Thu, 30 June 2022
Weekly Newsletter

DVN-I
Automotive Interior

NEWSLETTER #118

# Editorial

## DVN-I Think Tank Seminar № 1: HMI, Sustainability

YANFENG XIM18 (YANFENG IMAGE)

The first DVN-Interior Think Tank Seminar will be held this Autumn. The idea is to have a small, closely interactive group of experts—not just listening to lectures, as interesting and informative as that is. We'll get into great discussions on topics of general interest to the whole community. We'll talk and listen with each other on how to build a more advanced common perspective on hot automotive interior topics.

Last week's in-depth article on polyurethane confirmed the huge challenges we face with sustainability, especially for the interior community making decisions about the part of the car where the greatest amount of plastic material is used. This week's in-depth article confirms the growing importance of remote software updates to open new income streams for the industry. They will also influence how occupants interact with their vehicles, and how designers and engineers will define HMI.

That's why the Think Tank Seminar will focus on these two topics, HMI and sustainability. We are tentatively planning it for 29 November in Köln, Germany. We'll keep you informed as we develop the event. How does the idea strike you? What would you like to discuss and do at the event? Please **send us your thoughts**.

Sincerely yours,

Philippe Aumont
*General Editor, DVN-Interior*

# In Depth Interior Technology

## HMI, OS and OTA Activated Services


IP.NET IMAGE

It's very expensive to travel the inevitable road toward electrification and autonomous driving, so automakers are looking to monetize every possible aspect of the interaction between humans and vehicles. They're getting into offering subscription-based services—news, weather, and traffic advisories, yes, but also car features and functionalities, with capable hardware built into the car but dormant until activated, wirelessly, for as long as the vehicle 'owner' keeps paying money.

Increasing numbers of vehicle recall campaigns involve software one way or another—not surprising, given the steady rise in the amount of software/firmware used in vehicles. OTA (over-the-air) software updates greatly streamline recalls and customer-satisfaction adjustments: instead of having to make time and book an appointment at a dealership garage. OTA updates also allow for functional upgrades and activation of new features (with ongoing payment, of course), without having to add new hardware or other accessories to the vehicle.

A study published earlier this year by Gartner states *as digital technology makes the difference in cars, software is becoming the main driver of profit growth for car manufacturers*. Gartner predicts that by 2025, five of the top 10 car manufacturers will develop their own chips and establish direct, long-term working relationships with chip makers. Tech giants, such as Amazon; Apple; Google; Alibaba; Tencent, and the others will integrate the car into their ecosystem. Gartner predicts that 70 per cent of vehicles sold will use the Android Automotive operating system by 2028. Now: will automakers develop technology and software in-house with extensive internal resources, or partner with the big tech corporations to make software a major revenue generator?

Open data will be the model. The data itself will no longer be central to the business model, which will hinge on building or integrating ecosystems to allow access to a wider variety of data to develop more attractive features or digital services.

Automakers are expanding their OTA programs as important digital sales channels. Many makers have updated the hardware in the vehicles to allow software updates, and are now moving to a revenue model based on services. Gartner analysts predict that by 2023, half of the top 10 automakers will offer unlocks and feature upgrades through software updates that can be purchased after the vehicle is sold.

All of this means that HMI and OTA services are the two sides of the same coin. Tesla is the first example of what this looks like.

## Tesla HMI and Business Model

STACK TABLETS IMAGE

When the Tela Model S launched in 2012, one of its most unusual features was the tablet-style central touchscreen that dominates the dashboard. This controls all in-cabin features and has a clean, iconic interface that echoed the design of Apple's iOS. It was presented as far more advanced than any other infotainment system, immediately helping the Tesla stand out. Tesla's on-board software was, at first, sold in a similar manner to many other automakers: customers would configure the exact software options they wanted when purchasing the car, increasing the purchase price with each new function added. However, the company has developed a new way to monetize this system by offering customers the option to subscribe to additional services in the future. Specifically, Tesla offers their most advanced $L^2$ driver assistance package, the so-called 'Full Self-Driving', as a subscription that can be added after purchase. It uses the car's existing processors and cameras, and allows the car to drive itself with human supervision on certain surface streets. This is available as a USD $10,000 option; as a $99/month charge for cars with 'Enhanced Autopilot', or as a $199/month charge for cars with basic 'Autopilot'.

Hot on the heels of Tesla is fellow US EV startup Rivian. The electric pickup and SUV company began delivering vehicles to customers shortly ago, and they're already prediction earnings of up to $15,500 per vehicle over ten years' time, just through software subscription services: $10,000 for subscription to autonomous features, and $5,500 for infotainment; connectivity, and diagnostic features. General Motors and others also have stated intent to offer autonomous functions on a subscription basis.

