The Pathway to Driverless Cars and the Sacred Cow Problem

Some behavioural challenges to think about

National Infrastructure Commission
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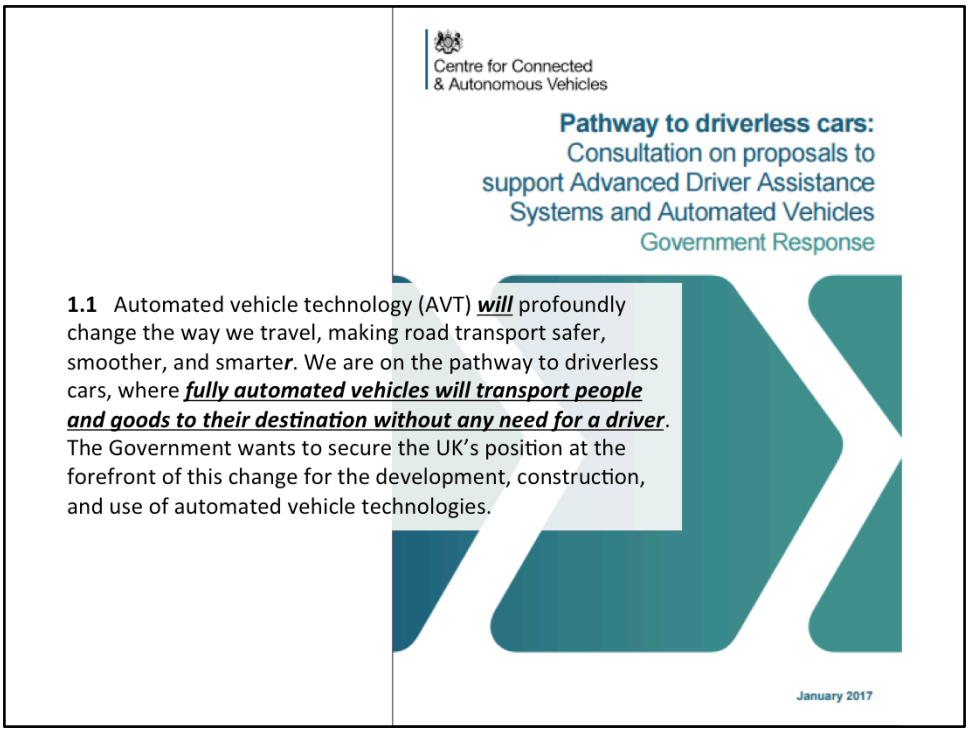
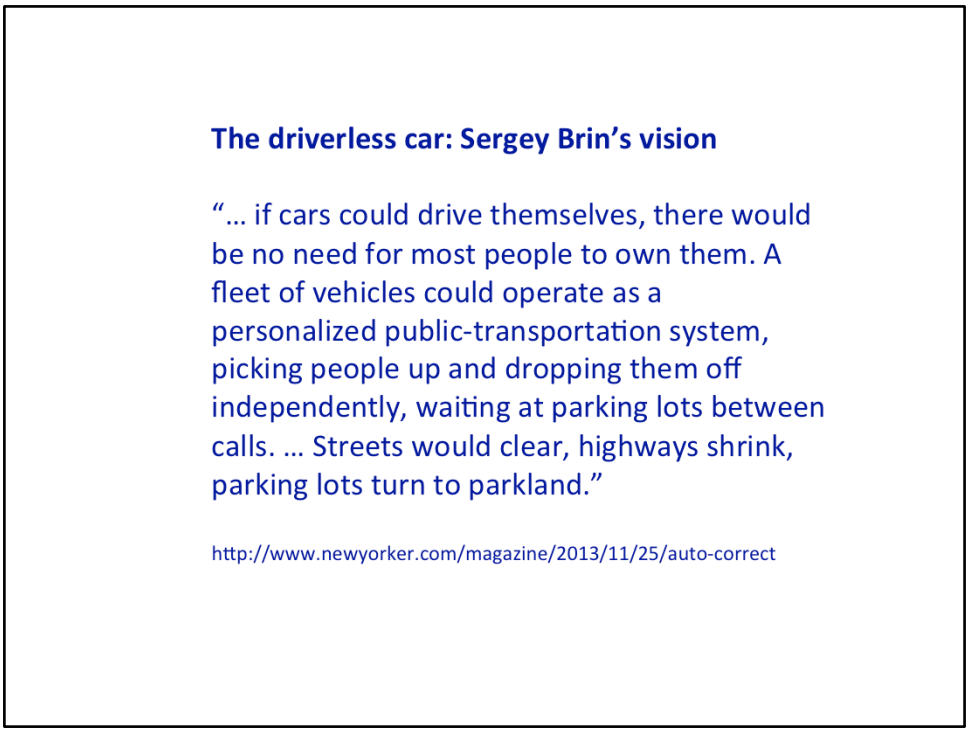


