

DVN Munich Report

2025 February 19-20



Table of Content

Introduction.....	4
About the authors	6
Executive Summary.....	8
The Keynotes	12
Marelli	12
Roland Berger.....	13
Forvia Hella.....	14
S&P Global Mobility	16
Valeo.....	18
Session : DEVELOPMENT OF NEW WAY OF WORKING – SIMULATION, AI, SW INTEGRATION, VALIDATION, FUNCTION DEVELOPMENT.....	20
Dassault Systèmes:	20
Synopsys & Dassault Systèmes.....	21
FORVIA HELLA	22
EDAG Engineering.....	23
ASAP	24
Volvo Car Corporation.....	25
OPmobility	26
Ansys.....	27
Audi	28
BMW Group	29
Capgemini Engineering.....	30
Session : Innovative technology – Light source	31
Lite-ON	31
Refond	32
LG Innotek	33
Session : 2W, trucks, small volume, Premium & Sport cars	34
BMW Group	34
Wipac.....	35
HSL Italia	36
J.W. Speaker	37
Bentley.....	38
Hero MotoCorp	39
Automobili Lamborghini.....	40
L.E.S.S	41
Session : EE.....	42
Magna.....	42
Marelli	43
Continental.....	44
Robert Bosch	45
ams OSRAM Group	46
Onsemi	47
STMicroelectronics	48
Infineon Technologies	49
Melexis	50
Inova Semiconductors.....	51

Session : Innovative Technology Start-Ups & New Player	52
Muth Lighting	52
Reichle Technologiezentrum	53
Niebling	53
BrightView Technologies	54
INEVO GmbH	54
CTM-do GmgH.....	55
Murata Electronics	55
OLEDWorks	56
MD Group	56
Fraunhofer Institute.....	57
Session : ADB & Projection	58
ams-Osram Group	58
Nichia.....	59
Lumileds	60
Maradin.....	61
Infineon Technologies	62
Mercedes-Benz.....	63
Odelo	64
BMW	65
Session Innovative Technology-Design	66
Hascovision	66
Audi	67
Liaowang	69
Mind.....	70
Polestar.....	71
Appotronics.....	72
Sony	73
OP Mobility	74
Nio	75
Session : sustainability	77
Volvo.....	78
ams OSRAM Group	79
Llink Technologies Inc.....	80
ZKW Group.....	81
Renault	82
Session : sustainability	83
A2MAC1	83
RISE Research Institutes of Sweden	84
SABIC.....	84
Covestro	85
Capgemini Engineering.....	86
SAATI SpA.....	86
Pictures of the 2025 DVN Munich Workshop	87
Exhibitors Innovations	93
List of main DVN Monthly Reports.....	119
DVN ecosystem and scientific community	120

Introduction

19 / 20
FEB. 2025
MUNICH



DVN MUNICH WORKSHOP

SOCIAL COCKTAIL • MEET & GREET DINNER • CONFERENCE • EXPO

34TH DVN
WORKSHOP

NEXT CHALLENGES :
SUSTAINABILITY, DEVELOPMENT
SPEED ACCELERATION AND SW

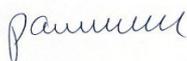


We are pleased to publish, just after 10 days, our detailed report about Munich event. We tried to cover the different challenges our automotive lighting supply chain is facing :

- Transformation due to EV & SDV shift, pushed by new comer from California and China, coming from Tech industry (Tesla, Rivian, Xiaomi, Huawei) and meanwhile by the tech new possibility including high power compute (Qualcomm, Nvidia) and AI. What was a dream is becoming reality, much faster than our industry was expecting, and ready to accept. No training, no learning curve, you are in the bath like a baby who need to learn swimming if he wants to survive.

- Transformation due to new technologies (MEMS, display, compute optics, laser) and new regulations that offers new possibilities (projection and intelligent lighting) and new constraints (Cybersecurity management and software update management, needed for V2X communication, especially needed for ADAS L2++ and L3 features). Because cars is now open an external Cloud (AWS etc ...), legal framework is needed and totally changed the way to develop and certify cars. CS and SUMS round table was very informative about this concern and will be covered in a dedicated reports next month.
- Transformation due to CO2 footprint reduction need. this is now coming in reality. From ideas we see concrete things. Supply chain is starting to be organized with a lot of initiatives well cover during the long sustainability session. This could totally change our way of development. As said by Valeo, 80% of the CO2 footprint is defined during the design phase. 3 years of design and 7 years of production for a classical vehicle. That is to say that what we design now is valid for 10 years. If we want to change something in 2035, it is now in 2025 that we have to think about

Sincerely yours,



Paul-Henri Matha
DVN Chief Executive Officer and Lighting General Editor

About the authors



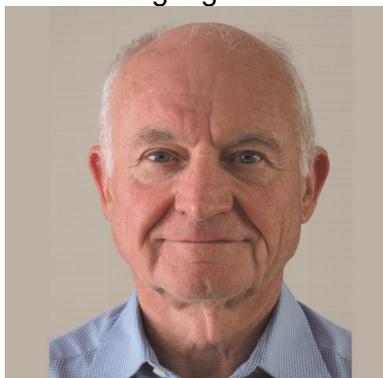
Paul Henri Matha

Graduated from Ecole des Mines Saint Etienne in 2000. 18 years' experience in Renault France in the lighting department, from project leader position to lighting expert. 5 years' experience in Volvo cars Sweden as exterior lighting, technical leader. Member of SAE lighting expert group. Former Member of GTB, chairman of working Group installation and co-chair of working group Strategy. President of SIA VISION Congress. Member of IFAL organization committee. Member of ISAL organization committee. Paul Henri joined DVN in August 2023 and has been appointed CEO in august 2024.



Wolfgang Huhn

From 1987 to 2000, Wolfgang Huhn worked at BMW as head of lighting development then as Head of Production Planning Electrics / Electronics. In 1999, he got the PHD at TU Darmstadt. From 2001 to 2005 in Audi AG, Dr.Huhn was Head of Development Lighting and Switches. From 2006 until the beginning of 2021, he was Head of Development Lighting and Vision Systems at Audi. Wolfgang acts now as DVN Senior Advisor and he is still GTB Strategy WG Chairman. Dr Huhn is one of the foremost worldwide experts in automotive lighting and has greatly influenced the evolution of lighting technologies.



Jean Paul Ravier

Jean-Paul Ravier graduated from ISAE SUPAERO and IAE Paris. He worked for over 41 years at Valeo, including 29 years at Valeo Lighting where he held a variety of management positions first in IT and finance, and then in R & D, projects, and innovation, including in Japan from 2005 to 2009 at Ichikoh as a board member and managing director. He retired from Valeo in 2013. Shortly thereafter he was appointed chair of the ELS program (Embedded Lighting Systems) for Advanced Master training and Research in Lighting at the Institut d'Optique Graduate School, ESTACA and Strate School of design. He held that position through the end of 2017 and is now Senior Advisor for DVN.



Hans Joachim Schwabe

Hans, a graduate in electronic engineering and business administration, has over 30 years of experience in the lighting industry. He began his career as a strategic consultant at Siemens before joining Osram in 1991 as a Senior Product Manager in vehicle lighting. Between 1997 and 2001, he held various managerial roles, progressing through R&D, product management, and sales in industrial lighting. From 2002 to 2005, he served as Managing Director of Osram Taiwan. He later managed the global Display Optic business unit in Berlin, overseeing plant operations and sales. In 2009, he merged Osram's vehicle lighting and display optic units into the Specialty Lighting Unit and was appointed CEO. In 2018, he focused on leading the vehicle lighting business as CEO, also supervising the joint venture with Continental. In 2023, he transitioned from Osram to pursue executive and strategic consulting in lighting.



Franco Marcori

Franco, an electronic engineering graduate (1996), has over 20 years in vehicle lighting, progressing from optical engineering to technical and managerial roles. He served as Technical Director at CRP (2012), focusing on opto-electronics research. Previously, he managed regulatory tasks for rear lamps at CUNA and GTB, later consulting for both. From 2016 to 2022, he led Operations and R&D at Gewiss, specializing in industrial lighting. Returning to automotive in 2022, he worked as Senior R&D Manager at Olsa, overseeing Magna Lighting's European rear lamp development until 2023.



Michael Hamm

Michael Hamm earned a PhD in electrotechnics in 1997 from the University of Darmstadt, Germany. He joined Bosch's lighting division in 1996 and spent 12 years as a department manager at Bosch, later Automotive Lighting, developing front lighting technologies for customers worldwide. He contributed to major innovations such as the world's first full-LED headlamp, LED modules, camera-controlled ADB functions, and the development of light guides and DRLs. In 2012, he took charge of headlamp development at Audi. Since 2022, he has returned as a lecturer at the Lighting Lab of the Technical University of Darmstadt.



Gerd Bahnmüller

Gerd Bahnmüller graduated as a Mechanical Engineering at University of Stuttgart. He worked 6 years in Technical IT at Robert Bosch GmbH, and 21 years at Bosch and Automotive Lighting in R&D for Front lighting as Manager and Director with global responsibility. At last, he spent 6 years at Automotive Lighting and Marelli as Vice President R&D Lighting and Electronic. Since 2022, he is Senior Advisor at DVN

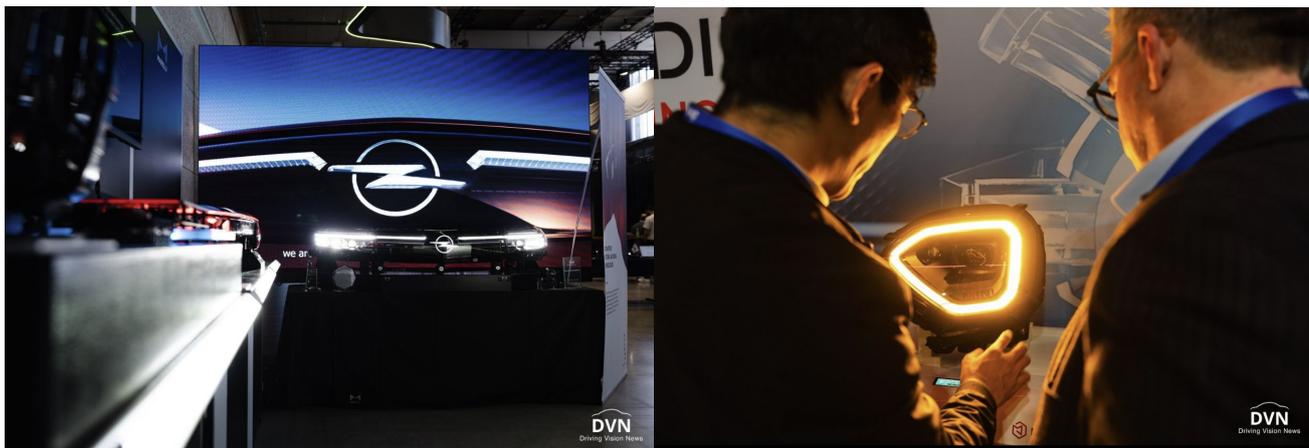


Thomas Fröhlich

During the end of his study of electrotechnical engineering at the university of Karlsruhe Thomas Fröhlich started his professional career in Bosch. His first task was basic research on autonomous driving in 1989. But soon he joined the lighting division of Bosch to work on lighting electronic design. In 2002 he took over the worldwide responsibility for R&D and project management on lighting electronic added by body electronics. To extend the business of Automotive Lighting to new fields he built up design activities on new activities like interior lighting and LiDAR sensing. Since mid 2022 Thomas has retired and is now supporting DVN as consultant.

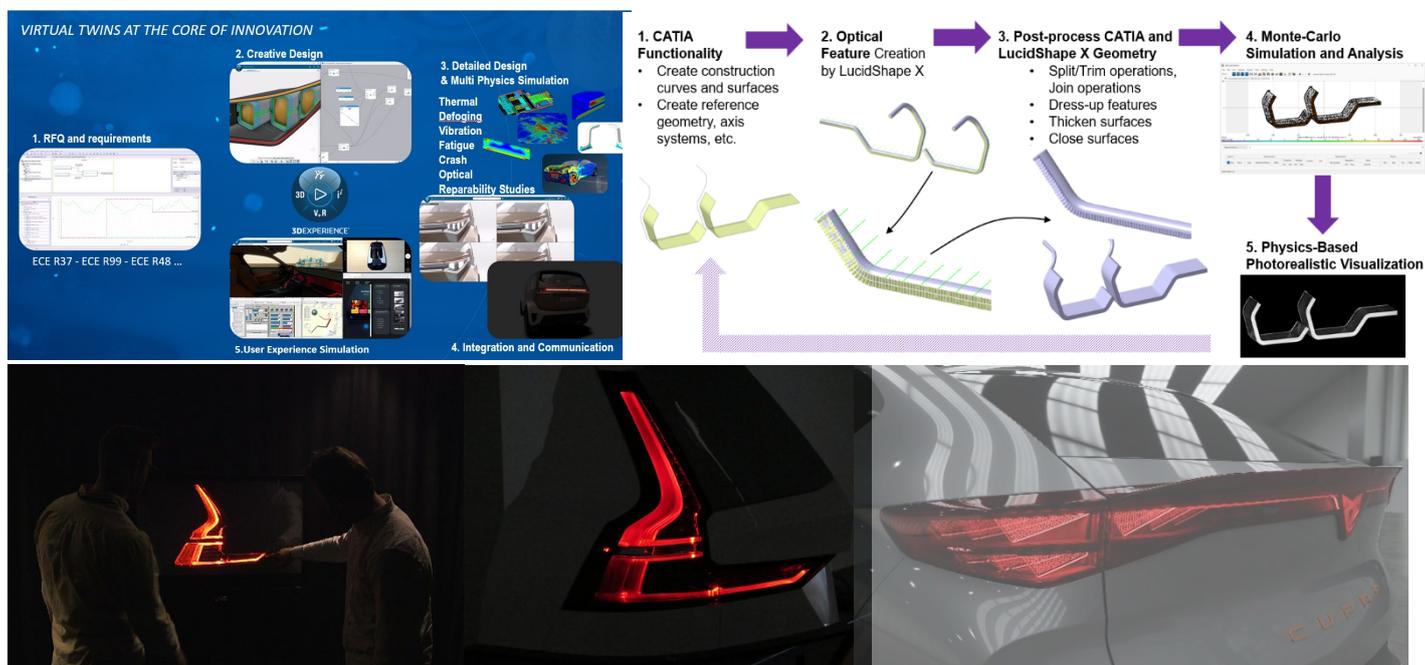
Executive Summary

DVN Munich main technical takeaways



We took time to read carefully all the presentation that were done 2 weeks ago with all DVN senior adviser to be able provide a full resumé of our Munich event. From that, we selected my main **technical** takeaways. Which technology seems to have a great future and possible application, to save time, save cost, create new design or reduce CO2 footprint ?

- 1- **Digital twin to develop faster** : how can our CAD be translate as fast as possible in optical concept, including thermal simulation, optical rendering, pedestrian crash result including all rating (NCAP, HSPR, IIHS ..). How can digital twin, with support of AI, modify the original A-surface from design to give the correct performance and specification ? how important is rendering simulation to shorten development loops



- 2- **MiniLED and MicroLED Display** : light source innovation is continuing to push the design boundaries.

Liaowang presented their last MDL plus release on Lynk&Co 900 with front ISD including 10,000 pixels, pitch 2mm and luminance 2.500 nits. OTA and instant communication is available

Mind presented at their booth an interesting mockup of lamp including transparent display in front of low beam and high beam (“Hello”)



Next steps were shown by tier 2 (from left to right)

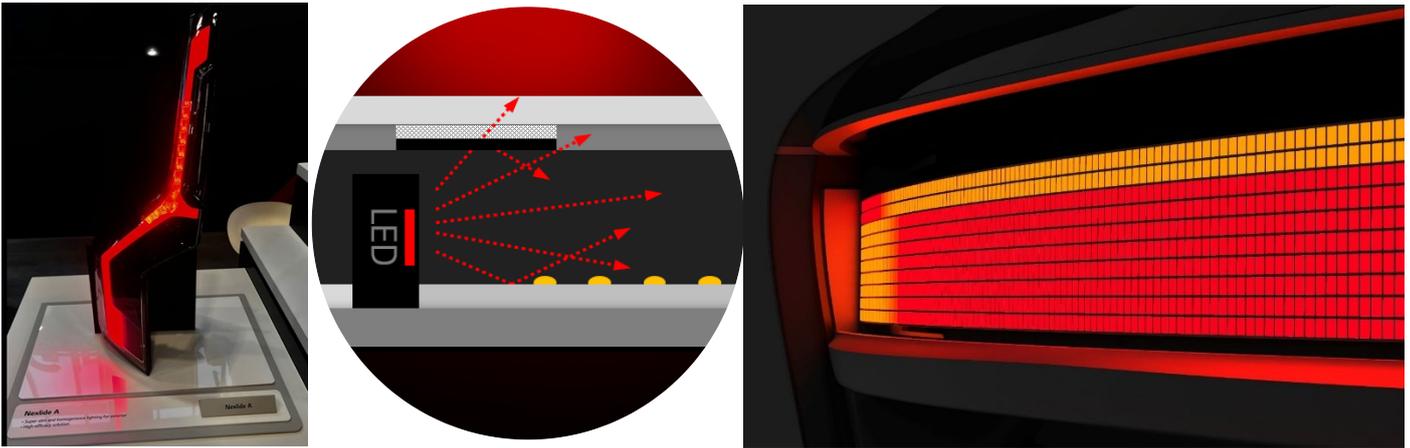
- Flexible miniLED (Liteon - pitch 1.25mm - 4000 nits – RGB)
- Refond miniled pitch 0.92 (Great Wall SAR) and demo with 0.39mm pitch
- Everlight demo with pitch 0.1mm
- Vueral microLED with pitch 0.2mm and 6000 nits luminance



- 3- **Diffusive solution** : designer willingness is always to have the most homogeneous oslution in all possible viewing angle, and R&D are chasing cost and power consumption. Skytop BMW design is a quite interesting example with DRL height 12mm and rear position lamp height 4mm. New solutions are coming with efficient solutions :



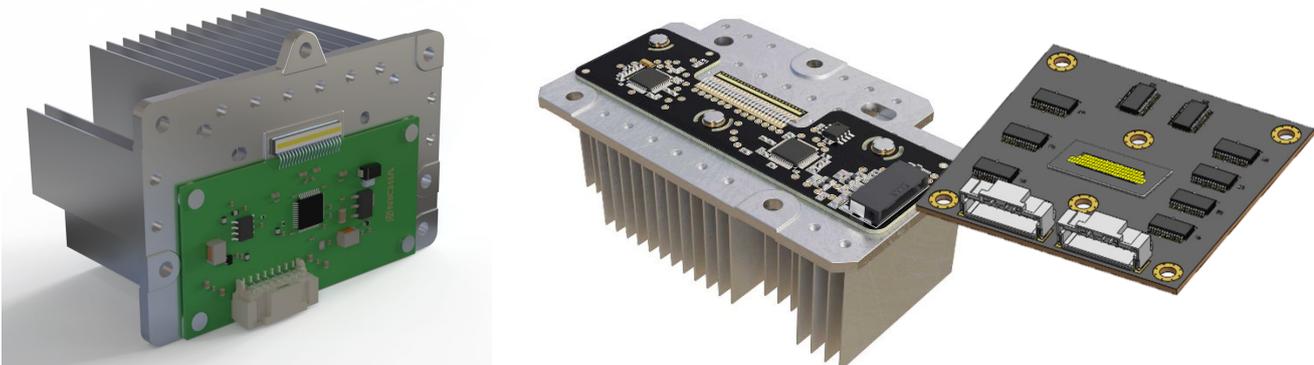
- Nexlide From LG Innotek (Rear PL with nexlide A and 1.8W power consumption) or Nexlide Vision (CES 2025 with pixel 5x5mm and 5W per square meter power consumption)



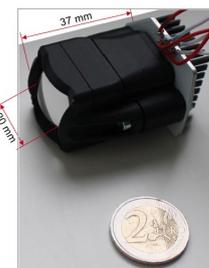
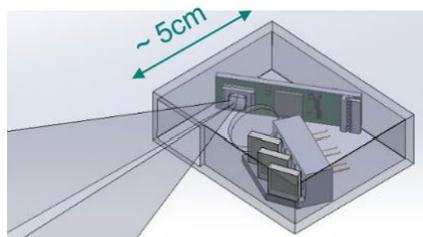
- Laser texturing and usage of films to scatter the light (from left to right : brightview technology, Reiche, Microrelleus, DBM Reflex)



- 4- **ADB Design to cost solution** : proposal from Nichia (standard ADB engine with 16 or 24 pixels), Lumileds (Luxeon NeoExact with direct imaging system) or Liteon (with chip on board technology to improve thermal dissipation)



- 5- **Minuturization of Projection systems** for welcome sequence or Signaling road projection : 3 colors lasers & MEMS (Maradin and Infineon : FoV 45 x 30 degrees and > 600 Kpixels, size < 60 cm³) or much simpler system from Odello with Gobo system and sequential activation of 3 leds



- 6- **Laser usage for lighting application** : Appotronics who is already delivering a RGB laser DLP on Smart #5 for welcome / cinema application showcased an extravagant concept of distributed illumination from a central light engine driver by laser and cooled by battery cooling system. More will come soon with a Demo on Shanghai autoshow in april. DVN will cover the event.
This architecture, if dream come true, could be a total game changer for vehicle architecture



- 7- **Sustainable solution** : in a nutshell, there is not a unique one, but different initiatives to lower the Co2 footprint. I just put here some examples among the multiple ones discussed during the event. However, what is clear is that 80% of the possible C02 reduction is done during design phase:
- Power consumption with low power solutions (like ams OSRAM DRL proposal 7W with XLS, compared to an average 21W DRL power consumption analysis done by A2MAC1)
 - Exchangeable LED solution for easy recyclability and LED replacement (Volvo trucks and ams OSRAM XLS solution)
 - Mucell technology to reduce componet weight (Renault)
 - Usage of sustainable polymer (ZKW target 80% in 2032), low carbon aluminium and sustainable PCB (RISE)
 - Development of collecting waste, and compounding plants to develop circular solution (Sabic and Covestro)
 - Development of PFAS free solutions



Volvo trucks, Renault, ams OSRAM, RISE

The Keynotes

Marelli – "Illuminating the future", Frank Huber

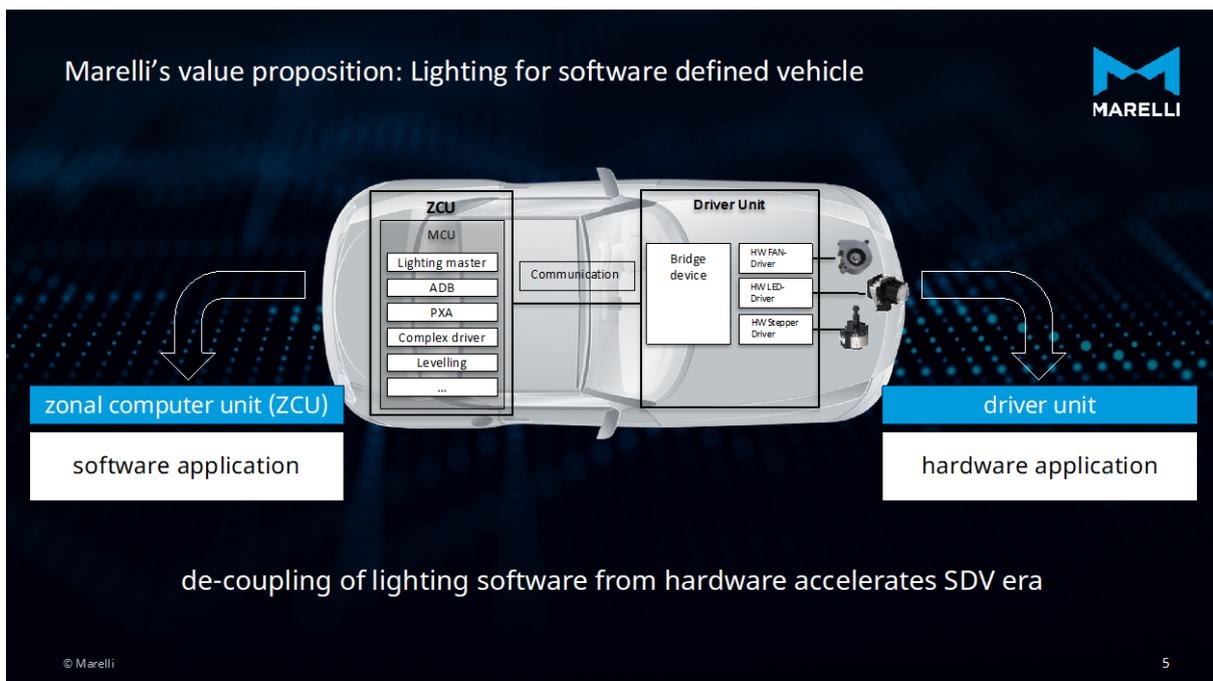


The first keynote, entitled "Illuminating the future", was given by Frank Huber, CEO of Marelli Lighting. He divided the customer experience into 4 segments:

- affordable & sustainable
- Interaction, personalization & communication
- design-led innovation
- comfort & safety

He pointed out the need for holistic approaches. Recyclability goes hand in hand with repairability and efficiency, which means increased electrical efficiency and standardization.

Another step towards the future is the process of "software defined lighting". This essentially means decoupling the lighting software from the hardware. On the design and styling side, design-led innovations such as functional integration and breakthrough lighting concepts are key differentiators. The important area of personalization and communication includes displays for signaling, OTA programmable lighting functions using mini-LEDs and OLEDs, and of course the inevitable differentiation and branding for OEMs.



