



DVN SHANGHAI WORKSHOP

19 - 21 April 2021

High Tech Lighting :  
impact on Safety, Regulation and Styling

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## Editorial

# Job Enrichment By Research: Keeping Your Engineering Innovative

*Editorial by Wolfgang Huhn, DVN Senior Advisor*

Over the years and months, DVN has reported several times about the activity of GTB Strategy Working Group. This WG sponsors research about high-level innovative lighting functions to collect knowledge about the influence on traffic safety on a worldwide base. Such public knowledge is fundamental for the development of future technical regulations for road projections, communication devices, super low headlamps, and CO<sub>2</sub> reduction.

But how does the industry bring smaller innovations into real traffic? We don't talk about game-changing new systems, but visible new functions inside the country-specific regulations.

One company with a significant scientific knowledge about the market introduction of lighting innovations is Audi. My first visit as a DVN Senior Consultant leads me back to Audi to talk with the lighting team's researchers about how they introduce something totally new in a responsible way. The team around Michael Hamm consists of fresh young Ph.D. Holders, Ph.D. Students, Bachelor and Master students. This team of researchers involves the employees of the whole lighting department and enriches the jobs of the engineers, software developers and project managers with a little bit of research work. No doubt, this is motivating and interesting beside the daily work. Audi use resources and infrastructure to ensure by publishing research that their innovations are neither glaring nor distracting but improve traffic safety. The results you can see every day on the road.

Some days ago, DVN and Osram Continental held a new kind of session: "OC x DVN @ Clubhouse–Transformation of Automotive Lighting" with about 25 listeners. Clubhouse is a new fancy invitation-only audio social media app for Apple iOS devices (Android in preparation). Overall it was a very nice first experience. More to come; we'll keep you updated.

A handwritten signature in blue ink that reads "Wolfgang Heilmann". The signature is written in a cursive, flowing style.

DVN SENIOR CONSULTANT

# In Depth Lighting Technology

## Interview: Audi's Lighting Research Team



Wolfgang Huhn caught up in Ingolstadt with Michael Hamm, Jonas Kobbert, Tilman Armbruster, Johannes Reschke, and Christian Hinterwalder, all working in the lighting engineering department at Audi. Each answer in this interview is a summary of the discussion of each question with the whole team. The discussion was in a meeting room together with a MS Teams connection to a part of the group who worked from home.

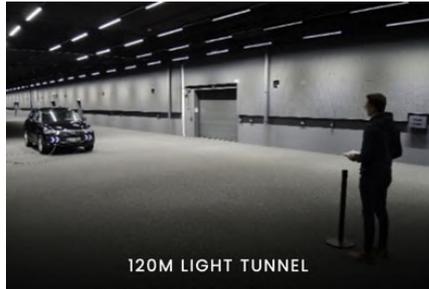


### DVN: What is the intention for a car company's lighting research?

**Audi Team:** Audi push lighting innovation to increase traffic safety. Research must be carried out to prove the benefit of an innovation and to exclude unwanted side effects. The necessary environment for reproducible and stabile results is available 24/7 in really fantastic quality.

Resources available to lighting researchers includes:

- the 120-metre light tunnel;
- the test track with a high-speed oval, several handling courses, and a huge circular flat area;
- the Driving Experience Centre at Neuburg, and
- public city roads, country roads, and the motorway close by.



## **DVN: How come Audi don't shop out studies like this to research institutes?**

**Audi:** For really basic questions, like the headlamp performance rating system, we go to internationally accepted lighting research institutes. Research Coöperation within national or EU projects also run together with external institutes. This is of course much more time and money consuming than in-house research work.

Our own projects are fast. They're done exactly when necessary, not when capacity is available somewhere in the world—a big advantage in timing by using research capability available in house. Another reason for in-house projects is the necessity to work with secret prototypes which must not leave the Audi area.



AUDI TEAM

## **DVN: Who is planning the evaluations and test set ups? Who is carrying out the research work?**

**Audi:** Our young Ph.D. holderst and students come from reputable institutes like TU Darmstadt, KIT Karlsruhe, Delft, Illmenau, Augsburg, and Regensburg. They instruct and advise students and employees. They carry out the research projects exactly like they have learned in their university institutes.