I would like to offer a few thoughts about the future envisioned in this document published last January – both the driverless end state, and the provision of Advance Driver Assistance Systems to be provided on the pathway to it.

The opening paragraph stakes out a pretty deterministic position – it ***will*** happen. We ***will be*** transported to our destinations without any need for a driver.

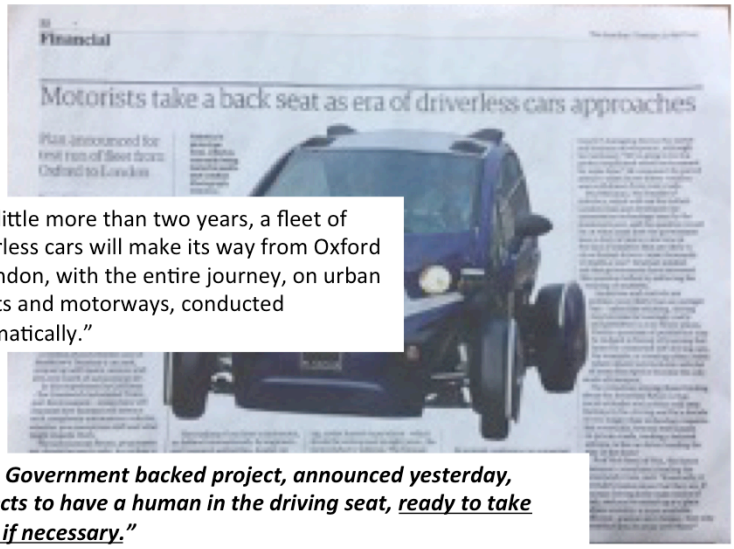


This is Sergey Brin's vision of what might lie at the end of The Pathway.

But most of the this document is devoted to problems encountered on The Pathway, not at its final driverless destination.

And the most difficult, so far unresolved, problem encountered on the Pathway is driver distraction.

The more Advanced Driver Assistance takes over the driving task the less the attention of the driver is required, and the greater becomes the problem of driver distraction.



Financial

Motorists take a back seat as era of driverless cars approaches

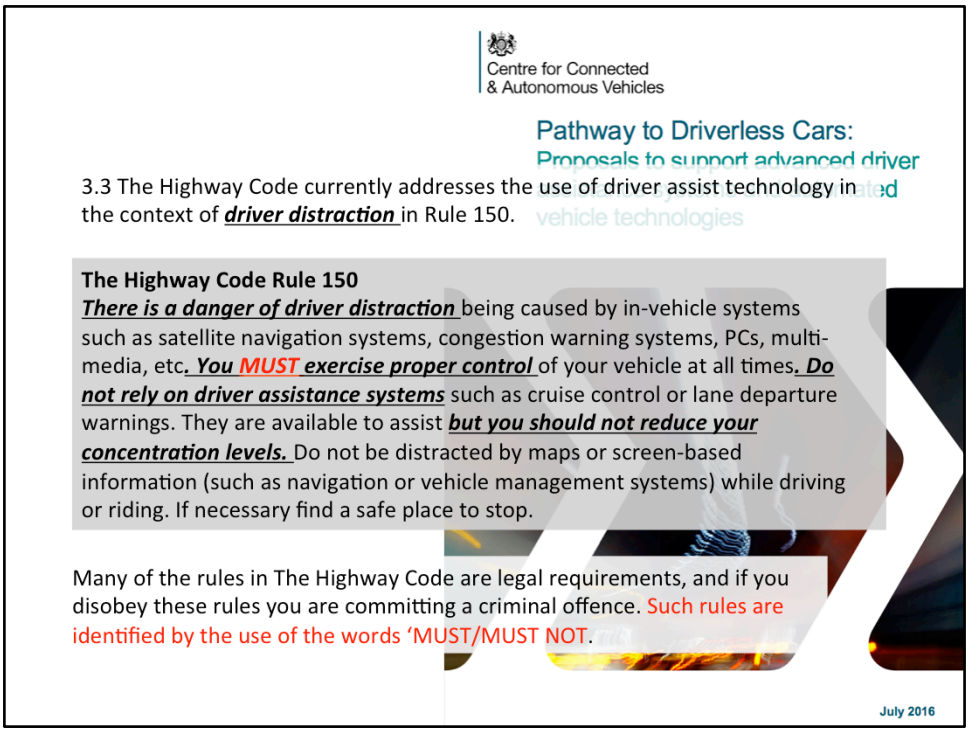
Plan announced for test run of fleet from Oxford to London

