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Weekly Newsletter

DVN-I
Automotive Interior

NEWSLETTER #156

Editorial

Infotainment Makes Problems! What Shall We Do About It?

This week's in-depth report looks into the latest iteration of findings that automotive Infotainment systems continue to be the most troublesome thing in the interior. That's a big and persistent problem, as infotainment systems are growing well beyond their original instrument-cluster-plus-radio to engulf more and ever more functions and features inside the car. The DVN Interior Köln Workshop—it's only about 12 days away!—will address the topic with two HMI/Smart Surfaces sessions, presenting new technologies and solutions to solve these issues. More than 120 attendees have already registered, with high participation by industry including BMW; Volvo; JLR; Ford; Honda; Hyundai, and Toyota. If you haven't registered yet, there's still time, but only just barely—**don't delay**!

The workshop is centered around the theme Human Centered Interior Technologies; that's really the primary main focus of the industry. You'll find coverage of relevant topics this week including Toyota's new safety model; Asahi's new way of detecting impaired drivers; Xperi's insights into in-car listening, as well as news about BMW and AirConsole; competition for games, and more. Enjoy!

Sincerely yours,

Philippe Aumont
General Editor, DVN-Interior

In Depth Interior Technology

Infotainment Systems are Still Problematic: JD Power

Excalibur pretend-oldie: dozens of gauges and switches

Tesla 3: just a single screen on a stalk

The current fashion in the automotive industry is to create dashboards dominated by big screens with multilayered hierarchical digital menus and a minimum of physical buttons and knobs. Customers hate this; complaints about infotainment systems once again dominate the gripes from U.S. owners of three-year-old vehicles in J.D. Power's latest survey of vehicle dependability. We could easily expect similar results in the rest of the world, except maybe in China where priorities are different.

The 2023 U.S. Vehicle Dependability Study (VDS), released last month, reports an industry average of 186 problems per 100 (PP100) vehicles, a slight improvement over the 2022 figure of 192. The study examines how 2020-model vehicles are currently performing in terms of quality; component replacement, and 'appeal'. A lower PP100 indicates higher performance.

Mass-market brands fard best at 182 PP100, down from 190 last year and noticeably better than the 205 score of premium brands this year. The gap between the two segments is wider than it's ever been since the first study 34 years ago, and continues a trend that began in 2016. The dependability disparity between the two segments is largely down to new technology being introduced first and in greatest concentration in premium vehicles. More technology means more complexity and greater likelihood of more problems.

The high problem rate with in-car technology suggests OTA updates could play a significant role in correcting issues with in-car systems and keeping the information in them up to date (…but what if the OTA updates are in the group of problem-prone systems?).

The study was redesigned in 2022 to include features and technology. It now covers 184 specific problem areas across nine major vehicle categories: climate; driving assistance; driving experience; features/controls/displays; infotainment; interior; seats; exterior, and powertrain.

The 2023 study, fielded from August through November 2022, is based on responses from 30,062 original owners of 2020-model vehicles after three years of ownership. Here are its key findings

- **Infotainment systems continue to be the most problematic** with an average of 49.9 PP100—up from 45 a year ago, and almost twice as many problems as the next-highest category, which is exterior. Six of the top 10 problem areas in the study are infotainment-related, including voice recognition (7.2 PP100); Android Auto/Apple CarPlay connectivity (5.5); Bluetooth system connectivity (4.0); touchscreen screen usage to use (4.0); not enough power plugs/USB ports (3.8), and navigation system inaccurate/outdated maps (3.3). A year ago, inconsistent audio volume (2.7), was also in that list.
- **Technology improves appeal for parts that seem outdated**: Owners' relationships with their vehicles go beyond wear and tear on parts; it also includes their expectations of how current the technology remains over time. For example, satisfaction scores for vehicle condition improve when vehicles receive software updates to tart up infotainment systems perceived as not up-to-date.
- **Reduction in component replacement**: 63 per cent of vehicles required fewer component replacements in the past 12 months (excluding wear items), including key fobs and their batteries; brake rotors; headlight components/bulbs; and other exterior lights/bulbs, than in the 2022 study—probably largely on strength of the galloping pace at which LEDs are shoving light bulbs off of cars. Nothing significant for Interiors.
- **Driving assistance issues are growing**.Problems with ADAS declined in 2021, but have increased in 2022. The most problematic ADAS system is lane departure warning/lanekeeping assistance, with 4.1 PP100.