## **DVN: What about test persons?**

**Audi:** Test persons are another key factor in case of human factors research. We use different pools of test persons, like paid persons from commercial institutes, pools of students, unpaid sports (or other) club members who take part because it's exciting,

friends, relatives, and in case of public tests we ask passerby pedestrians to spend some minutes with us. Online studies are also done; they can attract over a thousand participants. In case of tests with secret prototypes, employees outside the lighting department are invited to the light tunnel or test track to serve as test persons.

### **DVN: Are the results public or closed? How do you publish the research results? Are the results neutral and independent?**

**Audi:** All Ph.D. theses done in the Audi lighting department are public. All other research work results are in 80% of the cases public also. Only a minor part of about 20% is closed, mainly because the results are not in the public interest. Publications by Audi researchers can be divided into 3 groups:

- Peer-reviewed Journals like "Advanced Optical Technologies", ATZ worldwide, and SAE papers;
- Public events (congresses) with publicly accessible documentation (published with an ISBN, for example) like ISAL, OLED summit, LOPEC, VDI optical Technologies, ALE Shanghai (WeChat publication), IFAL Shanghai (WeChat publication), automotive electronic congresses, and books like Handbook FAS;
- Semi-public events (congresses and workshops) with documentation for members and participants only like the Vision Congress and DVN events.

An official bibliography with references is mandatory if the research results will be used by authorities or NGOs for lighting regulation development.

### **DVN: What else would you have us know?**

**Audi:** Fields of Audi lighting research are communication (projections, symbol displays, signalling lamps) and traffic safety (glare, glare control, distraction, guidance and support by lighting functions, performance ratings).

**DVN: Thank you all for this exciting afternoon. Audi lighting's mindset seems to be strongly influenced by the integration of the whole department into the research activities of a group of young science professionals.**

# Lighting News

## MEMS scanner design improves ADB

LIGHTING NEWS



(A) CONVENTIONAL ZONAL SHIELDING THAT EXCESSIVELY MASKS A ROAD SIGN AND A PEDESTRIAN.  
(B) SPOT SHIELDING FOR ONCOMING AND LEADING VEHICLES.

A project at the University of Tokyo has now developed a new ADB system built around a MEMS optical scanner, which might provide a more versatile platform.

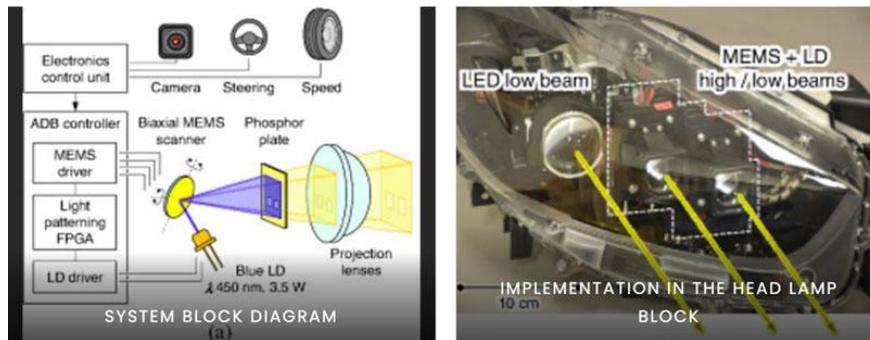
The work was published in the [Journal of Optical Microsystems](#).

"We have developed a MEMS two-dimensional optical scanner to produce various illumination patterns from a phosphor luminescent material, which are projected forward through the imaging lenses," commented the project.

The system's design involves attaching a thin lead-zirconate-titanate oxide (PZT) film to a silicon-on-insulator wafer, creating a structure which can then piezoelectrically excite the mechanical oscillation of a scanning mirror in controlled ways.

In use, the oscillations of the mirror are used to direct light from a 450nm - 3.5W blue laser diode onto the phosphor luminescent material in various illumination patterns, with the white light generated from the phosphor then being directed outwards

through suitable lenses. The Tokyo team arranged the actuation in its ADB architecture so as to allow for large-angle horizontal and vertical deflections of the scanner, which enables two-dimensional scanning of the headlight beam, and also designed the modes of the mechanism so that it did not react to low-frequency noise, such as that arising from other vehicles.



The ADB system was incorporated into an assembled headlight block and mounted onto the right-hand side of a vehicle. As proof of concept, two MEMS-ADB modules to cover high- and low-areas of illumination were employed, although a single MEMS module capable of both would be the ultimate goal. A camera and image recognition function were installed to interpret the road conditions and adjust the ADB accordingly.