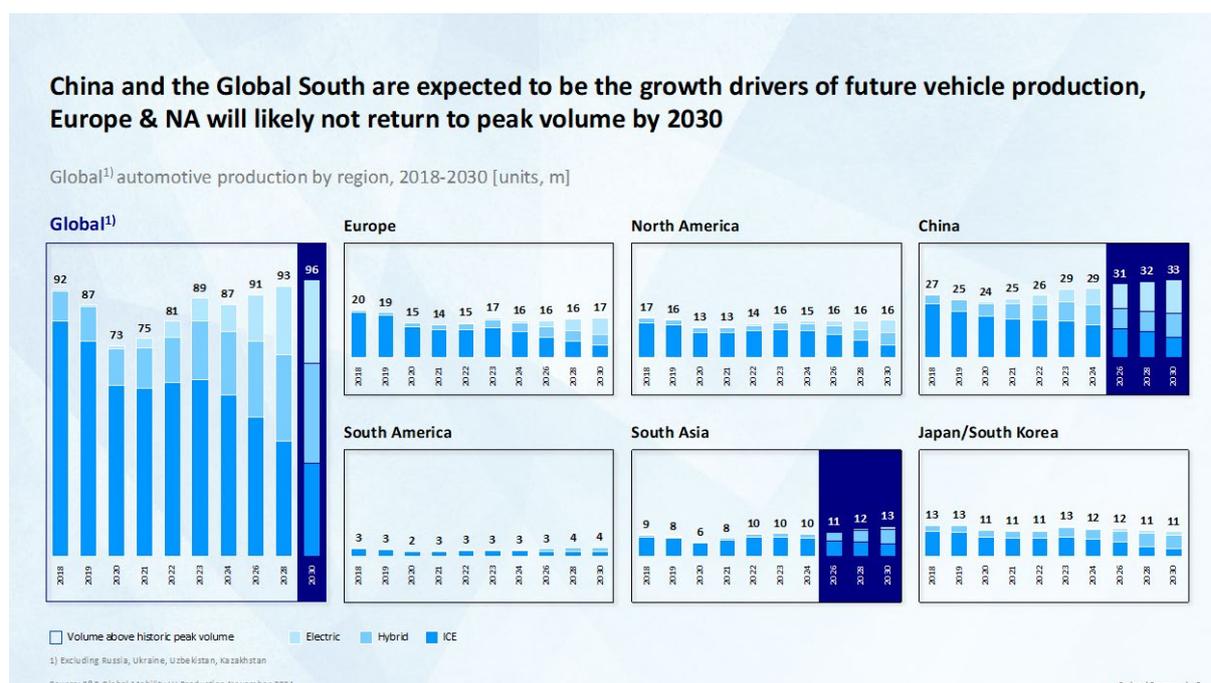
Roland Berger – "Health check and key developments in the global automotive supplier industry", Florian Daniel



Florian took over from Frank and gave his keynote "Health check and key developments in the global automotive supplier industry", which spoke directly to 95% of the audience.

Florian said that the expected growth drivers for the future are China and the Global South. The EU and North America will not return to peak volumes until 2030. The global automotive industry has the capacity to produce 100 million cars per year, but demand remains below 90 million. Margin development for suppliers is heterogeneous, with tires being the most profitable. But the automotive lighting business is also well above average in terms of innovation speed. One danger is that, despite the lack of real growth, the number of suppliers has increased until recently, undermining productivity.

Five main trends will dominate the agenda, says Florian. Volume flattening, slower BEV adoption, SDV, competition in and from China, and geopolitical tensions. The number of BEV suppliers is greater than for ICE powertrains, with traditional players competing with many new entrants in all areas. Chinese OEMs have gained domestic market share with a growing portfolio of new energy vehicles and a share of the high end segment. The key success factors for the automotive lighting industry can only be innovation and cost control.



Forvia Hella – "Lighting the Way: Overcoming Challenges as a European Automotive Tier 1 Supplier in a Transforming Industry".

Yves Andres, Managing Director Business Group Lighting

Yves delivered the first keynote on the second day of the workshop entitled "Lighting the Way: Overcoming Challenges as a European Automotive Tier 1 Supplier in a Transforming Industry".

Yves pointed out that the global automotive industry is undergoing a major transformation. The rise of Chinese OEMs and more and more new entrants are challenging the established global industry. The challenge is expected to increase as Chinese brands begin to "go west". Another transformation is the technical change in the lighting industry from halogen and xenon to LED and the proliferation of new advanced lighting technologies. The innovation effort is huge, as evidenced by the strong increase in R&D spending and patent applications. The highest growth is again in China. The changing business environment is forcing companies to be faster, more innovative, more agile and more regional at the same time. Technologies and innovations are important and must include functional value while being different. Necessary adaptations in all areas of the value chain are crucial.

INNOVATION EFFORTS IN AUTOMOTIVE

R&D Spendings for EV, AD % CZX (billion €)

Region	2014	2024
Europe	23	32
USA	18	27
China	12	41

Europe: +38%
USA: +50%
China: +238%

Patent filings (units)

Region	2014	2024
Europe	3,450	10,250
USA	1,100	2,000
China	1,400	6,500

Europe: +198%
USA: +82%
China: +364%

R&D Spendings per Patent Filing (million €)

Region	2014	2024
Europe	24	18
USA	16	14
China	13	6

Europe: -25%
USA: -13%
China: -54%

Source: Patent offices + Industry reports

- R&D Spendings for Electric Vehicles, Autonomous Driving and Connectivity rising
- Highest growth in China, both in terms of spendings and number of patents
- China with very high innovation effectiveness

FORVIA
Inspiring mobility

- Driving safety, branding, and differentiation.
- Powering mobility trends: electrification, autonomy, personalization.
- Success means being faster, cheaper, better.
- Collaboration is key.

AUTOMOTIVE LIGHTING TECHNOLOGY TRANSFORMATION

Headlamp technology penetration

Year	Halogen	Xenon	LED Basic	LED ADB Entry	LED ADB Mid	LED ADB High
2000	95%	5%	0%	0%	0%	0%
2005	85%	10%	0%	0%	0%	0%
2010	70%	15%	10%	0%	0%	0%
2015	50%	10%	25%	0%	0%	0%
2020	30%	5%	35%	10%	0%	0%
2025	15%	2%	30%	20%	10%	0%
2030	5%	1%	20%	25%	15%	35%

Declining dominance of Halogen

Broad penetration of affordable systems

Spread of advanced technologies

2008

2010

2013

2016

2021

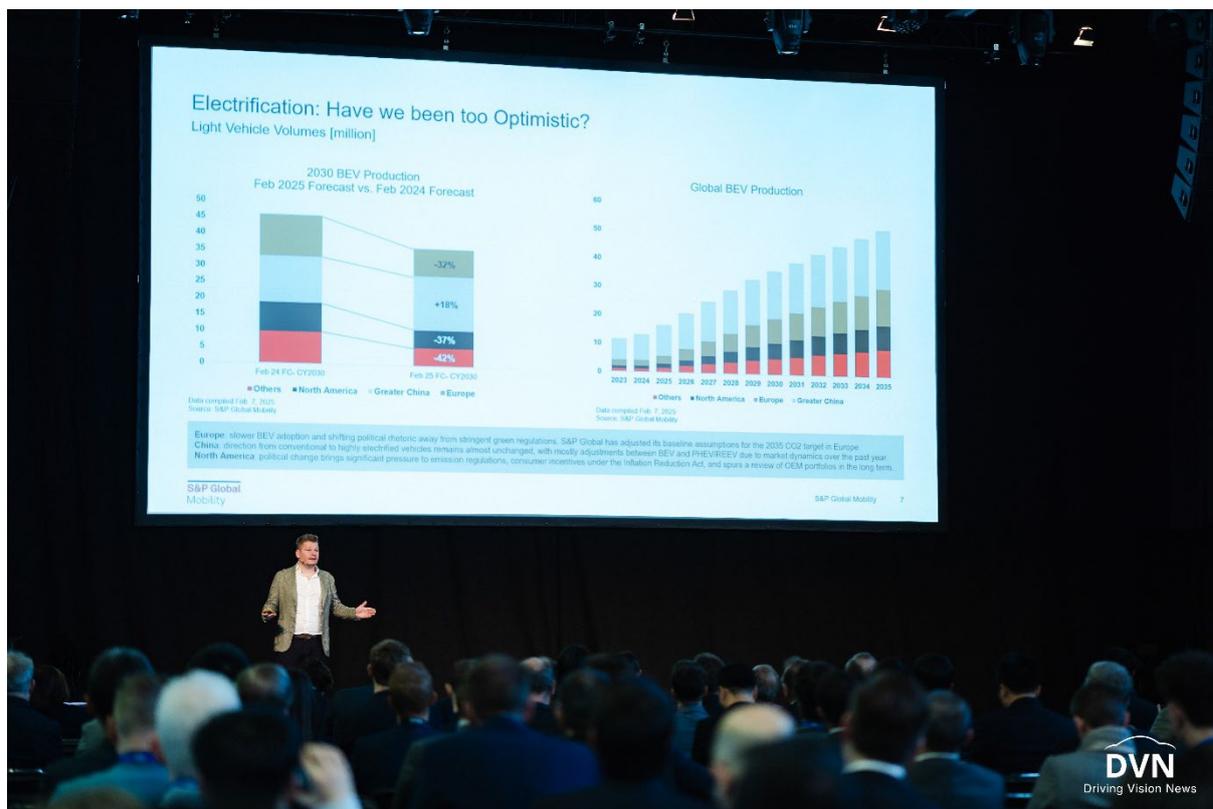
2023

2024

FORVIA
Inspiring mobility

S&P Global Mobility – "Lighting Market Update. Evolution or Revolution? A short market outlook in numbers"

Sascha Klapper, Research and Analysis Manager



Sascha followed Yves with his keynote entitled "Lighting Market Update. Evolution or Revolution? A short market outlook in numbers". Like Florian from Roland Berger (Keynote 2), Sascha showed the global car production from 2023 to 2030. He also showed the top 10 global brands and their sales development in 2024. Toyota leads ahead of Volkswagen. Number 3 is already BYD with +29% in 2024 compared to 2023. Ford, Hyundai and Nissan follow.

Regarding electrification, Sascha admitted that we were too optimistic. BEV sales in 2024 were -32% in Europe and -37% in North America compared to the forecast. Only China was above the forecast at +18%.

Europe: Due to slower BEV adoption and shifting political rhetoric away from stringent green regulations, S&P Global has adjusted its baseline assumptions for Europe's 2035 CO2 target.

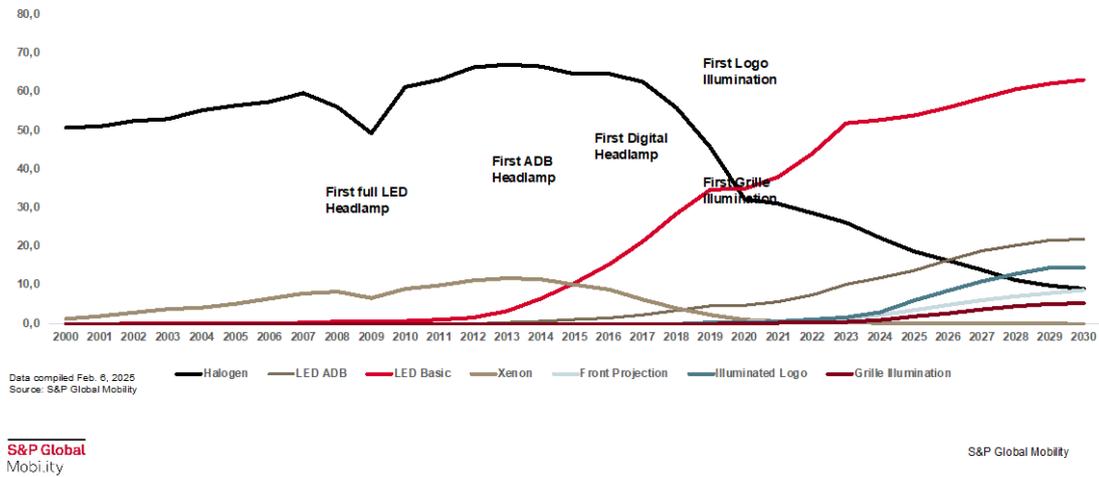
China: Direction from conventional to highly electrified vehicles remains largely unchanged, with adjustments mainly between BEV and PHEV/REEV due to market dynamics over the past year.

North America: Political changes bring significant pressure on emissions regulations, consumer incentives under the Inflation Reduction Act, and spur a long-term review of OEM portfolios.

Most interesting to us was Sascha's forecast for the front lighting market. He showed a long term graph from 2000 to 2030 showing the rise and fall of lighting technologies. As we know, the "LEDification" of headlights is rising in all regions, the strongest in China. He predicted that the ADB market will continue to grow rapidly.

Front Lighting – What is Next?

Light Vehicle Volume Global [million], 2000 – 2030



Summary. Vehicle production, electrification and autonomous driving: Established OEMs are expected to maintain their production levels, while mostly Chinese EV brands are increasing their production. Electrification has been pushed back recently, while the main trend remains stable. Autonomy still has a long way to go.

Innovative automotive lighting industry: In recent years, there have been several innovations in automotive lighting. Halogen and HID headlights have had a long run, while new innovations have found their way into the volume market. Recent new technologies are shaping a new innovation cycle with increased speed.

ADB, projection lighting and exterior lighting: There is no question about the future of LED in automotive lighting. Even ADB has been widely accepted by the volume market. The next question is pixel content. Front projection and side projection have already gained momentum.

Ambient Lighting: The trend for ambient lighting is unbroken. In the future, it is predicted that we will find more and more surface lighting in the interior.

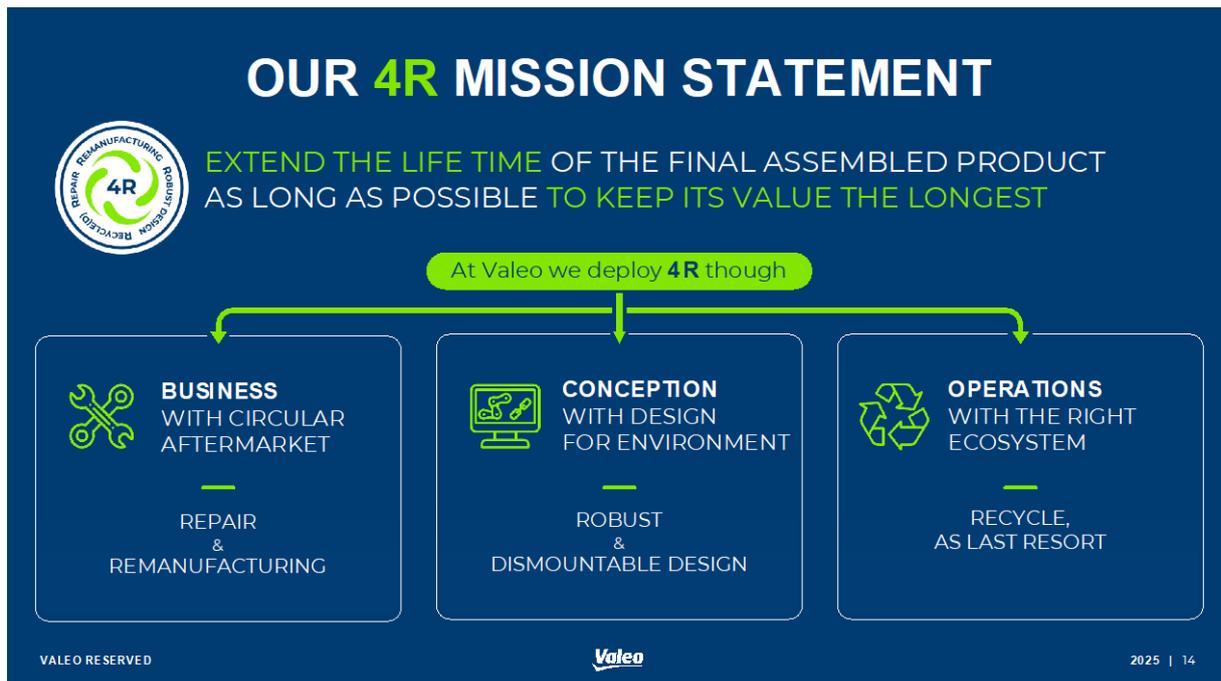
Valeo – "Lighting the Way: Pioneering the Future of Sustainable Mobility"
Mino Yamamoto, Circular Economy and R&D Excellence Director



Mino gave her keynote speech entitled "Lighting the Way: Pioneering the Future of Sustainable Mobility" in the middle of the second day. In her introduction, she mentioned climate change and resource scarcity as the motivation for circular mobility. Valeo's goal is to build the sustainable lighting of tomorrow. To achieve this, the entire life cycle and value chain is relevant: pre-use - use - post-use. In the use phase, the priority is to decarbonize mobility, for example through adaptive lighting management. This means that the brightness is always adapted to the driving situation. In the pre-use phase, renewable resins and recycled aluminum are key.

The guiding values are Valeo's 4Rs: Robust Design, Recycle(d), Repair, Remanufacturing. The implementation of the circular economy at Valeo is one of the key levers to reduce our recourse consumption. Specifically, 4R

means robust design to maximize product life, repair to give broken products a second chance, remanufacturing to make products as good as new, and recycle(d) to recover raw materials for reuse in new products



An important step is to remanufacture products as good as new. Fast time to market with a high level of quality from definition to testing to delivery. All remanufactured products are covered by a 2-year warranty. Today, Valeo supplies 1 million remanufactured parts, with a target of 2 million by 2030. Examples include rotating machines, transmissions and braking elements for cars and trucks, high-voltage components and electronics for cars and light mobility.

Design for disassembly DFD is a design approach that involves creating products that can be easily disassembled at the end of their life, allowing for efficient recycling, repair or reuse of components. This includes simple and reusable fasteners, modularity, low assembly depth, standardization, and ease of use. Examples include fasteners, drivers and levelers with easy access from the rear, removable adhesive with screw fixing and removable lighting modules.

Mino invites you to join us in building the sustainable lighting of tomorrow.

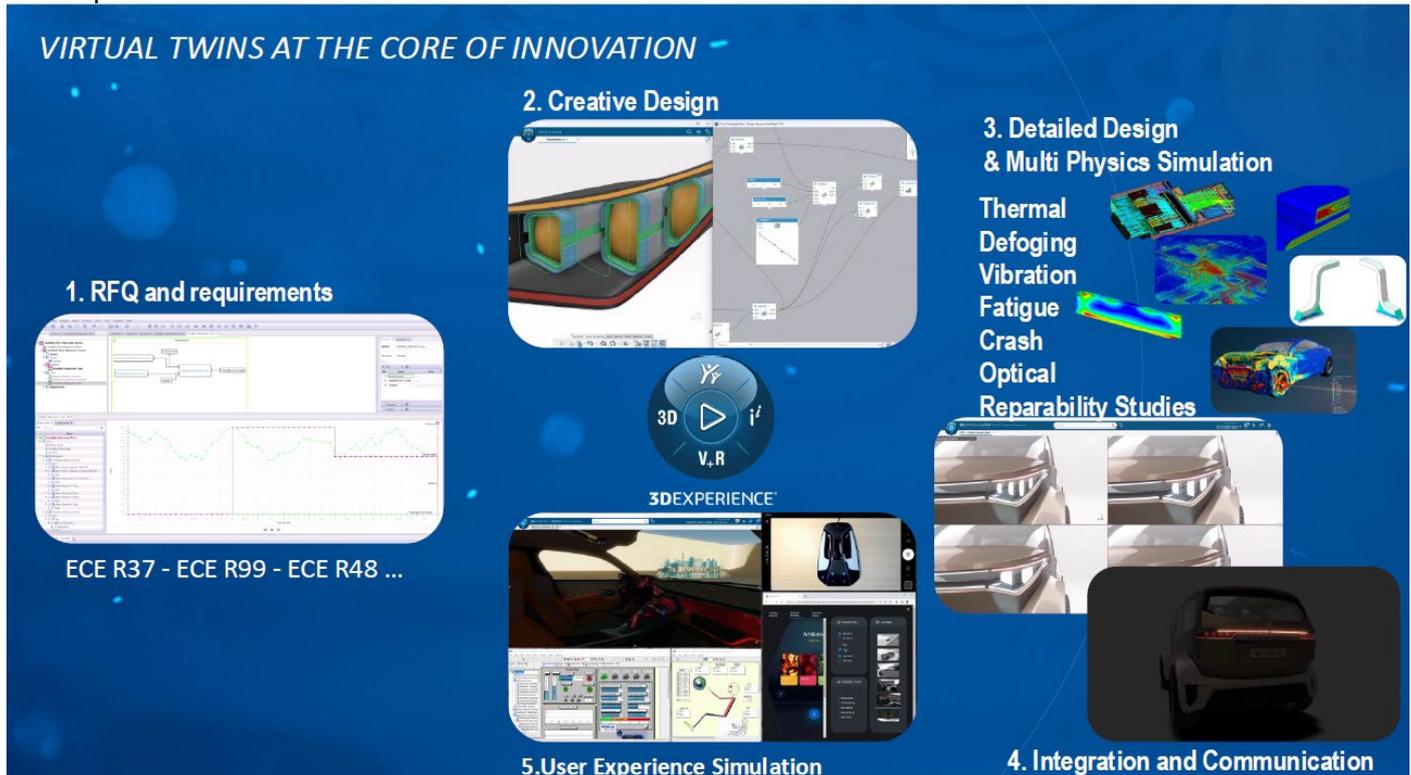
Session : DEVELOPMENT OF NEW WAY OF WORKING – SIMULATION, AI, SW INTEGRATION, VALIDATION, FUNCTION DEVELOPMENT.

Chaired by Wolfgang Huhn

Dassault Systèmes: – “How Virtual Twins Are Redefining Automotive Lighting Developments”
Sofiane Benhelli - T&M Industry Solution Experience Director

Dassault Systèmes, the creator of the widely used CATIA software, continues its development by supporting the technological evolution of Lighting products.

They are calling Virtual Twins their global approach, targeting to help the users at the different stages of their developments.



For instance, for the step 1 of definition of requirements, taking the example of adding a new control process on a headlight, the headlight pitch angle adjustment, they are proposing to utilize the INCOSE standard, past RFP requirements, and design rules to generate a comprehensive set of requirements using LLM technology, then to simulate the new control process to minimize risks and streamline validation of embedded systems. Naturally, their tools can be applied for every lighting application, as well as for exterior lighting and interior lighting.



Synopsys & Dassault Systèmes – “LucidShape X and CATIA on the 3DEXPERIENCE Platform: Emerging Opportunities Fueled by the Digital Transformation”

Stephan Ritz – Dassault Systems ; Tobias Schmid – Ph.D. Synopsis

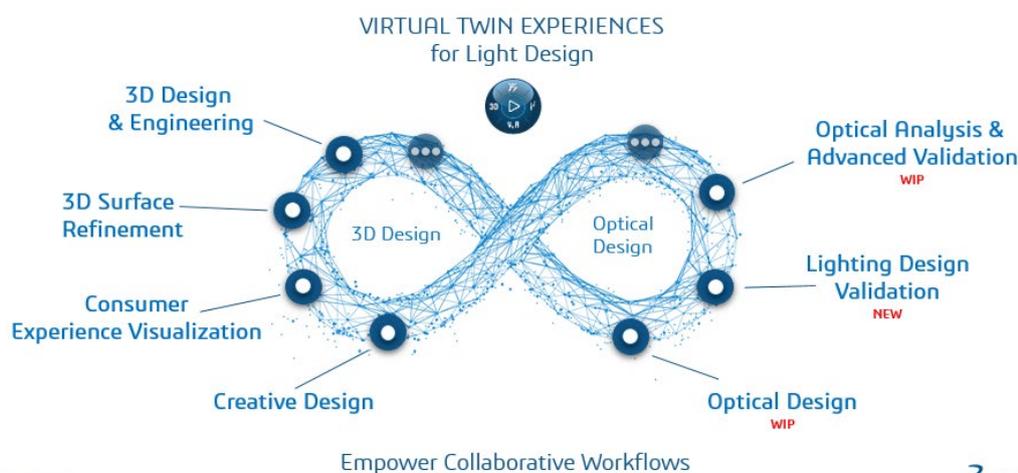
3D Experience is redefining lighting developments with 3D Virtual Twin Experience, this for the different steps of each development including Requirements, Virtual Design, Detailed Design, Multiphysics Simulation, Integration, User Experience, etc.

Lighting design experience with 3D Experience Virtual Twin is realized with a collaborative lighting design workflow for the different actions of the sequence Imagine, Create, Experience, Validate.

The association of Catia and Lucidshape is now allowing complete 3D Experience including the optical design and its validation.

3DEXPERIENCE CATIA & LucidShape X

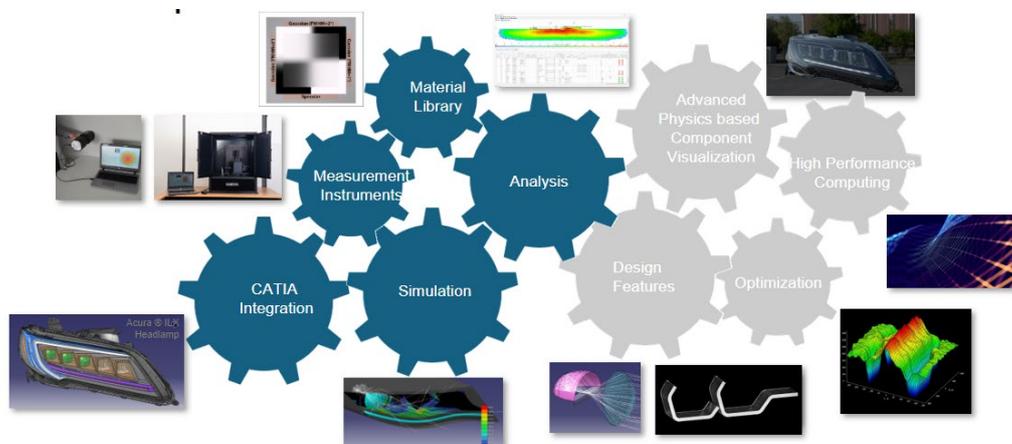
A Paradigm Shift for Unified Lighting Design Workflows



The target of the integration of LucidShape in 3D Experience is a complete modelling application including the reference geometry, the light sources, sensors and actors, the optical materials and the material library, and the measurement hardware.

However, the first release of Lucidshape X on 3D Experience will be focused on simulation and analysis, with the objective to perform Monte Carlo simulations to produce light distributions for the defined scenarios, and analysis of the light distributions including regulation compliance checks and custom analyses.

In the future, the integration will include also advanced physics component visualization, high performance computing, design features and optimization.

