaths and injuries is highly likely.<sup>88</sup>

❑ **Preemption would eliminate much of the truth-finding function of the civil justice system.** Product liability lawsuits routinely uncover defects and wrongdoing that have escaped regulatory detection.

❑ **The revolving door between federal agencies and the private sector means there should be other checks and balances.** Bureaucrats often go on to take jobs in the industries they regulated, which lessens the incentive for vigilance. State laws and the civil justice system function as important checks and balances on corporations when federal agencies are unable to hold them accountable.

❑ **Preemption would not only violate principles of states’ rights, but also individuals’ rights.** The Seventh Amendment right to a jury trial would effectively be eliminated and replaced with nothing.

❑ **The costs of crashes would be passed on to consumers.** Injured consumers and their families would absorb the costs directly, through lost wages and medical

bills. Ultimately, society as a whole would pay, through lost productivity and increases in Medicare and Medicaid expenditures.

❑ **State courts can investigate problems more thoroughly than agencies, and without substantial commitments of public funds.** Through juries, courts also add the legitimacy of public participation in novel ethical issues.

**Even immunity proponents believe in the civil justice system**

There is a consensus that the civil justice system is best placed to handle technological innovations, even among those who advocate eventually giving corporations immunity.

University of Washington law professor M. Ryan Calo, a proponent of shielding robotics manufacturers from legal liability, has also admitted that we are unlikely to fully understand robots’ capacity for harm, “*in the absence of legal intervention,*” leading him to conclude, “*I do not believe that immunity from lawsuit is necessarily appropriate for robotic software.*”<sup>89</sup> Gary Marchant and Rachel Lindor, professors at Arizona State University law school and avowed fans of corporate immunity, have nevertheless admitted that, “*one disadvantage of these approaches is that by immunizing the internalization of accident costs from vehicle manufacturers, they may reduce the pressure on manufacturers to make incremental improvements in the safety of their autonomous systems.*”<sup>90</sup>

Adam Thierer, a senior fellow at George Mason’s Mercatus Center and an advocate of the vaccine immunity model for robot

cars, has stated that, at least initially, the courts are the best place to figure out liability for new technology:

*“As new technologies emerge, product liability and accident compensation have been handled traditionally through a variety of legal mechanisms, including: strict liability,*

*negligence, design-defects law, failure to warn, breach of warranty, and so on. In fact, that’s essentially what happened a century ago with the rise of the old-fashioned automobile.*

*Generally speaking, we should let these new liability norms evolve freely as intelligent-vehicle and driverless-car technologies become more ubiquitous. When crashes occur, courts can assign liability to those parties with the greatest knowledge and control over these systems, which will increasingly be the firms that manufacture or operate robotic cars.”*<sup>91</sup>

Similarly, the RAND Corporation, while espousing the benefits of restricting manufacturer liability, also concludes, *“while this may be appropriate calculation of the long-run socially optimal solution, it may also undermine incentives for safer product design in the short run.”*<sup>92</sup> And the Brookings Institute, traditionally an advocate of tort reform, has strongly recommended letting the civil justice system runs its course:

*“[B]road new liability statutes aimed at protecting the manufacturers of autonomous vehicle technology are*

*unnecessary. The legal precedents established over the last half a century of products liability litigation will provide manufacturers of autonomous vehicle technology with a very strong set of incentives to make their products as safe as possible. In the overwhelming majority of*

“WHEN CRASHES OCCUR, COURTS CAN ASSIGN LIABILITY TO THOSE PARTIES WITH THE GREATEST KNOWLEDGE AND CONTROL OVER THESE SYSTEMS, WHICH WILL INCREASINGLY BE THE FIRMS THAT MANUFACTURE OR OPERATE ROBOTIC CARS.” – ADAM THIERER, GEORGE MASON

*cases, they will succeed. However, despite these efforts, there will inevitably be some accidents attributable in whole or in part to defects in future vehicle automation systems. While this will raise complex new liability questions, there is no reason to expect that the legal system will be unable to resolve them.”*<sup>93</sup>

Under the Supremacy Clause of the United States Constitution, federal law preempts state law in three circumstances:

□ **Express preemption.** Congress explicitly states that a statute should preempt state law.

□ **Field preemption.** The state law attempts to regulate conduct in an area that Congress intended the federal government to occupy exclusively

□ **Conflict preemption.** State law actually conflicts with federal law.