"In a little more than two years, a fleet of driverless cars will make its way from Oxford to London, with the entire journey, on urban streets and motorways, conducted automatically."

"The Government backed project, announced yesterday, expects to have a human in the driving seat, ready to take over if necessary."

The Guardian, 25/04/2017,

The distraction problem is a challenge highlighted by this article in last Tuesday's Guardian.
Driving all the way from Oxford to London in car that is supposed to drive itself, while remaining vigilant for situations where the Advanced Driver Assistance might fail to cope, will be a real challenge.
This is why Google took out the steering wheel. It said that its test drivers started to trust the car too much, and they lost concentration.



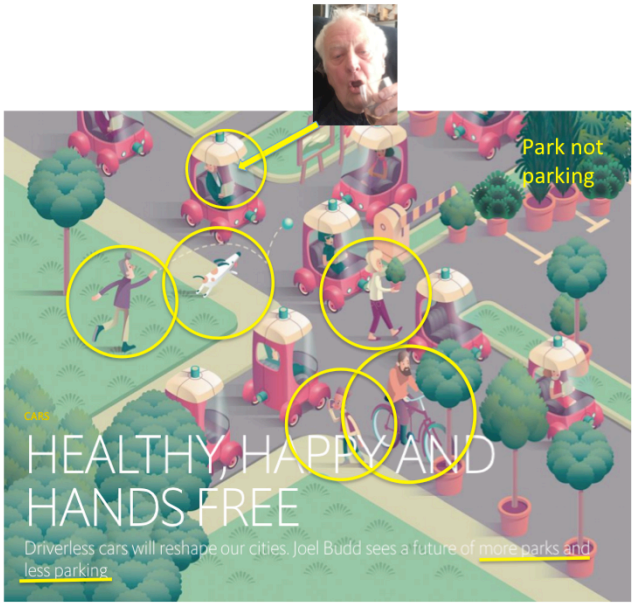
The problem is addressed briefly in this precursor Pathway document published last year.

It suggests the solution might be found in the Highway Code. This is what rule 150 has to say.

I have highlighted the word MUST. Most of the 307 rules in the Highway Code are merely advisory. But whenever the word MUST appears the rule has the force of criminal law.

Beyond saying that distracted driving leading to loss of control is against the law I can find no other mention of how the problem might be dealt with.

But today I want to focus on a problem that lies at the Pathway's destination.



https://www.1843magazine.com/technology/healthy-happy-and-hands-free

The problem posed by people not in cars.
This is a picture of Sergey Brin's vision, published last year by The Economist.
The picture captures the principal features of the driverless future being advertised by its promoters: *There will a return of free-range children, and cats and dogs. *Pedestrians will be free to cross the street anywhere. *There will be no more discussion of cyclists needing helmets. *And lots of car parks will become true parks.

And finally, that's me in that car. I am a representative of a group that stands to benefit greatly from driverless cars: those who are too old to drive. We are making common cause with those who are too drunk to drive. We will be able to toddle out the front door and be taken by car to our parties, drink as much as we like and get driven safely back home. It's a wonderful vision.
We can even drink on our way to the party.

The cars are being driven by algorithms that have been programmed to respond to the vulnerable road users depicted here − the children, the dog, the pedestrian and the cyclist − ***with extreme deference***. The algorithms confer ***"sacred cow status"*** upon them. But this scene is very sparsely populated − 9 cars and 5 vulnerable road users coexisting harmoniously.
What might happened in dense urban areas with lots of sacred cows and lots of deferential algorithms?

"Vehicles and traffic come to a grinding halt in India every day when the cow decides to cross. In such instances, the cow is supreme."