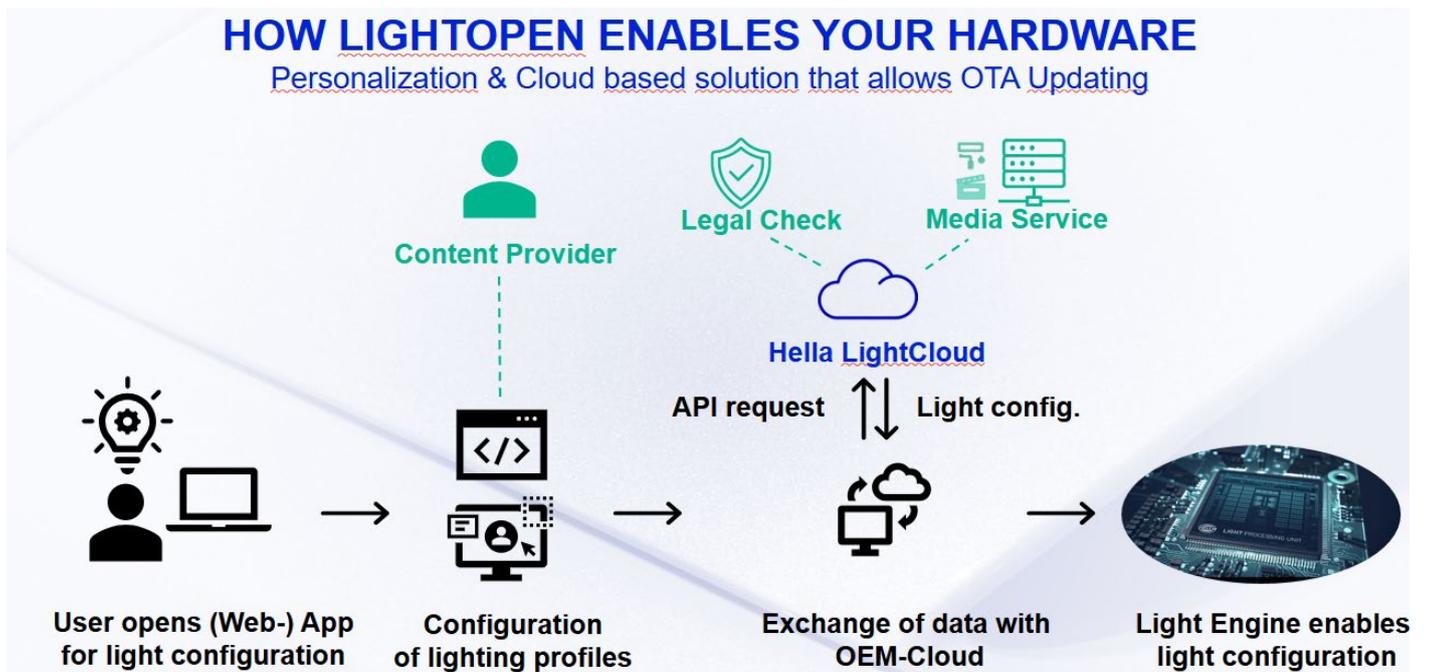


FORVIA HELLA – “LightOpen – A cloud-based ecosystem to enable the full potential of SDV’s lighting hardware”

Mario Saure

Today’s OEM and tier 1 core business is mostly linked to hardware. But more than 75% of those who enjoy driving like to customize their vehicle lighting, particularly in China where this ratio is going up to 92%.

Now, vehicle customization needs to be redefined as a competitive advantage, particularly as hardware is capable of a lot more than what is available today, digital personalization can change the outward appearance of the vehicle, a new user experience easily configurable and responsive can be created.



For Forvia – Hella, the main interest of their Lightopen approach is to enable the full potential of the lighting hardware, with an innovative process including:

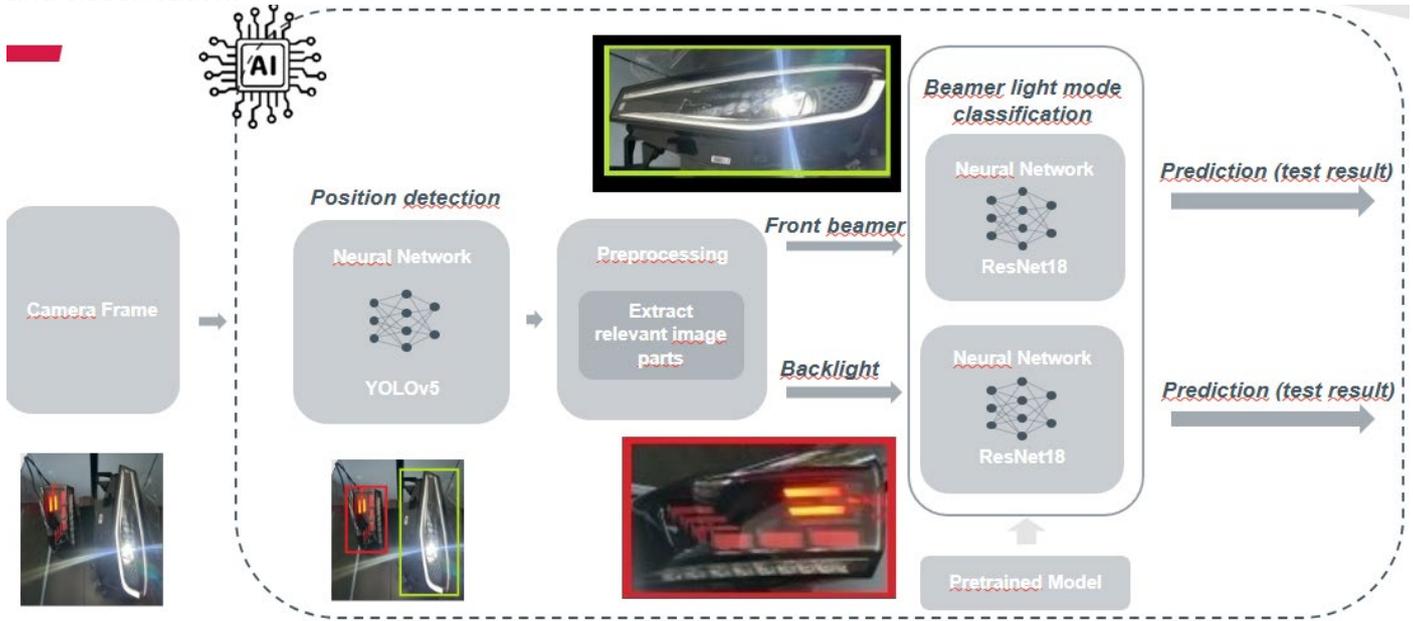
- a new way to configure and interact with lighting,
- a cloud base solution that allows OTA updating,
- an improved user experience for complex configurations via mobile devices,
- an improved car fleet management,
- new business models for instance for advertising.

EDAG Engineering – “EDAG EDlight + Homogenium – AI-based lightfunction detection & measurement evaluation”

Jannes Buthmann

With the current modern lighting systems, testing is becoming very difficult as there are many cases that could be above the ability of human engineers to manage, and their measurements like homogeneity are always difficult. So, EDAG is proposing two tools, one EDLIGHT for SW integration testing, and the second one HOMOGENIUM for the optical validation particularly for the measurement of homogeneity.

EDLIGHT is a AI based automated testing using a model training with neural networks for images treatment and classification.

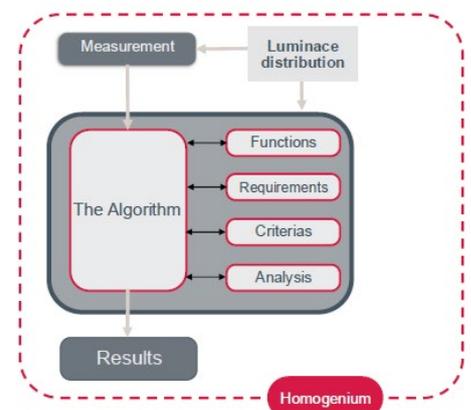
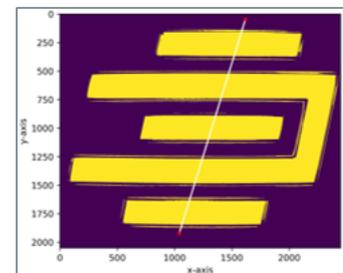


The analysis of the images to define their homogeneity could be a nightmare in some cases like for the following image.

The tool HOMOGENIUM is working with 4 steps:

- Step 1: Importing and analyzing the image to assess parameters for filtration, binarization and labeling
 - Step 2: Filtering and binarizing the image, preparing the image for the next step
 - Step 3: Labeling the binarized image and applying morphological operations to smooth out edges
 - Step 4: Calculating the homogeneity on the labels according to standard models and OEM requirements
- HOMOGENIUM lies in an algorithm that can calculate the results automatically, relying on predefined functions, using customer specifications or general requirements, concluding in reference on criteria's, and producing a complete analysis.

Finally, thanks to the use of EDLIGHT and HOMOGENIUM, time can be reduced from 4-8h to less than 1h, with repetitive and precise results.



ASAP – Rethink Validation – “How to Validate Exterior Lights in an Evolving Automotive Ecosystem”

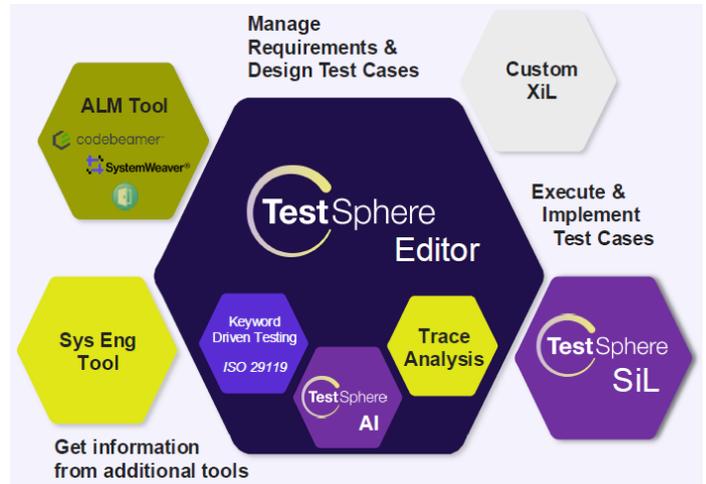
Christina Riebl - Project Lead, Software - Virtual Validation ASAP Group –Part of HCLTech

Current challenges for development are becoming difficult with end-to-end traceability, growing complexity of functions, lack of testing vehicles and hardware, but also with the opportunities to have AI elevated validation, reduce time to market, and the shift towards software.

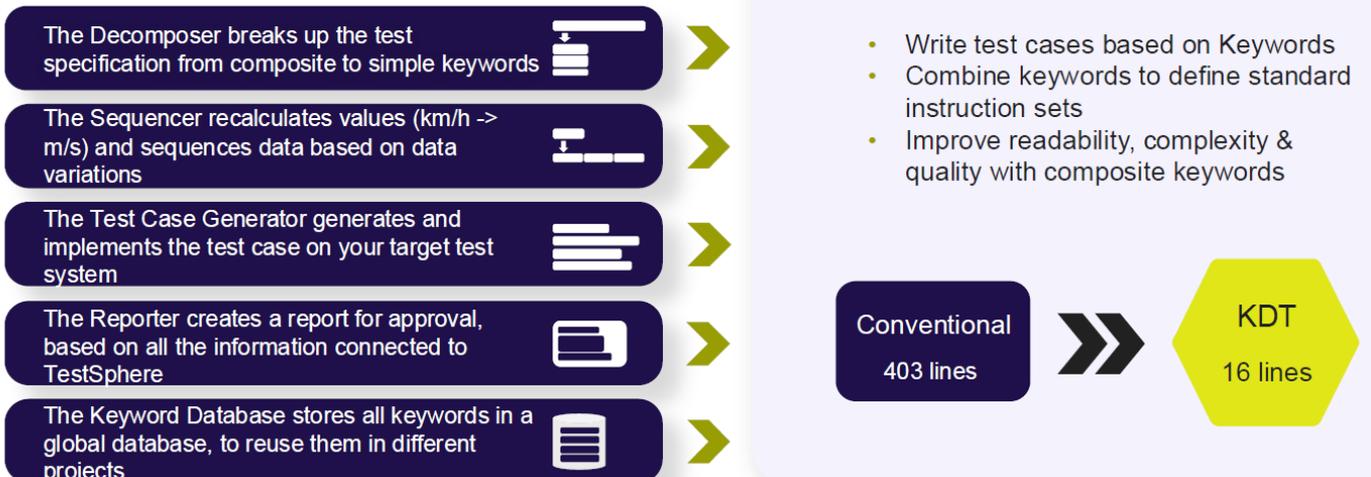
ASAP is proposing the tool TestSphere to support development, targeting to Integrate the whole tool landscape into one homogeneous ecosystem, to unify the test design for SiL, HiL & vehicle testing, to improve quality by combining everything relevant in one unified editor, and to realize advanced test design with AI support.

The key benefits presented are saving 75% of design time with test cases only once, automated testing with fully automated test implementation, no duplicate work with updates in keywords, developing test tool independent with focus on test design and not the test tool centralized.

The KDT service is an ISO 29119-5 Keyword Driven Testing.



Key components of KDT



The key features of the TestSphere AI are a generation of keyword driven test design out of requirements, an automated trace analysis and detection of potential anomalies, an assisted writing and verifying of requirements, an automatic competition in the editor based on the current context & history, and a help based on current context and steps in TestSphere.

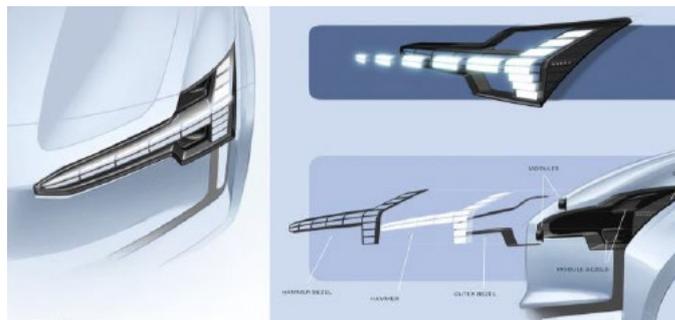


Volvo Car Corporation – “Technical Expert Light Aspect Simulation & Visualization”

Henrik Mattsson

Design Renderings are necessary for:

- Visualization, so a visual representation of a concept or design to understand and evaluate the proposed project
- Communication, to simplify complex ideas
- Marketing and Sales to showcase designs in an appealing way
- Design Development to allow experimentation with layouts, materials, and lighting and facilitate final design decisions
- Decision-Making to offer a clear and detailed view of the design to make informed choices



But rendering, particularly when targeting communication, are often exaggerated and embellished for a better selling experience.

Optical simulations on their side analyze and predict light behavior in systems focusing on physical properties and light-material interactions. They are accurate using high precision complex mathematical models and algorithms and try to replicate real-world optical phenomena. But they can also enhance or hide certain issues and are not very designer or management-friendly

Comparison virtual and physical prototyping

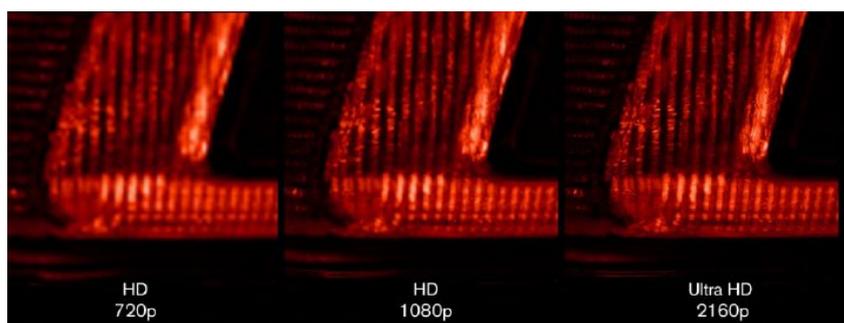
Virtual prototyping is more cost efficient, quicker by enabling real-time changes for faster iterations and quicker market entry, more flexible with easy design modifications based on feedback without physical constraints, offers enhanced collaboration across different locations, achieves simulation accuracy, but may differ from real-world performance, are often too perfect lacking process defects, and with risk of missing issues in specific conditions.

Physical prototyping provides valuable insights into usability and functionality,

with immediate tangible feedback on design aspects not apparent in virtual models, is essential for real-world safety tests e.g., automotive headlamps, but have high costs, are time-consuming, and prototype could have flaws like wrong materials or poor fit and finish.

For Volvo, the recipe to success is:

- A good understanding why using virtual prototypes is important, what they are useful for, knowing their limitations and decide if they are right.
- Choosing simulation and visualization tools carefully because switching later can be difficult.
- Gain hands-on experience with both virtual and physical prototypes and work closely with different teams and suppliers to get accurate results.
- Plan setup, environments, quality, and quantity carefully as changing these later can be hard
- Decide the best review of virtual prototypes by choosing the right hardware for visualization, considering limitations like display quality, brightness, and color range,
- Keep up with new developments, automate tasks, keep learning, and find new ways to work
- And naturally to have good tools and computers for their realization.



OPmobility – “The Modern Vehicle Front: Advantages & challenges of a unified system approach”
Michael Rosenauer

OPmobility group have 26,000 employees in 74 plants and 28 R&D centers in 18 countries. They are mainly involved in bumpers, tailgates, body panels, headlamps, rearlamps, and auxiliary lighting.

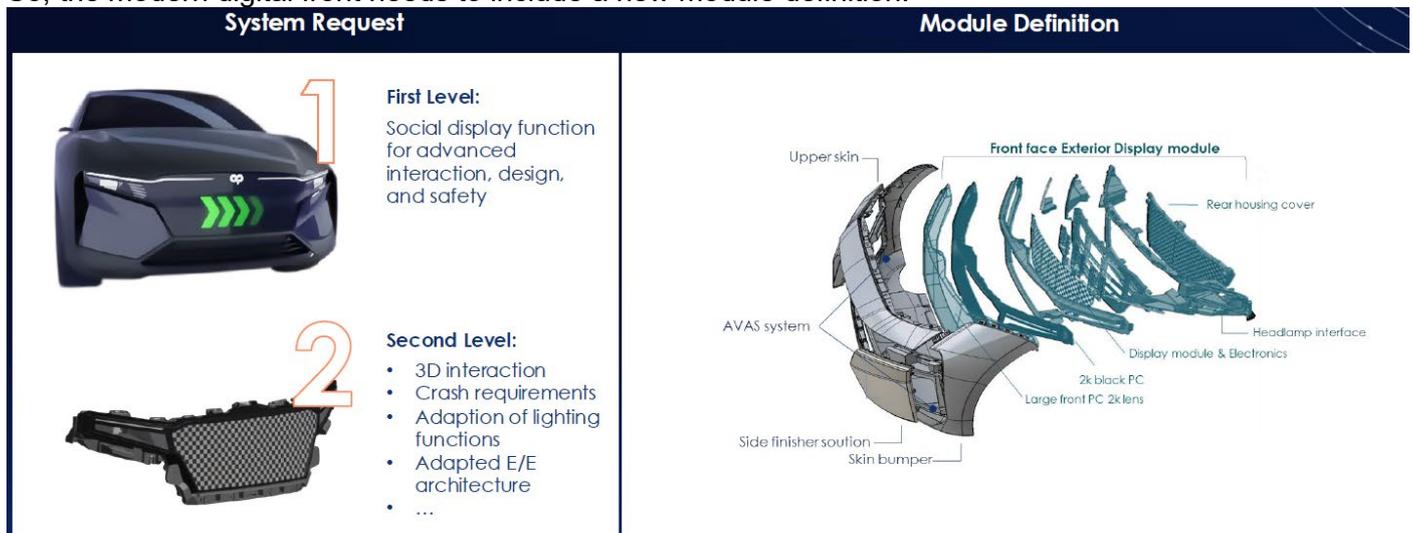
There are many new trends for the front end like 3D effects, miniLED displays, illuminated logos, edge-to-edge lamps, LED matrix technology, high-segment DRL, illuminated panels, or charging interaction. In parallel, with EV, the rise of new players and the disruption of traditional business require a new approach to the way a vehicle is designed and manufactured. And we have now illuminated panels & augmented modules



Cutting-edge solutions

- Animated lift panels and tailgates
- Cross car headlamps
- 3D- shaped screen integration
- Tailgates with integrated lighting and display

Cost reduction is necessary with simplified diversity management, shorter and faster lines with reduced investments, for more affordable yet individual and highly modern vehicles. So, the modern digital front needs to include a new module definition.



The breakthrough solution for new assembly lines, applicable to conventional and casting bodies, needs to allow a single body with several silhouettes realized at the end of the line with optimized fit and finish throughout design and assembly, with extended units for the vehicle front and rear,

Ansys – “Power saving through AI-optimized optical design”
Alejandro Marin Villalobos – Senior Application engineer

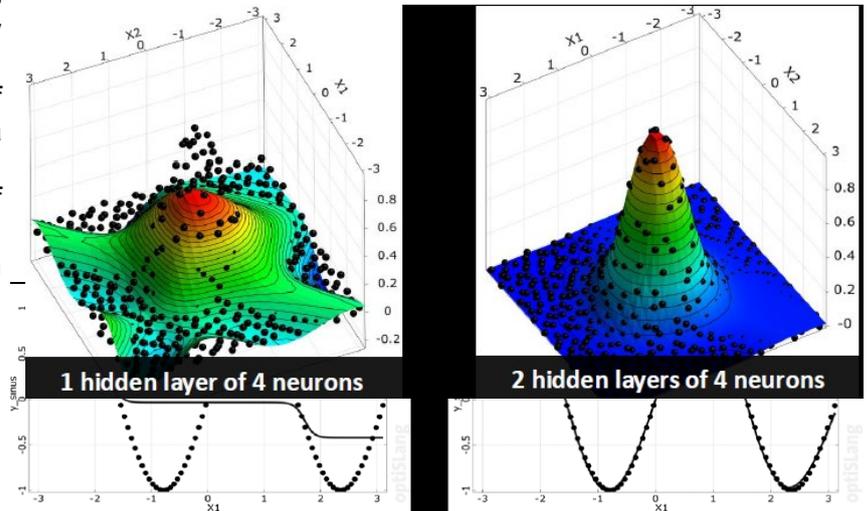
Ansys is a company focused on simulation for 50 years with now 6,600 employees and generating revenues of \$2,3bn in 2023.

Photometry is facing several challenges including regulation, performance or homogeneity and its optimization is difficult with all the parameters to take into account including high dimensionality (design parameters and flux), non-linearity, large number of constraints (regulation), multiple local optima, and trade-offs between objectives.

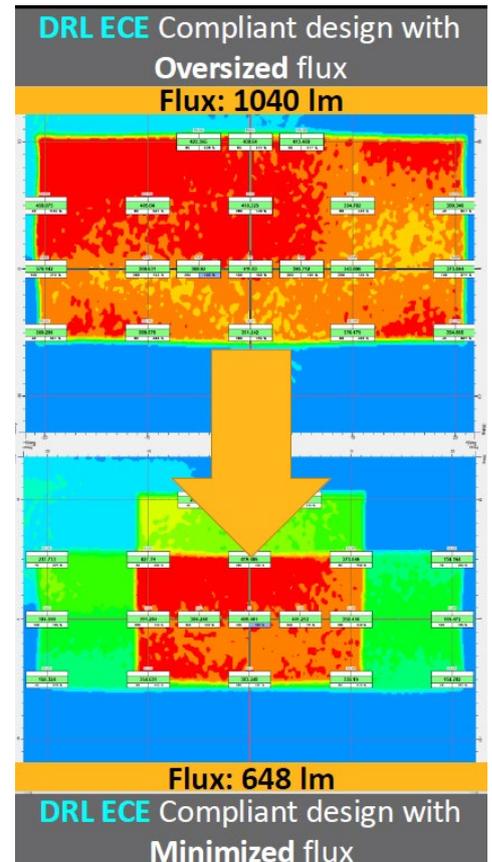
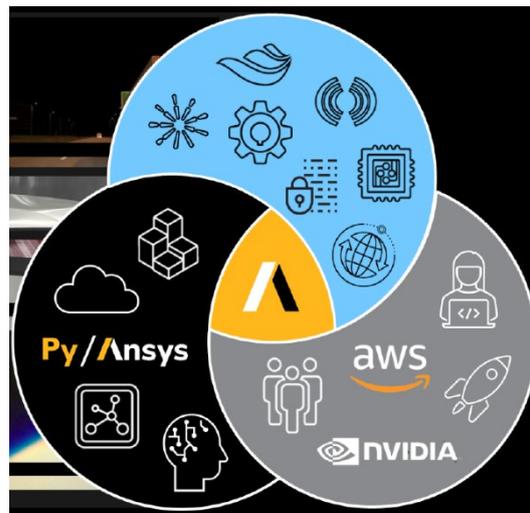
To face these challenges, Ansys has developed renown solvers enhanced by AI, GPU and process integration.

For AI regressions, the use of metamodels and machine learning with a high density of points is necessary.

To deal with these huge amounts of information, an acceleration is essential, and Ansys took the simulation acceleration to its best expression by developing GPU compute, transforming hours to minutes using this GPU acceleration. So, GPU compute is the perfect complement to map the search space.



Applying these principles and these tools to the calculation of a DRL, the optimization was concluded in 1.5 days, the sensitivity analysis was done with 1100 designs with NVIDIA RTX A5500 laptop, including 6000 predictions + 20 validations with the solver. This has allowed 37% of flux reduction from first compliant results.



Audi – “Experiencing Innovative Lighting Functions with the myAudi App” Andre Hainzmaier

With digitalization the innovation potential of Lighting is growing, and software is enabling innovation along many categories, enhancing the digital user experience.

myAudi App is the specific mobile application used by Audi for the personalization of lighting, adding more and more functions and being able to do demo, to personalize the signatures, and evolving towards a more complete communication and gaming tool.

v1.0

- 1) Live-Demo* Matrix LED
- 2) Live-Demo* CH/ LH scenario

v2.0

additional to v1.0:

- 1) Live-Demo* light signatures + personalization
change signatures (up to 8 variants)
CH/ LH scenario for each signature
set signature via personalization 2.0***
- 2) Live-Demo* communication light
automated driving mode
hazard warning

v3.0 *yet to come*

additional to v2.0:

- 1) Live-Demo* Digital Matrix LED
- 2) New communication light functions
- 3) Trailer check
- 4) Gamification
- 5) Live-Demo* exterior staging

Function on Demand

- Matrix LED
- signature package

It can control for instance the dimming of signs to avoid glare with the ADB function. At the rear, the app can help to choose the signature, but the system can also be a communication device for instance for hazard warning, proximity indication or assisted parking.