According to the U.S. Supreme Court, an analysis of any attempt to circumvent state law starts, “*with the assumption that the historic police powers of the States were not to be superseded by the Federal Act unless that was the clear and manifest purpose of Congress.*”<sup>94</sup>

In other words, the critical question is whether Congress intended federal regulation to supersede state law. At this point, there is nothing even close to a suggestion that Congress believes

robot cars should be exempt from the accountability of state laws. Granting such preemption anyway would give corporations complete immunity even when they knowingly injure and endanger consumers with unsafe products.

# STRICT LIABILITY

- Car makers are already trying to shift blame for automated crashes onto humans.
- Without human drivers, personal car ownership, or personal auto insurance policies, liability may eventually have to shift.
- Strict liability may eventually be the most appropriate approach to liability.

Vehicle automation is increasingly shifting towards making vehicles completely driverless. As such vehicles become more and more common, it makes less and less sense to hold their human “operators” liable. At NHTSA’s Level Four of automation, it is the car that is assumed to be in control — “*By design, safe operation rests solely on the automated vehicle system.*”<sup>95</sup>

Cars without drivers may result in the virtual elimination of the auto insurance industry. Who needs an insurance policy if they’re not driving? Especially if they no longer own a car, but use robot ride share services like Uber. The result would be to shift liability from individuals (auto claims) to the manufacturer (product liability claims).

However, product liability cases are already highly complex and expensive, and would likely be more so with robot cars. The machine learning techniques involved in vehicle automation allow manufacturers to

do things that would be all but impossible by human programmers, but their flipside is that they make it very difficult for humans to understand exactly how such systems work or what specifically has gone wrong when they don’t.<sup>96</sup> When engineers look into the neural networks they have created, they see only “*an ocean of math.*”<sup>97</sup> The potential complexity of a robot car case would mean those injured with anything less than traumatic injury would be unlikely to be able to bring a case. Unless manufacturers take full responsibility when the robot system is driving, then the majority of claims would be left without recourse. Individuals are unlikely to embrace the idea of riding in robot vehicles if doing so entails a significant financial risk.

## Enter Strict Liability

Many experts foresee strict liability as the solution to such a dilemma.<sup>98</sup> Under strict liability, manufacturers would accept responsibility for all crashes caused by their

cars, no matter whether the damage was minor or major. Unless this precedent is firmly established, these companies will spend more time and effort trying to make control complicated — so they avoid liability when it fails — rather than safe.

Strict liability removes the issue of manufacturer negligence and replaces it with the consumer expectation that a product not be unreasonably dangerous. Complexity would no longer be an obstacle to justice. The Google bus crash case was instructive in this regard. It didn't take a computer expert to see from the YouTube video that the robot car swerved in front of the bus.<sup>99</sup> What line of code made it do that is irrelevant to determining liability.

In this sense, robot cars would be like the automatic elevators that began to replace the existing manual elevators in the 1930s. States enacted specific safety requirements, the insurance industry developed a special “elevator liability” insurance that was sold to the manufacturer, and courts deemed elevators “common carriers” — meaning an entity that transports people or goods for a fee, like a taxi — which held operators and manufacturers to the highest duty of care under the law.<sup>100</sup> Under this heightened duty of care, “common carrier” are liable for injuries to passengers resulting from even the slightest negligence.

There are several reasons why strict liability would be a good idea in a world of driverless vehicles:

❑ **Strict liability would provide compensation for those injured through no fault of their own.** Passengers will have little to no control over operation of the

vehicle. Nor will passengers have much ability to take action to protect themselves in an emergency.

❑ **Corporations would be less able to wriggle out of accountability through legal loopholes.** Uber recently updated its terms of use to include a forced arbitration agreement that requires consumers, whether they know it or not, to surrender fundamental constitutional rights. Strict liability would make it less likely that future ride sharing services would be able to funnel legal disputes into their own private courts.

❑ **Passengers will be shouldering all the physical risk.** Forcing them to suffer the financial risk too would injure them twice — once when the vehicle crashed and they were injured, and again when they were forced to absorb all medical costs, and damages such as lost income, and pain and suffering. Not to mention pedestrians, bicyclists, and other humans that made no agreement to accept a robot vehicle's risks.

