How much human do we need in a car?

The evolution of artificial intelligence and the acceptance of autonomous vehicles

The better the question. The better the answer. The better the world works.

RINSPEED

EY
Building a better working world

The evolution of artificial intelligence and the acceptance of autonomous vehicles

Contents

Market indicators

>90%

Car accidents caused by human error[1]

85 million

Autonomous-capable vehicles expected to be sold annually by 2035[2]

Up to 15%

Reduction in car crashes among cars that have forward collision warning systems and automatic braking features[3]

1. "National Safety Council Estimates Traffic Deaths Down Three Percent in 2013", *National Safety Council website*, http://www.nsc.org/NewsDocuments/2014-Press-Release-Archive/2-12-2014-Traffic-Fatality-Report.pdf, accessed 26 February 2016.
2. "Advanced Driver Assistance Systems and the Evolution of Self-Driving Functionality: Global Market Analysis and Forecasts", *Navigant Research*, October 2015, © 2016 Navigant Consulting, Inc.
3. "Autonomous cars likely to increase congestion", *RenewEconomy website*, http://reneweconomy.com.au/2016/autonomous-cars-likely-to-increase-congestion-28009, accessed 26 February 2016.

Randall J. Miller
Global Automotive & Transportation Sector Leader, EY

"To provide more comfortable and safer urban mobility, vehicles with more connectivity and self-driving functionality will be required on our roads. Digital technologies will support the provision of customizable mobility packages. As they move closer to reality, autonomous vehicles will not only play an integral role in the urban mobility ecosystem but will also support a number of new business models. However, as these vehicles evolve through different deployment scenarios, a sophisticated – adaptive and intuitive – human-machine interface (HMI) will be imperative. This means that software and software development will become more important for the automotive supply chain than ever before."

The key to successful application of autonomous technology will be a seamless transition of control between the vehicle and the driver

Technology improvements with systems and components, such as computer vision, radars, lidars and GPS, have supported more automated driving technologies to help address rising safety concerns, increased demand for fuel efficiency and traffic gridlock by creating more efficient transportation solutions. Technology advancement and proliferation are accelerating at an unprecedented rate – and this is expected to continue. Autonomous vehicles and the possibilities that they bring have caught consumers' attention and are also gradually gaining their acceptance.

Market indicators

>40%

Drivers who can imagine letting an autopilot steer their car[4]

66%

Drivers who are willing to let an autopilot steer their car if given an option of taking over the wheel in an emergency[5]

Trust will be built by defining the boundaries of human and vehicle control

Trust of the new automated functionality is a key component of how quickly these technologies become available. As customers use the new systems and get comfortable with how they function and their dependability, they will be ready for more functionality. Another key component to proliferation of automated functionality is the legal and regulatory element. A major step toward getting autonomous vehicles on the road was the February 2016 announcement from the National Highway Traffic Safety Administration (NHTSA) (US) that stated that Google's artificial intelligence system is deemed to be considered a driver.[6]

The transition from "automated" to "fully autonomous" driving must be well-managed

The new division of labor between humans and fully automated vehicles – including a logical, safe and seamless transition of control between the two – will be the essence of successful operation and application of autonomous vehicles. To facilitate this, a framework that defines the delegation of authority and balance of control under different circumstances is needed. With this evolution, we also need to address the emotional aspect of human driving since it will not only be difficult to give up control but many people simply enjoy driving.

75%

Plane crashes caused by pilot error[7]

0.003

Fatality rate per billion km traveled by plane (0.27 by rail, 2.57 by car)[8]

How can autonomous vehicles learn from the autopilot in aviation?

Starting point

- Transition from propeller-driven aircraft to jet aircraft defined the shift of balance in control between humans and machines

Transition

- Regulations – insurance, operating procedure
- Rise in sophistication of technology
- Need for paradigm shift in training

Obstacles

- Costs – R&D, training
- Automation confusion – ambiguity in transfer of control between pilot and machine, more accidents during transition phase
- Pilot acceptance

Learnings

- Incremental approach to introduction of technology
- Standardized operating procedures defined for numerous scenarios
- Collaborative effort of regulators, manufacturers and service providers toward application
- Educating pilots through exhaustive training and simulation exercises

4. "Who's in the driving seat?", EY, May 2015, © 2015 EYGM Limited
5. Ibid.
6. "In boost to self-driving cars, U.S. tells Google computers can qualify as drivers", *Reuters website*, http://www.reuters.com/article/us-alphabet-autos-selfdriving-exclusive-idUSKCN0VJ00H, accessed 26 February 2016
7. "Do The Right Thing: Decision Making for Pilots", *AOPA Air Safety Foundation*, October 2006, © 2006, AOPA Air Safety Foundation
8. "Safer skies", *Allianz Aviation Insurance*, July 2015, © Allianz Global Corporate & Specialty, 2015

Intuitive HMI and sophistication of artificial intelligence will support the evolution of autonomous vehicles so that they eventually perform better than human drivers