Culturally programmed drivers deferring to a group of fatalists

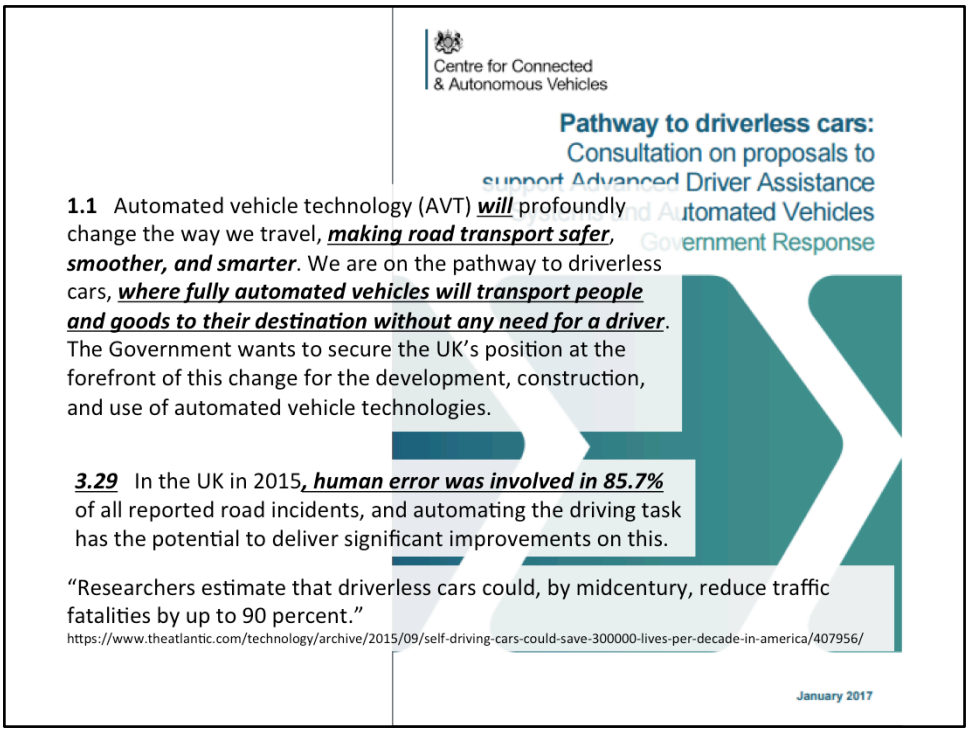
Result: deferential paralysis

https://www.google.co.uk/search?q=sacred+cows+india&espv=2&biw=1469&bih=1267&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiJk6H66c_NAhVhBMAKHdzfD44Q_AUIBigB#imgrc=ucjWGDg6gU7XpM%3A

I refer to the drivers in this picture as **culturally programmed** to defer to cows they consider sacred − it's much safer in India to cross the road if you are a cow than a pedestrian.

The behaviour of cows appears to be governed by very simple algorithms. But people aren't cows. What about the algorithms governing the behaviour of the people depicted in the last slide − pedestrians, cyclists and human drivers
People are programmed to respond deferentially to things that might harm them. How might their behaviour change if their perception if the threat of motorised traffic changes? I will return to this question in a moment.

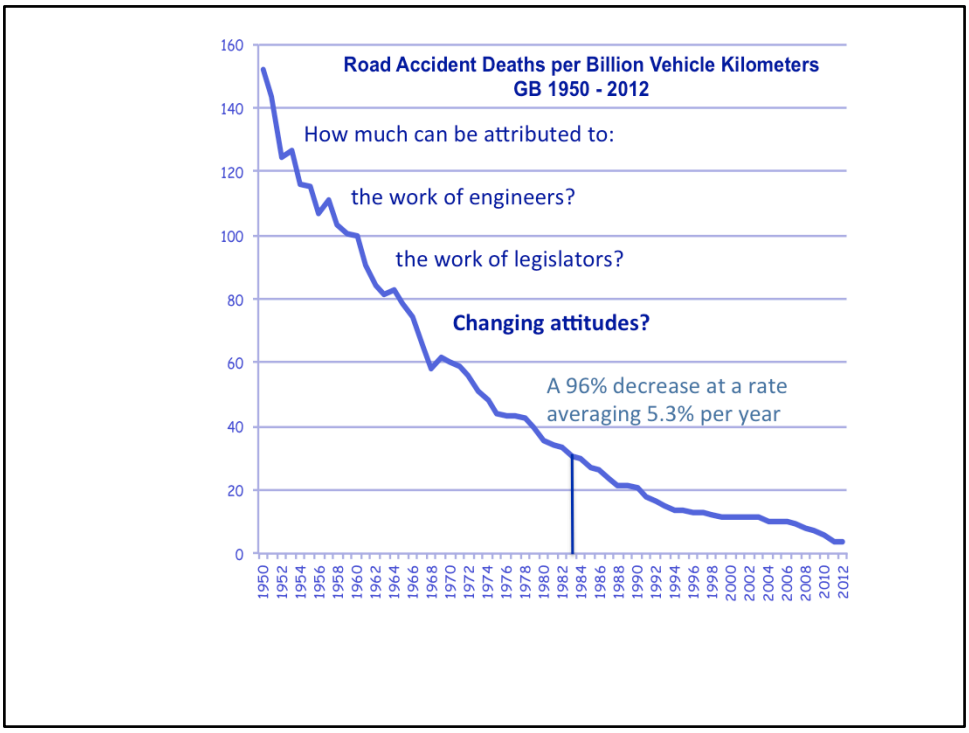
First I want to take a look at the contribution that driverless cars are widely assumed to make to road safety.