❑ **Consumers will likely be more willing to pay for robot cars.** Whether purchasing a vehicle or service in a ride share vehicle, knowing that manufacturer will be liable for crashes will make consumers more likely to accept the risk of giving up control. This is particularly true if the costs are offset by decreases in, or the complete elimination of, drivers' insurance premiums.<sup>101</sup>

❑ **Corporations will make huge profits off robot cars, and are better placed to financially absorb the cost of crashes.** Robot cars are big business —



there are already 19 major companies with autonomous vehicle programs — so they should absorb the financial risk of crashes and be accountable for injuries caused to consumers. Particularly if those crashes become as rare as the manufacturers themselves predict. Or corporations can build the cost into fleet pricing and thus spread the burden.

❑ **Strict liability would ensure justice for everyone who was hurt, not just those who are killed or traumatically injured.** The cost of pursuing a product liability case against a manufacturer, or collection of manufacturers, would outweigh all but the most traumatic of cases.

❑ **Strict liability would get around corporations' refusal to share proprietary data.** The corporations forging a path to robot vehicles have been vehemently opposed to any moves that would require them to share information, even to regulators.<sup>102</sup> When corporations keep data secret, it is almost impossible for injured consumers to discover what exactly caused a crash. A strict liability system would offer access to justice in the most

routine cases without necessitating drawn out, expensive, discovery disputes..

❑ **Strict liability has a better chance of encouraging innovation.** Such a system would be stable and predictable, which corporations tend to prefer, as can be seen by Google, Volvo, and Mercedes Benz proactively embracing what amounts to self-imposed strict liability.<sup>103</sup>

Strict liability may not be necessary at this point, or even in the near future. Traditional common law should be allowed to take on new issues on a case by case basis. But if the shifting dynamics caused by robot cars require a new approach to accountability, strict liability is the obvious solution. It would hold manufacturers to a high standard, offer a safety net to consumers, and allow technology to thrive.

# CONCLUSION

- The law is a living thing and will adapt and evolve to the advent of robot cars.

On February 18, 1964, while driving a friend's Chevrolet Corvair, David Larsen was involved in a head-on collision that would fundamentally change the way cars were designed. Larsen was seriously injured when the Corvair's steering mechanism – a solid shaft that began less than three inches

from the front of the car's tires – was thrust backwards, ramming the steering wheel into his head. He sued General Motors under a theory that had never been successful before — that the Corvair had not been designed to be “crashworthy.” Previously, car makers had been held liable for manufacturing defects, but not for defects in design. In court, General Motors claimed they had no duty to design an automobile that would protect the occupant if a crash occurred. The court disagreed and established for the first time that manufacturers had to take safety into account.

The *Larsen* case became a landmark decision. Since then the civil justice system has worked hand-in-hand with regulation to protect Americans, while spurring generations of safety innovations. Cars have developed seatbelts, airbags, side impact protections, roof crush standards, and dozens of other safety features, in large part due to pressure from the courts. Problems with tires, gas tanks, ignition switches, and again many more, have been identified by courts and pursued



**KILLER DESIGNS:** Chevy Corvairs were notorious for causing injury due to a design that forced the steering wheel into the driver's head upon impact.

until the problems have been resolved and the injured compensated.

The same will hold true of robot cars. Automation should not be used as an escape from accountability. Society is not well served by the claim that bad outcomes are just the result of systems too complex for anyone to be held accountable. Particularly when it comes to software-based industries, which have traditionally operated on the principals of “release now, fix later.”<sup>104</sup>

By holding manufacturers accountable, the civil justice system will continue to spur safety innovations, as it has done for more than half a century. The law will adapt and evolve just as the

technology adapts and evolves. Attempts to circumvent accountability, through reform proposals that grant corporations immunity, will eliminate incentives to make vehicles safe, and almost certainly result in more lives lost. Eventually, as human error crashes fade away, leaving only crashes caused by design and manufacturing defect, liability may shift from personal injury to product liability. Given the costs involved in pursuing a product liability claim, strict liability, which holds manufacturers accountable for every crash their vehicles cause, would ensure victims continue to be able to access justice. But no matter what, courts should and must be allowed to oversee consumer products, for the best interests of all society.



**KAT-5: Experimental driverless vehicle Kat-5 crossing the finish line in fourth place in the 2005 Darpa Grand Challenge. The race had been run the previous year, but no cars had finished the course. In 2005, 5 of the 23 cars finished the course. (DARPA - U.S. Government)**

# TIMELINE TO ROBOT CARS

- Robots from 1920 to today and beyond.