If we look at the results brand wise, the Asian brands are still in the leading positions (in the US). L**exus** ranks highest overall in vehicle dependability, with a score of 133 PP100. Other premium brands with high dependability scores include **Genesis** (144); **Cadillac** (173), and **BMW** (184).

Kia (152 PP100) ranked highest in the mass-market segment for a third consecutive year, followed by **Buick** (159); **Chevrolet** (162); **Mitsubishi** (167), and **Toyota** (168).

The parent corporation receiving the most model-level awards is **Toyota** with six—the Lexus NX and RX; Toyota C-HR; Highlander; Sienna, and Tacoma.

BMW and **GM** each receive four segment awards; BMW for their 4 Series; X2; X5 and MINI Cooper, and GM for the Chevrolet Blazer; Silverado HD; and Tahoe, and the GMC Sierra. **Hyundai** received three segment awards for the Kia Forte; Optima, and Sportage.

The analysis shows that vehicle residual values can be significantly affected by long-term quality. JD Power VP and GM of Vehicle Valuations said, "The used-vehicle market has helped sustain dealers' profitability in the past couple of years, but they need to know which vehicles to have on their lots; having vehicles with strong dependability scores will nurture a positive brand perception and drive foot traffic".

Genesis (Hyundai Group) is ranked № 2 as a brand. Let's take a closer look at that; Genesis; Hyundai, and Kia top the JD Power 2022 U.S. Tech Experience Index ("TXI") Study.

GENESIS IMAGE

Based on the responses of 84,165 owners surveyed after 90 days' ownership of new 2022-model vehicles, the U.S. TXI Study analyzed 35 automotive technologies across four categories: convenience; emerging automation; energy and sustainability, and infotainment and connectivity. The study measures how effectively each brand brings technologies to market, measured on a 1,000-point scale.

Genesis ranked first overall and top among premium brands for the second consecutive year. With an Innovation Index score of 643, Genesis secured the № 1 position, finishing more than 50 points above of the second-place brand.

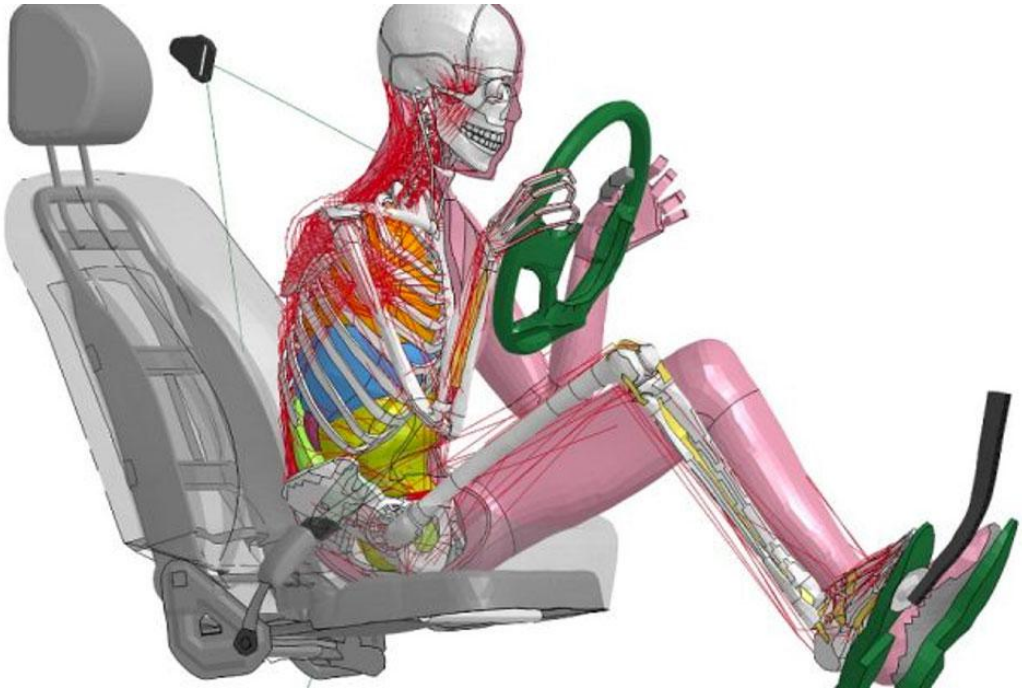
Meanwhile, Hyundai Motor ranked highest among mass-market brands for the third consecutive year, with Kia coming second.

