

How Safe Is Safe Enough?



STUDENT DRIVER

Americans still don't trust self-driving cars

Nearly 3 in 4 Americans say autonomous vehicle technology "is not ready for primetime"

By [Andrew J. Hawkins](#) | [@andyjayhawk](#) | May 19, 2020, 12:01am EDT

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TRANSPORT

Do you trust automated cars? If not, you're not alone

20 April 2021

<https://bit.ly/2QnxD3f>

by [Fintan Burke](#)

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In Europe, trust in automated cars is still pretty low. In a 2019 Eurobarometer survey, half of the respondents said they would not use automated vehicles if given the opportunity. Only 2% said they would buy an automated vehicle right away. Image credit - Ian Maddox licensed under CC BY-SA 4.0

Is Supervised “Autopilot” Actually Safer?

- Active safety seems to be dominant benefit, not “autopilot”

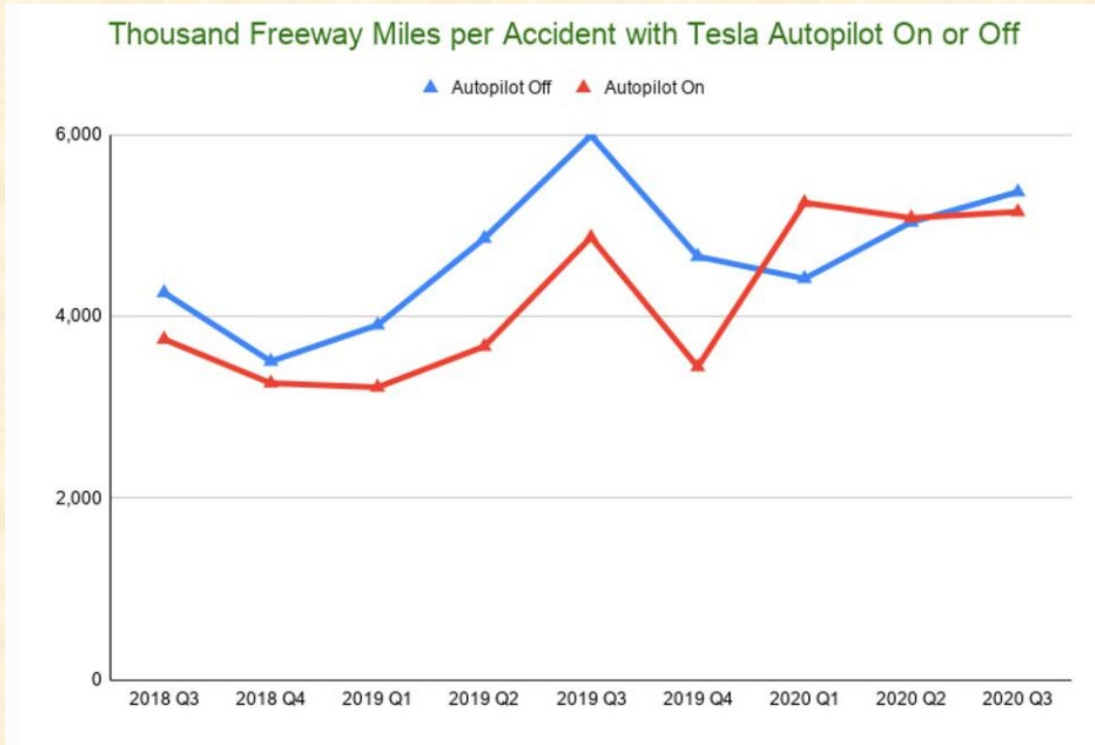


Chart of miles per "accident" with and without Tesla Autopilot, corrected for freeway vs. city ... [+] BRAD

TEMPLETON

<https://www.forbes.com/sites/bradtempleton/2020/10/28/new-tesla-autopilot-statistics-show-its-almost-as-safe-driving-with-it-as-without/>



KEY POINTS

- Cognitive biases may lead to unrealistic safety requirements from self-driving cars.
- Most people require higher levels of safety before agreeing to a ride with a self-driving car than a human driver.
- We tend to regard ourselves as safer drivers than we actually are.
- The safer drivers we regard ourselves as being, the more safety we demand from self-driving cars.

<https://bit.ly/3gENLaX>

Current Regulatory Strategy

- US Govt. regulates technology
 - State governments regulate/license drivers
 - Regulators have minimal software expertise
 - **Vehicle makers self-certify**
 - Reactive safety – recalls & litigation
- EU starting to specifically regulate (e.g., ALKS)
 - Type approval based on testing
- Safety primarily via vehicle tests
 - US Federal Motor Vehicle Safety Standards (FMVSS), NCAP
 - EU Type approval tests, Euro NCAP
 - Emphasizes functionality, not software safety



FMVSS 138 Telltale

How Safe Is Safe Enough?



DOT HS 813 060

December 2020

[DOT HS 813 060 & DOT HS 813 021]

■ 2019 NHTSA data (public roads)

- 36,096 fatalities (1.10/100M miles)
- 2,740,000 injuries
- 6,756,000 police-reported crashes
- *Data includes drunk drivers, speeders, no seat belts*
 - Unimpaired, law abiding drivers would have lower rates

■ Non-occupant fatalities: 20% (pedestrians, bicycles, etc.)