## BMW 3: new cockpit tech

The 2023 BMW 3-Series features a newly designed cockpit with a curved screen, which pairs a 12.3" information display behind the steering wheel and a 14.9" center control display. The car features BMW's iDrive 8 infotainment system with a new OS: BMW Operating System 8 processes twice the number of information signals and 20 times more data volume than before.

Competition within the luxury EV markets will continue to be on features and brand, and the luxury ecosystem will contribute increasingly to the success of the maker's business model. OTA and mobility-related services will be the money maker of the future.

## Porsche: Updated infotainment system with new software

PORSCHE IMAGE

Porsche has announced a revised infotainment system that will be available immediately as standard equipment in all 911; Taycan; Cayenne, and Panamera models. Porsche Communication Management is now entering software version 6.0 in some models, visually recognizable by the new colored icons and slimmer menu structure that the company developed at the suggestion of their customers. The entire interface has been refreshed and the scope of the Voice Pilot function has been improved. Messages, operating instructions and music streaming are now said to be more easily accessible.

Probably the most important innovation here is the integration of Android Auto wireless connectivity. It opens a new business environment, with additional revenue stream. Users only need to log in with their account, like a Spotify account. There is no need for a smartphone connection, as all the necessary data is included in Porsche Connect. The integrated application offers all the functions of the app, including the Like function; saved playlists, and the new Go to Radio option.

For EVs, the Charge Planner app has been improved and uses better algorithms so customers can plan their journeys more efficiently. When calculating the total driving time, the Charge Planner now also takes into account the time needed to start and finish charging at the charging station. And Porsche is manging the ecosystem around EVs and charging.

## Tencent, Desay SV Linkup for Smart Cabin Platform


TENCENT IMAGE

As a leader in China’s smart cockpit field, Desay SV is one of the few tier-1 companies with mass- production capabilities for cockpit domain controllers. The partnership with Tencent enables the two companies to integrate Tencent’s smart cabin products into Desay SV’s business ecosystem and distribute them synchronously. The

products include applications such as Tencent's popular online karaoke platform "Quanmin K Ge". Meanwhile, Tencent Smart Transportation will build a comprehensive support system for sales and marketing services, helping Desay SV through the full pre-sales, sales, and after-sales life cycle. Tencent therefore plans to use the power of the ecosystem to reach more clients and deploy their products onto more platforms.

## Minieye, Blackberry QNX co-develop smart vehicle technologies


Chinese intelligent driving solution provider Minieye announced a partnership with Blackberry QNX to jointly develop intelligent vehicle solutions. Founded in 2013, Minieye's mission is to provide reliable sensing solutions for vehicles.

The partnership means Minieye now becomes a member of Blackberry QNX's Channel Partner Program, which is Blackberry's way to add value and integrate the mobility safety and embedded software market. It addresses the whole value chain, with a program of global value-adding integrators; distributors, and dealers, providing integration service for program members. Building on Blackberry QNX's embedded technologies, the program helps partners design and develop safe key task solutions, and eventually accelerate products' time to market. The pact will allow Minieye to use key Blackberry technologies, including QNX Neutrino real-time operation system; QNX Momentics toolkit; QNX virtual machine manager; applications; media QNX SDK, and more.

## Blackberry, BICV develop smart cockpit for Renault–Jiangling EV

Blackberry and BDStar Intelligent & Connected Vehicle Technology (BICV) co-developed the next-generation intelligent cockpit in the Yi, which is the first electric sedan from the Renault-Jiangling JMEV joint venture.

JMEV IMAGE

Blackberry's QNX Neutrino Realtime Operating System (RTOS) and QNX Hypervisor provide an engaging and immersive driving experience, with a safe, secure, and reliable software foundation.

The Yi features a futuristic design with advanced intelligence; safety, and driving experience. Its smart cockpit is equipped with a dual-linked screen; full LCD dashboard, and spacious central console. The cockpit enables various functions, including in-vehicle infotainment, ADAS, voice and gesture recognition, and HUD. European exports are planned, including use by the Renault Group's subscription-based mobility unit, Mobilize, as the go-to

vehicle for taxis, online ride-hailing, private vehicle hires, and more—that's another type of business model, behind this new operating software.

## Cocos Launches Fully Featured HMI

Open-source game engine developer Cocos has released Cocos HMI, a smart cockpit solution made up of four distinct elements: an in-vehicle human-machine interface (HMI); automatic assisted driving visualization capabilities; an in-vehicle avatar, and in-vehicle games.