Ricky Lao, Hyundai North Ameria's director of product planning, says, "The key is making these innovative features user-friendly and offering them to a wide range of customers. We also provide extensive customer education at our dealerships to ensure consumers get the best experience with their vehicles".

Interior News

Toyota’s All THuMS

INTERIOR NEWS



TOYOTA IMAGE

Toyota says they have refined their latest crash testing analysis system to model accident scenarios in L^3 cars.

At Level 3, new use cases are possible thanks to (partial) autonomy, such as relaxed occupant position with the seatback reclined to the max, along with other postural changes—any of which can mean significantly different effects in the event of an impact, and different types of injury.

Toyota's THuMS (Total Human Model for Safety), is a software simulator, developed and evolved along with the changes in modern safety systems since 1997, which is said to take account of changes in people’s posture when they use automated driving systems.

The latest Version 7 of THuMS also claims improved modelling of the human bodies—women; men, and children—with more accurate rendering of the geometry and properties of key body parts, including the pelvis; abdominal organs; spine, and ribs. The program can better predict the effects on bones; organs, and muscles when vehicle occupants are in a reclined position, and reproduce how people will change their position and brace muscles when maneuvering a vehicle in an emergency, or when safety systems such as a emergency braking and steering control kick in.

The new capabilities allow greater precision in crash simulations, helping the development of more effective safety provisions. Sabine Compigne, technical manager in Toyota’s R&D safety research operations, says, "Special attention must be paid to ensuring the pelvis remains in the seat at the time of a crash. This is crucial to avoid the ‘submarine effect’ where the occupant slides out from under the lap belt, risking abdominal injuries. Good pelvis retention helps to limit compression on the spine and thus prevent spinal injuries".

Toyota has made THuMS available free of charge, and over 400 users have downloaded the application globally.

Asahi Kasei's Impaired-Driver Detector

INTERIOR NEWS

ASAHI IMAGE

The US Infrastructure Investment and Jobs Act includes incentives for new technology, including the ability to passively detect when drivers are under the influence of alcohol and prevent them driving.

Japanese chemical and electronics company Asahi Kasei acquired Swedish tech company Senseair five years ago. Senseair has been working on alcohol- and gas-detection sensors for other applications for 25 years, and their new mission is to develop a sensor to be seamlessly integrated into vehicles without the need for new cabin hardware.

Drivers would exhale toward a small sensor that could be embedded in the steering column or side door trim, and await a quick pass/fail reading on the alcohol content of their breath—not quite exactly passive, as it still requires the driver to deliberately do a thing (blow toward the sensor) they didn't have to do before.

ALCOHOL DETECTION SENSOR (ASAHI KASEI IMAGE)

It uses an algorithm that detects the amount of ethanol on a driver's breath compared with naturally-occurring carbon dioxide. The sensor measures how much infrared light of a specific wavelength is absorbed by the surrounding air. This measurement is then used to calculate the concentration of ethyl alcohol. No word (yet?) on what if the driver hops in the car after using mouthwash, which usually contains alcohol but is spat out rather than consumed.

Xperi Lets Broadcasters Keep an Eye on In-Car Listeners

INTERIOR NEWS

DTS IMAGE

DTS, an audio, imaging and sensing technology subsidiary of Xperi, has revealed details of their AutoStage Broadcaster Portal, which provides radio broadcasters with access to data on listener engagement—essentially, it lets broadcasters track listeners.

The system is designed to deliver AI-powered connected radio; audio; and video content for over 52 connected-car models. It blends linear broadcasts with IP-delivered content to enable a personalized in-vehicle infotainment solution.