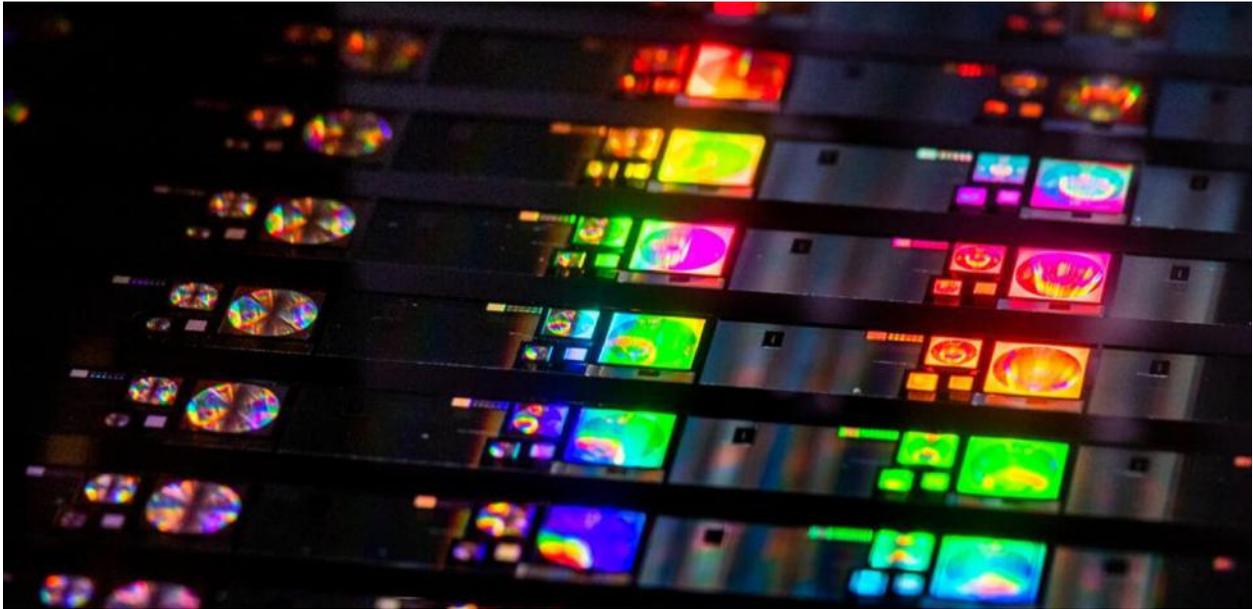
The researchers found that the system provided the driver with better visibility, especially when it came to seeing pedestrians. It could visualize a pedestrian standing next to an oncoming vehicle while modulating the light to avoid dazzling the other driver.

"While this technology certainly advances drive-assist technology, it also has other potential applications in light detection and range finding, as well as inter-vehicle optical communication links," noted the project.

"The system could find use in self-driving technology of intelligent traffic systems in the future."

# Startup Prints 10,000 Lenses at a time on Silicon Wafers

## LIGHTING NEWS



A new startup out of Harvard Labs has invented a way to print camera lenses 10,000 at a time just like computer chips in the same semiconductor foundries that make chips for computers and phones.

They're 100X thinner than standard smartphone camera lenses and simpler and cheaper to make. Plus, they capture the full electromagnetic spectrum, not just visible light, and have excellent 3D-sensing capabilities that could bring Lidar-based dimensional sensing functionality to all phones.

Currently, that's only available on high-end phones like Apple's iPhone 12.

The company is Metalenz. The potential of its technology is a major game changer in multiple industries, not just smartphones, and the Harvard Labs startup has just raised \$10 million from Intel, 3M, and venture capital firms.

*"if you look at it the way that they make lenses, they're injection molded lenses, ground and polished, and they're pretty much done in a sort of pick and place, one by one manner,"* co-founder Rob Devlin said. *"Even though we're making billions of cameras for smartphones, it's still a relatively old and slow process."*

Traditional lenses have multiple components. Metalenz' product uses a flat one-component construction that uses tiny nanostructures 1000 times smaller than a human hair to focus light. In fact, the company says that it can adjust exactly how it focuses light, making the camera lenses suitable for a wide range of uses. Ultimately, it's thinner, lighter, and far less complex, says the company, adding there's huge cost savings. Production efficiencies of moving to a single flat lens from a complex four-piece construction save about 20% right up front. Even more can be saved in assembly, because the camera modules in modern smartphones are complex, multi-stage systems. In some cases, that could result in close to a 50% overall cost savings, Devlin says, though not in all. Printing lenses like CPUs at semiconductor fabs means that Metalenz can scale production at an unheard of pace: from one to five million per day.