So, in the future, the smartphone will be more and more the main controller of lighting.

eUX Digital User Experience:
New forms of interaction with Lighting

LIGHT FUNCTIONS ON DEMAND

EXPERIENCE OF LIGHT FUNCTIONS

NEW LIGHT FUNCTIONS OVER THE AIR

PLAYING WITH LIGHT FUNCTIONS

BMW Group – “Temperature Behavior in Headlights: BEV vs. ICE”

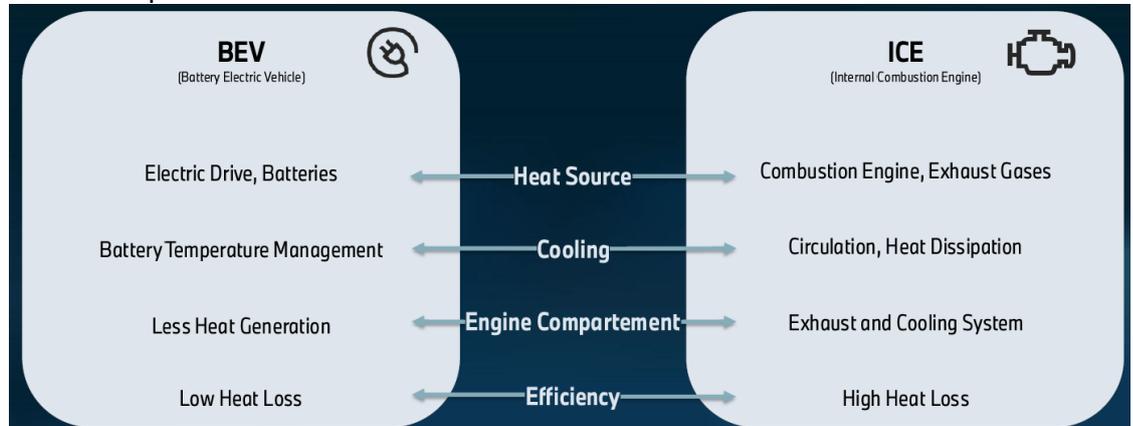
Tabea Schlürscheid

Components of headlamps have different specifications, for instance LEDs need to fulfil AEC-Q102, modules ISO 16750, and the complete system the requirements of the car maker and the regulation.

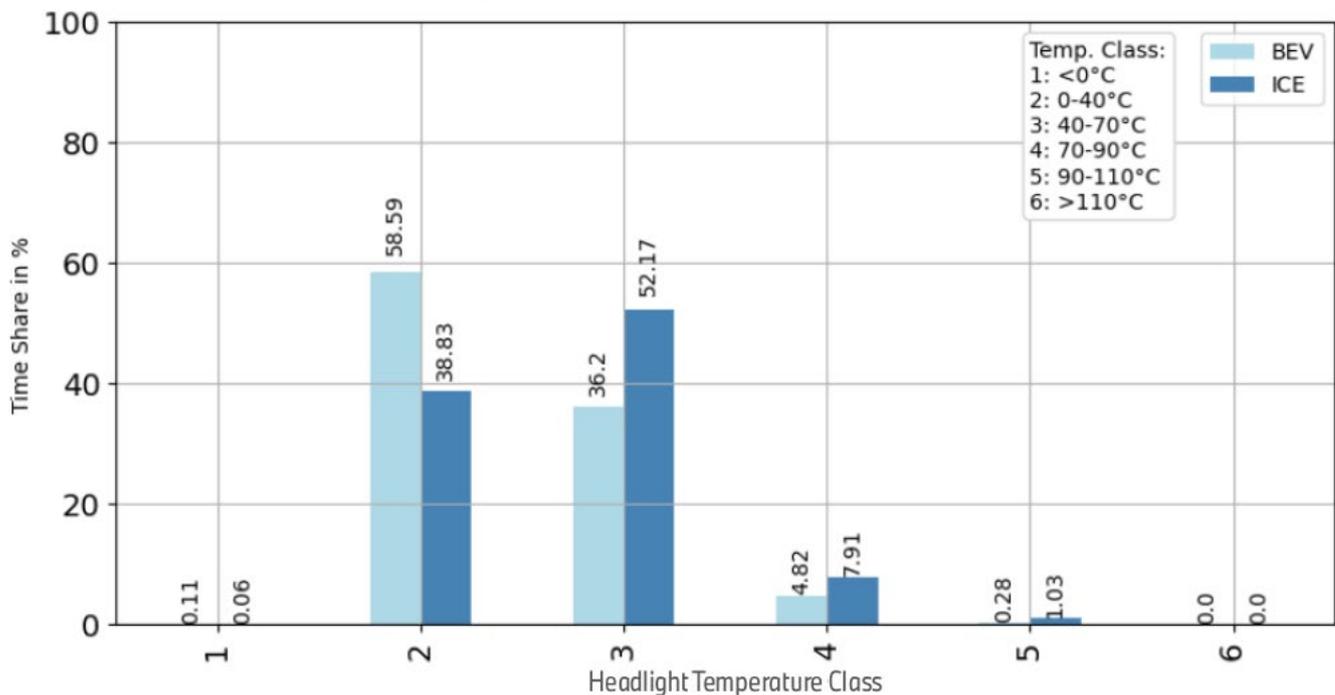
The parameters influencing the temperature inside the headlamp are the engine type, the location weather, the light function, and the driver profile.

For the study, four classes of local temperature were defined: Class 1: $\leq 15^{\circ}\text{C}$; Class 2: $15^{\circ}\text{C} < T \leq 20^{\circ}\text{C}$; Class 3: $20^{\circ}\text{C} < T \leq 25^{\circ}\text{C}$; Class 4: $T > 25^{\circ}\text{C}$

A large number of vehicles was measured, 7086 BEV for 6124 km, and 19708 ICE for 8930km.



The results hereafter is showing that in similar conditions, BEV headlamps have significantly less temperature constraints, and that ICE are over 50% of the time in a temperature range of 40-70°C, when BEV are over 50% of the time in a temperature range of 0-40°C.



And when the ambient temperature is higher than 25°C, the temperature in headlamps surpassing 90°C is achieved in 2,25% of time for ICE compared to 0,47% of time for BEV.

Consequently, the lower temperature for BEV is allowing reduction of requirements, adapted validation tests, and naturally adapted heatsinks.

BMW intends to pursue the study by analyzing the temperature behavior for each function, and the influence of the driving profile.

Capgemini Engineering – “Predict & Control your Design realization: it’s Visualization”
Paul Jacquet-Pierroulet Expertise Center Director Lighting

Visualization for Lighting application needs a physics based, highly accurate and reactive digital mockup through all the development, a process to serve design & engineering stakeholders in decision taking.

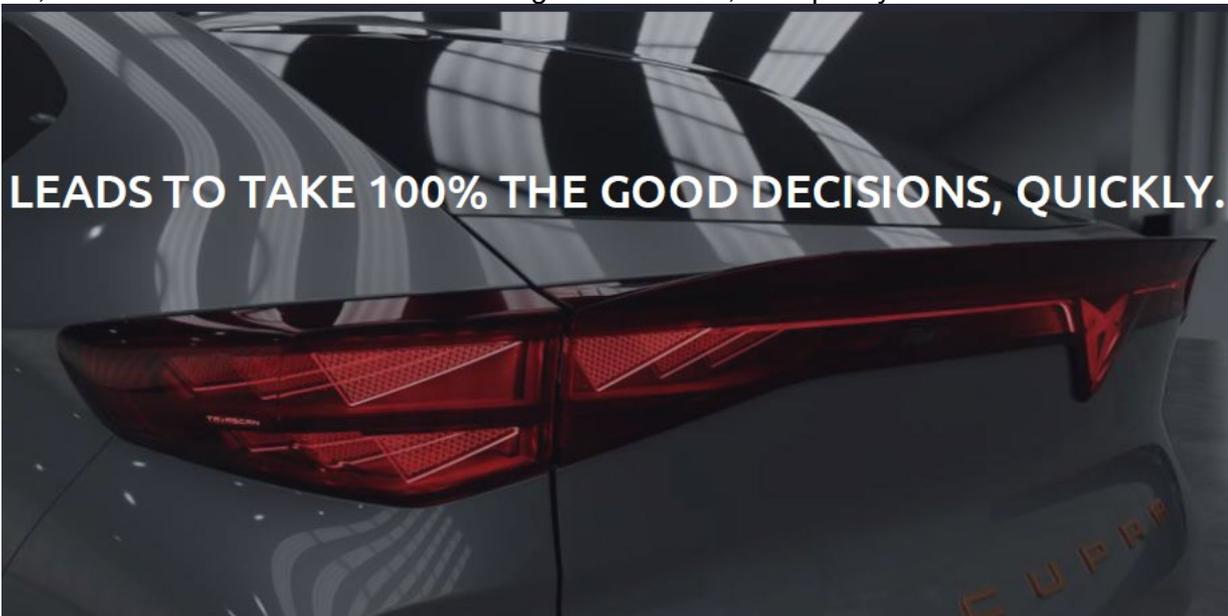
The need stands in both perception and accuracy to achieve 98% of correlation between optical simulation and visualization mockup and the future serial part.

To allow fast decision and perception, real-time is necessary.

Visualization is based on matter characterization, by running raytracing calculation in real-time, and by being based on A class and concept hypothesis, or direct DMU data once the theme is under development.



So, visualization leads to take 100% the good decisions, and quickly.

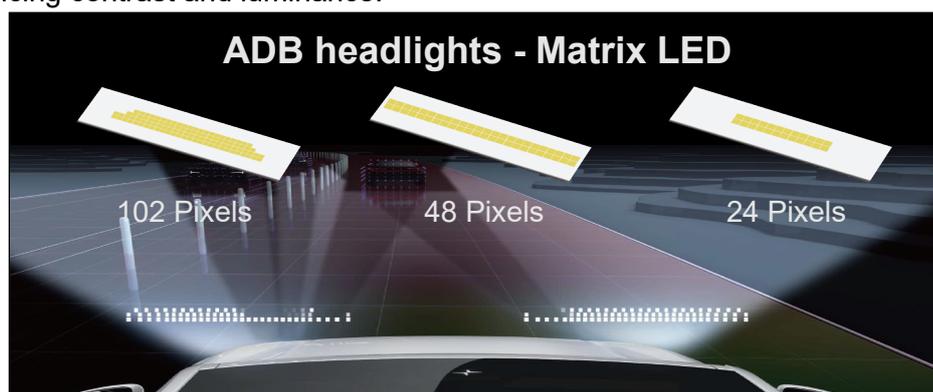


Session : Innovative technology – Light source

Lite-ON – “Redefining Automotive Lighting: Innovative LED Solutions for Light Engines”

Yi-Fei Lee

The presentation by Yi-Fei Lee from LITEON highlights advancements in optoelectronics and semiconductor technologies, focusing on automotive lighting solutions. LITEON, a leader in LED innovation for 50 years, integrates optical-electronics technology into automotive applications, enhancing safety, performance, and sustainability. Key topics include the development of Matrix ADB (Adaptive Driving Beam) Headlights, which utilize high-luminance, cost-effective optical structures with advanced chip geometry and thermal interface designs. The company provides modular solutions with pixel variations (102, 48, and 24 pixels), optimizing efficiency while balancing contrast and luminance.



Semiconductor-level Matrix LED Module with premium brightness and contrast

Further innovations include RGB+IC and SoC modules for smart ambient lighting, which improve individual lighting control through advanced PWM control and temperature compensation for color stability. The company also presents MiniLED-based direct displays, offering >10,000 nits brightness, wide-angle illumination, and flexible display designs for both interior and exterior applications.

MiniLED on lamp



1st Flexible miniLED display – 4,000 nits

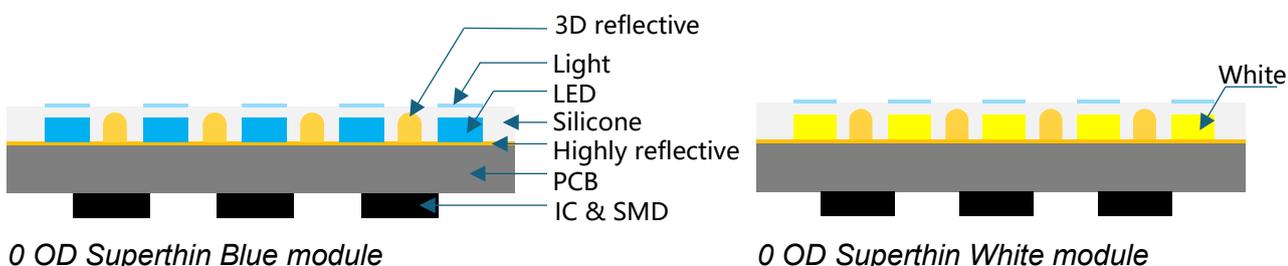
The Smart Ambient Lighting Solutions support high-speed data transmission (12M-18 Mbps), enabling precise color control and enhanced visual experiences. LITEON's product roadmap emphasizes miniaturization, high efficiency, and intelligent illumination solutions. With annual revenue of €4,4 billion and market capital of €7,4 billion, LITEON continues to drive innovation in automotive lighting by integrating AIoT, 5G, and cloud computing into its development strategy, shaping the future of intelligent automotive lighting solutions.

Refond – “Innovative application of MINI LED technology in vehicle backlighting”

Grayson Liao

The presentation by Grayson Liao from Refond explores advancements in Mini LED backlighting technology for automotive applications, focusing on smart cabin displays and next-generation in-vehicle illumination. The Chinese passenger vehicle market has experienced rapid growth, particularly in New Energy Vehicles (NEVs), with a 40,7% year-over-year increase in 2024, reaching 10,9 million NEVs. The average number of screens per vehicle is expected to reach seven, with high-end configurations featuring up to eleven displays, including instrument panels, central entertainment systems, heads-up displays (HUDs), and electronic mirrors.

Refond introduces several innovative Mini LED backlighting technologies. The 0 OD Superthin Module eliminates optical distance, reducing module thickness to less than 2mm, with chip-scale optical patterns and 3D reflective structures enhancing brightness by 10% and reflectivity by 5-10%. This design offers a highly efficient, low-halo solution for premium display applications. The White COB (Chip-on-Board) Module integrates 3D microlens designs for improved light uniformity and low thermal resistance, ensuring high reliability with features such as high-thrust force, corrosion protection, and no wire bonding. Additionally, Mini AM IC Technology with 4/6/8-channel Active Matrix IC eliminates screen flicker, providing a seamless visual experience while reducing costs by 40% through Aluminum PCB and AM IC integration.



Real-world applications include the Feifan R7, which features a 43-inch triple-screen display with a 10,25-inch Mini LED instrument panel, the Mercedes-Benz VISION EQXX with a 47,7-inch integrated Mini LED backlighting system, and the Lincoln Nautilus, which incorporates dual 23,6-inch wraparound screens with Mini LED local dimming. Refond continues to drive cost-effective, high-performance LED solutions for the automotive sector, shaping the future of smart cabin displays and vehicle illumination.

Headlights		Signal lights					Interior lights				RGB	Backlight	
6930	new ADB module	CW	CW	CW	CW	CW	CW	CW	CW	3535 RGB+IC	3030		
5630	2016	PC	PC	PC	PC	PC	PC	PC	PC	3528 RGB	4014		
4330	3537	R	R	R	R	R	R	R	R	20mA	3030		
3030	3030	Y	Y	Y	Y	Y	Y	Y	Y	3030 RGB	3014		
2016	3030	Y	Y	Y	Y	Y	Y	Y	Y	60mA&150mA	3014		
Ceramic N in 1	ADB & Bi-color	2720 0.5~2W	3030 0.5~2W	3014 0.3~0.4	3535 0.5W	3528 PLCC4 0.2W	3528 lens 0.2W	2835 0.5W	3528 PLCC2 0.06W	2214 0.06W	1608 0.06W	3030/ 3535/ 3528	3014/ 4014/ 3030

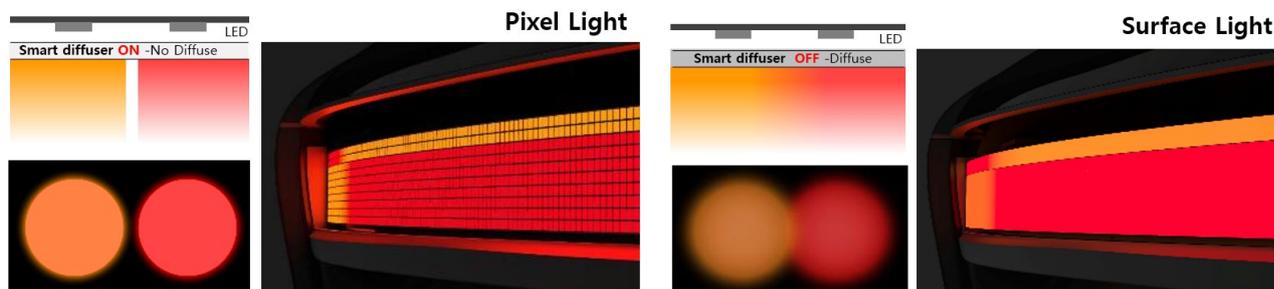
Refond Automotive – LEDs

LG Innotek – “Nexlide: Advancing the Vision of Future Lighting Solutions”

Somi Jun

The presentation by Somi Jun from LG Innotek highlights advancements in next-generation automotive lighting technologies, focusing on the Nexlide product series and its role in shaping future lighting solutions. Since its first mass production in 2014, LG Innotek has collaborated with major global automotive manufacturers, achieving over 160 project nominations, including 140 in mass production as of 2024.

The Nexlide product lineup offers various lighting applications, including tail lights, stop signals, turn signals, daytime running lights (DRLs), and decorative lighting for logos and grilles. The roadmap emphasizes high-resolution, high-contrast, and 3D lighting effects, integrating smart diffuser films for homogeneous pixel and surface lighting within a single module. The Nexlide-M series introduces full-color RGB LEDs, pixel lighting with a minimum size of 5x5mm, and 3D multi-layered lighting animations using optical films and half-mirror projections.

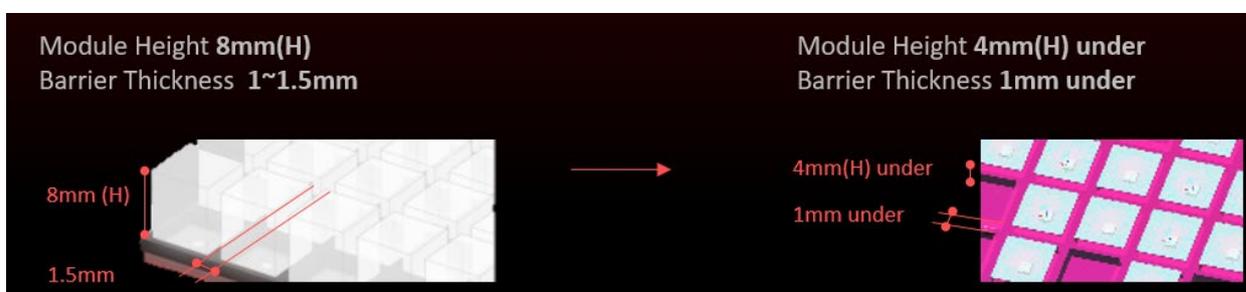


Pixel Lighting and Smart Diffuser Film technology



Nexlide Smart Diffuser: Pixel lighting & Surface lighting in one module

A key innovation is Smart Diffuser Film Technology, which enables dynamic lighting effects with ultra-thin pixel solutions and gradient color animations. Additionally, flip-chip LED technology enhances efficiency and reliability for stop and tail lighting applications. The roadmap envisions integrating lighting with vehicle structures, reducing module height to under 4mm, and expanding projection lighting capabilities.



Next step in Ultra Thin Pixel solution: Study on the Pattern mask Optic Technology for Pixel Light Slim Solution

With a strong commitment to high-efficiency, customizable lighting solutions, LG Innotek aims to redefine automotive illumination by combining aesthetic design, smart integration, and advanced optical technologies to meet future mobility demands.

Session : 2W, trucks, small volume, Premium & Sport cars

BMW Group – “BMW SkyTop, Focus on the lamps design”

Andreas Knödler-Bunte

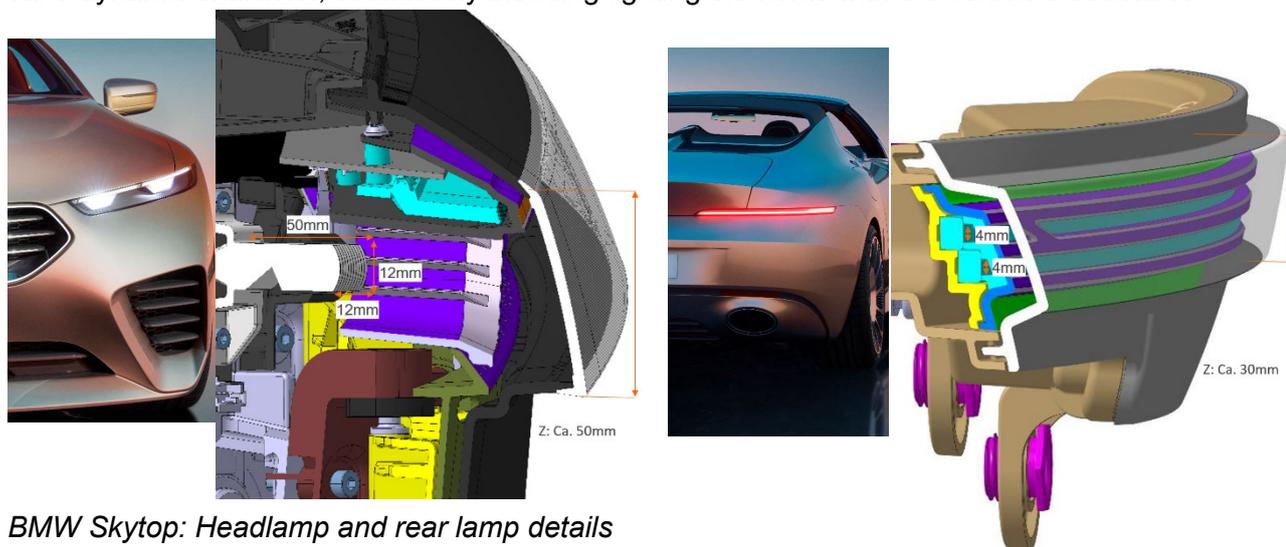
The presentation by Andreas Knödler-Bunte at the DVN Workshop Munich 2025 highlights BMW's latest advancements in automotive lighting design, focusing on the BMW Concept Skytop, a luxury two-seater cabriolet showcased at the Concorso d'Eleganza Villa d'Este 2024.



BMW concept car: Skytop

This concept emphasizes floating, clean design lines, organic proportions, and precise detailing, integrating ultra-slim lighting technology to enhance aesthetics and aerodynamics.

The exterior lighting design incorporates the thinnest possible headlamps and taillights, employing advanced LED technology to maintain an optimal body-to-lighting proportion ratio. The front features an ultra-slim headlamp system, working with minimal height constraints, inspired by aircraft engineering to achieve high precision and efficiency. The central fin/spline design, along with the Coke Bottle body shape, enhances the car's dynamic character, seamlessly blending lighting elements with the vehicle's structure.



BMW Skytop: Headlamp and rear lamp details

The tail lamp system integrates LUXEON 3D LEDs, optimizing tail, stop, and indicator light functions within an ultra-thin housing. This approach ensures maximum efficiency, precision, and visual impact while maintaining lightweight engineering. BMW's mastery of craftsmanship and engineering is evident in its attention to detail, utilizing high-tech materials and aerodynamically inspired proportions to set new benchmarks in luxury automotive lighting design.

Wipac – “Lightweight, High performance and Modular Lighting”

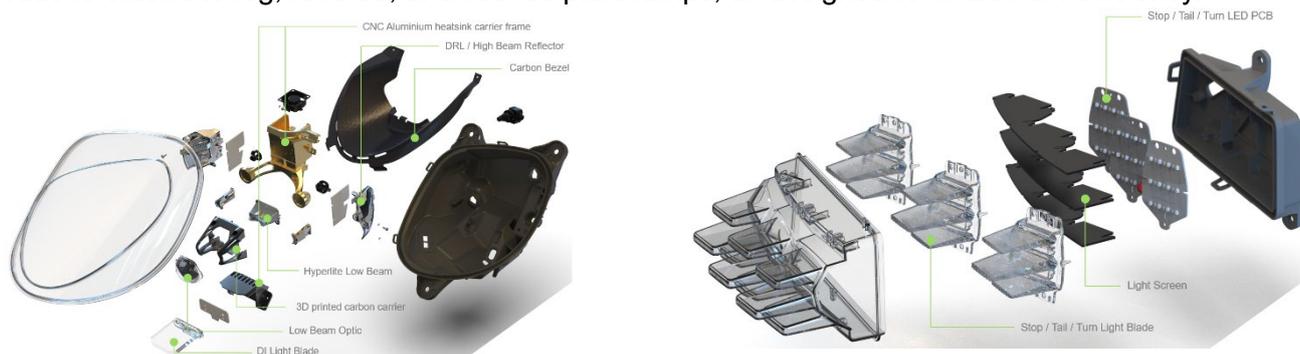
Simon Baker

The presentation by Simon Baker from Wipac Technology explores advanced lighting solutions for hypercars, focusing on lightweight design, high performance, and modularity. Using the Aston Martin Valkyrie as a case study, the presentation highlights how extreme weight reduction strategies, typically seen in Formula 1 technology, are applied to automotive lighting to optimize efficiency and aerodynamics.



The Aston Martin Valkyrie is a true Hypercar, taking F1 technology to the road

For headlamp design, Wipac employs topological optimization to minimize material usage while maintaining structural integrity. The 3D-printed carbon carriers and CNC-machined aluminum heatsinks reduce weight, while the hyper-light low beam system ensures high optical performance without additional AFS/ADB complexity. The result is a 1,5 kg headlamp system, achieving an optimal balance between weight and functionality. In small lamp designs, minimal component usage is prioritized, leading to the world’s smallest ECE-compliant brake light, measuring only 5mm x 18mm, and a side repeater weighing just 40g. These innovations extend to fog, reverse, and license plate lamps, all designed for maximum efficiency.