More sophisticated, customizable and intuitive interfaces are needed

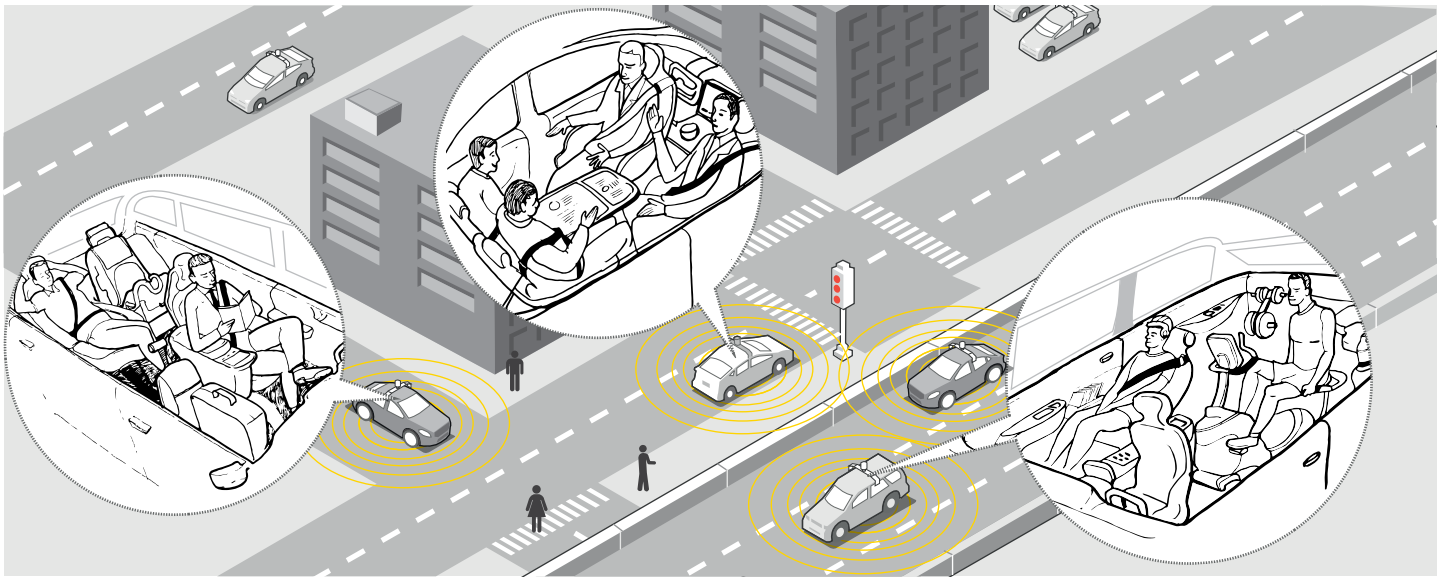
With the deployment of autonomous vehicles envisioned through the evolving shared mobility ecosystem, automakers and technology companies will need to allow customized HMI for multiple users sharing a car. This can be done through seamless integration of various "brought-in" personal devices, personalized interior options, etc. As autonomous technology is not yet ready to handle all driving conditions, a sophisticated – adaptive and intuitive – HMI is crucial, considering factors such as distraction and complacency.

Vehicle intelligence needs to be self-learning and adaptive

"The processing systems used for autonomous vehicles are expected to rely on advances in 'machine learning' to better mimic the human brain's ability to deal with unique situations. The software of a fully autonomous vehicle will need to be adaptive, intuitive and self-learning, like a chess super computer that learns from its opponents' moves as well. The requirement of artificial intelligence in the car will push software development beyond its current limits. It will open up entirely new opportunities for IT and technology companies to add significant value to the cars of the future and also capture future mobility customers."

Peter Fuss

Senior Advisory Partner Automotive GSA, **EY**



Vehicle design needs to evolve to achieve new opportunities

"As vehicles become fully autonomous, dramatic opportunities for changes to the interior and exterior of the vehicle are possible. Completely new interfaces are supported as the steering wheel, shifter, brake and pedals are no longer required. Interior space opens up and I envision reconfigurable seating and interiors that easily adjust to meet the varying needs of passengers – especially in this emerging realm of car sharing and ride sharing. Data will validate that fully autonomous vehicles are safer than human drivers; safety regulations can change to allow much lighter and more efficient vehicles. A broader use of technology and other activities within the vehicle are possible as there is no human driver necessary. This opens up a whole new world and a new way of thinking about transportation."

Kristin M. Schondorf

Global Automotive & Transportation Mobility Leader, **EY**

Consumer acceptance of autonomous vehicles will be facilitated by improvements in technology

Consumers will learn to fully trust autonomous technologies over time, but the fundamental question will be whether autonomous vehicles should be allowed to share the road with vehicles driven by people and other road users.

How will the society grow to accept autonomous vehicles?

Incremental improvement in automation

The industry has been introducing driving assistance features over the past few years. This bodes well for autonomous technologies. A step-by-step approach will help gain consumer trust, assuming they do not have a poor experience.