## 1920 — The Word “Robot” is Created

Czech writer Karel Čapek introduces the word “robot” in his science fiction play R.U.R., adapting the old Slavonic word, rabota, meaning forced labor. The robots in the play reshape the worldwide economy before rebelling and wiping out the human race.<sup>105</sup>



**RISE OF THE ROBOTS:** The word “robot” is introduced in a 1920 Czech science-fiction play.

## 1968 — The Landmark MacPherson Case Establishes that Automakers Have a “Duty of Care”

David Larsen is driving a Chevy Corvair when he is involved in a head-on collision

that rams the Corvair’s steering mechanism into his head. General Motors claims it had no obligation to design an automobile that would protect the occupant in a crash. In what will become a landmark decision, the court disagrees and for the first time establishes that car manufacturers have a “duty of care” to ensure customers are sold a safe product.<sup>106</sup>

## January 1979 — A Robot Kills a Human

Robert Williams, a 25-year-old assembly line worker at a Ford plant in Flat Rock, Michigan, becomes the first human to be killed by a robot. Williams is working in a storage facility in close proximity to the robot when he is hit by its arm. He dies instantly. A jury finds a lack of safety measures are to blame and awards the family \$10 million.<sup>107</sup>

## November 2007 — Two Experimental Driverless Cars Collide During the DARPA Race

Two “bot” cars in the third DARPA Urban Challenge, a race designed to promote research into driverless cars, bump together



while trying to share a lane. The cars, from teams at Cornell and MIT, are separated and allowed to complete the race.<sup>108</sup>

### **October 2010 — Google Announces It's Been Secretly Testing AVs**

Google announces that it has secretly been testing a fleet of seven AV cars which have already accumulated 140,000 miles with minimal human intervention. The company's engineers say the only crash was when a Google car was rear-ended while stopped at a traffic light.<sup>109</sup> Such rear-end collisions will later dominate the incidents Google cars are involved in. Officials from the California Department of Motor Vehicles say they regard the Google cars as *"just a big step up from cruise control. If the vehicle goes too fast, or strays across the line, the human would be responsible for operating the car legally."*<sup>110</sup>

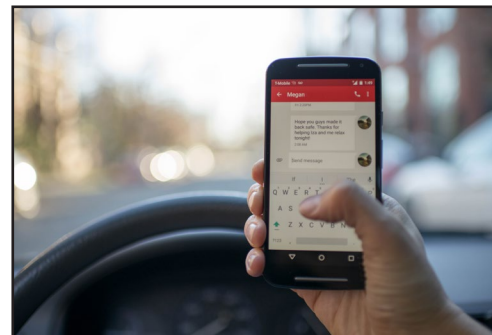
### **August 2011 — A Google AV Causes its First Crash, But Under Human Control**

A Google self-driving Prius causes a five-car fender bender in Mountain View, California, the first where an AV is apparently at fault. Google states that the car was under human control at the time.<sup>111</sup>

### **February 2012 — Nevada Becomes the First State to Expressly Allow AVs**

After lobbying by Google, Nevada becomes the first state to issue regulations expressly allowing autonomous vehicles on its roads. The regulations required companies to post a \$1-3 million bond, retain a human capable of taking over operation, and that the cars be equipped with black-box style data collectors. Nevada also created an exemption in its law prohibiting texting or talking on a cellphone while driving,

but maintains the prohibition on drinking and driving.<sup>112</sup>



**TEXT BUT DON'T DRINK: Nevada creates an exemption in its law prohibiting texting or talking on a cellphone while driving, but not for drinking and driving.**

### **October 2013 — Toyota Sudden Acceleration Case Shows How Bad Code Can Kill**

A team of experts in embedded systems testify in *Bookout v. Toyota Motor Corp.* that the source code of Toyota motor vehicles contains bugs that could cause sudden unintended acceleration. An Oklahoma jury finds Toyota liable for \$1.5 million for the driver, Jean Bookout, injured in the crash and a further \$1.5 million to the family of passenger Barbara Schwarz, who was killed. Toyota settles the case before the jury begins deliberations on punitive damages.<sup>113</sup>

### **October 2015 — Tesla Activates Autopilot Over the Air**

In October 2014, Tesla begins outfitting its cars with the hardware necessary for automated driving — sensors, radar, digitally controlled brakes — but it is not until the following year that the company issues a software update that activates Autopilot. Overnight, a fleet of cars becomes able to self-steer, change speed and lanes, and self-park.<sup>114</sup>