The company has an exclusive worldwide patent on the technology through Harvard University's Office of Technology Development.

# Custom Holographics from Ceres

## LIGHTING NEWS



Ceres Holographics, in St. Andrews, Scotland, are a developer of holographic optical elements for displays. They've formed a partnership with Covestro for the production of volume holograms.

Ceres will use Covestro's Bayfol HX photopolymer films for transparent automotive displays, to create specialty solutions with customised HOEs (holographic optical elements) designed to enable a new generation of transparent displays for passenger and commercial vehicles.

Bayfol HX film is a transparent thin film featuring a light-sensitive, self-developing photopolymer. It can be used for line-of-sight applications in vehicles. Ceres holographic transparent display technology has already been successfully demonstrated in prototypes, enabling full-colour display of information on front, side and rear car windows.

Covestro's Yuen-Ling Lok says "Ceres have been testing how to harness the unique properties of our Bayfol HX film for holographic transparent display applications for years, and has produced outstanding results".

Ceres CEO Andy Travers says "Our digitally-mastered HOEs feature full colour and a wide vision field, yielding precision-engineered optical performance and functionality in windscreens and windows at prices that the market demands".

# Audi e-tron GT to Challenge Tesla Model S

LIGHTING NEWS



Audi's E-tron GT demonstrates that electric mobility is becoming dynamic and fascinating. The front and rear lights are characteristic elements that anchor and enhance the expressive exterior design. The LED light signatures at the front and rear feature pronounced three-dimensional modelling.



The DRLs provide a striking light signature, set off by blue designer trim on the optional laser high beam booster placed in the centre of the headlamp for the first time from Audi.



A sculptural light strip spans the entire vehicle at the rear, changing dynamically from a line in the centre into ever larger segments toward the outside, which makes the car appear even more powerful.

As in November, DVN replaces full-length auto show reports—not possible at this time with the shows closed on account of the pandemic—by a quarterly report to be published next week, presenting the lighting features of vehicles launched in the last four months.

# BMW iX Has Super-Slim Front, Rear Lights

LIGHTING NEWS



BMW's Vision iNEXT concept is now becoming the BMW iX.



The slimmest headlamps ever on a series-produced BMW provide a fresh, minimalist take on BMW's familiar four-eyed face. The white LED daytime running lights, which also light in amber for the turn signal function, have a new design as two-dimensional strips along the upper edge of the headlamp units; they fit neatly into the imposing design of the car. This gives the front lamps a totally new appearance in daylight.



The single-piece rear lamps are set neatly into the tailgate, which sweeps a long way into the car's quarter panels. Like the headlamps, the rear lamps have a slimmer design than on any previous series-produced BMW Group vehicle. All light functions use LED technology.

The light fixtures are integrated directly into the three-dimensional lens cover mouldings, creating a strong, bold appearance. The L shape familiar from other BMW

models is present here within the single light strip housing both the tail and stop lamps, and also comprising the horizontal turn indicators, which only become visible when active.

# Acura MDX: Great Improvement of Lighting performance

LIGHTING NEWS



The 2022 Acura MDX glitters with new lights and lamps.



The new MDX has a new version of Acura's "JewelEye" headlamps with four paired lighting cells per side, each with a low- and high-beam LED. They give better performance compared to the ones on the previous MDX; the low beams provide 3 per cent longer reach and 35 per cent wider coverage, while the new high beams give 8 per cent more seeing distance and 25 per cent wider coverage.



New "Chicane" taillights are shaped to enhance the vehicle's premium bona fides. Their 3-dimensional design is defined by an eye-catching light-blade. It's a work of light sculpture offering depth shape, and brilliance while complementing the car's pronounced rear fender forms.

# How Headlamps Inspired Renault 5 Design

LIGHTING NEWS



The facial expression of the new 5 is rooted in Renault's heritage. Everybody knows remembers the mischievous and mutinous look of the original 5, that quickly became an anchor point of the car's cult following.