AutoStage enables radio broadcasters to retain editorial control of content while providing a consistent and engaging user experience and providing listener insights and analytics. Via an easy-to-use dashboard, portal users can eyeball how in-car listeners engage with their content.

Available data includes the geographic definition of the audience; popular locations and thoroughfares; program performance, and retailer maps displaying shopping locations in proximity to the station's audience.

"DTS AutoStage Broadcaster Portal is enabling a completely new level of data insights for radio broadcasters to connect with target audiences and power new revenue opportunities with brands and advertisers," said Joe D'Angelo, senior vice president of broadcast and digital audio at Xperi.

BMW, AirConsole Launch Game, 'EX' Competition

INTERIOR NEWS

BMW IMAGE

BMW and AirConsole have launched a competition which invites game developers to create and submit ideas and concepts for games tailored for inside vehicles. The concepts can be submitted via the official competition website, with four winners being chosen after the competition closes on 8 June.

Each winner will be given €5,000 to develop a prototype; if their game shows promise, AirConsole will fund its entire development and feature it on the AirConsole platform. Winners will also be invited to BMW's Munich headquarters to see the games in a real-world application.

BMW Group's VP for entertainment and app development Stefan Butz says, "This competition is a great opportunity for game developers to work with AirConsole to create engaging gaming experiences specifically for vehicles. We want to offer our customers a first-class EX (Entertainment Experience) and gaming is all about joy".

And Antti Makkonen, director of games at AirConsole, says, "As highlighted by the automotive industry at CES, gaming in the car is happening. G ame makers need to start creating games for the car use-case, not just bring games to the car. Using phones as controllers inside the car makes playing accessible and fun for everyone".

The BMW Group chose nDream, the company who created the AirConsole platform, as a partner to bring gaming into vehicles through the BMW Startup Garage program.

Cayenne Heralds New Porsche Driver Experience

INTERIOR NEWS

PORSCHE IMAGE

The new Porsche Cayenne will be first shown on 18 April at the Shanghai Auto Show. Porsche has outlined details of the vehicle's new display and control concept, the Porsche Driver Experience, to deliver new ways for both the driver and the passenger to interact with the fourth-generation Cayenne.

The updated system has a fully digital instrument display; versatile individualization, and intuitive operation for ease of use. For added driver convenience, the most vital controls are located around a new steering wheel, with the automatic gear shifter now situated next to the wheel (a latter-day column shift; there's nothing new under the sun!). That makes room for air conditioning controls on the redesigned center console, which has digital and analog controls, with high-quality touch recognition paired with haptic feedback to provide tactile and aesthetic functionality.

There's a curved, freestanding 12.6" digital instrument cluster without a hood cover, which enhances its slimline appearance.

To elevate the front passenger experience, the Cayenne can also be optioned with a 10.9" passenger-side display, which lets the passenger assist the driver—for example, by operating the navigation system or by selecting media for example (in German, the front passenger is known as the *beifahrer*, co-driver). A special foil is used in production to ensure the driver cannot see the passenger display.

The control center for the interior is the high-resolution, 12.3" PCM (Porsche Communication Management) central display. Occupants can select and change a wide range of driving and comfort functions from here, in addition to using standard online navigation and multimedia functions. The PCM is Apple CarPlay and Android Auto compatible, and enables integrated apps such as Spotify and Apple Music. A new in-car video function enables videos to be watched directly in the PCM via streaming provider Screenhits TV. This is available in the central display when the vehicle is stationary and on the passenger display while driving.

Car Content Creep: High Tech is Elevating Trim Levels

INTERIOR NEWS

GMC IMAGE

Market trends; customer demands, and innovation technology are fostering car content creep, ending up with vehicles positioned above their original target. From a car interior perspective, this is pushing trim levels up, into a luxury vehicle territory.

GMC's strategy exemplifies this shift; it has been pushing up prices and content for that brand's premium trucks and SUVs, a trend which may not yet have peaked. According to GM Financial data provided by GMC to Automotive News, the brand's average transaction price last year was around USD $59,000. It rose to $62,400 in the first quarter of this year.

The introduction of the Denali Ultimate and AT4X lines are a way "to really push the upper echelons of where can we take GMC," a GMC spokesman said.