Pathway to Driverless Cars promises more safety and suggests, in para 3.29***, a lot more safety***.

It joins many other driverless visionaries who anticipate enormous reductions in road accident fatalities.

I want to provide some context for this promise.



Here is a graph showing the enormous reduction in fatalities per vehicle kilometer achieved in Britain since 1950.

How might we account for it? And might we expect reductions of a similar magnitude in the future if we go driverless. There is an enormous literature that seeks to explain, and claim credit for, the reductions shown on the graph.

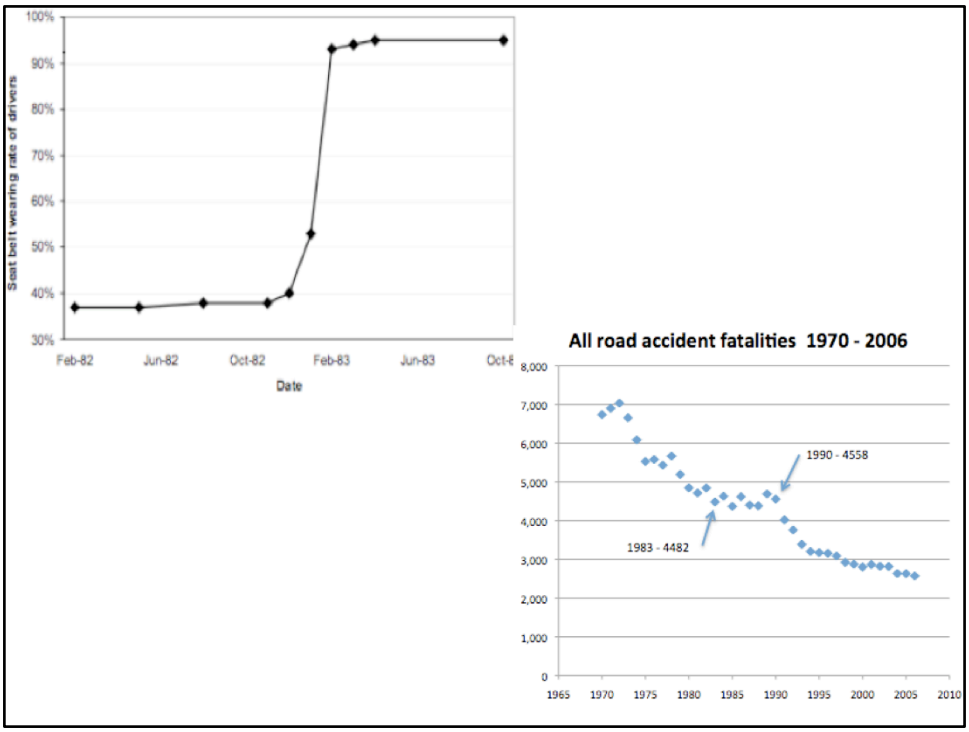
The engineers are proud of their achievements: better roads, better brakes and tires, more crash protection, and now things like pre-emptive braking and other Advanced Driver Assistance Systems.

The regulators and legislators also claim a share of the credit with drink drive laws, speed limits and the 305 other rules in the Highway Code.

The engineers and legislators claim joint credit for seat belts − the design of the webbing and anchorage points, and the laws compelling their use.