### December 2015 — Elon Musk Says Teslas will Drive Themselves in Two Years

The Tesla CEO tells Fortune, “We’re going to end up with complete autonomy, and I think we will have complete autonomy in approximately two years,” though he adds the caveat, “When I say level 4, I mean level 4 autonomy with the probability of an accident is less than that of person.”<sup>115</sup>

### January 2016 — Tesla is Sued for a Fatal Crash in China

Gao Yaning, 23, dies when his Model S Tesla crashes into a street sweeping truck on a highway near the Chinese city of Handan. Video shows the car plowing into the truck at great speed, with no apparent attempt at braking.<sup>116</sup> Tesla claims the damage to the car is so great that the company cannot determine whether Autopilot was engaged at the time of the crash. Chinese authorities conclude that the crash was the result of driver error, but the driver’s family reportedly sues Tesla in Beijing Chaoyang District People’s Court.<sup>117</sup>



### January 2016 — An Autonomous Nissan Leaf Crashes, Driver is Blamed

An autonomous Nissan LEAF, run by Cruise Automation, collides with a parked

Toyota Prius in San Francisco. The incident begins when the automated computer steered towards the parked car. The human operator takes control, but fails to prevent the crash. No one is hurt and the damage is minor. Cruise Automation CEO Kyle Vogt appears to blame the driver, saying he “made a mistake,” even though he had only a few seconds to react.<sup>118</sup>

### February 2016 — A Google AV Causes its First Crash in Autonomous Mode

A Google AV causes a crash for the first time. According to a crash report filed with the DMV, the Lexus model self-driving car tries to make a right hand turn, only to find itself unexpectedly blocked by sandbags around a storm drain.<sup>119</sup> The car, under autonomous control, waits several seconds, then attempts to merge into traffic directly in front of an oncoming bus which it had apparently predicted would slow down. The bus was traveling 15 mph when it hit the Google car, crumpling the car’s front left side and tearing off its radar. No one was injured in the crash. In its monthly report, Google said it bore “some responsibility,” but qualified that:

*“This is a classic example of the negotiation that’s a normal part of driving – we’re trying to predict each other’s movements. In this case, we clearly bear some responsibility, because if our car hadn’t moved there wouldn’t have been a collision. That said, our test driver believed the bus was going to slow or stop to allow us to merge into the traffic, and that there would be sufficient space to do that.”<sup>120</sup>*

The Santa Clara Valley Transportation Authority clears the bus driver of any blame, which video footage would seem to support, and says an independent claims adjuster will determine liability.<sup>121</sup>

### **May 2016 — A Tesla Under Autopilot Kills Joshua Brown**

Joshua Brown, 40, of Canton, Ohio, is killed when his Tesla Model S crashes into a tractor-trailer at 74 miles per hour. Tesla suggests the Autopilot may have failed to recognize the white truck against the background of the sky, or mistaken it for an overhead sign. The company admits that a “*technical failure*” of the automatic braking system played a role in the crash, yet claimed that its Autopilot was not at fault. The *New York Times* quotes Karl Brauer, a senior analyst at auto research firm Kelley Blue Book, as saying, “*Those systems are supposed to work together to prevent an accident. But either the car didn’t know it had to stop, or it did know and wasn’t able to stop. That involves Autopilot and the automatic braking.*”<sup>122</sup> Despite claiming that Autopilot was not to blame, Tesla chief executive Elon Musk later claimed that updates to Autopilot would have prevented the crash.<sup>123</sup>



**JOSHUA BROWN:** Joshua Brown was a vocal fan of Tesla before his death.

### **December 2016 — Uber pulls self-driving program in San Francisco amid reports red-light-running**

Uber debuts a self-driving ride-share service in San Francisco, California, despite

regulators warnings that they were illegal. One week in, with reports of the vehicles running red lights, the California DMV revokes the registration of the 16 cars.<sup>124</sup>

### **2018 — Audi pledges it will have the first car capable of Level 3 autonomy on the road by 2018**

The “Traffic Jam Pilot” system will still require a driver, and will only operate in certain conditions.<sup>125</sup>

### **2020 — Volvo sets 2020 the goal for offering autonomous cars to the public**

The company also promises that by 2020, no one will be killed or injured in a Volvo.<sup>126</sup>

### **2021 — In 2016, both BMW and Ford announce plans to release fully autonomous cars in 2021**

Ford’s car will have no steering wheel, accelerator or brake pedal, and is initially planned only as a ride-share.<sup>127</sup>