GMC IMAGE

The Denali Ultimate trim comes with GM's Super Cruise hands-free driver assistant, along with luxury features around infotainment; connectivity, and materials. AT4X offers additional capability, including heated and ventilated 16-way power front seats with massage; Obsidian Rush interior trim featuring full-grain leather seating with technical-grain leather accents and Vanta Ash wood, and a 12-speaker Bose sound system with Centerpoint® surround sound.

This example reflects what is happening with many brands on many markets: formerly non-luxury brands, now loaded with luxury trim and priced at luxury levels!

Average transaction prices across the industry will moderate as production normalizes after years of supply constraints, said Srini Rajagopalan, managing director of data and analytics for J.D. Power, particularly as automakers build more entry-level models and base trim levels. But, he added, automakers also have learned that they don't want to overproduce and have to drop prices.

The issue is getting even bigger with EVs, as positioning and price are higher than combustion-engine cars. So trim level and materials are developed accordingly, ending up with products which are overpriced, reducing the market volume development of EVs.

The Design Lounge

Who Killed the Electric Car?
By Athanassios Tubidis

THE DESIGN LOUNGE

GM EV1 (WIKIMEDIA COMMONS IMAGE)

"*That sucker **goes**! It will take down the [Pacific Coast Highway] so fast that you'll get a ticket! Running with no gasoline!*" This is Tom Hanks in the 2006 American movie, *'Who Killed the Electric Car?'* after his first EV driving experience. How far, how much and how fast, were the main debates since General Motors EV1 hit the roads in the mid 1990s, bringing GM and the entire automotive industry backwards into the future. Nearly 5000 electric cars where designed and manufactured by Chrysler, the Ford Motor Company, General Motors, Honda, Nissan and Toyota and then later destroyed or donated to museums and educational institutions. In the case of GM's EV1, it is stated in the film that never a company was so cannibalistic against its own product, joining even the Federal Government (presidency of George W. Bush) to sue California against its zero-emission vehicle mandate regulation. That was back then.

"*Did you remember to plug in the car before going to bed last night?*"

…this is more likely today's common phrase related to a new domestic concern. Electric cars are a synonym for range anxiety since 1888, however, nowadays when your electric car runs out of electricity you can call a gas-powered tow-truck to come and take you to the charging station. Well...it is a little bit like a vegan that secretly eats meat. Nearly two-thirds (63.3 per cent), of global electricity came from fossil fuels *(2019_ourworldindata.org)*. While our environmental policies along with statistics constantly improve, if your local electricity where you plug in your car is still produced by fossil fuel, you are still part of the problem when you drive an EV, though in most cases an EV powered by fossil-fuel-generated electricity still emits less pollution and greenhouse gas than a vehicle powered directly by petrol.

Between visual journalism and compelling posts with dramatic pictures of people working on oil rigs and children on lithium camps, there is something oddly ironic about electric cars and their fossil-energy agnostic aspect.

In 1885, the Benz motorwagen was the first ever automobile and an amazing achievement. In 1908, the ford Model T was the first-ever mass produced automobile, making cars cheaper and available to ever more vast populations. That was another success that gave birth to a century of technical innovations and social progress depicting automotive mythology as a part of who we are. In 2017, Tesla made electric cars exciting and fast, yet challenged by people who love cars.

The oxymoron has to do with each one's solution being to a certain extent part of the other's problem. Haunted by the ghost of EV1 electric cars and maybe some lack of corporate wisdom, this debate started back then and will remain as one of the greatest contradictions in automotive history: do we still call it gas pedal in electric cars? Welcome to now.

Interior of the Lamborghini Revuelto: "Feel Like a Pilot"

THE DESIGN LOUNGE

The new Lamborghini Revuelto has a plug-in hybrid drivetrain combining the most powerful V-12 engine made by Lamborghini with three electric motors to boost its output to 1,001 hp (1,015 CV).

The Revuelto follows Lamborghini's tradition of getting its name from a Spanish fighting bull; *revuelto* is the Spanish word for "unruly".