But I want to claim most credit for changing attitudes,

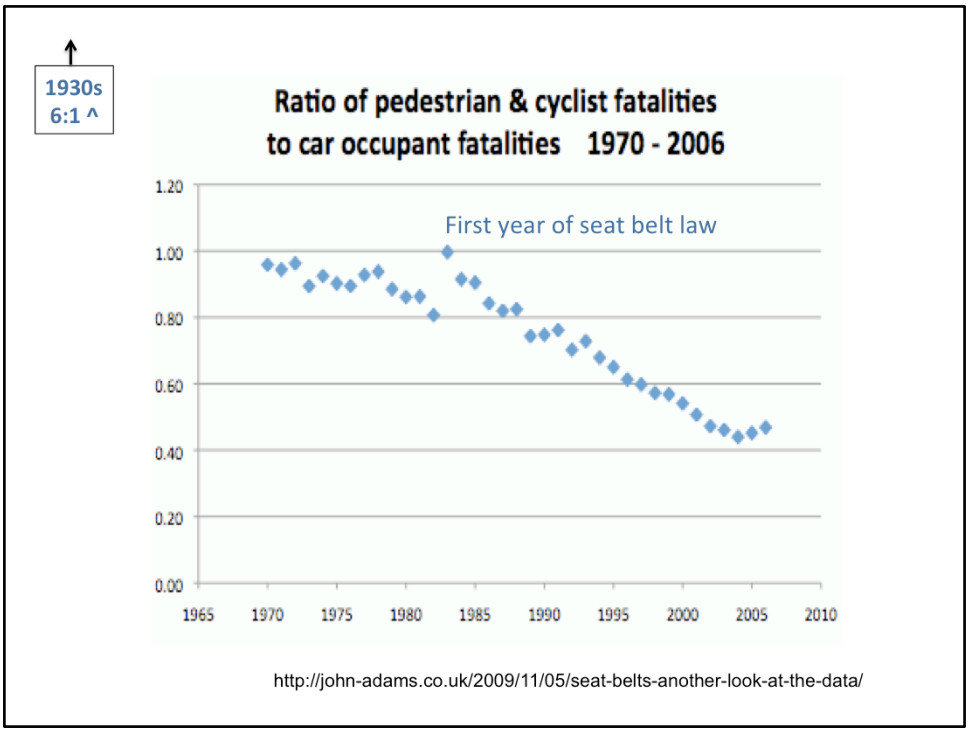
If one looks through the claims in the road safety literature the life-saving claims for seatbelts, and the law that compelled their use, are far greater than all others − enormous fatality reductions were promised. But unless you already knew when they were introduced, looking at the graph you would be hard pressed to guess the year − 1983. But if the claims for the effectiveness of seat belt were true there should have been a large and sudden drop in 1983 because in that year there was a large and sudden increase in seatbelt wearing rates.



In 1983 seatbelt wearing rates increased from under 40% to over 95%.

In the parliamentary debate that led to the passage of the seatbelt law 1000 lives a year was a widely cited promise of the law's effect

But what happened to fatalities? A fairly well-established downtrend was interrupted for over 7 years.
I983 was also the year in which evidential breath testing machines were introduced − a bumper year for engineers and legislators.



This graph provides a clue as to what might have been going on.

From the 1930s there was a well established downward trend in the ratio of vulnerable road users (pedestrians and cyclists) killed to car occupant fatalities.

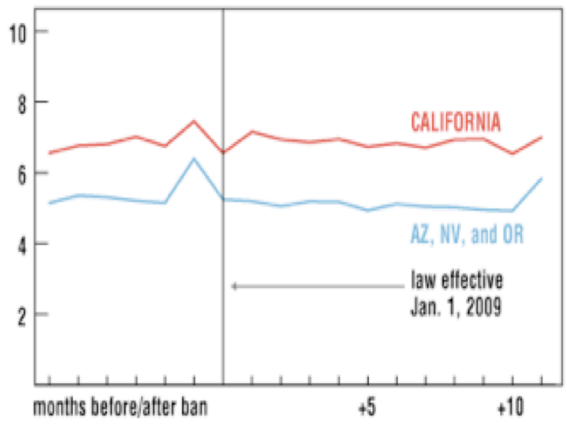
In 1932 it was 6.5:1. By 1970 it had dropped below 1:1 and was continuing to fall - until 1983 when the seatbelt law came into effect and it jumped 25%, after which the downward trend resumed.