The new Renault 5 prototype unveiled last month displays the immediately recognisable genes of its vintage classic ancestor. It's a deliberate reinterpretation of the R5 and its projection into the future, to make it a modern object. The final version, meticulously worked and chiseled, evokes laughing eyes. The DRLs are rounded-corner squares in the bumper fascia, reminiscent of the accessory fog lamps of the old

car's day. They fit into a bumper in body colour, just as on the old car. A **5** callout in etched light, visible side-on, adds flair and panache.

Finally, ultra-modern processes have taken over to reinvent the iconic look of the R5. Notably the LED matrix technology that allows the integration of movement by programming animations to bring the headlights to life. This is illustrated with the welcome sequence. The car's new logo lights up and triggers an animation that extends into the front grille. Then the headlights come to life as if the car blinks. Impossible to miss this wink!

Thanks to the matrix technology and animations in the welcome sequence, Renault were able to reimagine the expressive, mischievous look of the original car.

# ZKW: New offices in the Czech Republic and China

LIGHTING NEWS



OLIVER SCHUBERT, CEO OF THE ZKW GROUP

The 10 international locations of ZKW are to be expanded by a new development office in Olomouc (Olomouc) in the Czech Republic and a sales and development office in Shanghai at the beginning of May.

Despite the pandemic, sales of more than €1 billion were achieved in 2020. Oliver Schubert, CEO of the ZKW Group, commented on the turnover achieved in the past year, saying that production was "continuously maintained thanks to great organizational effort and enormous flexibility".

According to ZKW, the new branch in the Czech Republic will support the global engineering network and take on additional development tasks in addition to the existing capacities in Austria. At the beginning 50 new jobs are to be created, by 2023 more than 100 skilled workers will be employed. The new sales and development office in Shanghai will support the existing location in Dalian.

Olomouc, which is home to the second oldest university in the Czech Republic and also has its own lighting technology department, offers a good basis for the professional basis of new employees. Besides, the greater area of the city in Moravia has a long tradition in the development and manufacture of automobile headlights.

The new sales and development office in Shanghai, China, is "a strategic decision to be closer to our customers such as SGM and Volvo", explained Schubert.

At the end of 2020, ZKW had received funding of €150m from the European Investment Bank (EIB). The group intends to use the funds to further expand its innovation activities. In addition, investments are to be made in sustainable production and green development - for example in energy-efficient systems in the Slovakian plant in Krušovce.

"In any case, the order books are well filled for the next three years. ZKW expects a new sales record for 2022, said Schubert." We are delighted with the highest order backlog in the company's history. "

# Hella Confirm Mid-Term Growth, Profit Targets

LIGHTING NEWS



Hella are sticking to their medium-term targets despite the increasingly challenging market environment. The company confirmed this during their virtual Capital Markets Day last week.

Specifically, the company expect to achieve an annual sales growth of five to 10 per cent and a profitability level (adjusted EBIT) of at least eight per cent in the next few years. They will continue to invest heavily in future themes such as electromobility, autonomous driving, digital light and software. At the same time, the company's competitiveness will be strengthened further through digitalisation, automation and structural adjustments. With these strategic guidelines, Hella consider themselves well equipped to continue to outperform the market in the future and to further expand their own position.

"Despite the many challenges in the industry in general, our strategy is and remains intact. We have a solid, sustainable business model. Our attractive product portfolio is the basis for our aim to continue outperforming the market", said Hella CEO Dr. Rolf Breidenbach, in his strategic outlook.

Accordingly, the main driver of sales growth is good strategic alignment along key automotive market trends. In recent months, Hella have started series production for numerous key automotive technologies, including 77-GHz radar sensors, battery electronics for high- and low-voltage applications, steering electronics, and SSL100 lighting technology, and have acquired numerous large-volume orders. Hella also have further strengthened their good position in China's largest-in-the-world car market via new partnerships and by expanding business activities with local automotive manufacturers.

Hella also provided an outlook for future market developments. According to this

forecast, global vehicle production is currently recovering somewhat faster than expected. Nevertheless, even in 2025, the global market volume is forecast to remain significantly below the planning assumptions made before the beginning of the pandemic.