The car has a dry weight of 1,772 kg, which is 222 kg more than the Aventador Ultimae. Its weight-to-power ratio is 1.77 kg/hp. Carbon fiber has been widely used to keep its weight low despite the addition of the high-voltage battery.

Its design was inspired by aerospace elements, with sculpted surfaces encompassed by two lines that start from the front and embrace the cabin and engine, tapering down to the hexagonal-shaped exhausts. "We gave adrenaline a shape", said the brand's design chief, Mitja Borkert

The exterior design reflects styling cues from past Lamborghinis, including the 1971 Countach prototype's vertically-opening scissor doors; the Diablo's floating blade on the rear fender, and the Murcielago's inclined front.

Y-shaped lights at the front and rear set a design cue also followed by interior features such as the center console and the top of the dashboard. Infotainment includes a 12.3" digital cockpit plus a 9.1" display on the passenger side. Four rotors on the driving wheel spokes are used for selecting both the driving modes and the car's lifting system and rear wing tilt.

CEO Stephan Winkelmann says the Revuelto will cost about €500,000 (USD $542,165) and is "the beginning of a new era for Lamborghini", adding that the brand's product range—the Huracan sports coupe and the Urus SUV—will be hybridized by the end of 2024.

Lamborghini will launch their first fully-electric car in 2028, with a second model following in 2029. One of them will be an entirely new model, while the other will be the successor of the Urus.

Ferrari's Purosangue SUV Premieres

THE DESIGN LOUNGE

FERRARI'S PUROSANGUE SUV PREMIERES

Ferrari has developed an SUV with four doors; twelve cylinders, and 725 horsepower. Ferrari themselves don't speak of an SUV, but of a "Supercar". The Purosangue's cabin looks and feels like an elegant and sporty lounge. When the doors are opened, a generous amount of space is revealed. The luxury of the interior exudes a sense of both elegance and modernity.

The driver's cockpit is almost exactly mirrored on the passenger side. A 10.2" display provides all the information required to help them participate in the driving experience. The interior architecture is based on the dual cockpit dashboard concept which has been extended and replicated in the back of the car, creating four areas quite distinct in terms of their functionality, volumes, materials and colors. Comfort-related controls are located on a hideaway rotary interface in the central section of the dash, and the rear passengers have access to the same functions via a second rotary interface.

For the first time in Ferrari history, the cabin has four separate and independently adjustable seats. The integration of comfort-focused components, the use of variable density foams, and the new suspension system deliver occupant comfort. The backseats are heated and the front seats feature 10 air bags and deliver a relaxing, targeted massage with a choice of five different types of massage and three levels of intensity. An air quality sensor checks the air outside the car and improves quality in the cabin by smart air recirculation control.

The Burmester 3D High-End Surround Sound System has 23 speakers with 1,420 watts. This audio system delivers high performance from low to high frequencies, achieved by new technologies. The ribbon tweeter makes its first appearance in any production car, and the subwoofer is housed in its own closed cabinet for special bass clarity, power and speed combined with astonishing low frequencies. 3D sound, plus additional pre-sets, offers a high-quality sound experience. Is it worthy for a 12 cylinders background?

Owners can personalize the roof of their car by opting for a full-length electrochromic glass roof instead of the standard carbon-fiber version. The glass is coated on its lower surface with an electro-sensitive film which can change its tint level to either flood the cabin with sunlight or provide shade.

Sustainable materials have been used extensively; 85 per cent of the launch trim for the car was sustainably produced. The fabric rooflining is recycled PE; the carpet is made from recycled PA from fishing nets, and there's

newly-formulated Alcantara—the Purosangue is the first car in the world to use this special version of Alcantara, made of 68 per cent post-consumer recycled polyester. For this version of the material, Alcantara obtained Recycled Claim Standard (RCS) certification from ICEA, a leading international standard that verifies recycled material and tracks it from the source to the final product.

News Mobility

Self-Driving in London with Bill Gates

NEWS MOBILITY

BILL BLOG IMAGE

Microsoft founder Bill Gates got the chance to ride in a Jaguar I-Pace fitted with self-driving technology developed by British company Wayve, and the YouTube **video** of the ride shows the Jag navigating the chaos of London's busy, narrow streets. There are cyclists to avoid; other cars doing u-turns in the road, and all manner of other obstructions.