Based on the Cocos 3D real-time rendering engine, this smart cockpit solution is claimed to be suitable for mainstream car systems such as Android, Linux, and QNX. It incorporates a variety of features. For example, the HMI uses real-time 3D rendering capabilities provided by the Cocos engine to render instruments and a vehicle's central display. It also allows for the visualization of automated and assisted driving functions, such as displaying perception and map data in an integrated fashion.

Furthermore, the HMI can render car avatars without using excessive computing power. Cocos states that it can help manufacturers build in-vehicle game centers, with game content linked to the hardware capabilities of the cockpit. Gaming is another by-product business model.

## How much drivers would spend on digital services?


VW IMAGE

German drivers predominantly want to use digital services in their vehicles and spend extra money on them. According to a survey by the consulting agency Bearing Point, 87 per cent of respondents expressed a general interest in downloading paid-for additional software, such as for navigation, driver assistance or entertainment. On average, Germans said they would spend up to €210 per year on this kind of OTA service. The survey came up with higher figures in China (94 per cent; €300) and the U.S: (99.5 per cent; €350).

In order to participate in these sales, car manufacturers are investing a lot of money in their software departments. VW with their Cariad subsidiary; Mercedes-Benz with their new software hub, and BMW are considered the leaders in OTA updates among traditional manufacturers. Still, they're experiencing difficulty catching up to Tesla on this front.

Major suppliers such as Bosch; Continental, and ZF are also developing software products and cloud systems. They serve automakers by providing platforms and systems that can be integrated quickly. And now, semiconductor manufacturers are increasingly entering the space—like Intel; Nvidia, and Qualcomm, who have accumulated software expertise in the automotive sector over the years.

In addition, Alphabet and Apple are entering the industry as new competitors. Android Auto (Alphabet) is the standard for Volvo and Polestar infotainment. Apple has so far provided only software that helps to better integrate the iPhone into the functions of the head unit. At the beginning of June, Apple announced an in-depth version of Apple Carplay: for the first time, the system is to become visible and shape the impression in areas like the speed display or the temperature setting. It is to be available in the first models from 2023.

# Interior News

## TomTom IndiGO + Kanzi One = UX Innovation

INTERIOR NEWS

RIGHTWARE IMAGE

In new generation of digital cockpit, automakers are striving to control the on-screen visuals, to align them to their brand and to offer proprietary applications tailored for their customers. Off-the-shelf operating systems such as Android, migrated from mobile phones to the automotive space, offer a broad network of services and functions—but the industry needs simple ways to integrate third-party apps and services into a seamless multi-screen user experience. Rightware, based in Helsinki, Finland, work to help automakers transform the digital cockpit into an intelligent cockpit and deliver a signature UI true to the automaker's brand.

Rightware spent the last several years developing their Kanzi toolchain to solve the HMI development challenges specific to Android. The release of Kanzi One introduced the automotive industry's first all-in-one HMI tool, providing uniquely deep integration with Android and streamlining the process of bringing high-quality 3D graphics into the user interface. At the same time, TomTom identified a market need for an open; scaleable; modular; customizable digital cockpit platform for simple delivery of third-party services into the Android Automotive environment. They've met this need with TomTom IndiGO.

Based on their shared goals of accelerating HMI design and development and enabling automotive innovation; creativity, and design, TomTom chose Rightware as their HMI/UI tool launch partner.

The unique combination of the TomTom IndiGO digital cockpit open platform with Kanzi One forms a powerful and flexible UI framework enabling carmakers to implement brand-defining graphical user interfaces across all the screens of the modern intelligent cockpit.

This partnership between Rightware and TomTom opens opportunities for automakers to create brand-aligned intuitive user interfaces; to compose seamless consumer apps and services across displays; to integrate advanced functions such as virtual assistants and AI, and ultimately to create a truly compelling automotive user experience.

# JLR Brings What3words Geocoding Technology

INTERIOR NEWS


WHAT3WORDS IMAGE

Jaguar Land Rover says they're the first automaker to integrate What3words global location technology into vehicles already on the road through an OTA update. What3words is a proprietary geocode system designed to identify any location with a resolution of about 3 meters. It is owned by **What3words Ltd**, based in London, England.