Lightweighting applied to Headlamp design

Minimising Rear Lamp complexity through modular design

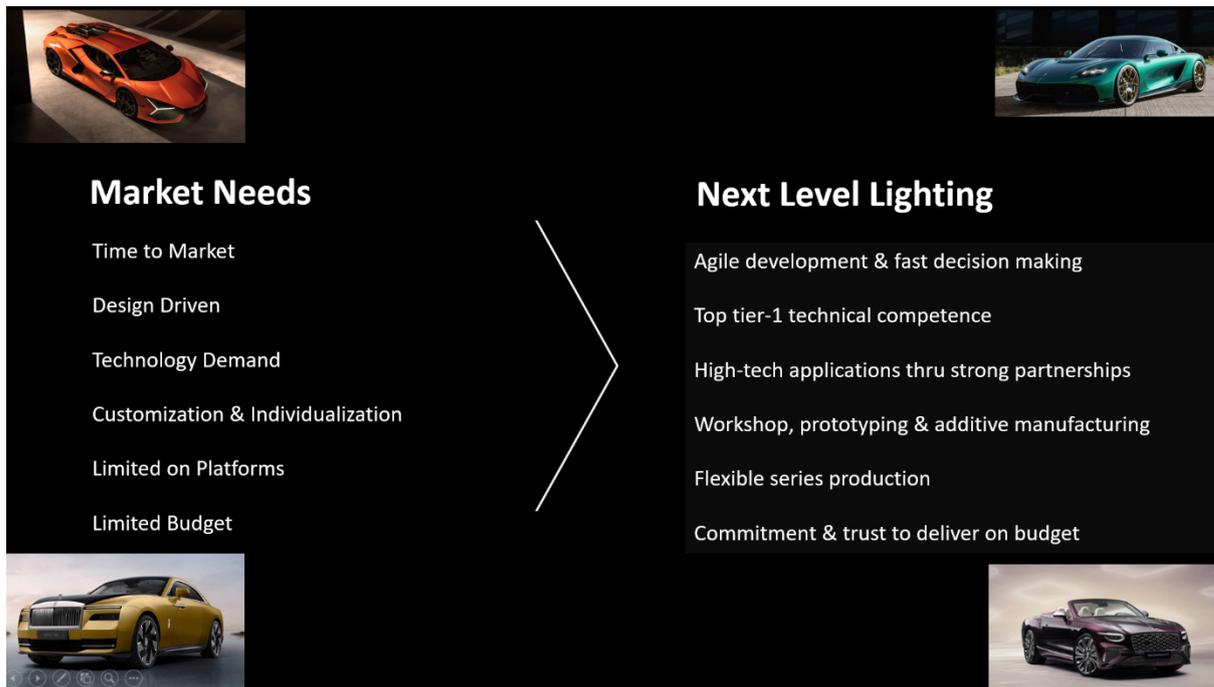
For rear lighting, Wipac introduces a modular optical light blade system that supports stop, tail, and turn functions. This modular approach reduces tooling complexity, accelerates vehicle launch timelines, and enhances design flexibility while maintaining compliance with ECE, CCC, SAE, and VSCC regulations. The presentation concludes that lightweight, high-performance, and modular lighting solutions significantly contribute to sustainability and manufacturing efficiency, ultimately reducing CO₂ emissions and development time while maintaining exceptional visual performance.

HSL Italia – “HSL – Next Level Lighting”

Jan Denecke

The presentation by Jan Denecke from HSL Italia explores advancements in technology-enabled lighting, focusing on cost-effective, high-quality, and lightweight solutions that enhance brand differentiation and customer experience. The core strategy emphasizes speed to market, styling-driven innovation, and platform-based personalization, addressing the increasing demand for flexible, customized lighting solutions.

Current industry challenges include rigid standardization processes, excessive change management, and a volume-driven market focus that limits innovation. To overcome these constraints, HSL Italia adopts an agile development approach, leveraging high-tech applications, strategic partnerships, and advanced manufacturing techniques such as workshops, prototyping, and additive manufacturing. This approach ensures fast decision-making, cost-effective production, and scalable solutions.



The answers of HSL to the market needs focusing on luxury and exclusive car lines

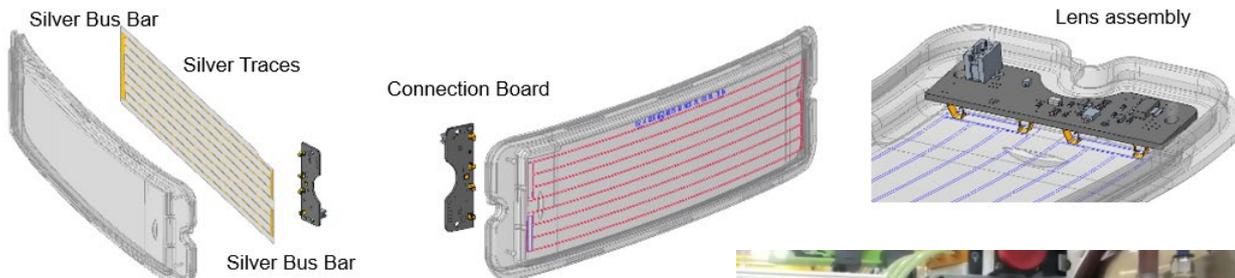
HSL Italia offers a comprehensive portfolio of full-scope lighting modules, including integrated exterior panels, exterior display solutions, in-mold electronics, and OLED technologies. Their global production footprint spans three technology hubs and three production facilities, employing over 1,400 specialists and 180 engineers across 34,000 m² of manufacturing space.

By integrating cutting-edge technology with scalable manufacturing processes, HSL Italia aims to redefine automotive lighting through flexibility, efficiency, and enhanced user experience, ensuring that new lighting solutions meet both technical and aesthetic market demands while optimizing time-to-market and production costs.

J.W. Speaker – “De-icing technology for exterior lighting – ‘Smart Heat’ ”

Dragan Popovic

The presentation by Dragan Popovic from J.W. Speaker introduces Smart Heat, an innovative de-icing technology for exterior vehicle lighting, particularly in extreme cold environments. The transition from halogen to LED lighting in snowplows and heavy-duty vehicles has presented challenges, as LEDs generate significantly less radiated heat, leading to ice accumulation on headlamps. To address this issue, JW Speaker developed a conductive grid heating solution, utilizing silver ink screen printing on polycarbonate films.



This heating element is integrated into the lens assembly through a specialized injection molding process, ensuring durability, efficiency, and reliability. The system includes an NTC (negative temperature coefficient) resistor, automatically activating the heater between 5°C and 15°C, with power levels ranging from 1 W/in² to 3 W/in² depending on application requirements.



Films and PCBs are placed into injection mold

Testing demonstrated that Smart Heat technology clears 2-3mm of ice buildup in under five minutes at -30°C, significantly outperforming traditional methods. The second-generation Smart Heat Gen 2 incorporates nano-wire conductive overlays, improving power dissipation and response time, making it ideal for high-speed applications in extreme weather conditions.



Head Lamp with “Smart Heat” Technology

J.W. Speaker’s automated production process ensures precise manufacturing and scalability, positioning Smart Heat as a pioneering solution for maintaining visibility and safety in adverse winter conditions.

Bentley – “Heritage and Technology”

Andy Twiss

The presentation by Andy Twiss from Bentley highlights the brand’s commitment to heritage, craftsmanship, and advanced lighting technologies, ensuring best-in-class luxury and performance. Bentley’s lighting vision is centered on enhancing extraordinary journeys, integrating analogue and digital lighting elements to create a seamless and sophisticated driving experience. Bentley’s approach to lighting design focuses on exclusivity, quality, and superior craftsmanship, reflecting its low-volume production philosophy.



Bentley: “As a luxury brand it is important to uphold the true values which made it.”

The Bentley Bentayga headlamp serves as an example of how functionality and luxury are harmonized, ensuring that lighting is not only aesthetic but also highly functional. The integration of advanced LED and digital lighting systems enhances visibility, safety, and vehicle identity, contributing to Bentley’s signature design language.



Bentley Bentayga headlamp (2020 facelift)

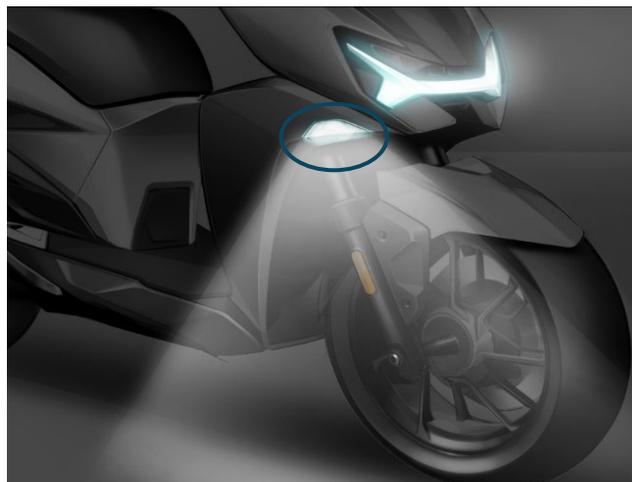
As part of its Beyond100 strategy, Bentley is transitioning toward sustainable luxury, with a commitment to introducing a new model every year until 2035 and launching its first fully electric vehicle (BEV) by 2026. This aligns with Bentley’s “Dream Factory” initiative, aimed at producing sustainable automotive luxury products while maintaining its heritage and brand values.

Bentley’s fusion of technology and tradition ensures that its lighting solutions continue to set industry benchmarks, delivering a unique and refined experience for luxury vehicle owners.

Hero MotoCorp – “Unfolding of new technology at Hero Motocorp”

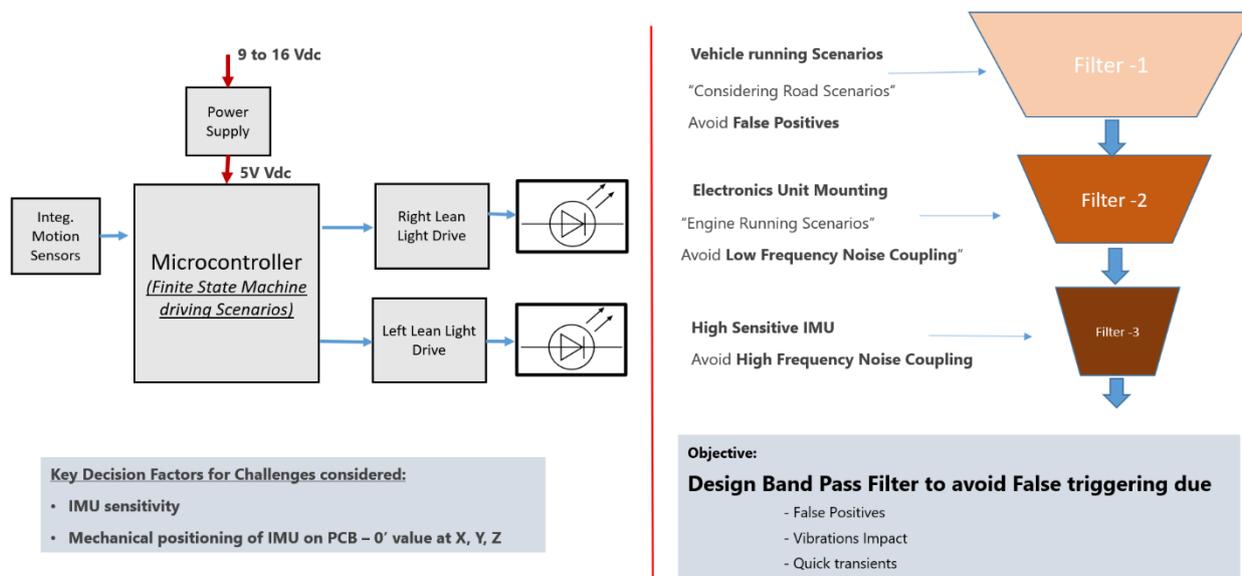
Rohit Sharma

The presentation by Rohit Sharma from Hero MotoCorp introduces the Hero Intelligent Cornering Light (HICL), an advanced additional lighting unit (ALU) designed to improve visibility and safety in two-wheelers. This innovation addresses a critical challenge: poor illumination in corners, which has traditionally been a feature in four-wheeled vehicles but absent in two-wheelers due to regulatory constraints.



Hero Intelligent Cornering Light for two-wheelers

The HICL system is designed to activate additional lighting when the vehicle leans beyond a predefined bank angle, ensuring improved road illumination during turns. The system integrates an Inertial Measurement Unit (IMU), which detects the lean angle and dynamically adjusts the light output. Through comprehensive track data analysis and vehicle testing, Hero MotoCorp has fine-tuned the system's activation thresholds to prevent false positives caused by road vibrations.



Hero Intelligent Cornering Light: Hardware and software filter design

The hardware and software architecture includes highly sensitive IMU sensors, band-pass filters to eliminate noise, and a microcontroller-based control system. The integration of dynamic and static behavior models ensures reliable performance across various riding conditions.

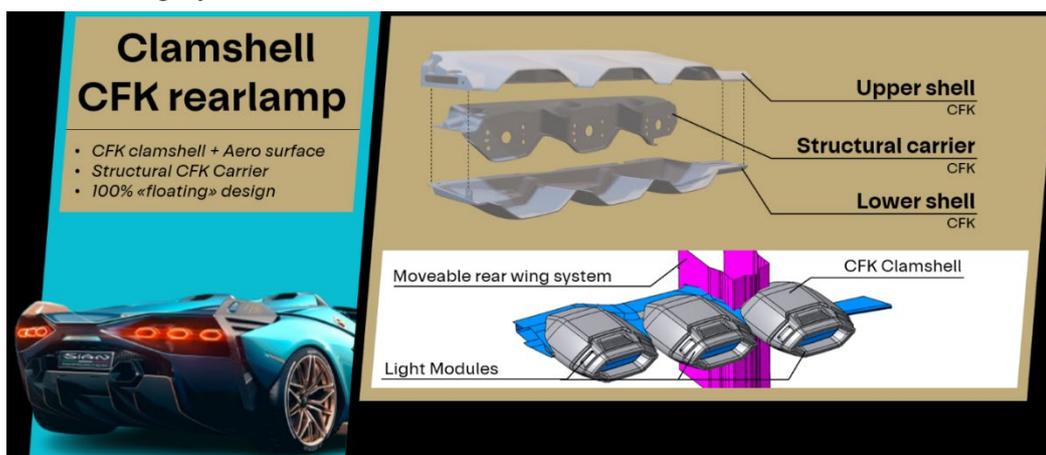
Testing results demonstrate that HICL effectively eliminates blind spots in night conditions, significantly enhancing rider safety. This groundbreaking technology showcases Hero MotoCorp's commitment to innovation and mobility safety, bridging the gap between advanced lighting solutions and real-world riding conditions.

Automobili Lamborghini – “Possibilities and design challenges of lighting on limited edition cars”

Francesco Micoli

The presentation by Francesco Micoli from Lamborghini explores the design and engineering challenges of lighting systems in limited edition vehicles. Lamborghini’s heritage and innovation drive the development of distinctive lighting solutions, integrating advanced materials, precision engineering, and unique aesthetics into its exclusive high-performance models.

One of the key challenges in limited-edition lighting design is balancing functionality with aesthetics while maintaining Lamborghini’s signature sharp, futuristic styling. For example, the Sian FKP 37 features a carbon fiber composite (CFK) clamshell rear lamp with a fully floating design, which enhances aerodynamics while maintaining structural integrity.



Lamborghini SIAN FKP 37: Clamshell CFK rear lamp

Similarly, the Countach headlamp incorporates a CFK inner bezel within a polycarbonate outer lens, improving durability and weight efficiency. Another innovation is laser engraving on day- time running lights (DRLs), showcased in the SC20, which enhances light diffusion and aesthetic appeal. However, Lamborghini engineers must address quality control issues such as lacquering flaws, degassing risks, machining inaccuracies, and vibration-related stress fractures.



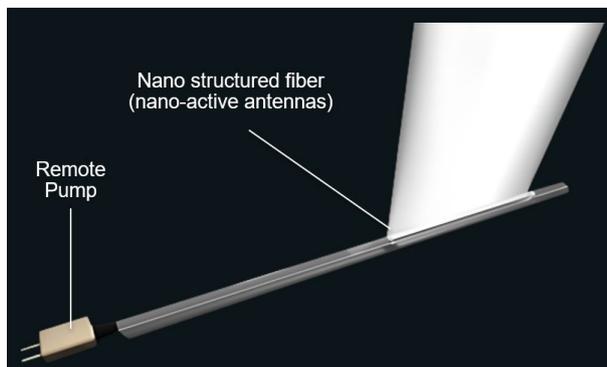
Lamborghini SC20: DRL lamp with laser engraving

Despite these challenges, Lamborghini continues to push technological boundaries, ensuring that each limited-edition model integrates cutting-edge lighting technologies that align with the brand’s vision of exclusivity, performance, and craftsmanship. This commitment solidifies Lamborghini’s position as a leader in luxury automotive lighting innovation.

L.E.S.S. – “LUXIBRIGHT™: Enabling High-Intensity, Lightweight & Ultra-thin Lighting Functions”

Yann Tissot

The presentation by Dr. Yann Tissot from L.E.S.S. SA introduces LuxiBright™, an innovative nano-structured fiber lighting technology designed to replace traditional LED systems in automotive applications. This proprietary technology, developed as a spin-off from the Swiss Federal Institute of Technology (EPFL), enables ultra-thin, high-intensity, and energy-efficient lighting solutions while significantly reducing weight.



LuxiBright™ Technology: Ultra-thin, high candela light source

Unlike conventional LED lighting, LuxiBright™ utilizes nano-active optical fibers activated by laser sources, allowing for unmatched brightness and uniform light distribution within a compact and lightweight form factor. The system eliminates the need for additional optics or reflectors, reducing weight by up to 30 kg and power consumption by 30% compared to existing solutions. It also meets ECE and SAE regulations with fully customizable light intensity, color, and beam angles.



LuxiBright™ Technology: Applications with light intensity and electrical power consumption

Key automotive applications include daytime running lights (DRL), turn indicators, taillights, and autonomous lighting. LuxiBright™ has been successfully integrated into the BMW M Hybrid V8 for endurance racing, demonstrating its high efficiency, robustness, and ultra-bright performance. Additionally, it has been featured in the Pininfarina PURA Vision concept, showcasing its ability to provide seamless, flush integration into vehicle designs.

With over 60 patents, IATF 16949 certification, and in-house production capabilities, L.E.S.S. SA is pioneering next-generation lighting solutions that enable lighter, more efficient, and highly adaptable designs for the automotive industry.

Session : EE

Chairman: Thomas Fröhlich

Magna – “Evolution of EE Architecture and Sensor Integration in Lighting” Luca Gioanola

Key Elements:

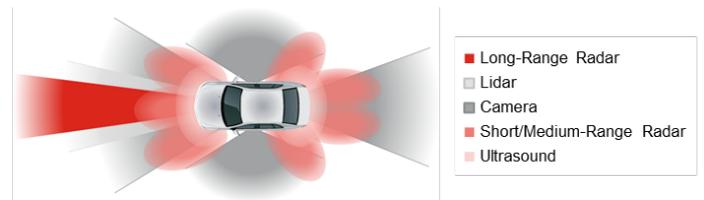
Radar has the best performances, more robust versus fog, dust and rain.

Lidars will become smaller and improve performance

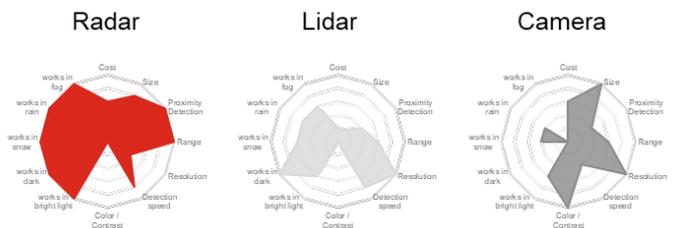
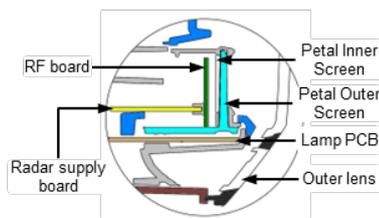
Magna proposes a combination of sensor and headlamp modules

ADAS and Lighting as unique domain

Promotion of standard approach – cost reduction



ADAS key Sensors



Electronic Architecture: It could be good to agree on one communication standard towards lamps, different ECU and topologies will cost extra money. Open points will be V2X communication and high resolution matrix as key roles for the future trends.

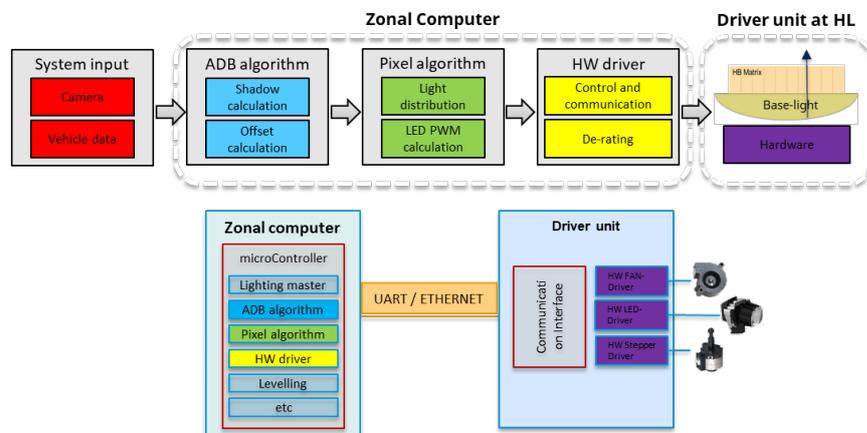
Marelli – “Marelli’s vision: Lighting within Zonal-Architectures”

Wolfgang Ritter

Key Elements:

Standardization means innovation. Our cars are becoming more and more mobile phones with app store and apps inside. LED-Driving units in headlamps have no software – that enables cost reductions and avoid software changes during production period. Software is still necessary, but will become an app running on zonal computers. Example was given with the ADB app. Any app will be downloadable. Innovation will become software with new functions, use cases user experience and AI. Innovation and app parts is also needed to distinguish between customer demands. This gives improvement of time-to-market, cost and deployment. New features, use cases & performance over vehicle lifetime. Positive is the decoupling lamp infrastructure from vehicle EE architecture

Marelli Vision: Lighting at Zonal Computers



Continental – “SW transformation for Light Control Units”

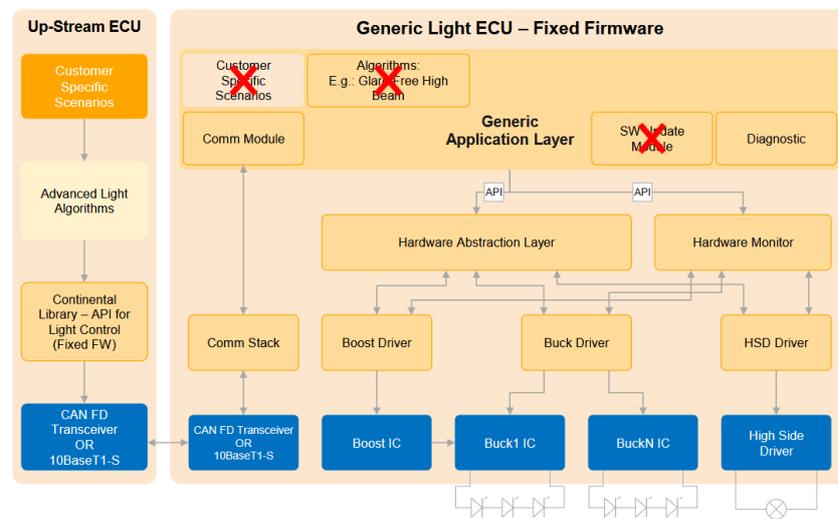
Ion Rosca

Key Elements:

Software Transformation: SW Defined Vehicle pushes industry for a centralized control approach and simplifying end nodes in the vehicle.

Current SW-less/uController-less solutions on the market rely on streaming of drivers commands for various ICs over another physical bus: CAN FD / 10BaseT1-S.

Continental Approach: Fixed Firmware with secured parametrization in light ECU. Transform Light Sources Driver (Buck-Boost, HSD, LMMs) into Light Segment Space centered on mechanical solution of customer. Fixed Firmware Safety Mechanisms (Low Beam, TI) and Built-in derating for HW Protection of ECUs. SW Components to be integrated in up-stream of the Light ECU (Customer specific scenarios, Advanced Light Algorithms (ADB, Dynamic Levelling, Glare-free high beam, etc.,) API for controlling Fixed FW)



Robert Bosch – “CAN FD light, the low-cost CAN bus for Lighting”

Gregor Sunderdiek

Key Elements:

CAN FD delivers Cost efficiency, removed external clock for slave nodes is saving of \$0,40 per device. Only master node still needs a clock. All bits sent at the same speed, much higher bitrate. Move software light application in Zone ECU. Trend for MCU-less end-nodes (reduced cost /complexity) Enable SDV (Software Defined Vehicle) for the end-node. Reduces risks because existing ECUs, Transceivers and cables can be reused, ISO 11898 standardized solution.



ams OSRAM Group – “Open System Protocol (OSP) enables innovation for Dynamic Light Applications”

Stefan Grötsch

Key Elements:

First focus interior, but protocol is open to all applications. Ambient interior first target with precise colours and various lighting spots all over the cars interior. System manages temperature with integrated sensors, colour correction not on the chip. LVDS between devices, Manchester Encoding and Bidirectional communication. System provides 2.4 Mbps data transfer. Daisy Chain master-slave architecture, Single-ended iRGB-LED Interface to μ C/Gateways. LED with integrated drivers for 300 devices.

amsOSRAM OPEN SYSTEM PROTOCOL is royalty free and open for partners and competitors. Coming extensions: sensors, external applications, front grill, rear light animation.