Writing about the experience on his blog Gatesnotes, Gates says he believes AVs will "change transportation as dramatically as the PC changed office work". Gates is confident that most of the hardware required to automate the world's vehicle fleet has already been developed, and that most of the remaining work revolves around tuning the software. And there is definitely some work left to do; Gates noted that the safety driver alongside him in the driver's seat of the Jaguar EV for the London trip had to assume control on several occasions.

Although he tested the technology in a passenger car, Gates believes passenger vehicles will be the last to be fully automated and will only mass-adopt the technology after trucks, delivery vehicles and taxis.

Wayve has been working since 2017 to bring deep learning and AI to the next generation of autonomous driving. The Wayve-equipped car works its way through traffic by 'learning' as its drives; the claim is that it can go literally anywhere and react to whatever jumps in front of it.

Ford's Next EV Truck Will Self-Drive While You Sleep: CEO

NEWS MOBILITY

FORD F-150 LIGHTNINGS BEING BUILT (FORD IMAGE)

Ford CEO Jim Farley made hopeful statements about self-driving tech and said the automaker's next electric pickup will drive itself.

In a new interview with Bloomberg published last week, Farley said his company's next electric truck, set to debut in 2025, is a breakthrough product: "On the highway on a sunny day, you should be able to go to sleep in your truck or make a call or do whatever you want to do in your truck while it drives for you", Farley said.

The type of system Farley described would be a huge step forward from Ford's top-rated existing driver-assistance feature, BlueCruise, which invites drivers to take their hands off the wheel while it steers, brakes, and accelerates on certain highways, but drivers need to keep their eyes on the road and be ready to take control at any moment.

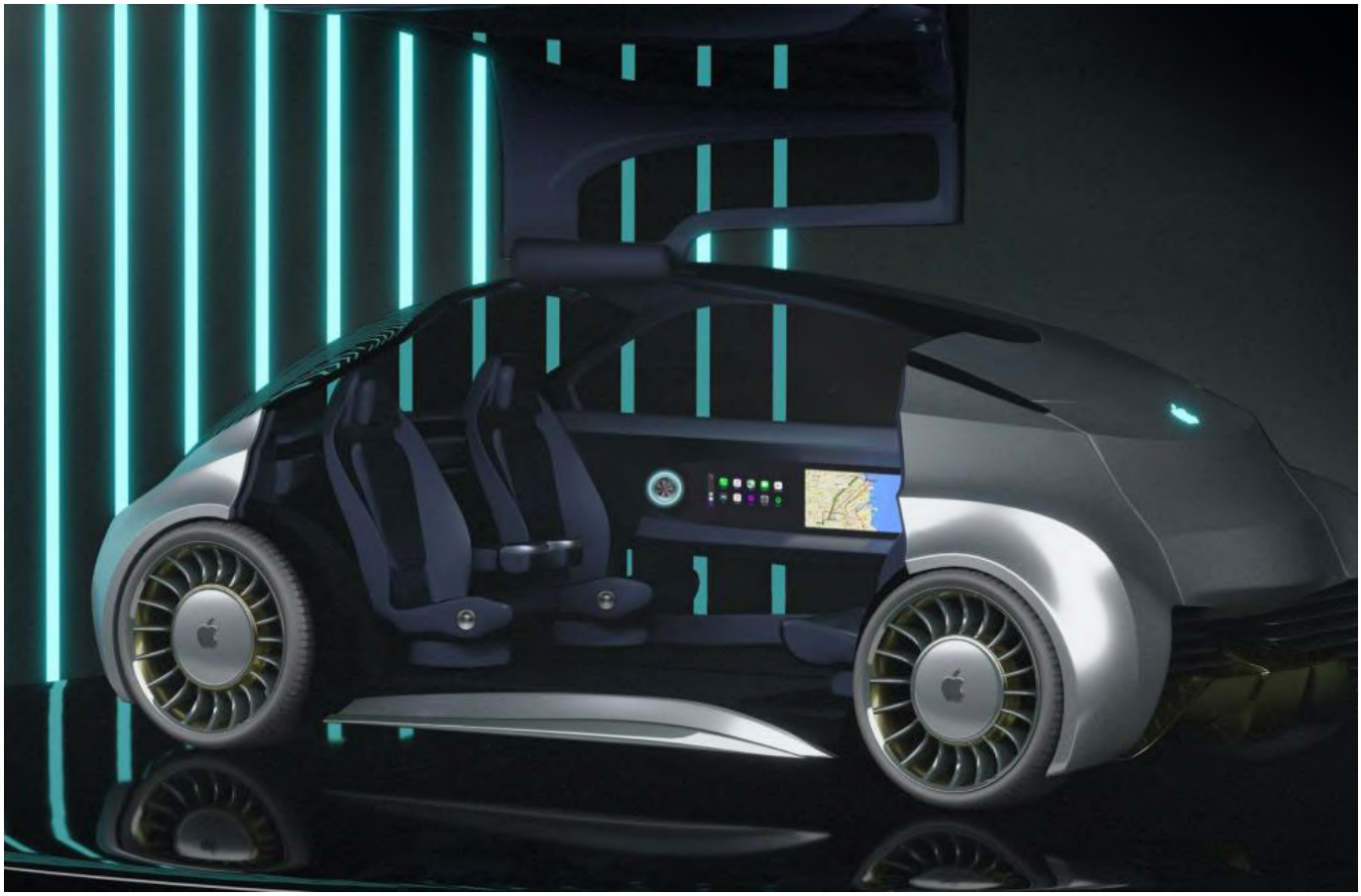
For at least nine years now, Elon Musk has been promising (real) self-driving vehicles "next year"; so far there's none on the horizon from Tesla; their $15,000 'Full Self-Driving' option is an L^2 driver-assistance suite which has consistently fared poorly in tests and is increasingly a target of regulators and watchdogs.