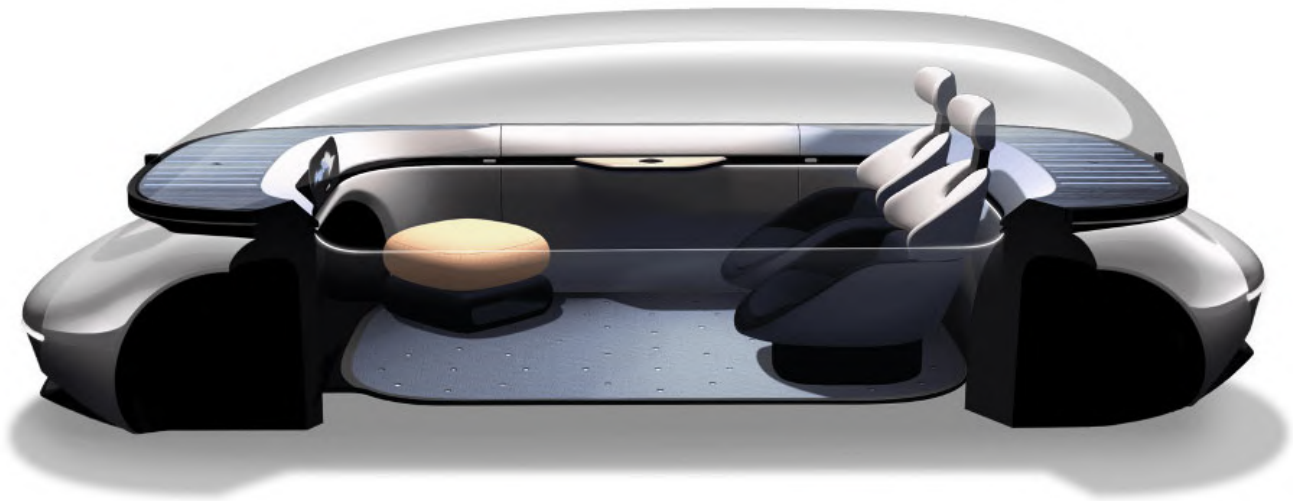
What3words has divided the globe into a grid of 3 × 3-meter squares, and given each one a unique combination of three words. Through the always-on technology, which works without the need for mobile connectivity, new and existing customers will be able to navigate to any precise location in the world using just three words. For example, *petty.modern.match* is right in the middle of what DVN-I can affirm is a very good Italian restaurant.

This is part of the latest OTA upgrade offered to customers this year, following the previous update which gave 200,000 owners of existing vehicles access to Amazon Alexa. In total, JLR has completed 1.3 million vehicle level updates and three million engine control unit updates as part of their always-on, always-connected capability.

Once updated, the system allows customers to input what3words addresses directly into the navigation bar on the Pivi Pro Infotainment system. The integration has been delivered by navigation supplier Here Technologies. Integrated what3words is available in all new and existing vehicles fitted with the Pivi Pro infotainment system.

# Asahi Kasei Concept Car for Sustainability

INTERIOR NEWS



ASAHI KASEI IMAGE

Asahi Kasei, headquartered in Tokyo, is a multinational Japanese chemical company. Their main products are chemicals and materials science.

In honor of their 100$^{th}$ anniversary, the company released the new AKXY2 concept car, which is claimed to reimagine how values for sustainability, satisfaction and society will influence the needs of future mobility on the road to automation and electrification.

From textiles to elastomers, materials that can contribute to a lower carbon footprint are integrated into the vehicle. The interior surfaces are covered by Dinamica, a premium microfiber suede partially made of recycled polyester. The vehicle seats are cushioned by Cubit, a 3D mesh material made of PET and partially bio-based PTT. The S-SBR tires, made from bio-based butadiene, offer low rolling resistance to improve fuel and energy efficiency and reduce the generation of microplastics.

According to the company, one of the AKXY2's major themes revolve around senses—from the smell of the cabin and the feel of the textiles to the soundproof atmosphere and futuristic looks. To address evolving safety needs beyond crashes, elements from Asahi Kasei's Healthy Car Portfolio are implemented, including antimicrobial fabrics to protect the automotive interior from the spread of pathogens. Furthermore, a sensor monitors $CO_2$ levels in the cabin to maintain optimal air quality while reducing energy usage and monitoring the cabin for children or pets left behind. In addition, semi-transparent and backlit fabrics, as well as plastic optical fibers, allow for customized ambient lighting inside the vehicle, while sustainable textiles and foams equip seats with a new level of comfort.

# Von Holzhausen, Unplugged Partner for Vegan Leather Interiors

INTERIOR NEWS

VON HOLZHAUSEN IMAGES

Von Holzhausen is a team of material innovators on a mission to replace all the animal leather in the world with non-animal leather. This material Innovation approach targets to transforming discarded materials into remarkable ones. Vicky von Holzhausen left her auto design career in 2014, to create her own company. Now they are starting to sell new interiors for Tesla cars through a partnership with Unplugged Performance (UP), a longtime Tesla tuner and aftermarket part company, to bring aftermarket luxury interiors to Tesla vehicles.