### **2023 — Elon Musk claims true autonomous driving will have taken hold by 2023**

Musk’s estimate, made in 2014, includes two or three years for regulatory approval. “*I think we’ll be able to achieve true autonomous driving, where you could literally get in the car, go to sleep and wake up at your destination.*”<sup>128</sup>

### **2030 — Uber anticipates its entire fleet will be driverless<sup>129</sup>**

### **2040 – The Institute of Electrical and Electronics Engineers (IEEE) anticipates that as many as 75 percent of cars on the road will be autonomous.<sup>130</sup>**

Honda also sets 2040 as the target date by which time its vehicles never crash.<sup>131</sup>

# VIEWS & QUOTES

- What others are saying about robots and accountability.

“It’s almost to the point where you can take your hands off [. . .] but we’re very clearly saying this is not a case of abdicating responsibility.... The hardware and software are not yet at the point where a driver can abdicate responsibility.... [The system] requires drivers to remain engaged and aware when Autosteer is enabled. Drivers must keep their hands on the steering wheel.”

– **Elon Musk, CEO of Tesla**<sup>132</sup>

“If you’re told you don’t need to pay attention to something, you could go to sleep and, in a matter of a few milliseconds, you could be told you have to wake up, have your wits about you, that the vehicle needs you to take control.”

– **Ken Washington, Ford’s head of research and advanced engineering**<sup>133</sup>

“People worry about the wrong thing when it comes to the safety of autonomous cars. There are going to be times where the driver has to take over. And that turns out to be by far the most dangerous and totally understudied issue.”

– **Clifford Nass, Stanford University**<sup>134</sup>

“[Elon Musk’s] statements have been utterly irresponsible. He’s also the one who was quoted sometime last year as saying automated driving on highways was a solved problem, and then six months after that he was complaining that the lane markings on the California freeways weren’t clear enough for the system on his vehicle to be able to see them.”

– **Steven Shladover, California PATH (Partners for Advanced Transportation Technology)**<sup>135</sup>

“While liability will always be important with respect to motor vehicle operation, automation will dramatically increase safety on the highways by reducing both the number and severity of accidents. To some extent, it already has. For example, electronic stability control systems, which help drivers maintain control on turns and slippery surfaces by automatically selecting which wheels to use for braking, have saved thousands of lives. And, they have done so without confronting the courts with insurmountable questions regarding liability.”

– **John Villasenor, Brookings Institute**<sup>136</sup>

“The first is how to apply the law of products liability on the assumption that any liability concern with the machine is the result of human (but not driver) error—that is, a design or manufacturing defect, an information defect, or a failure to instruct humans on the safe and appropriate use of the product. In my view, the application of these reasonably settled principles is a straightforward one, and there is no justification for treating even autonomous thinking machines differently than any other machine or tool a human may use, except, perhaps, holding them to a higher standard of care.”

– **David Vladek, Georgetown University Law Center**<sup>137</sup>

“In essence, holding carmakers liable for accidents involving self-driving cars makes good sense. It takes the insurance service from traditional insurance companies and transfers it to the manufacturers. Rather than buying separate auto insurance as drivers now do, the insurance would be bundled into the purchase of the car, liberating drivers from the agony of insurance markets and simplifying one of the busiest areas of American tort law.”

– **Omri Ben-Shahar, University of Chicago Law School**<sup>138</sup>

“In the development of robots and complex technologies, those who design, market and deploy systems should not be excused from responsibility for the actions of those systems... Compromising safety, appropriate use and responsibility is a ready formulation for inviting crises in which technology is complicit.”

– **Wendell Wallach, Yale Interdisciplinary Center for Bioethics**<sup>139</sup>

“Through an examination of technical, social and legal histories, we observe a counter-intuitive focus on human responsibility even while human action is increasingly replaced by automation... Researchers have pointed to ways in which automation does not eliminate human error, but rather creates new and unexpected errors.”

– **M.C. Elish and Tim Hwang, Data Research Institute**<sup>140</sup>

“[M]oving back to strict products liability in the design defect area, which has been abandoned after the courts misinterpreted the concept of “defect” and failed to develop a proper doctrinal and institutional infrastructure of no-fault responsibility, far from having serious negative consequences for the American industry, will in fact accelerate technical progress, increase general safety, and open entirely new business horizons, such as an integrated manufacturing and insurance industry. It will also bring more market mechanisms into the area of consumer safety, speed up innovation, and ultimately make industrial products less expensive.”