Ford, the №-2 EV seller in the US in 2022, thinks they have better ideas than Tesla, and hopes to surpass Tesla's sales by 2025. "We plan to challenge Tesla and all comers to become the top EV maker in the world," Farley said last April.

General News

Apple’s Steadily Increases Self Driving Prototypes

GENERAL NEWS

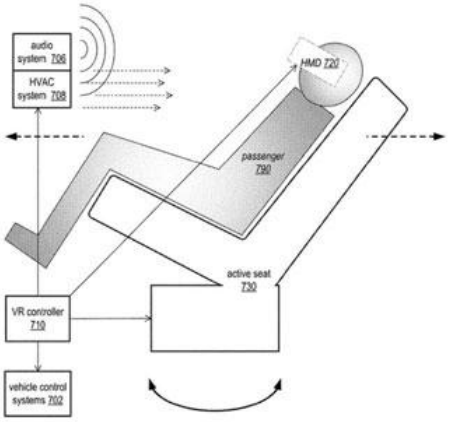


APPLE ICAR DESIGNER DEJAN HRISTOV VIEW (BEHANCE IMAGE)

Rumors about Apple’s entry into the automotive space are still going up and down. Last up was in 2021, when rumors about an Apple-Kia tie-up were popping up. Since then, both Toyota and Porsche have been in the list, but nobody what will be Apple's next step, nor what a possible Apple car might look like.

Experts agree that Apple is continuing ahead with their plans to bring a car to market, and focusing on self-driving tech. According to MacReports, judging by the latest data from the California DMV's AV program, Apple has been steadily increasing the number of drivers for self-driving prototypes—201 of them, now, for Apple's self-driving fleet of 67 cars. In parallel, Tesla has 59 drivers across 14 cars, while Mercedes employs 179 drivers for 55 cars.

Main efforts come from Waymo (971 drivers and 326 cars); Cruise (414 drivers and 709 cars); and Zoox (1021 cars and 167 cars), while Nvidia records a higher driver count at 262 but operates far fewer cars, with just 13.



UNITED STATES PATENT AND TRADEMARK OFFICE IMAGE

Apple registered a patent in 2022, suggesting that they are committed to integration between its car project and new VR technologies. The same filing also details a 4D-like system capable of surround sound audio and motor-powered seat movements, implying that Apple is placing as much emphasis on the physical experience of the driver/passenger as the visual.