Von Holzhausen's work has led to the creation of Bamboo Leather, a vegan leather that is buttery-soft like lambskin; scratch-stain-water resistant; lightweight, and made from the most renewable raw material on earth. It will be available for all Tesla models.

The custom interiors are handmade of Bamboo Leather with 83 per cent plant-based content and 33 per cent lower carbon footprint than cow hides. It weighs just one-third what cow leather weighs, which helps with vehicle efficiency.

Features include an engraved VH × UP metal brand plaque and unique patterns, textures, and materials as specified and designed by the buyer.

# BMW X1 Has Big Interior, Curved Display, and More

INTERIOR NEWS

BMW IMAGES

The new X1  brings advances for the interior including extra space for those on board and their luggage, and a fundamental upgrade of the display and control/operation system. The new BMW iDrive vehicle experience based on BMW Operating System 8 represents a reimagining of the driver-centered cockpit design to focus on touch and voice control - via the BMW Curved Display and the BMW Intelligent Personal Assistant. The large implementation of digitalization enables the number of physical buttons, controls and switches required for intuitive operation to be significantly reduced. Key features include the elegant instrument panel, which serves as a stage for the BMW Curved Display, and a "floating" armrest with integral control panel.

The BMW Curved Display has a frameless glass surface angled slightly towards the driver. Below it, the slim instrument panel accentuates the width of the interior with its big horizontal decorative surfacing. Five interior trim strip variants are possible, including the new open-pore eucalyptus wood and Aluminum Hexacube. Slim air vents ensure an even distribution of fresh air around the interior. The side air vents are integrated into the A-pillars.

The standard BMW Live Cockpit Plus includes the cloud-based navigation system BMW Maps and an audio system with six speakers and amplifier output of 100 watts. The optional Harman Kardon Sound System raises the number of speakers to 12 and the amplifier output to 205 watts. Its tweeters are integrated into the door trim under stainless steel covers.

The rear compartment of the new BMW X1 includes three full-sized seats with comfort similar to front seats, with backrest angle adjustment.

The car is fitted with an interaction airbag deployed between the driver and front passenger in the event of a side-on impact and with an active bonnet to improve pedestrian protection. Pyrotechnic actuators raise the bonnet if the vehicle collides with a pedestrian, creating more deformation space between the bonnet and the hard underlying structures.

Existing functions can be improved by OTA update, which also lets customers add new functions, such as the Steering and Lane Control Assistant.

The engaging user experience starts before the driver has reached the vehicle thanks to a newly devised welcome scenario. It starts with an orchestrated lighting effect using the exterior and interior lights, including the light carpet in the entrance area. The vehicle then automatically unlocks when the driver is about 1.5 m away. And as they get into the car, the BMW Curved Display plays a choreographed start-up animation and shows a customized welcome window for the driver with a personal greeting as well as handy suggestions and information. In addition to this, the BMW ID settings are loaded and the smartphone connected.

BMW IconicSounds electric treats customers to soundscapes. If desired, an emotionally rich drive sound developing a transparent timbre with spherical components delivers authentic feedback to every movement of the accelerator. The character of the sound alters according to the vehicle setting chosen with the My Modes button. A likewise brand-typical drive sound emitted externally at low speeds helps to protect pedestrians acoustically by making them aware that the car is approaching.

# Jidu Robo-1: Baidu-Driven Geely Vehicle

INTERIOR NEWS

Baidu, China's rough equivalent of Google, is showing their ambitions in the car industry. Jidu, an automotive company they recently created together with Geely, unveiled a prototype of their first vehicle. It's a futuristic, largely autonomous hatchback called the Robo-1. The company says it will cost at least the equivalent of USD $30,000, and is expected to go on sale next year.

BAIDU IMAGES

A sparse interior includes racing-style seats; a steering yoke, and a widescreen display that covers the entire dash. The vehicle bristles with sensors, including lidar that pops up from the hood when activated, for mapping the road ahead in 3D. Jidu says the final model of the Robo-1 will be 90 per cent the same as the one shown in Beijing.

Baidu is essentially betting that the growing importance of software in vehicles—especially AI, in which Baidu has invested heavily over the past decade—gives it an opportunity to stand in this industry.

Geely has a successful track record of manufacturing electric cars with Polestar, a subsidiary of Volvo, as well as several Chinese brands.

Jidu decided to design and build cars, rather than just sell the software to other carmakers, because of the importance of integrating software and hardware—a philosophy long proven in the smartphone space. Jidu will also make extensive use of voice control, another AI technology Baidu has spent years developing and perfecting in products like smart speakers.