– **Andrzej Rapaczynski, Columbia Law School**<sup>141</sup>

“We argue that maintaining a focus on human accountability in complex human machine systems is crucial as we enter a time of increasing technological innovation. This accountability must exist not only in the form of the operator or the physical manufacturer of a system, but also in the designers of the software and human-machine interface (HMI) that directs the system and creates the structures for potential human intervention. A computational agent is not, and must



not, be seen as an individual agent but rather as an extension of the engineers and designers—the human agents—who developed it.”

– **M.C. Elish and Tim Hwang, Data Research Institute**<sup>142</sup>

“The more forthcoming the self-driving car industry is with testing performance, the better. While a lack of legislation allows for unhindered innovation—which is necessary for autonomous technology’s advancement—transparency and publicized tests are needed for public safety and understanding. It’s up to legislators and car manufacturers to do so.”

– **Seth Birnbaum, CEO of Everquote**<sup>143</sup>

“Given the historical patterns described above, we could reasonably expect that in the case of driverless cars liability will shift to the operator (or rather, overseer) of the vehicle, even as media and marketing materials claim the vehicle operates autonomously.”

– **M.C. Elish and Tim Hwang, Data Research Institute**<sup>144</sup>

“[A] significant information asymmetry exists between manufacturers and operators in the function of intelligent systems. This asymmetry prevents consumers from effectively assessing and making informed choices about their use of autonomous vehicles. We would continue to impose strict liability unless manufacturers complied with provisions that eased this information asymmetry.”

– **M.C. Elish and Tim Hwang, Data Research Institute**<sup>145</sup>

“It is the manufacturer who bears front line responsibility for design and

manufacturing defects, and is generally the principal if not the only defendant in litigation. That allocation of responsibility makes sense, because the manufacturer sets the price for the vehicle, and so the manufacturer can build in an “insurance premium” into the vehicle’s sale price to offset expected liability costs.”

– **David Vladek, Georgetown University Law Center**<sup>146</sup>

“Accidents are seldom simple - they usually involve a complex web of interacting events with multiple contributing technical, human, and organizational factors... Accidents are often blamed on a single cause like human error. But virtually all factors involved in accidents can be labeled human error... Concluding that an accident was the result of human error is not very helpful or meaningful.”

– **Nancy Leveson, University of Washington, and Clark Turner, University of California, Irvine**<sup>147</sup>

“In each case, the machine functions and makes decisions in ways that can be traced directly back to the design, programming, and knowledge humans embedded in the machine. The human hand defines, guides, and ultimately controls the process, either directly or because of the capacity to override the machine and seize control. As sophisticated as these machines are, they are, at most, semi-autonomous. They are tools, albeit remarkably sophisticated tools, used by humans. Where the hand of human involvement in machine decision-making is so evident, there is no need to reexamine liability rules. Any human (or corporate entity that has the power to do things that humans do, enter into contracts, hire workers, and so forth) that has a role

in the development of the machine and helps map out its decision-making is potentially responsible for wrongful acts—negligent or intentional—committed by, or involving, the machine. The reason, of course, is that these machines, notwithstanding their sophistication, have no attribute of legal personhood. They are agents or instruments of other entities that have legal capacity as individuals, corporations, or other legal “persons” that may be held accountable under the law for their actions.”

– **David Vladek, Georgetown University Law Center**<sup>148</sup>

“[M]anufacturers of autonomous cars will not avoid liability for suits because, on the whole, these cars are safer than manually driven cars. For example, even if a human-driven car with an adaptive cruise control system combined with a lane-centering system is safer on the whole than a car without the system, the manufacturer of the car would be liable if a reasonable alternative design for the system could have prevented the injury. Any other approach would be contrary to the current approach and would, in effect, immunize sellers of cars with electronic stability control system from liability and thus eliminate incentives to make these systems safer.”

– **F. Patrick Hubbard, University of South Carolina School of Law**<sup>149</sup>

“While automation is generally assumed to relieve humans of menial tasks, freeing them to think about more important decisions, this has proven not to be the case. More free time does not necessarily lead to high-level judgments. In fact, pilot awareness generally decreases with increased automation. Human factors research has demonstrated that skills atrophy when automation takes over.”

– **M.C. Elish, Data Research Institute**<sup>150</sup>

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