# Driver Assistance News

## Panasonic's AR-HUD for Cars

### DRIVER ASSISTANCE NEWS



Panasonic Automotive have a new AR-HUD (augmented reality head-up display), unveiled at this year's virtual CES. It uses artificial intelligence technology and a cockpit domain controller to render near- and far-field content for features such as object and pedestrian detection, mapping and routing guidance, and vehicle information such as speed.

The AR-HUD projects 3D information in the driver's line of sight to reduce distraction and increase awareness of potential hazards in the road. Using image positioning, the AR-HUD features reflection, a smart optical graphic road overlay for object/sign detection; intuition to focus on what is ahead on the road; a UX-optimised field of view that displays objects along the road; and mission control, bringing dynamic imaging visibility and the roadway together.

Other features include eye-tracking to project information based on the driver's eye position, advanced optics for a virtual image distance of 10 metres, multicolour 3D graphics that adjust to the moving vehicle, real-time situational awareness that provides driver assistance likewise in real time, 3D imaging radar for sensor-captured 180° forward vision up to 90 metres ahead and across three traffic lanes.

# Long-Range Lidar is AV Evolution Key: Continental

DRIVER ASSISTANCE NEWS



Continental aren't planning to start producing their long-range lidar device until 2024, but they're already calling it the final piece of the AV navigation system puzzle. Their Vice President and Lidar director Gunnar Juergens says "We believe lidar has a full place in the sensor fleet for higher automation of vehicles". The long-range lidar sensor Continental and their partner AEye are developing can see signs and overpasses up to 1,000 metres away. Vehicles can be detected from 300 metres, and objects on the road at about 160 m.

Continental call their new sensor the HRL 131 Micro-Electro-Mechanical Scanning Lidar. It's meant for L<sup>3</sup> and L<sup>4</sup> AVs, which need to see and understand objects farther away.

The company's short-range lidar is called the HFL110; it's a solid-state, 3D, high-resolution flash unit meant for L<sup>2+</sup> and L<sup>3</sup> AVs.



GUNNAR JUERGENS, VERY ACTIVE IN THE DVN LIDAR CONFERENCES

Last October, Continental made a minority investment in AEye and said at the time the mission was to "industrialise and commercialise this technology for automated driving on SAE levels 3 or higher" and that Continental and AEye would focus on both passenger and commercial vehicles.

All lidar sensors offer some intrinsic benefits, including point cloud and intensity data and resolution at range. But Continental and AEye say the HRL 131's longer range, high resolution with wide field of view, instantaneous resolution, and configurable software make it a fundamental piece of an L<sup>4</sup> AV's sensor system. It also is small enough and requires low enough power that it can be installed into several places in the car, including the grille, the windshield, or the roof.

# Velodyne Sign Pact With ThorDrive

## DRIVER ASSISTANCE NEWS



Velodyne have entered a five-year sales agreement to provide Ultra Puck sensors to ThorDrive, an autonomous technology company. ThorDrive are using Velodyne's lidar sensors to power cargo and baggage ground support tractors in a groundbreaking autonomous vehicle program at the Cincinnati / Northern Kentucky International Airport.

ThorDrive AVs, equipped with multiple Velodyne Ultra Puck sensors, were developed live in complex, safety-critical environments at the airport's gates. Their proof of concept aims to advance airport safety and cargo efficiencies, with units to be sold by the end of this year. ThorDrive's solution allows airlines to autonomously transport baggage and cargo to and from planes and throughout facilities at any time, day or night. Safe, effective materials transit is crucial to airlines for the protection and handling of goods while maintaining tight flight schedules.