# The Design Lounge

## DVN-I Coffee Corner

THE DESIGN LOUNGE

1954 MASERATI A6GCS/53 BERLINETTA (PENINSULA CLASSICS IMAGE)


The digital cockpit is an all-digital, software-defined, in-vehicle dashboard system that incorporates instrument clusters, infotainment, navigation, ADAS, proactive AI, comfort controls and more, using multi-modal interfaces, in one platform. By their very nature, digital cockpit platforms are flexible and scalable, turning market disruption into opportunities. Thus, new vocabulary takes over every single square centimeter of the vehicle cockpit. Curiously, though, to this day, no one really knows how the word ‘cockpit’ came about. Apparently, there are three competing theories:

The first one refers to cock (bird) fighting. The buildings in London where the king's cabinet was were called the "Cockpit" because they were built on the site of a theater called The Cockpit (torn down in 1635), which itself was built in the place where a cock-fighting site had once stood. Thus, the word *cockpit* came to mean a control center!

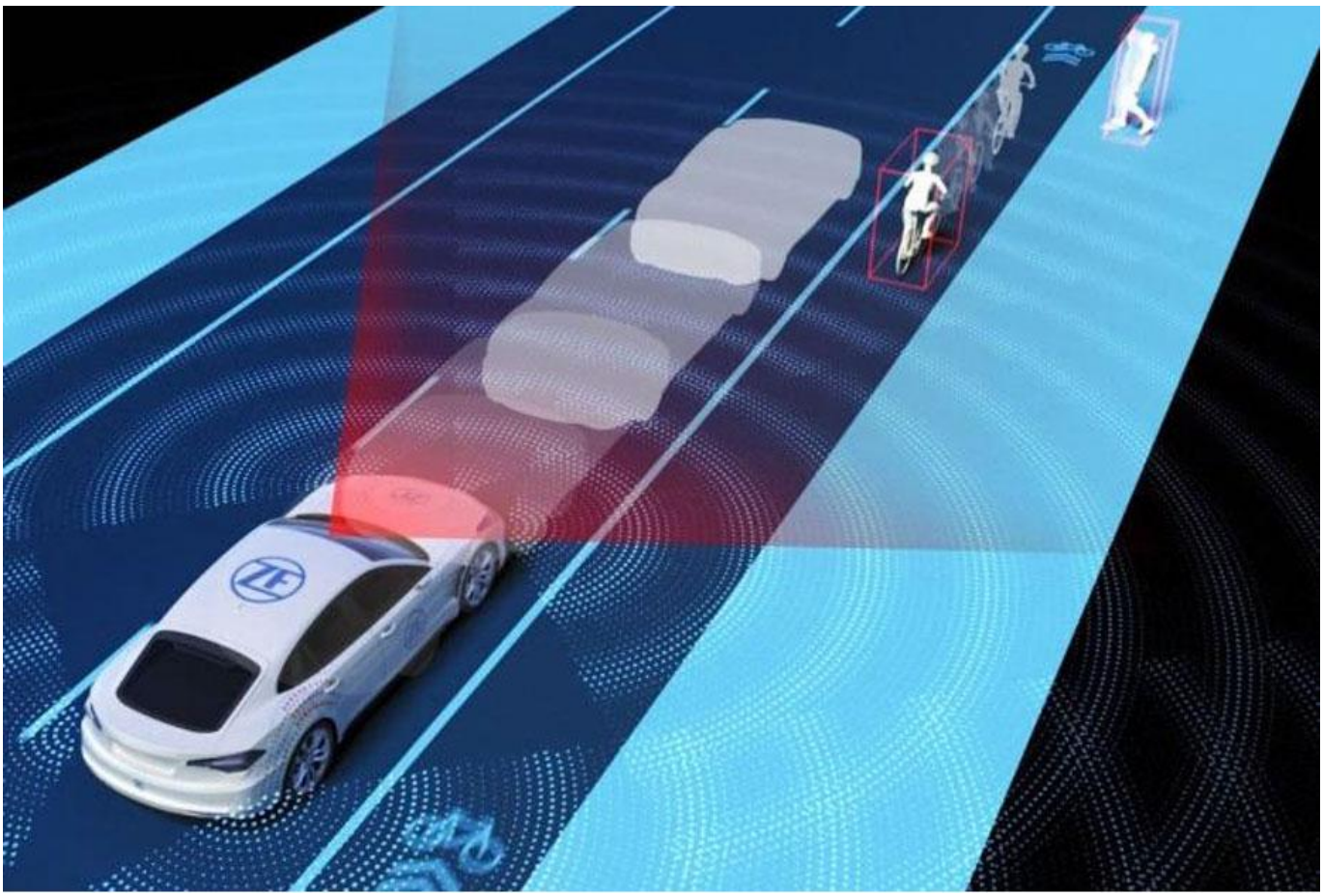
The second theory relates to a nautical term in the 17$^{th}$ century, defining an area in the rear of a ship where the coxswain’s (= "boat-servant") station was located. Coque is the French word for "shell", and swain was old English for boy or servant. The same term later came to designate the place from which a sailing vessel is steered, because it is also located in the rear, and is often in a well or *pit*.