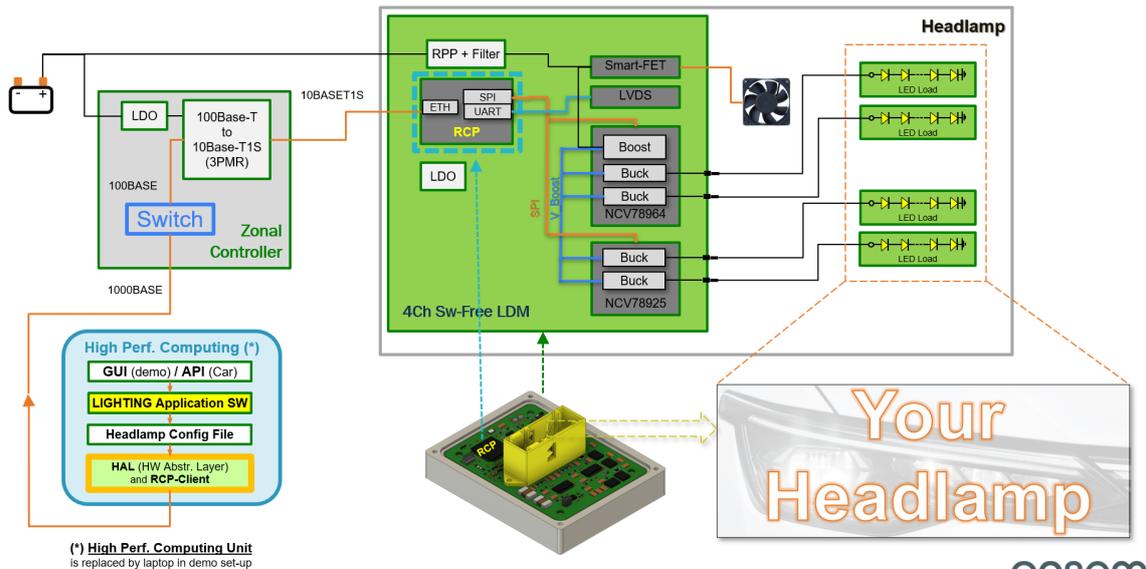
Onsemi – “Preparing Automotive Headlamps for the Era of Software-Defined Vehicles” Paul Decloedt

Key Elements:

No translation from one protocol to another. Ethernet can change data speed without changing protocol. Remove software from headlamp to central computer.

Software must be layered and responsibility has to be applied. First two layers are Customer experience: Inputs from Sensors and car /driver have to be translated to lighting application software. Other two layers are abstracting hardware independent commands into hardware commands in IC.

Ethernet Connected Headlamp Evaluation



7

Public Information © onsemi 2025

onsemi.

STMicroelectronics – “CAN FD Light controlled lighting in new EE architectures”

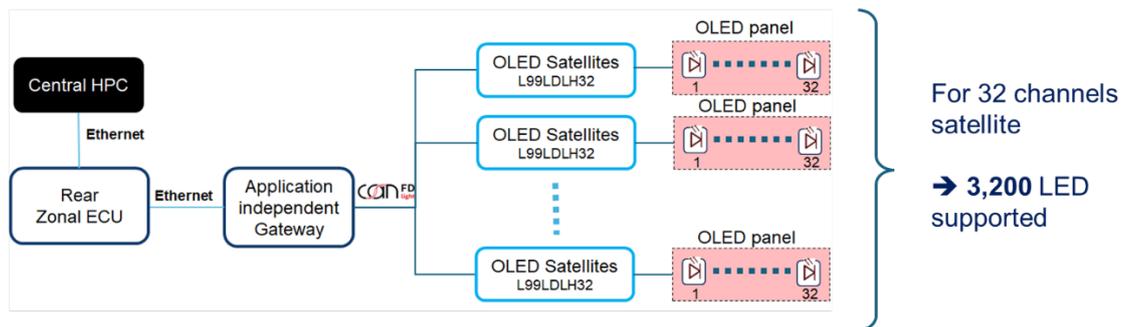
Marco Giudici

Key Elements:

CANFD light is designed to remove the need for an MCU in edge nodes. Moving the software into the domain controller and the network interface into the actuator / sensor hardware reduces the end-node complexity. Protocol is supported by existing CAN FD controllers. More cost efficient than CAN FD. Gateways are flexible and this bus is ISO 11898 standard. Example was given for OLED panels.

More than 100 satellites supported per CAN FD light bus

- Conservative estimation based on lab evaluation



Infineon Technologies – “How Infineon’s smart LED drivers enable SW-less architectures in automotive lighting”

Pierre Mehn

Key Elements:

Moving SW from lamps to Zone Controller requires “smart” LED drivers or gateways.

Two solutions: 1) directly driven from zone controller - Split of the ECU functionalities between the LED drivers with bus interface and the zone controller Control and diagnose of each light function in the zone controller

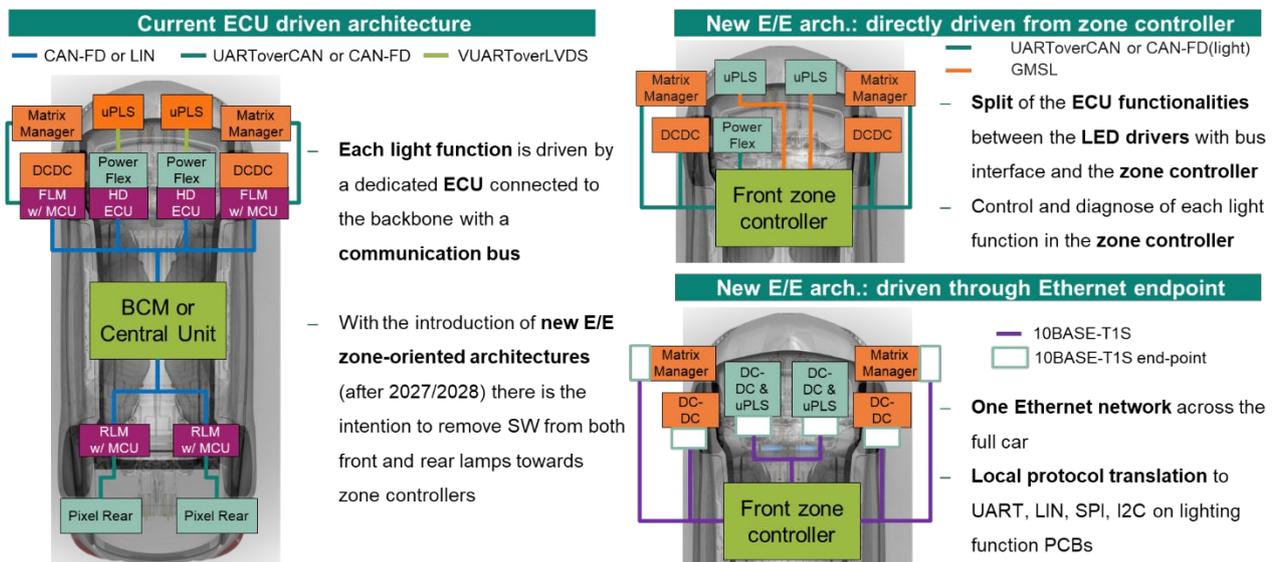
PRO: Lowest cost solution, No ECU or gateway needed, No royalty fees for Ips

CON: Dedicated support for custom interface needed, Difficult to mix IC’s on same bus

2) driven through Ethernet endpoint - One Ethernet network across the full car. Local protocol translation to UART, LIN, SPI, I2C on lighting function PCBs

PRO: Ethernet px addressing, Mix different ICs on endpoint

CON: Required Gateway produces higher cost



Melexis – “Exterior Display Trends & Innovations”

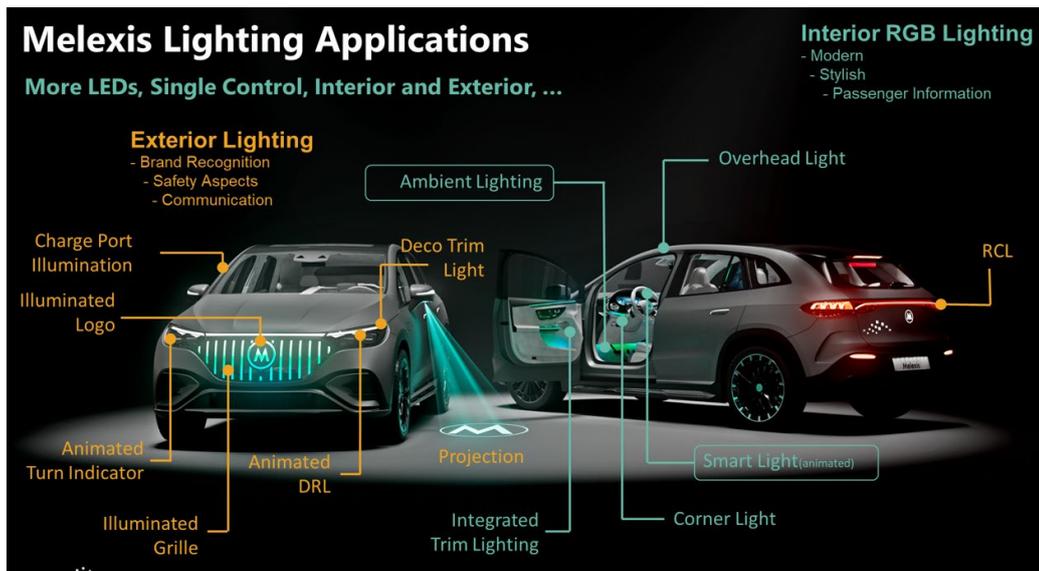
Andreas Laute

Key Elements:

Newer Cars have decentralized architectures with CAN, FLEXRAY and Ethernet. Display use cases for exterior are new and increasing. Grilles, Front bars, Panels are on the rise. Typical resolutions can range from 500 to 5000 pixels – not comparable to TVs, but need special drivers. Hardware requirements: 5V supply for driver IC and LEDs, higher supply voltage for stacked LEDs, e.g. for 48V board net. DC/DC converter support, e.g. via SPI or analog/PWM

wide LED current range of some mA to 100mA, fail safe, ASIL B.

Advanced Multiplexing (Scanning functions) are needed. Melexis offers scalability of high number of LED drivers using their MeLiBu® 2.0., f.e. applied as UART over CAN. This bus delivers 4 Mbit/sec.. 10BASE-T1S endpoint needed to connecting to the vehicle bus. Cyber Security integrated.



Inova Semiconductors – “ISELED – From now to Next”

Gerhard Nill

Key Elements:

Smart RGB LED with driver inside same package applying Iseled bus. All management functions inside LED. Same lighting configuration in Zonal Architecture. Only Application software running somewhere in the car. Centralized single point of SW enables Drastically simplified SW management - avoids coordination of different Tier1 SW required and allows Simple synchronization of lighting scenarios. Easy OTA SW updates at no additional cost, allows „lighting as a service“. Fully calibrated Smart LEDs Alleviates Tier1 from system calibration efforts – reduces system cost. Inova predicts BOM cost reduction. Licensing with Lextar coming. Actually since 2021 over 350 million smart LED on the road. 0 ppm defect rate on driver.



Session : Innovative Technology Start-Ups & New Player

Muth Lighting – “Understanding light and darkness and how it relates to automotive lighting” Robert Miller, Executive Director / Board Member, Innovation & Design

The first speech of the session drives us through the fascinating world of light and darkness contrast, two sides of the same coin. The presentation of Robert Miller, with his over 31 years of experience in interior and exterior lighting design, wants to teach new and valuable ways to think about and creatively apply light.

With several examples, Miller demonstrates that darkness in the design demands light to define its presence and light enhances contrast, reveals form and breathes life into motion. Examples of these basic concepts come from architecture and nature, where natural spot lights, diffusion, transparency, reliefs, projections, outlines, shadows and movement are normally visible for a careful observer. The same concepts can be applied to automotive lighting for both exterior and interior designs: several pictures in his presentation are used to demonstrate the practical use of these effects with the support of design technique, material science and electronic / software and optical expertise.



Also chromatic harmony is important in the design of a comfortable interior design and tunable color temperature of the interior light can be used to move from warm to cold white passenger compartment

illumination, matching the circadian cycle of natural light.

Miller, in his conclusion, invites designers to take a moment to seek the uniqueness of how light and darkness can work together.

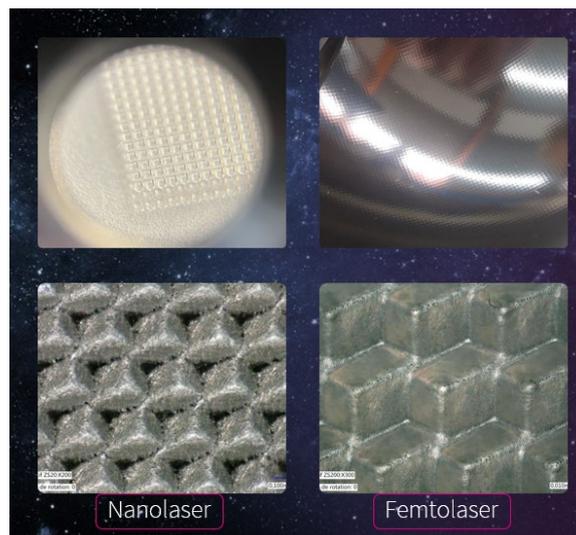
Reichle Technologiezentrum – “Innovative technical lighting surfaces via modern laser technology”

Maximilian Blackwell, Head of Sales & Logistic

Maximilian Blackwell drives the audience through the technology of femtosecond and nano lasers processing to generate fine diffusive structures. The most important advantages of laser structuring are the high reliability thanks to “hand-off process”, consistent structure reproduction with fixed parameters and machine settings once established, global standardization due to centralized customer support, data management and programming all done in the same site, sharp graining boundaries and high-quality engravings, possibility to create 3D-textures on 3D-surfaces, sustainability of the laser machining process and much more.

One reference of the market is VDI3400 texture, classically processed by electrical discharge machining during plastic mold making or successive chemical etching: several optical design databases (for example LightTools®) allow simulations with this type of diffusive fine structure. With LASER machining is possible to realize on a workable space of 4000x3000mm fine grainings without quality fluctuation, HWHM angles from 1.8° to 18°, replicability by injection molding process, flexibility to change scale of peaks and valleys, gloss levels, fade outs etc.

Blackwell illustrates, with support of microscopy images, the capability of femtosecond lasers and nanosecond lasers to create innovative optical surfaces having a great level of details with sharpened edges according to 3D-data, three-dimensional optics smaller than 100µm and minimum radius of 10-20µm, possibility to increase homogeneity of lenses due to diffusive fine structures on top of the optics, coherence of optical performances of protos and final parts, all possible on a machinery area of 2500x2000mm.



Niebling – “Film insert molding: forming illuminated front panels and headlamps for EVs”

Udo Weustenhagen, Director Sales & Marketing

The capabilities of high-pressure forming solutions are illustrated by Udo Weustenhagen. Niebling is a well-known supplier of forming & trimming equipment and tooling for the film insert molding process chain, where pre-formed and trimmed plastic films are back-injection molded. On the other side, Niebling is an innovation partner for TIERS and OEMs developing innovative solutions with high-pressure forming. The core competence is precise forming of plastic films or laminates with high repeatability, enabling aesthetic 3D plastic components which combine design and functionality in one single part. Plastic film becomes in this way a technology carrier with customized decoration options and smart functionality integration for a 24/7 mass production with automated in-line processes.

This technique is widely applied for both interior and exterior design and it started over 30 years ago with cockpit applications: initially 3D formed speedometer dials, expanding into applications like radio bezels, display covers, control panels steering wheel switches and door trims. Exterior applications began with radome chrome-look covers, now replaced by illuminated logos integrating radar and de-icing

THE FOUNDATION FOR YOUR INNOVATIONS
EMPOWERING THE DESIGNS OF THE NEXT GENERATION

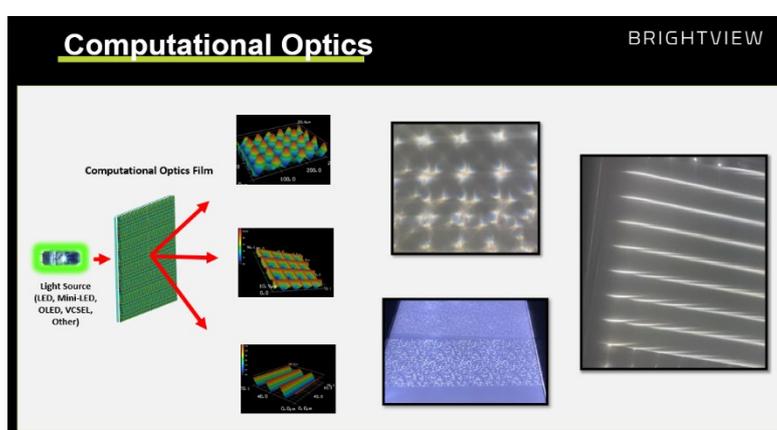
niebling



functionalities, where the heating layer is a key technology not only for radar but also for lidar operations, necessary for autonomous driving. Film insert-molding enables new headlamp design integrating lighting behind injection molded films: Weustenhagen presents an interesting concept rendering based on a Mercedes vehicle, highlighting the potentials of Niebling technology for advanced front panel decoration and illumination. Moving beyond rendering and prototypes, the company is going on at TIER and OEM levels with activities of research and development. In the conclusion of his contribution to the workshop, a new project in industrialization phase with FORVIA using over-molding of a thermoformed film is presented.

BrightView Technologies – “Novel automotive lighting solutions using computational optics” Jennifer Aspell, CEO

BrightView Technologies brings us in the world of micro-scale optics to enhance light efficient extraction and distribution for LED lighting, displays, virtual / augmented reality and three-dimensional sensing applications. In the automotive interior and exteriors, the applications of the proposed technologies move from consoles to head-up displays, to tail lights and interiors, with customized needs turned in reality. Quality is the foundation of the business in BrightView, with a manufacturing supported by a 1000-class clean room. The specialization of the company in the production of structured films containing arrays of micro-lenses, which design starts with optical engineers creating MLA (multi lens array) structures, then transferred in greyscale lithography process and replicated in master used to create robust tools for successive roll-to-roll process replication in the clean room. The last step of the process is the final cut and shipment of parts meeting customer specifications.



INEVO GmbH – “In mold coating for lighting and backlighted components” Andreas Popp, Managing Director

Andreas Popp starts his speech with a small introduction of the company, coming INCOS founded in Italy 37 years ago in a garage near Venice, passing through the evolution in HRSflow (hot-runners), INglass (injection compression molding tools) and finally INEVO in 2020. The company has today a turnover of 25M€, it produces more than 100 injection tools and 5Mio molded parts per year in 4 production sites. To provide an overview on the future in the lighting sector, Popp explains that INEVO is working on multicomponent injection with film in IMD/IML and PUR coating; he also provides some basic information on most common tool concepts (rotary, spinform and double spinform). The core of his contribution is the in-mold coating for lighting and backlighting components, with an exemple of a component composed by core in transparent PC a overmolded internal and external film, a further PUR layer and a black PC-ABS structure; the new double-spinform machine is also presented. The presentation ends with a couple of images illustrating potentials of this technology applied to concept cars with light going beyond just illumination.

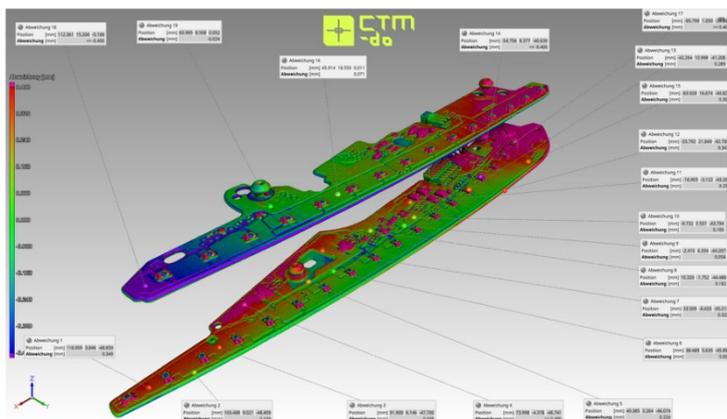


CTM-do GmgH – “Identify lighting improvement potentials via computer tomography”

Bob Knauff, Managing Director

CMT-do is a company specialized in advanced quality control through computer tomography (CT) scan and evaluation, who developed its own calibration algorithm for accurate analyses and a FEM-solution approach. With an experience of more than 15 years of experience in CT, Bob Knauff explains the wide range of industries needing the services offered by his company: from archeology to consumer electronics, from fire protection to medical engineering. The part more interesting for lighting applications is the 3D characterization of mechanical components and LED boards.

He shows an analysis performed to measure deformations of a complete device, composed by a lens, a housing and internal components assembled and welded, respect their original CAD data, with a colored map highlighting where deformations occur and how much they are. Moving to internal components, his analysis focuses on 2 LED boards containing a plurality of LEDs and other electronic components, each board being referred and fastened in its position into the device with some pins and 2 screws. In this case the colored map indicates where there are deformations in scanned components respect their expected CAD position and additionally an image with data inside callouts illustrates the numerical deviation of the control points respect the design.



Murata Electronics – “Headlight levelling using MEMS inertial sensors”

Iivari Heikkilä, Product Manager for new concepts

The presentation of Murata Electronics illustrates the possibilities of automatic headlight levelling devices defined in UNECE regulations for introduction in 2027 for new type approvals and in 2030 for all ordinary vehicles. Factors that the levelling components have to consider are in static condition passenger and cargo loads, in dynamic road geometry slopes and speedbumps, in vehicle dynamics acceleration squat and brake dive. The electronic solution offered by Murata is its SCH1633 sensor: the MEMS sensor may be placed directly into the ECU, eliminating the need for additional height sensor and wires, helping to reduce equipment approximately up to 20€ cost and 1kg saving compared to conventional mechanical sensors. The MEMS sensor directly measures the car angle, constantly updating the light position to be pointing at the road, with saturation resistance ensuring a continuous signal even on rough roads. This system is also able to compensate for harsh braking and accelerating and for any change in weight distribution inside the vehicle, making sure that lights are always at the perfect operating angle.



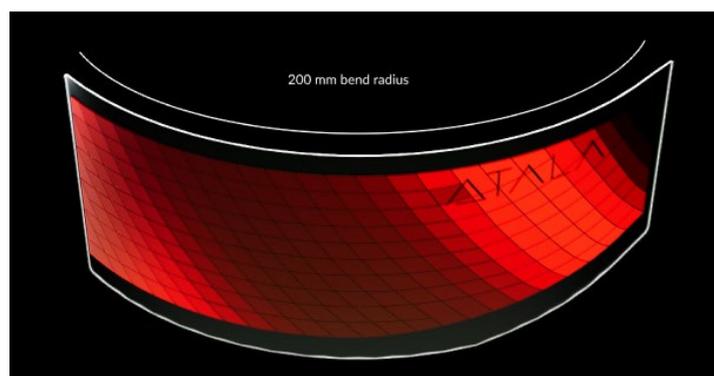
OLEDWorks – “Beyond illumination: shaping the future of vehicle lighting with bendable Atala OLED”

Philip Mooney, Director of Global Sales

OLEDWorks drives the audience through an overview of OLED lighting which represents a groundbreaking advancement in illumination technology. Main characteristics of OLEDs are the uniform emission across their surface whilst providing high contrast and glare-free illumination, their thinness, flexibility, and energy efficiency; additionally, OLED lighting offers unmatched design and application potential.

The presentation is then focusing on unique features of bendable Atala OLED technology, offering ultra-thin and lightweight design (<1mm), seamless integration and enhanced customization opportunities including the creation of a unique personalized design. Among safety advancements, Philip Mooney illustrates the improved visibility at wider viewing angles to ensure a uniform glare-free illumination and a clear V2X communication,

the possibility to illuminate the full rear width of the vehicle to better perceive its position and the dynamic lighting features for sequential turn signal and dynamic hazard indicators. Among sustainability benefits, the presentation lists energy efficiency (less power and lighter component), longevity (>15 years) and recyclability (made of glass and organic materials).



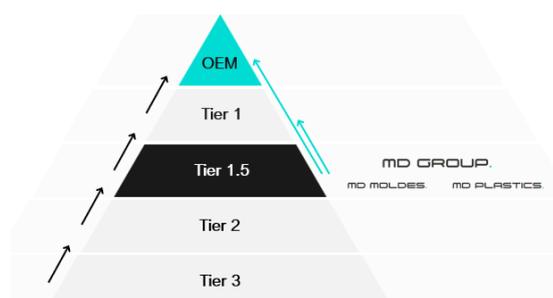
After a description of expected advantages of Atala OLEDs, the timing for the implementation of a bendable solution is presented: currently project phase is “in validation”, a start of production will follow in 2025 with first bendable product on the road expected for mid-2026. Mooney concludes his speech with the proposal for a joint development program to realize real-world OLED applications and a partnership to bring bendable OLED lighting to life through collaborative innovation to accelerate R&D, cost-sharing to effectively manage development investments and ongoing support to ensure seamless market entry.

MD Group – “New ways of working: Tier 1.5 approach”

Bruno Machado, CEO

MD Group is a company aiming to be a relevant lighting supplier in the market. It is specialized in high precision manufacturing solutions, keen on investing to support strategic partners on moving forward technologies. With the ambition to be wherever its customers and partners wish MDs to be, the company is headquartered in Portugal but it is investing in other regions across the globe with a presence in Asia and in North America and serving its lighting customers from Portugal, China and Mexico, with a turnover of the group being forecasted to 71M€ in 2025. The company considers illumination as a driver of innovation in manufacturing, it qualifies as a world reference in high advanced manufacturing of precision components and a driver of innovative projects solutions. This distinctive positioning brings flexibility, cost efficiency and engineering solutions to a very challenging lighting market. Being a Tier 1.5 supplier, MD carries responsibility and commitment to all stakeholders and it fills the gap that is often open when market is uncertain about level of requirements and technologies needed. The vertical integration of high-tech tooling,

New ways of working: Tier 1.5 Approach.



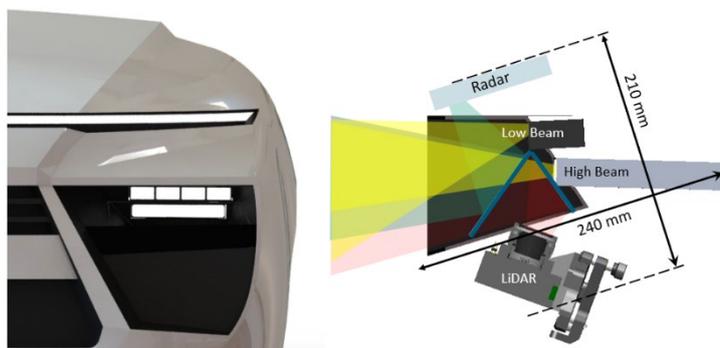
demanding precision products and sub-systems manufacturing, is an essential context for Tier 1,5 Suppliers. Bruno Machado concludes his speech with highlighting how product design and development, tooling manufacturing from prototypes to series, sub systems integration using the best practices and the right partners, are key factors to play this role of Tier 1.5 especially in a fast-growing market.