It appears that drivers feeling more secure wearing seatbelts were driving a bit more heedlessly – **an example of the well-known risk compensation effect.**

"Change has to take root in people's minds before it can be legislated."
Michael Sandel

Highway Loss Data Institute News Release –
"Texting bans don't reduce crashes; effects are slight crash increases"

California – Collision claims per 100 insured vehicle years, by month before and after texting law for all drivers, compared with Arizona, Nevada and Oregon

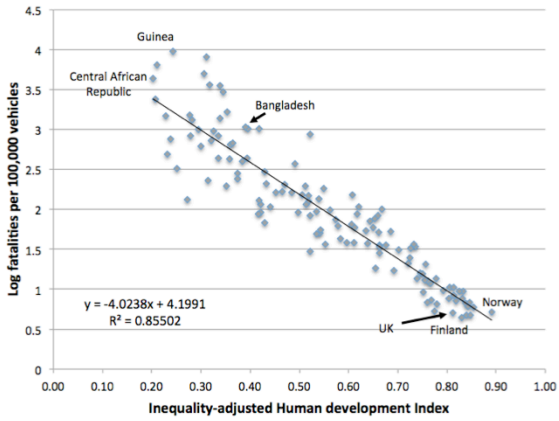


http://www.iihs.org/news/rss/pr092810.html

Another example of the failure of well-intended legislation:
In 2010 the Insurance institute for Highway Safety published the results of a study that confounded their expectations. Four states, California, Louisiana, Minnesota and Washington, had passed laws banning texting while driving – laws passed with the intention of reducing "distracted driving". These laws constituted natural experiments. Each state had on its borders other states that had not passed such laws, and these states served as ***controls*** against which the effects of the banning laws were measured. The result was: "texting bans don't reduce crashes; effects are slight crash increases." Figure 4 displays the result for California, measured against the control states of Arizona, Nevada and Oregon. This unexpected result was described by the authors of the study as a **"**perverse"twist".

Michael Sandel of Harvard − my new favourite philosopher - has observed that ***"Change has to take root in people's minds before it can be legislated.***" This would appear to be a nice example. Apparently the change in the law was not accompanied by a change that had taken root in people's minds; or rather not the *desired* change. A law that was intended to decrease "distracted driving" appears to have increased it. The report's somewhat tentative conclusion? - "clearly drivers did respond to the bans … what they might have been doing was moving their phones down and out of sight when they texted, in recognition that what they were doing was illegal. This could exacerbate the risk of texting by taking drivers' eyes further from the road and for a longer time."

"Change has to take root in people's minds before it can be legislated."



Finland – road fatalities per 100,000 motor vehicles - 4.4

Guinea– road fatalities per 100,000 motor vehicles - 9462

2150 X higher

Michael Sandel - http://www.theguardian.com/lifeandstyle/2013/apr/27/michael-sandel-this-much-i-know

This graph presents a wider picture, and one that provokes challenging questions about how the long-term decrease in road accident fatalities in Britain was achieved. It shows the correlation between the national road accident fatality rate per 100,000 vehicles for 134 countries plotted against the countries' scores on the United Nations Inequality-Adjusted Human Development Index. There are some large outliers, so it clearly does not explain everything.

(Created by Mahbub-ul-Haq and Nobel Laureate Amartya Sen, the Inequality-Adjusted Human Development index is a composite of average longevity, education and income, adjusted for income inequality - http://en.wikipedia.org/wiki/Human_Development_Index, see also Figure 7 in Adams, J. "Risk: mathematical ***and*** otherwise" The *Mathematics Enthusiast,* vol.12, no. 1&2, 2015)

Change taking root in people's minds? Almost all of the developing countries toward the top end of the trend on this graph have, on their statute books, laws banning speeding, drinking and driving and the use of mobile phones while driving; and almost all have laws requiring the use of seat belts and helmets. None of them have car-manufacturing industries; they are achieving their extraordinary kill-rates per vehicle with modern imported vehicles with 100 years of safety technology built into them. And the fact that they have inferior roads is unlikely to explain the enormous difference between the countries at the top and countries at the bottom; potholes are nature's speed bumps.

Finland – road fatalities per 100,000 motor vehicles - 4.4

Bangladesh – road fatalities per 100,000 motor vehicles - 1021

232 X higher

Attitudes toward safety on the road are shared in other aspects of life in the countries represented the last graph.