The third idea has soldiers of the 1700s using “cockpit” as a metaphor for the site of grisly combat, especially when the fighting was in an enclosed area. The word was adopted by WWI pilots to describe the cramped operating quarters of their fighter planes. It is, after all, a small pit where plenty of fighting takes place. Land-, sea-, and air-related definitions, then. In the last two decades or so, aviation manuals have replaced the term ‘cockpit’ by ‘flight deck’, to avoid association with impolite definitions of the word *cock*. Could 'drive deck' be in our future…?

# News Mobility

## AI-Based Situational Interpretation for Autonomous Driving

NEWS MOBILITY



ZF IMAGE

ZF; Technical University Dortmund, and Inggreen are researching predictions of critical traffic situations for autonomous systems. In this way, the Kissaf research project creates a prerequisite for highly automated $L^{3+}$.

In the Kissaf project for AI-based situation interpretation for automated driving, ZF is conducting research together with the Technical University of Dortmund and the development service provider Inggreen to predict critical traffic situations as precisely as possible with the help of artificial intelligence. In $L^3$ systems, the human driver must be able to take control of the automated vehicle within 10 seconds. The traffic situations that may occur during this time must be predicted as accurately as possible using artificial intelligence. The traffic situations that may arise during this time must in turn be handled by the autonomous system. To enable autonomous vehicles to drive predictively in the future, an AI is trained using machine learning methods.

First, the automated vehicles must be able to record and analyze their environment as accurately as possible. This includes road conditions, traffic signs, vehicle speed, and the positions and speeds of other road users. The data collected must also be processed in such a way that it can be interpreted by an artificial intelligence. This can then model possible situation progressions from the description of the environment and assess the scenarios according to probability. Based on this assessment, the vehicle can adjust its own driving behavior at an early stage.

# General News

## Sony, Honda Partner for Electric Mobility and Services

GENERAL NEWS

SONY VISION-S 02 (SONY IMAGE)

Sony and Honda are examining a strategic alliance with the aim of coöperating in the fields of electric mobility and mobility services. The intent also includes building and selling electric cars in a new joint venture to be launched as an independent entity before the end of this year, provided regulatory approvals are granted.

HONDA E (HONDA IMAGE)