Fraunhofer Institute – “Smart headlight - Innovative approach for integration of light, LIDAR and radar into a headlight”

Martin Kratz, Group Leader at Fraunhofer ILT, Fraunhofer Institute

Martin Kratz provides with his lecture an excellent description of potentials offered by laser-based optics manufacturing.

Smart-Headlight: Takeaway



The focus is on optics for automotive, but in the first part of the presentation the study approach explores the multispectral integration with the target to combine in one headlamp a lens for road illumination, a remote LiDAR transparency and a remote radar emission reflector. This result is achieved with addition on a glass polished substrate of a transparent and conductive silver film mesh composed by 3 μ m width lines spaced at 150 μ m pitch. This kind of thin and quite invisible mesh, realized with ultra-short pulses laser micro-structuring, can guarantee low reflection losses for LiDAR and light, low attenuation of reflected radar signal with no glass substrate damage and film delamination. Some laboratory measurements

allow to assess the proposed concept: a smart headlamp with a dimension of 360x210x240mm (width x height x depth) containing a Radar with 25°H x 90°V FoV, a LiDAR with 30°V x 40°H FoV and a visible light exit height of 68mm demonstrated to have 1dB total radar loss (2-way) for combiner, 88% transmission of visible light and 97% transmission for LiDAR. With such design it is possible to integrate without important losses radar and LiDAR into a headlight with freedom of design, being sensors completely hidden and with the additional cost of only 2 more components easy to manufacture.

In the second part of his presentation, Kratz illustrates the applications of laser-based processing in optics. Depending on materials, laser can be used for glass form generation with etching and/or ablation, for surface polishing, for shape correction, but lasers can also be used for marking, cutting and packaging. Laser processing can be considered a supplement to the established (classic) manufacturing processes or an enabler for innovative hybrid process chains classic+laser. The advantages of laser applications depend on parameters like geometries, flexibility, process speed and substates: the right consideration of unit costs, product complexity and lot size shall be investigated to take a decision on digital photonic production convenience.

Session : ADB & Projection

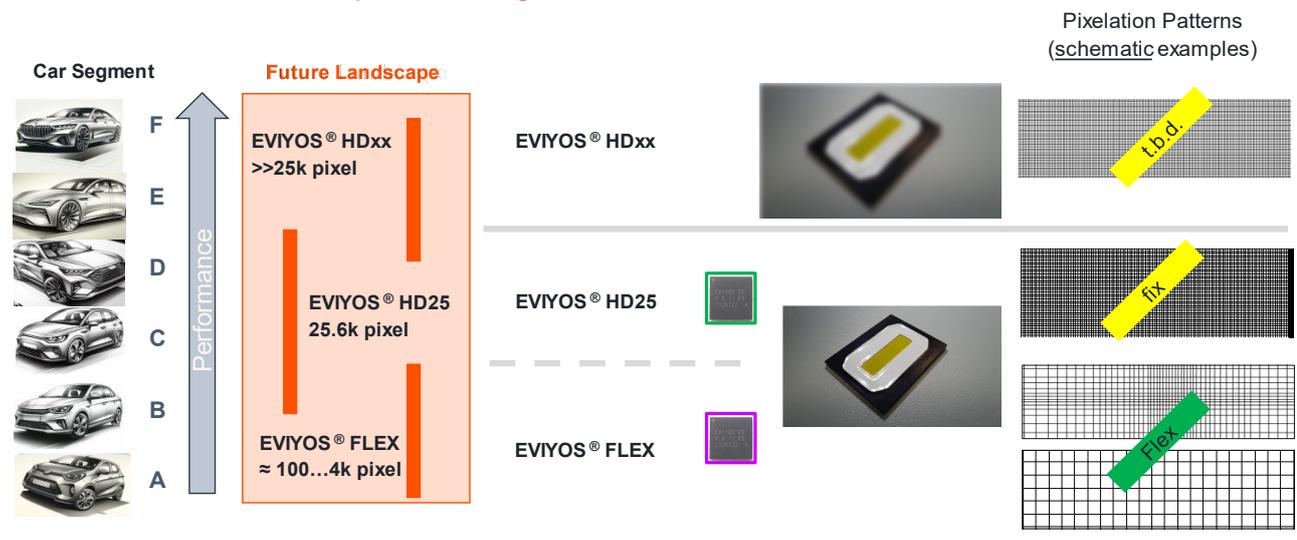
ams-Osram Group – “Simplified HD matrix system” Markus Hofmann, System Solution Engineer

New players on general lighting for LEDs and electronics are moving to Asia. In second step they try to enter automotive business.

Therefore it is important for Europe and America work on innovative bulbs/LED solutions to keep ahead. Eviyos is in production for HD applications with 25.6k pixel. To close the gap between this and applications with single LEDs up to 100 Osram is working on a flexible solution called Eviyos flex.

Dynamic Forward Lighting – High/Mid Resolution

Product Placement and Platform Optimization using EVIYOS

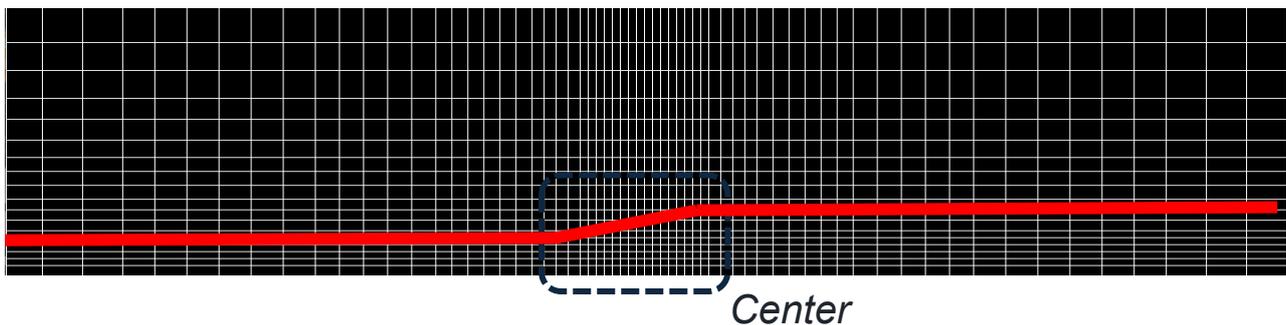


Pictures generated with AI

4

ams OSRAM

The pixels of the flex solution can be of different size and can be mapped in different groups to achieve high resolution in areas where needed.



Using the Eviyos flex several simplifications on system level are available:

- No HD processing: Usable in architectures with limited CPU power
- Simplified interface: UART over CAN-FD for Video and control interface
- Use of standard transceivers, connectors and cables
- Single Power DC-DC instead of multiple DC-DC in case of Matrix manager
- Simpler optics

Nichia – “Nichia Light Engine Approach for ADB Applications” Christopher Zilkens, Manager Automotive Innovation Center

Nichia has established their first Automotive innovation center (NAIC) outside Japan in Aachen to support customers with innovation and application.

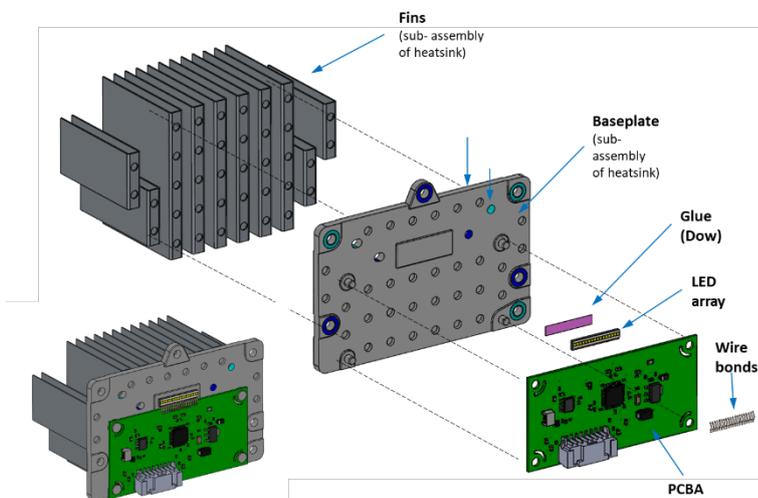
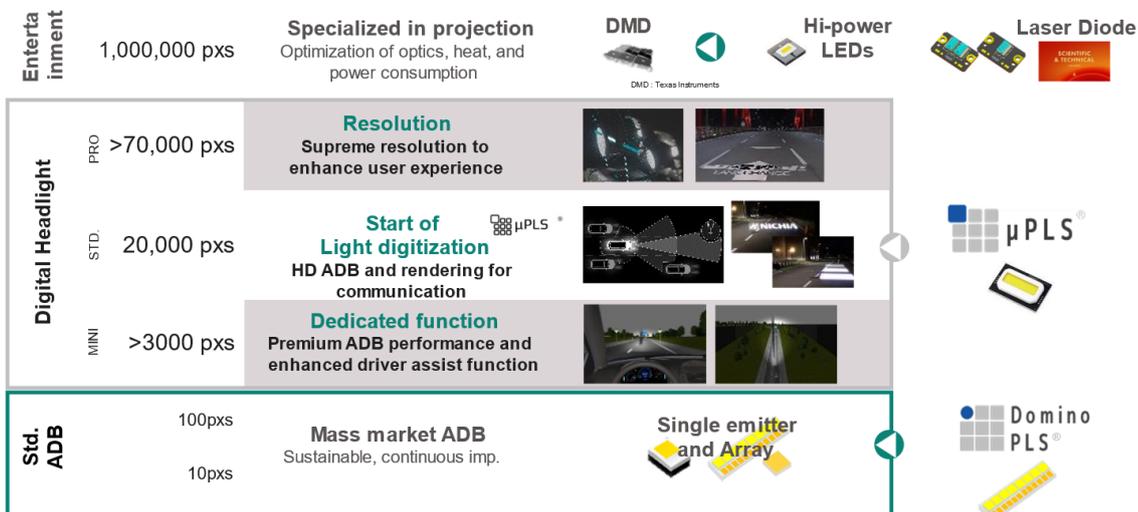
Christopher sees a strong growth in ADB applications until 2028 worldwide.

ADB Headlight	2023	2024	2025	2026	2027	2028
Matrix LED	3.3	4.9	6.7	9.8	13.0	13.9
Micro LED	0.002	0.02	0.1	0.4	1.4	4.0
DLP	0.10	0.10	0.10	0.09	0.08	0.07
Total (M Cars)	3.4	5.0	6.9	10.3	14.5	18.0

Source: TrendForce, December 2024

To support this trend they have designed a portfolio of LED solutions ranging from arrays with 16 and 24 Pixels per row (Domino PLS) over μ LED solution (μ PLS) up to Laser Diodes.

Nichia LED Solutions for ADB Headlighting



Therefore they offer now also μ LED and LED arrays with optimized thermal interface. To allow solutions without additional investment on customer side they offer already complete assembled Light engines including heatsink which can be operated up to a T_j of 150°C.

Lumileds – “ADB direct imaging solutions on the road”
Lars Dabringhausen, Head of European Technical Competence Center

Lars explained the possibility to move from collimated multi-row ADB systems to direct imaging solutions by using closely spaced LED arrays like their Luxeon Neo Exact.

This direct imaging offers several advantages like more system compactness and increased assembly robustness which is today difficult using the collimated ADB systems.



Key Benefits of Direct Imaging Systems for ADB

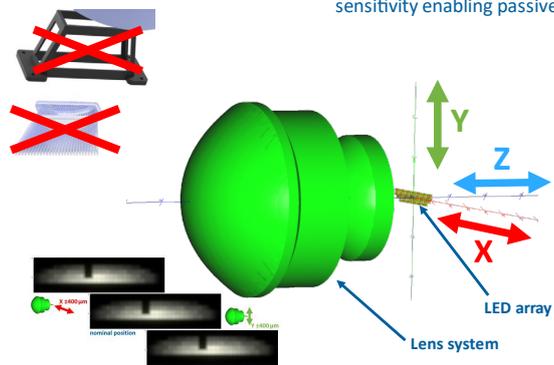
#1: System Compactness

- more than 50% volume reduction vs. „finger-optics“ collimated system



#2: Reduced System Complexity

- reduced number of components



No beam distortion with X,Y± 400µm and Z ± 150µm

Based on Lumileds Application Demonstrator (see earlier publications)

#3: Assembly Robustness

- reduced LED position tolerance sensitivity enabling passive assembly

They have solutions available where they place their LED chips of 1.0 mm² or 0.5 mm² with a gap of 50µm in one or more rows. The Pixel count can be quite flexible customized.

For optimized board design their LED arrays can be mounted either on FR4 with AlN inlay or with TopContact Interposer solution direct glued to the heatsink.

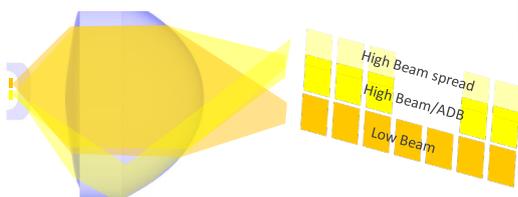
The high contrast available with this technology offers also benefits for ADB solutions designed for US FMVSS 108.



Outlook: next level direct imaging systems, functions combined

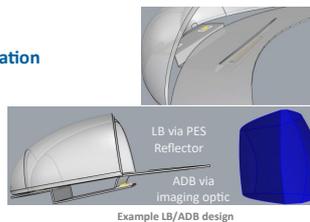
Preoptic to separate LB and ADB/HB spread

- Single module for adaptive LB/AFS and ADB
- Higher design freedom



ADB/LB combination

- Single module
- Compact



Lars gave an outlook on the next level of direct imaging systems with the possibility of combined LB and ADB/HB functions in one module allowing even more compact designs.

©2023 Lumileds Holding B.V. Confidential | February 28, 2025

Maradin – “New capabilities for interior and exterior lighting using laser projection”
Matan Naftali, CEO

As the digital world changes in real-time Matan presented the possibilities using their Laser projection solution.

Safety

Personalization / Appeal

Functionality
Signaling

New capabilities Exterior lighting

ADDED VALUE

- + Large Field of View: 45°x30°
- + Multiple projectors can be synchronized
- + Clear and sharp images
- + Changeable FoV
- + Bright due to laser power
- + Projected on any surface

Credit to: Hyundai Motors Europe Technical Center

Maradin PROJECTING THE FUTURE

Their Eye-safe RGB projection can be used for exterior and interior applications in a wide range.

The Laser projection works focus free and is therefore easy to implement also to project on uneven surfaces. Their solution is very compact (size around 2 sugar cubes) and can allows various implementations.

Matan compared the existing solutions of MLA and DLP with their Laser projection to give an idea of potential use cases.

	MLA		DLP	Maradin PROJECTING THE FUTURE Laser Projection
	1ea	4ea	Digital Light Processing	
COLOR	Single (white)	Colorful (ea in different color)	RGB	RGB
CONTENT	Static	Quasi-dynamic (4 images)	Full Dynamic	Full Dynamic
VIDEO CAPABLE	No	No	Yes	Yes
RESOLUTION	20K pixels	20K x4 pixels	194K pixels	>600K pixels
GROUND PROJECTION	Limited to simple images	Limited to simple images	Limited to simple videos	Always in focus. Complex images are possible
INTERIOR LIGHTING	Limited to specific locations	Limited to specific locations	Limited to specific locations	No limitation on projection angles and integration locations

Infineon Technologies – “Projections investigation based on MEMS”

Emanuele Bodini, Senior Director Business Development and Innovation for MEMS

Emanuele presented their solution of a Mirror MEMS which can enable Laser scanning applications for exterior and interior projection.

Advantages of a Mirror MEMS Laser scanning projector are:

- High energy efficiency (LED only switched on when needed), up to 90% saving
- Compact size compared to DMD projector
- Focus-free projection
- High contrast (> 1:6.000)
- Dynamic adjustment of projection field

Infineon offers a complete system solution including MCU, Mirror (size of 1-2mm diameter) and Drivers for Mirror and LED to allow a seamless and robust integration. They can operate up to 6 laser channels in parallel.

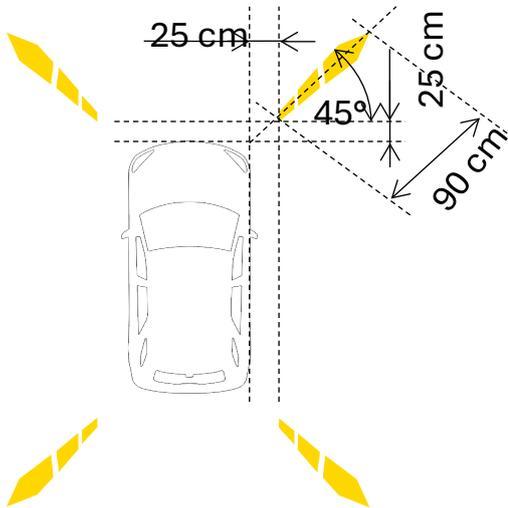
The projector can be used for exterior applications like dynamic signalling, dynamic logo projection, visual parking assist and welcome carpet projection due to the high brightness and small form factor.

Standard resolution used is 320*240 px using according to the application different LED colours (Amber, Monochrome White, Red, 16 Bit RGB)

Mercedes-Benz – “Signal road projection of the turn indicator: Investigation at different speeds and scenarios”

Philipp Trojan, Development Engineer

Mercedes-Benz sees high safety benefits in applying road projections of the turn indicator. They see as main benefits the avoidance of accidents with pedestrians, bicycles and other road users making the surrounding area of the vehicle more safe.



Luminance is 1100lx

They investigated different situations at different driving speeds

Therefore they investigated different use scenarios with an TI-arrow of 900 mm length at different speeds. The arrow is projected in all four corners in addition to the standard TI mounted in the corners and the external mirrors.

Activation is done according driving direction.

Procedure of the study

Overview of the investigated scenarios

Situation	Scenarios	Low speeds < 15 km/h	Medium speeds approx. 50km/h	High speeds > 100km/h
Parking situation		✓		
Intersection		✓		
Highway				✓
Hazard warning		✓	✓	

Observer

Mercedes-Benz SRP of the turn indicator | DVN Munich Workshop 2025 5

Results & Outlook

Summary & Proposals

- Activation at low speeds < 15 km/h sufficient
- Positive feedback of the hazard warning flasher at low speeds
- In parking situation, projection out of both car sides in reverse direction positively rated → Actually, not intended by law
- Projection out from the front and the rear desired
- No benefit at high speeds in the investigated scenarios
- Projection of the turn indicator beneficial in total**

Situation	Low speeds < 15 km/h	Medium speeds approx. 50km/h	High speeds > 100km/h
Parking situation	✓		
Intersection	✓		
Highway			✗
Hazard warning	✓	✗	

Mercedes-Benz SRP of the turn indicator | DVN Munich Workshop 2025 12

Investigations show that that the usage at low speeds <15km/h offers a lot of benefits. Instead the usage at high speed is not giving a lot of benefits at least in the investigated scenarios.

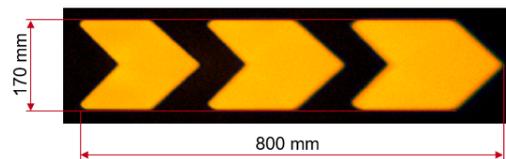
Philipp expects that the regulation will enable the usage starting mid 2025 as ECE discussion is still ongoing in the next months.

Odelo – “Efficient optics for signal road projection”

Thorsten Hornung, Optical Engineering for Predevelopment

Odelo is working on TI projector solutions to be visible also during daylight.

- Illuminance of more than **2500 lx** (yellow light)
 - Visible at days with overcast sky or in the shade
 - Proposed legal regulation: max. 12 000 cd
 - 220 lm **on road** → currently **impossible** with one single high power **yellow LED**
 - The higher the optical efficiency the lower the number of LEDs needed



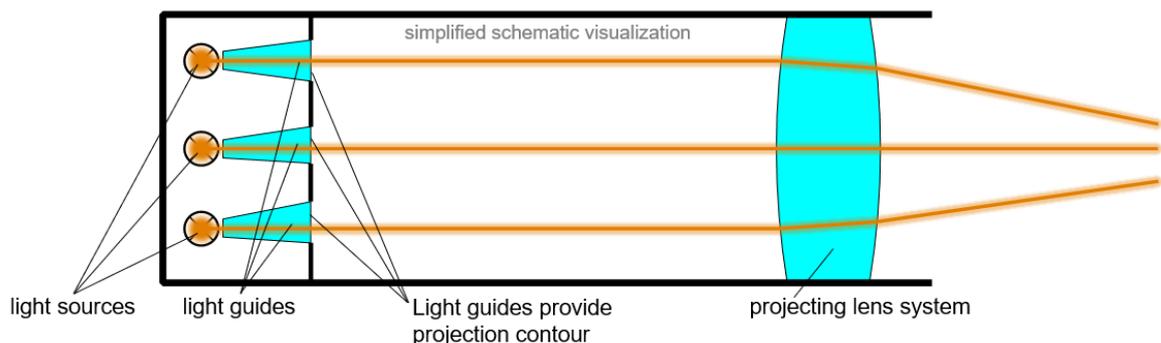
Their application and request for regulation is based on a TI with a length of 800mm composed by 3 chevrons and an illuminance of minimum 2500lx.

As the required illuminance of 2500lx is difficult to achieve using only one LED they have designed a projector using 3 LEDs which can be animated sequentially and dimmed.

This solutions avoids to loose a lot of luminous flux due to usage of light shutters.

odelo Projector – Functional Principle

odelo
Automotive Signal Lights



- Multiple light sources ✓
- Light usage maximized ✓
- Segments can be activated sequentially ✓
- Homogeneous projection on strongly tilted surface facilitated ✓

The Odelo prototype is operated with 4,7W and passive cooling. It shows a homogenous projection on tilted road. Investigations showed that the visibility on a sunny day in a shadow area is quite good. With direct sunshine on the illuminated road surface the visibility is not perfect.

BMW – “Visibility requirements for interior projections”

Alexander Stuckert, Project manager for projections in MINI

Statistical investigations of Statista on the most important vehicle features in the purchase decision for German market show that a good interior equipment ranks on second place behind low fuel consumption and ahead of easy operation and high driving comfort.

This shows that the trend of attractive interior equipment is an important selling point not only for Asia but meanwhile also for Europe.

The BMW Mini team started investigations into the visibility for interior projections taking into account on one side the user age and preferences and on the other side the impact of the environment as of surrounding light and surface conditions.

Their study is based in a first shot on 33 participants representing all age groups between 18 and 59 years old.

They investigated four different projection surfaces resulting in different luminance on the dashboard projection.

The result was a various brightness on the surface.

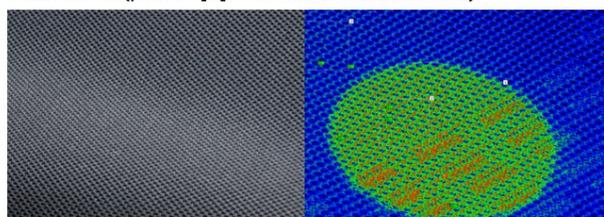
- Parameter:
 - Round target (75 mm diameter) on various surfaces
 - Viewing distance: 600 mm
 - Ambient luminance: ~45 lx

Materials	Luminance on dashboard [cd/m ²]
Leather dark	0.39
Cotton dark	0.77
Leather bright	4.09
Cotton bright	3.39

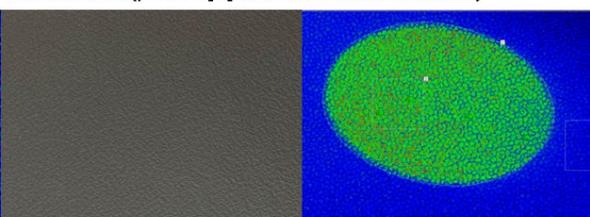
- Overview of the illuminance levels and Weber contrasts ($C_w = \frac{L_{Target} - L_{Background}}{L_{Background}}$ [6]) of the various brightness:

Grey scale [hex]	Cotton bright C _w	Cotton dark C _w	Leather bright C _w	Leather dark C _w
080808	0,02	0,09	0,05	0,12
...
363636	0,94	1,15	1,06	0,99

Cotton dark (picture [5] and illuminance measure)



Leather dark (picture [5] and illuminance measure)



Finally the participant testing showed a 90% threshold level of minimum detection contrast of $C_w = 0,2$ independent of the projection surface material.

First outcome of the survey is the needed detection contrast for different projection surface materials and that the surfaces material characteristic influence on perception. Important is the adaptability of the projection to different surfaces and settings.

90 % threshold level of detection contrast:

Material	C _w (P = 0.9)
Leather dark	0.205
Leather bright	0.191
Cotton dark	0.200
Cotton bright	0.204

Next step will be to extend the study to a larger sample of participants and validate the results in interior setting. Target is to define the optimal contrast for interior projections.