1

Humanizing driving

Vehicles must be designed to mimic aspects of human driving and adapt to personal style. Not everyone drives the same way. Mimicking needs to gradually move beyond average driver behavior toward varied driver profiles.

2

Taking cues from the aviation industry

Consumers have grown to trust commercial airplanes, even in autopilot mode. Learning from the aviation industry will help win consumers' trust.

3

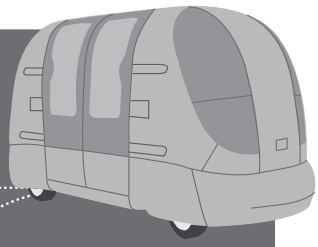
Educating and incentivizing customers

Dealers and automakers need to educate and incentivize prospective customers on autonomous features and technology.

4

Heathrow's personal rapid transit system

A step toward an urban mobility network, with autonomous vehicles on the road



Concept

- A 3.8km route that links Heathrow Terminal 5 with a car park; 18 driverless, battery-powered pods that operate on the route, carrying four passengers (and luggage) each

Regulatory challenges

- Stringent regulations around design and safety codes

Enablers

- Collaboration among multiple takeholders – airport operators, pod designers, etc. – to ensure seamless operation

Advantages

- Reduced emissions – meet Kyoto Protocol 2050 projections
- Reduced wait time for passengers

50%

Reduction in per-passenger carbon emissions vs. diesel buses[9]

80%

Passengers who have no wait time (wait time reduced to 10 seconds)[10]

Following the success of these driverless pods, they are now being repurposed and brought onto Greenwich's streets. They will be allowed to navigate the streets independently, and will be used to record exactly how the public reacts to self-driving vehicles.

9. "Hands off with Heathrow's autonomous pod cars", *The BBC*, November 2014, © 2016 BBC
10. Ibid.

EY collaborates with Swiss automotive think tank and mobility lab Rinspeed to demonstrate EY's commitment to innovation and shaping the future of mobility

At EY, we are committed to actively shaping the future of mobility. We have the potential to inspire innovative thinking – not just in the automotive industry, but also in IT, internet companies and all other stakeholders, who are involved in future mobility propositions.

An example of this endeavor is our collaboration with the Swiss think tank Rinspeed, an automobile manufacturer that specializes in building prototypes and concept cars. While the research centers of the automotive industry are still working on the technical solutions, the Swiss idea factory Rinspeed is already giving concrete thought to how automated private transport will transform the car and the human-machine system.

Swiss automotive visionary Frank M. Rinderknecht (CEO, Rinspeed AG) approaches the topic of "self-driving cars" primarily from the perspective of the driver and the occupants – the human component. In doing so, the automotive thinker and EY expressly put one question on the agenda: how much of a human component should, must or may there be in a machine?

Leveraging EY's trusted consulting services and the support of other partners across the mobility value chain, Rinspeed created its latest hybrid sports car, the "Σtos," using the skeleton of a BMW i8.

The technical highlight in the interior of the "Σtos" is no doubt the folding and retracting steering wheel. This creates lots of space in front of the driver, who can work or read a book in the old-fashioned way.

The "Σtos" drastically reduces the number of distracting manual entries – despite significantly expanded functions. Should it nonetheless be necessary to enter a command, the "Σtos" responds promptly to voice commands, gestures, touch input, controller or the push of a button.

Heads up: Σtos has an extremely high addiction and envy factor – future, here I come!

EY's Mobility Innovation Group – how EY can help

EY's Automotive & Transportation Sector works toward delivering the future of urban mobility – improving the movement of people and goods around the world. We bring "consulting in action" to our clients, enabling learning and development of new business models, products and technologies, while balancing their investment and attention to their traditional business.

Automakers are operating in an unfamiliar environment, requiring more speed and innovation. EY is collaborating with disruptor firms, suppliers, automakers, mobility service providers, cities and research centers to design recommendations and path-to-market for our key clients' most relevant issues. Let us help you on your journey.

Some examples of the tools and methodology we've used to help clients design and experiment with mobility offerings

Ideation

Fishbowls

Facilitating the generation, filtering and development of new business concepts through a transparent, iterative process

Design shops

Intense collaboration to understand the art of the possible – what can you achieve with the constraints taken away?

Three-box strategy development

Balancing between managing the present while creating the future

Think tank

Harnessing the power of your internal and external online communities to generate and develop new business ideas

Experimentation

Experiment design and execution

Running live in-market experiments that provide actual business results and organizational learning, fast

Hackathons

Bringing together developers, designers and external specialists to collaborate intensively and make rapid progress in a short time

Open innovation

Helping you to collaborate across an extended innovation ecosystem to enhance the value of your new propositions

Start up

Value stream mapping

Understanding where the value lies in your new propositions and how best to monetize them

Start-up challenges

Tools and techniques to allow mature organizations to innovate

Partner ecosystems

Building an ecosystem of business partners to support new product and service innovation

Scale up

Scaling approach

Quickly extending and industrializing proven concepts in the market to enhance value and first-mover advantage

City selection and collaboration

Identifying and collaborating with cities for mobility products and services

ROII

Measuring the return on innovation investment

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