Bangladesh has higher fatality rates on the road - and off it.

And in the 1930s the United States had much higher fatality rates both on the road and at work.

Connected autonomous vehicles and ***unconnected autonomous road users***

https://www.1843magazine.com/technology/healthy-happy-and-hands-free

What attitudes and behaviours might we expect to find in the brave new world of connected autonomous vehicles?

We are assured that the attitude programmed into the algorithms of autonomous vehicles will be one of extreme deference.

But what about the people on the roads – ***the unconnected autonomous road users***?

- If there are still any autonomous drivers (as distinct from cars) left on the road – we can expect the range of driver behaviours, and attitudes, that we find today – from wild and reckless young men to timid and cautious little old ladies named Prudence. But they will drive with different expectations of the behaviour of the driverless cars that they encounter.
- There will be no autonomous motorcycles. How might the behaviour of their autonomous riders change in response to the diminished perceived threat of CAVs?
- Irresponsible road users will still be with us. Might they feel liberated to behave even more irresponsibly?
- The behaviour of sacred cows is not expected to change, but
- What will happen on busy roads when pedestrians feel free to to step confidently in front of driverless cars?

The uniform spacing of the platooning cars in this picture renders the scene unrealistic. The cars could not defer to randomly encountered people and dogs and retain their uniform spacing.

Automated cars: A smooth ride ahead?

"Driving in cities would be unacceptably slow if autonomously-operating cars were required to assume that every pedestrian might jump into traffic as fast as humanly possible. But if pedestrians came to learn that cars would always avoid them then they would likely act in much less controlled ways on streets and pavements."

"Studies are underway using driving simulators to determine the optimal ways to design the human-machine interactions, but there are no clear answers today regarding design principles or standards."
http://orfe.princeton.edu/~alaink/SmartDrivingCars/PDFs/LeVine&Polak--Automated%20CarsFeb2014.pdf 2014

"Infrastructure must enable and support CAVs to make safe progress on the roads (i.e. controlling risks to other road users, especially vulnerable ones such as pedestrians and cyclists)."
http://www.racfoundation.org/assets/rac_foundation/content/downloadables/CAS_Readiness_of_the_road_network_April_2017.pdf

What do the proponents of Autonomous Vehicles assume about the behaviour of these autonomous people not in cars?
First, they assume that somehow they will be made to get out of the way.

Or, somehow − the way not specified − the risks to which they will be subjected must be controlled.

Autonomous cars will be expected to follow current guidelines, but the Highway Code will need to change to get the most out of them. ***The tech will allow more accurate driving so, for example, cars could overtake cyclists more closely***, while tailgating may no longer be an offence – as running driverless cars close together better uses road capacity and cuts emissions.

http://www.**autoexpress**.co.uk/car-tech/85183/driverless-cars-everything-you-need-to-know-about-autonomous-vehicles

I can find virtually no mention of the problem posed by the "risk compensation effect" in the literature enthusing about driverless cars.
Here is a typical example from a recent article in Auto Express.
The "tech" will allow driverless cars to pass cyclists more closely.
The article exhibits no apparent awareness of the likelihood that, if assured that driverless cars will defer to them, cyclists will confidently take up more space on the road.

Billions of £/$ are being spent on the development of driverless cars. These are some of the major players.
The economic and political lobbying weight of the developers is massive.

I can find no evidence that any of them have seriously considered, or found solutions to, the problem posed by human autonomous road users.

Financial

Motorists take a back seat as era of driverless cars approaches

Plan announced for test run of fleet from Oxford to London

Tuesday's (25/04/2017) Guardian

The media coverage is breathless.

And yet, the safety of vulnerable road users in this exciting new driverless world has barely begun to be addressed.

The image on the cover of this Pathway document from last year captures nicely the current prospects of driverless cars:

- Tremendously exciting,
  and
- Tremendously indistinct.

National Planning Policy

2.33 National planning policy sets out a clear approach to promote sustainable transport. One of the core planning principles set out in the National Planning Policy Framework15 is that the planning system should actively manage patterns of growth **to make the fullest possible use of public transport, walking and cycling, and focus significant development in sustainable locations**.

There is no mention in the DfT's ***Cycling and Walking Investment Strategy*** of the Pathway to Driverless Cars document – or vice versa.

Are these initiatives talking to each other??

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(presentation posted here)