- Motorcyclist fatalities: 14%

➔ Expect zero deaths in a 10 million mile road test campaign

(On average, expect 0.1 fatalities, 0.02 pedestrian fatalities)

Which Driver Are We Better Than?

■ ~100M miles/fatal mishap for human driven road vehicles

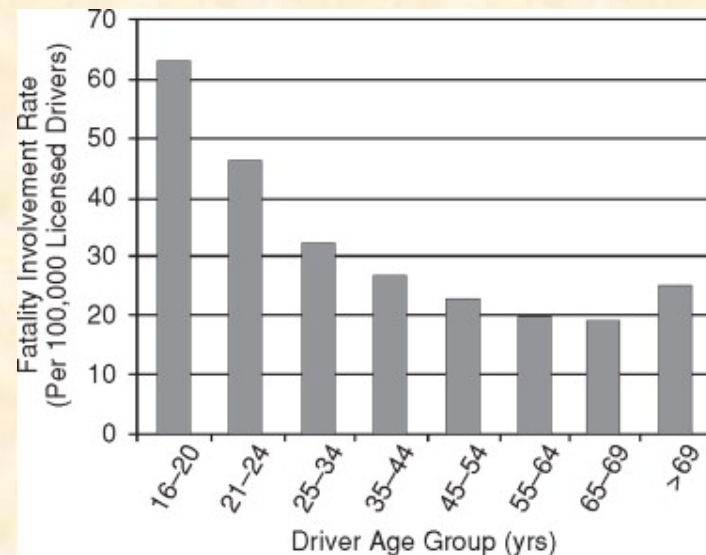
- 28% Alcohol impaired/Driving Under Influence
- 26% Speed-related
- 9% distracted driving
- 2% drowsy ...

(total > 100% due to multiple factors in some mishaps)

[DOT HS 813 060 & DOT HS 813 021]

■ Unimpaired drivers operating at safe speed are much better than 100M miles per fatal mishap

■ Fast reaction times do not necessarily ensure safety



<https://goo.gl/tEuoaS>

ODD Affects “Safe Enough” Value

■ Fatality averages for 2019 (IIHS)

Location	Deaths/100K people		Deaths/100M miles	
● DC	3.3	} 7.7x	MA	0.51
● US	11.0		US	1.11
● WY	25.4		SC	1.73

■ Fatal crash type

- DC: highest pedestrian rate (39%)
- NY, FL, DE: highest bicycle rate (5%)
- Fatalities per 100M miles: Urban 0.86 vs. Rural 1.65
- What about day/night, weather, vehicle safety features, etc.?

Approaches To Measuring “Safe”

- “Positive Risk Balance” → AVs kill fewer than human drivers
 - What about injuries? Property damage?
 - Adjusted for ODD vs. entire human fleet?
- What if fatalities have different victim profile?
 - Race/ethnicity (skin color, clothing, neighborhood)
 - Not a “typical” adult (children, impairments, agility)
 - Road use (pedestrians, cyclists, jaywalkers)
- Other possible considerations:
 - Expected cost (insurance) vs. as low as practicable (ALARP)
 - Adverse news events



Standards-Based Engineering Approach

US DOT:
 “This is exactly the way we wanted standards to be used” per US DOT AV 3.0

Finch Fulton • 1st
 Vice President of Policy and Strategy at Location1

I really like the way Philip Koopman lays out how different standards build on each other towards making the safety case for automated vehicle operations as a part of the #UL4600 discussions.* This is exactly the way we wanted the standards to be used when we gathered and published them in the appendix to #USDOT's #AV 3.0. (Link: <https://ninkd.in/gJW-MBa>)

Showing how all these standards line up and work with each other is critical to demonstrating safety approaches, and to providing transparency to #safety experts (and ultimately, to the public). Check out this video where he walks us through them: <https://ninkd.in/gVQMQR8>

Good stuff!

*for transparency, I'm on the standards development committee for UL 4600 with Phil

Standards-Based Engineering Approach

SYSTEM SAFETY	UL 4600	Safety Beyond Dynamic Driving
DYNAMIC DRIVING FUNCTION	ISO/PAS 21448 SaFAD/ISO TR 4804	Environment & Edge Cases
FUNCTIONAL SAFETY	ISO 26262	Equipment Faults
CYBER-SECURITY	SAE J3061 SAE 21434	Computer Security
VEHICLE SAFETY	FMVSS NCAP	Basic Vehicle Functions

HIGHLY AUTOMATED VEHICLE SAFETY CASE
UL 4600

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HIGHLY AUTOMATED VEHICLE SAFETY CASE

UL 4600

<https://bit.ly/3dV2LA5>

Changing Safety Expectations, Standards & Regulation

- ❖ “Safe as a human driver” is complicated
- ❖ Expectations beyond simple Positive Risk Balance
- ❖ Increasing regulatory pressure to follow standards