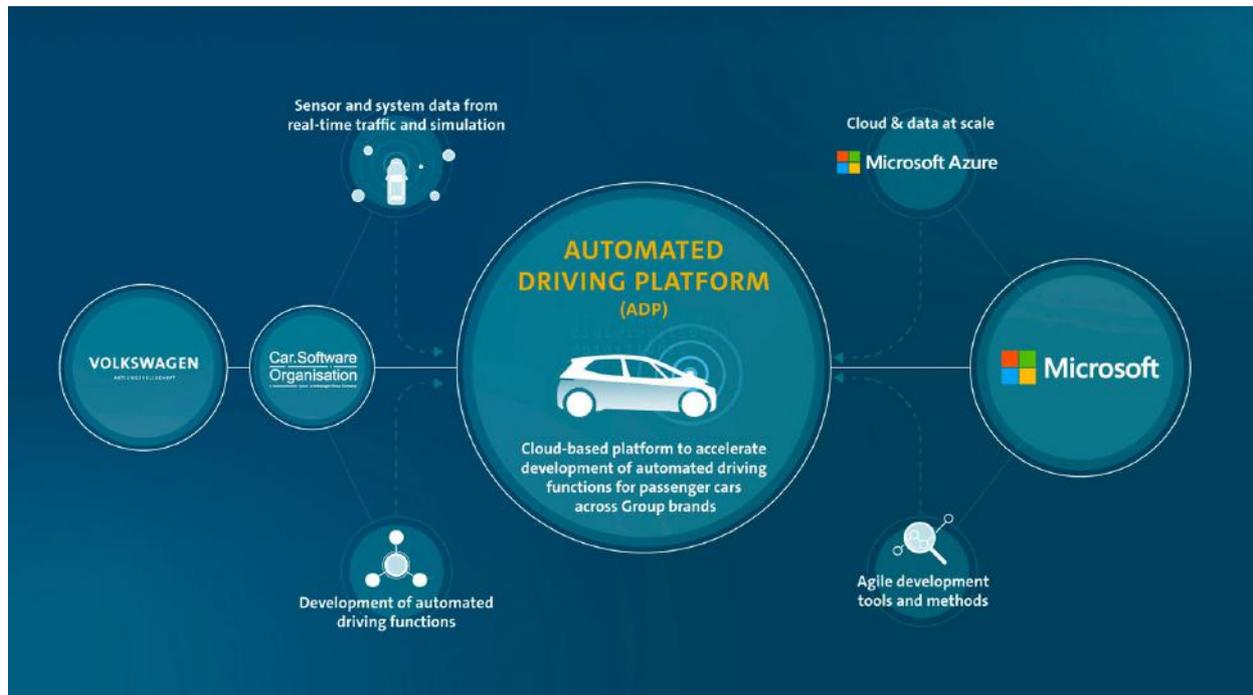
ThorDrive chose Ultra Puck because the sensor's 3D surround view technology provides real-time object detection for safe, efficient navigation and dependable operation. Equipped with Velodyne's lidar solutions, ThorDrive AVs use existing infrastructure and can operate in harsh weather conditions including rain, snow, and ice. ThorDrive have been using Velodyne lidar sensors since 2010, and are planning to expand their AV solutions further into the aviation ground support equipment market as well as to industrial and manufacturing applications.

*ThorDrive are a full-stack developer of autonomous driving technology for the aviation, industrial and tier 1 automotive markets. With operations in South Korea and headquarters in Cincinnati, Ohio, they have developed autonomous solutions for the safe and efficient movement of materials, cargo, baggage and people since 2016.*

# General News

## VW: Strengthening of Partnership with Microsoft

### GENERAL NEWS



### VW AND MICROSOFT TO ACCELERATE DEVELOPMENT OF AV SOLUTIONS

Initially signed to develop a cloud platform for connected vehicles, this partnership now includes the development of an Automated Driving Platform (ADP). Machine learning algorithms embedded in vehicles are trained upstream via real and simulated kilometers. To do so, very large amounts of data are processed daily, whether it be the condition of the road, the weather forecast, obstacle detection, the condition of the driver. The goal is to bring all this data together and use the computing power of Microsoft Azure to shorten the development cycle of ADAS.

"By combining our broad expertise in the development of connected driving solutions and Microsoft's know-how in cloud and software, we will be able to accelerate the deployment of safe and comfortable mobility services", says Dirk Hilgenberg, CEO of the division Car.Software. Going in this direction, Volkswagen has created the Car.Software unit, which is in charge of software development for vehicles, digital ecosystems and customer-centric functions to be sold by all of the group's brands.

The automaker has announced that it wants to invest nearly €27b in digitization by 2025 and increase the share of internal development of software for vehicles from 10% to 60%. A first software platform has already been developed with the help of Microsoft. Called "VW.OS", it allows in particular the exchange of data between vehicles and the cloud, and should eventually equip all vehicles produced by the group.

The strengthening of this partnership affects AV. Car manufacturers are realizing the need for them to enter into such alliances with partners who have the necessary calculation and storage capacities.

Microsoft has also just signed a partnership with Cruise and GM to help them deploy autonomous vehicles on a large scale.

Ford, meanwhile, recently announced its alliance with Google to accelerate its digital transformation and equip its vehicles with Android Auto.