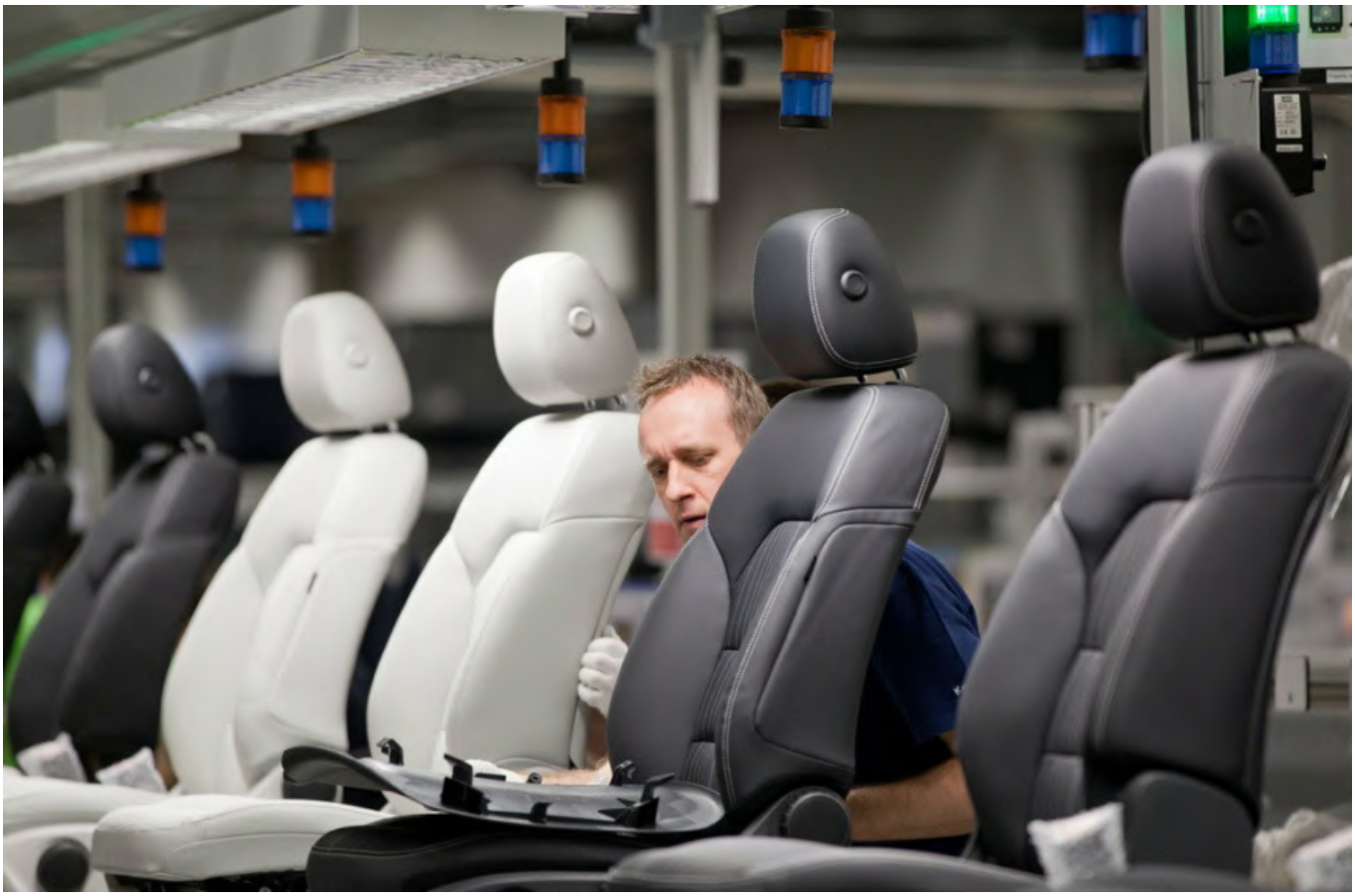
The aim of this alliance is to bring together Honda's expertise in mobility development; body engineering, and after-sales service management with Sony's experience in the development and application of imaging, sensor, telecommunications, network and entertainment technologies. This is expected to result in new, continually-evolving mobility applications and services closely aligned with users and the environment.

The first jointly-developed electric car is to be launched as early as 2025. Honda will handle production of the car; Sony is developing the corresponding mobility platform in parallel.

This past January, Sony presented their second electric car study at CES in Las Vegas and announced serious intent to enter the EV market. Whether the first joint electric car will actually be the production version of the Sony Vision-S 02 has not been clarified; Sony had support from Magna; Benteler; Bosch, and ZF in building that concept car.

# JIT Being Reconsidered: Report

GENERAL NEWS



ADIENT BEGINS PRODUCING CAR SEATS AT NEW FACILITY IN KECSKEMÉT, HUNGARY

The auto industry is having a sober second thought about the widespread use of JIT (just-in-time) parts logistics—a terrific system when there are no bottlenecks and parts are consistently available, but it's breaking down and causing problems amidst today's supply shortages and disruptions—the most fragile supply chains since the start of the century, according to a new report.

In-sequence JIT was conceived in the 1980s to manage bulky, diverse components like dashboards, front-end assemblies, seats, wheels, glass, and other suchlike—the idea is to get each component from the end of its own assembly line to the right part of the right car's assembly line just before that component is needed, to minimize the space and time (both of which cost money) in which components are stored.

The Achilles Supply Chain Resilience Index (ASCRI) report for the first quarter of 2022 indicates the resilience of global supply chains has fallen to 39.8—the first time the figure has fallen below its 40-point high-risk threshold, with further declines expected. With the semiconductor shortage dragging on; disruption caused by Russia's war on Ukraine, and China's Covid lockdowns, automotive manufacturing one of the industries most exposed to supply chain risks.

The restriction of workers' movements in China has led to many automakers such as the VW Group to stop production at plants in China, for example, not long after the semiconductor shortage prompted them to stop manufacturing at other Chinese and German factories last year.

The Achilles Supply Chain Resilience Index (ASCRI) is a time series index measuring changes in supply chain risk by country across six categories: economic; environmental; labor practices; legal and governance; resilience, and safety and security. Each country's score is derived by combining the scores of suppliers based in the country with that country's overall performance in those six categories. This framework is then supplemented by a range of global measures, including shipping and sentiment data. The Q2 Report uses data from January to March 2022.