Session Innovative Technology-Design

Hascovision – “Practice and Application of Digital Intelligent Lighting in the Chinese Market” Jinlong Ao

Presentation is focusing on Hasco Vision portfolio including DLP, ISD and signaling road projection

2 very interesting products were presented in the presentation and at their booth :

- New DLP with 0.9 millions pixel (versus previous generation with 1.3 million pixel). Emax is improved to 125 lux at 25 meters and they have kept similar Field of View (14 x 7 degrees). During Q&A Mr Ao confirmed a possible cost saving of 30%

Performance of MK8

- Pixel: 960*960
- Emax: 125 lx @25m
- FOV: 14°×7°
- Contrast: 260:1
- Power: ~66 W
- Cooling: Air cooling
- Weight: 900 g



MK8 is a projection lighting module with **high cost-performance ratio!**

- Hasco also presented different generations of Exterior displays (ISD) and their new “SHADE” concept with body color painting, including a luminance of 3.000 nits

- **ISD (Interactive Signal Display) Technology**

Shade

Light up the exterior for free creativity

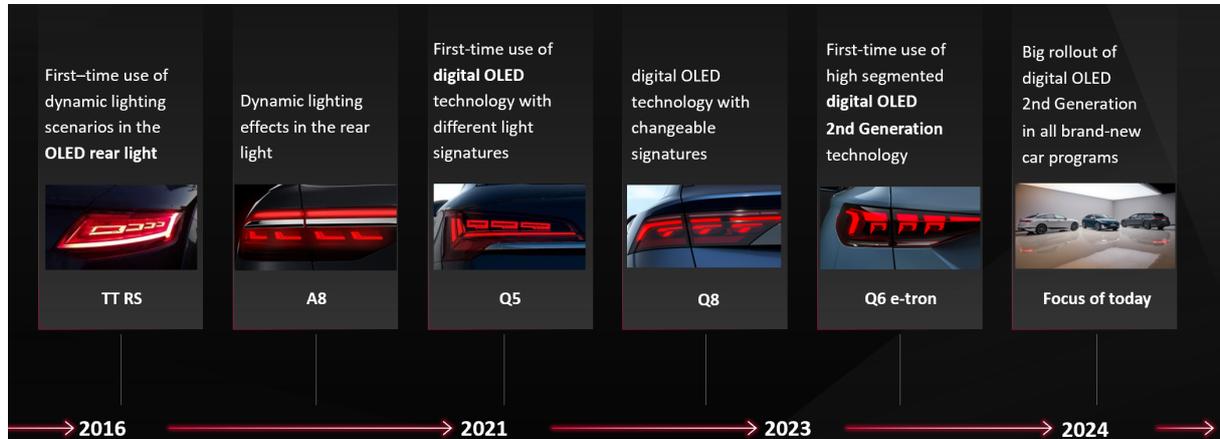
Provide great freedom for designers



Features	Invisible appearance Suitable for all car paint color (Bumper/ Grille / Doors)
Brightness	~3000nits daytime visibility
Functions	<ul style="list-style-type: none"> ✓ PL ✓ Interactive lighting ✓ Exterior lighting

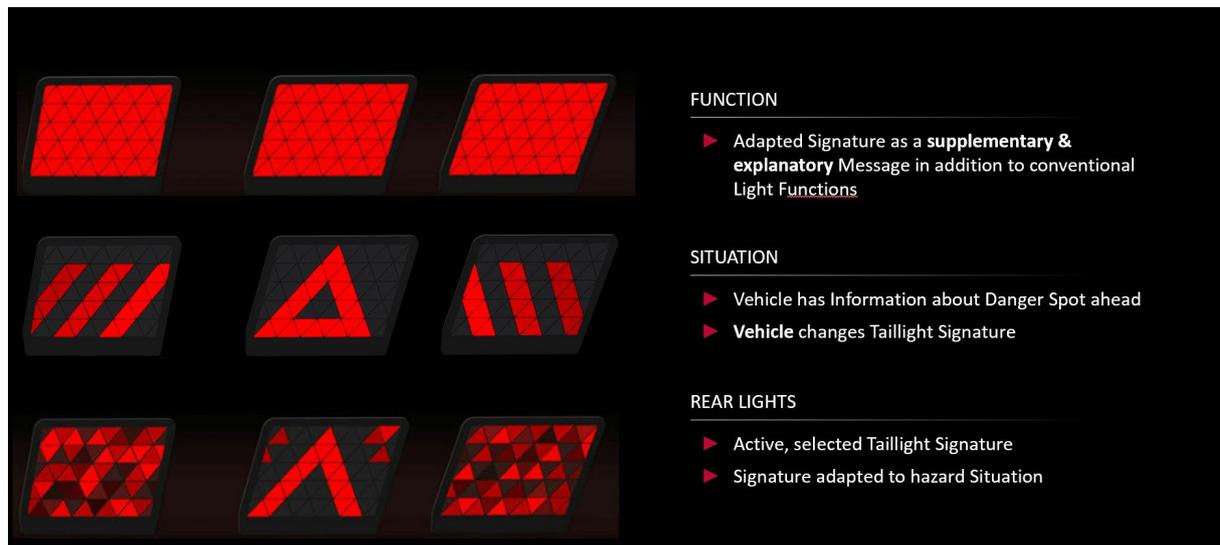
Audi – “The evolution of digital OLED lighting” Stefan Staudacher

Audi presented the evolution of OLED from 1st application in 2016 to digital 2.0 OLED on Q6 e-tron

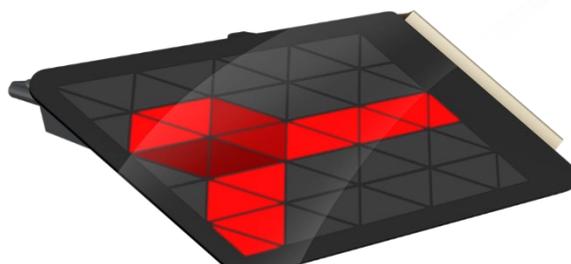


With digital OLED 2.0 and new EE architecture, “over the air” updates make possible some new welcome scenarios and signature.

Main challenge is still regulation and homologation . How to define different signatures and different use cases to realise V2X communication



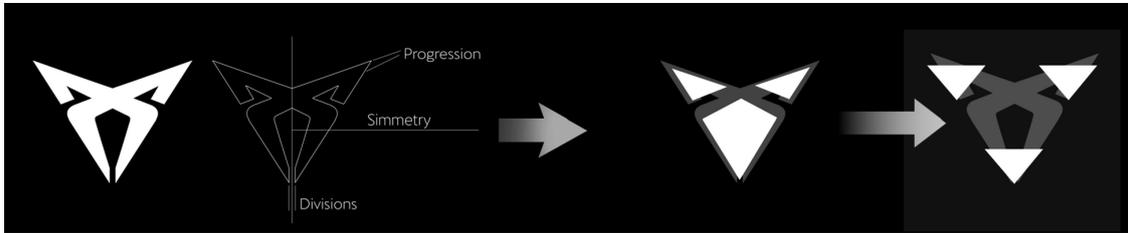
Audi presented their different lamps with different OLED panel size (45, 60 or 61 pixel per OLED). Important to notice, audi team were able to put exactly same rear lamp of different body (A6 e-tron and A6 avant e-tron, A5 Sedan and Avant, Q5 and Q5 sportback)



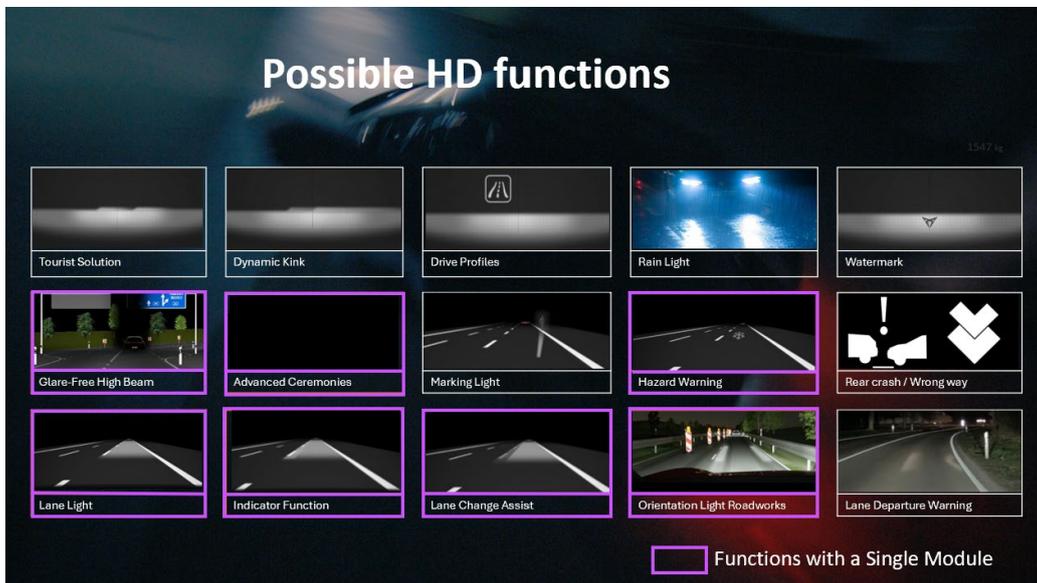
Microrelleus & Cupra – “Cupra Innovative Lighting signature powered by precision laser microstructuring”

Carlos Elvira & Raul Garcia

Cupra has realized new design by changing basic forms from round to triangle. (design principle). Cupra logo has also been deconstructed in 3 triangles



Tavascan is not only the car with the new Cupra light signature, but also is proposing the first HD headlamp on Cupra (only with single module to realize possible HD functions) on the right side (AFS legal requirement does not required symmetrical modules) . 7 functions are done by HD modules as described below



Microrelleus shaped plastic molds with Laser Texturing . they Have used Femtosecond Laser with 100-150 microns (micro prisms) engraved by production tool inserts.



Liaowang – “The development trend of Electronics under the evolution of Intelligent Interaction” Mr. Gu

DanGu presented the several milestones since 2023 Halo Lamp to 2025 Grill Lamp by White + Red Displays and how resolution has developed from 10 mm pitch with 1000 nits to 2 mm recently with > 2500 nits and instant communication (32 bits).



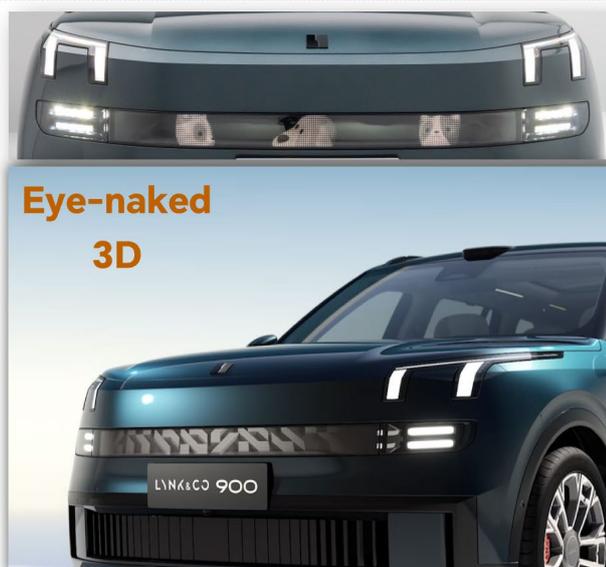
Development is ongoing by customer-oriented software (embedded in hardware) and fast electronic control.

They presented for the first time the new MDL plus display with pixel pitch 2mm, 10,000 leds and brightness 2,500 nits on Lynk&co 900. The car has OTA possibilities with CAN FD and ethernet interface, plus 32bit MCU with FPGA

MDL Plus



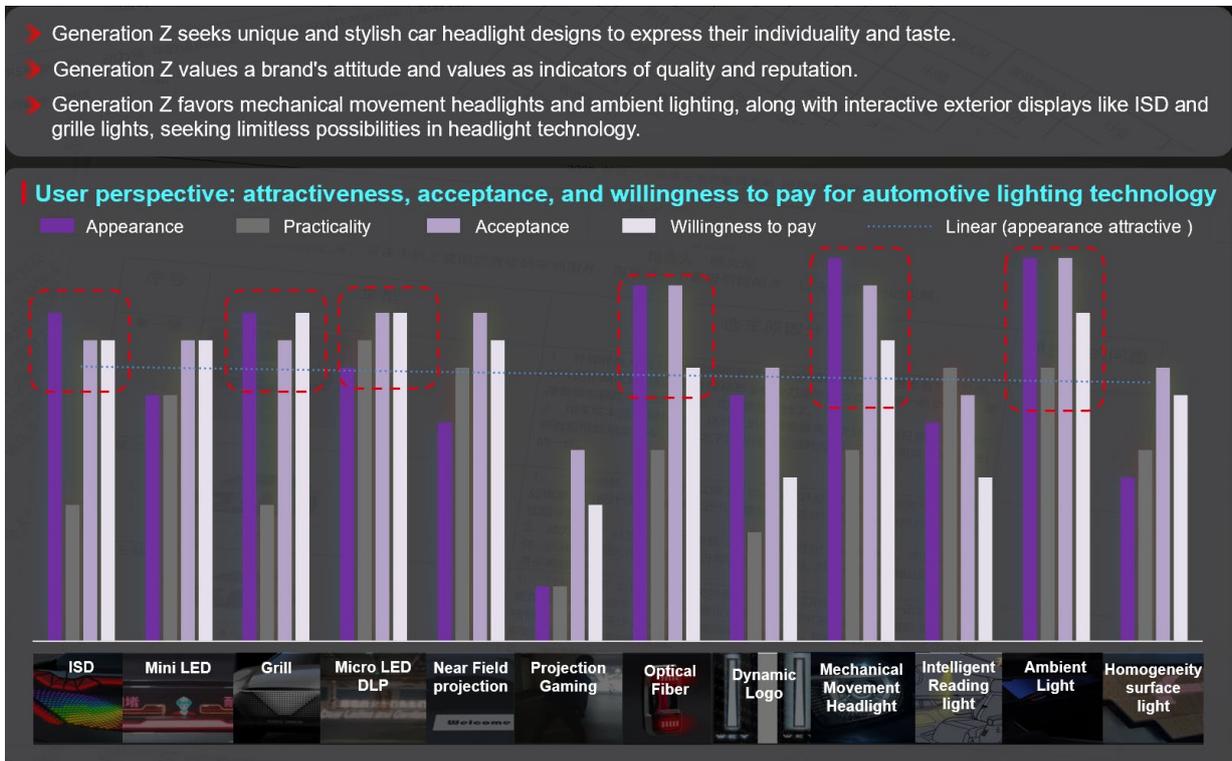
- **SOP:** 2025.3
- Interactive communication with pedestrians and other vehicles
- Technical Parameters:
 - Color : White
 - Pixel Pitch: **2mm**
 - Quantity : ≥ 10,000 pcs
 - Brightness: ≥ 2,500nit
 - OTA & instant communication available



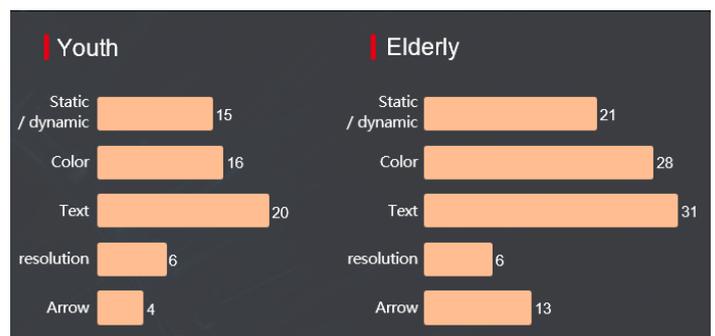
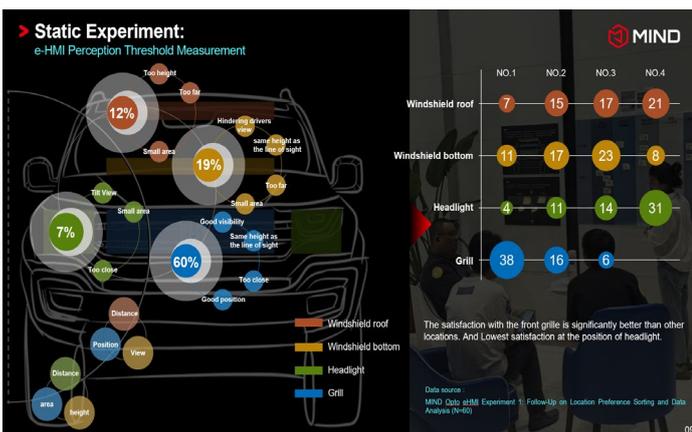
Mind – “Future Intelligent Lighting - User Experience Perspective from China & Mind View” Jin Hui

Mind presented a long study with preference analysis of young Chinese people, with main focus on E-HMI technology.

Functionality and styling are really important (mainly appearance, branding and practicality). Trust extremely important (in and outside the car with different focus).



Grill is preferred for displays (Headlight worst!).



for display information, static images with text and sensor integration required.

Polestar – “Polestar Design/lighting philosophy”

Christophe Ferreira Da Silva

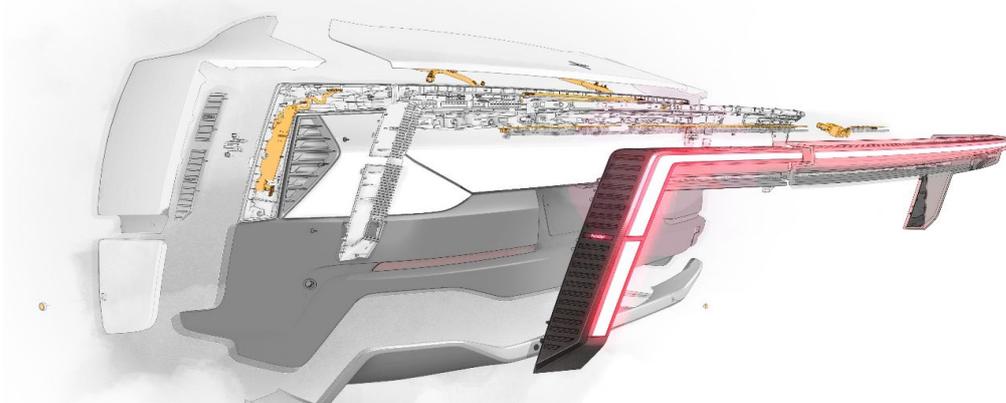
60 people are working for exterior Design in Gothenburg.



Polestar design is based on 4 key principles : Pure,Progressive,Performance,Sustainable.

Christophe give some hints about the different vehicle line up and lighting technology :

- Polestar 2 with Pixel 84 technology
- Polestar 3 with 1.3 mi pixel DLP technology
- Polestar 4 with 32 pixel ADB technology and front lit logo
- Polestar 5 with LG Innotek Hled technology for rearlamp



Appotronics – “Distributed illumination and display with fiber coupled light source” Han Meng

Appotronics is a well-established display maker and is coming in automotive.
First with interior (aito M9) ofr display projection, and then on Smart #5 for exterior display



With there technology they can display with very high contrast 1:200 message abd video on the ground or wall

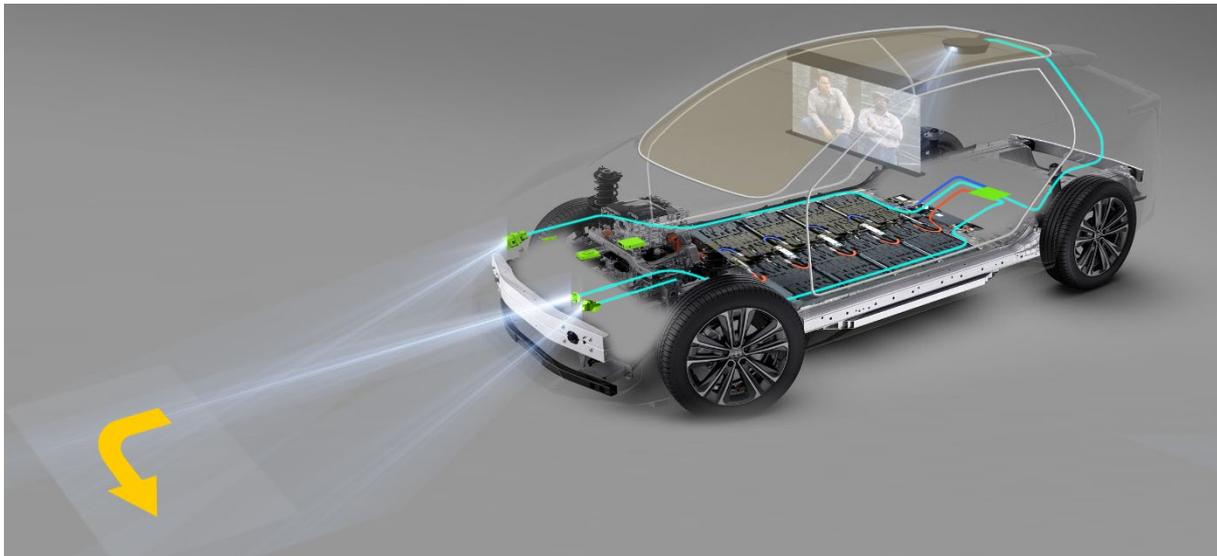
All-in-one Smart headlight

	LED	Laser ALPD®
F number	1.5	2.4
MTF	<50%	>50%
Contrast	1:80	1:200
Color option	B/W only	YES

ALPD® technology

Advanced Laser Phosphor Display

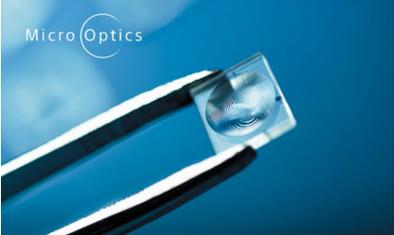
They are developing also a new technology with fiber coupled laser source, with cooling done bt the mattery management system. This demo will be presented in Shanghai auto show in april and DVN will provide then more information



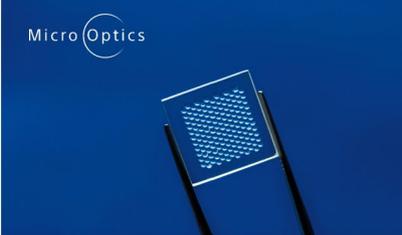
Sony – “Automotive Lighting : Innovative Polymer Micro-Optic Solutions” Sinisa Dohnal

Sony DADC is an Austrian company with 900 employees since 1983, mass manufacturing of wafer-level micro optics on polymer. They have a Cleanroom with 6000sqm realizing partially in cooperation with partners for microoptical components.

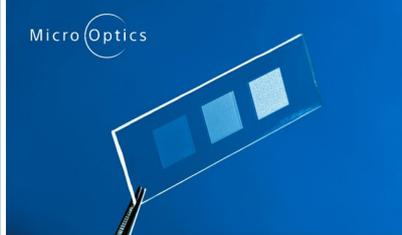
PROTOTYPES IN COOPERATION WITH PARTNERS & RESEARCH INSTITUTES



FRESNEL



MLA



DOE

NEW INITIATIVES

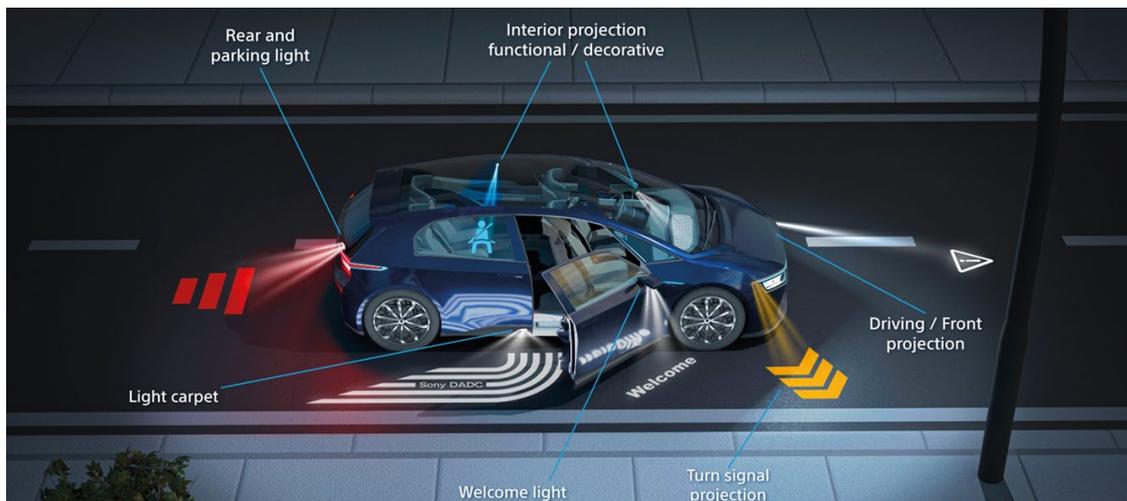
Amongst others we cooperate with:






02.2025 PUBLIC www.sonydadc.com

Polymers share optical properties of glass but have several pros .
They see different possible application for signaling road projections, diffractive optics with a quite interesting cost approach



OP Mobility – “Illuminated Digital Panels”

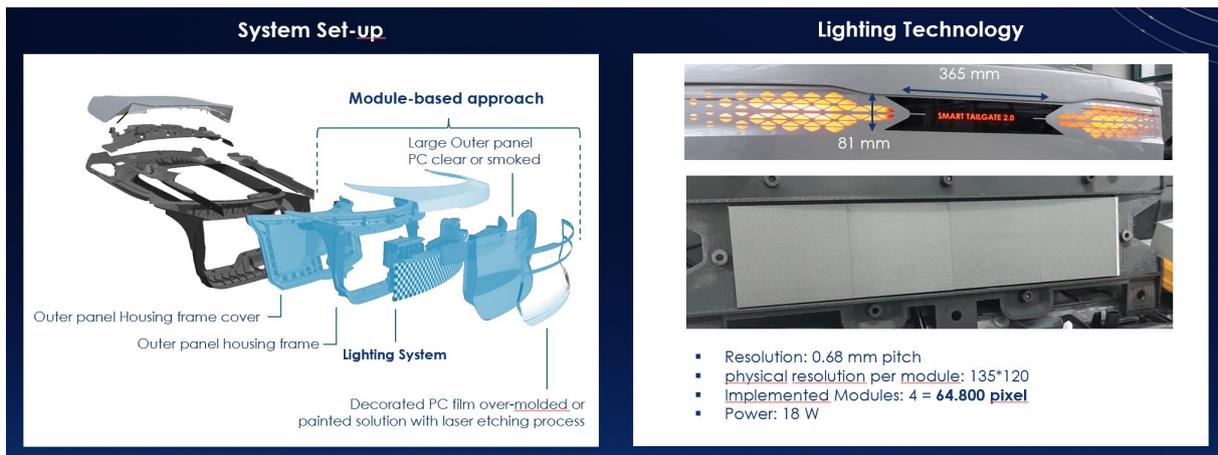
Tobias Huber

From Plastics to Electronics

they illustrated the development of illuminated body parts from lit logos to multifunctional tailgates (brand signature, signal lighting, light and sensor integration finally merged with actuators in an all-in-one manufacturing.

OPmobility has a module-based approach having all technologies under one roof (plastic molding, laser etching, UV curing and functional assembly).

For displays, Main focus in the future is warning and safety features as well aesthetics for communication and style. Using Mini LED and digitalized pixelization.



Nio – “The Pinnacle of NIO’s 10-Year Innovation”
Nio design : Adam Bazydlo and Erol Kursani



Adam and Erol explained Nio lighting DNA in 4 bullet points based on ET9 :

- Pure. Like super RED for rear tail with a crisp finish. Or bright carpet lighting with large dimensions. clean and bright surfaces that are in harmony with the fascia, and welcoming animations that are elegant yet simple.
- Human : We communicate with TECH – LIGHTING to bring friendliness in society. Thank to HD 20K pixel technology



Also 3 interior themes inspired by nature that follow circadian rhythms, to adjust the cabin to the time of day



- Progressive : about using latest technologies to bring brightness and quality.



- Sophisticated : about the finesse of execution and precision. Illustration with interior lighting from roof to side doors below



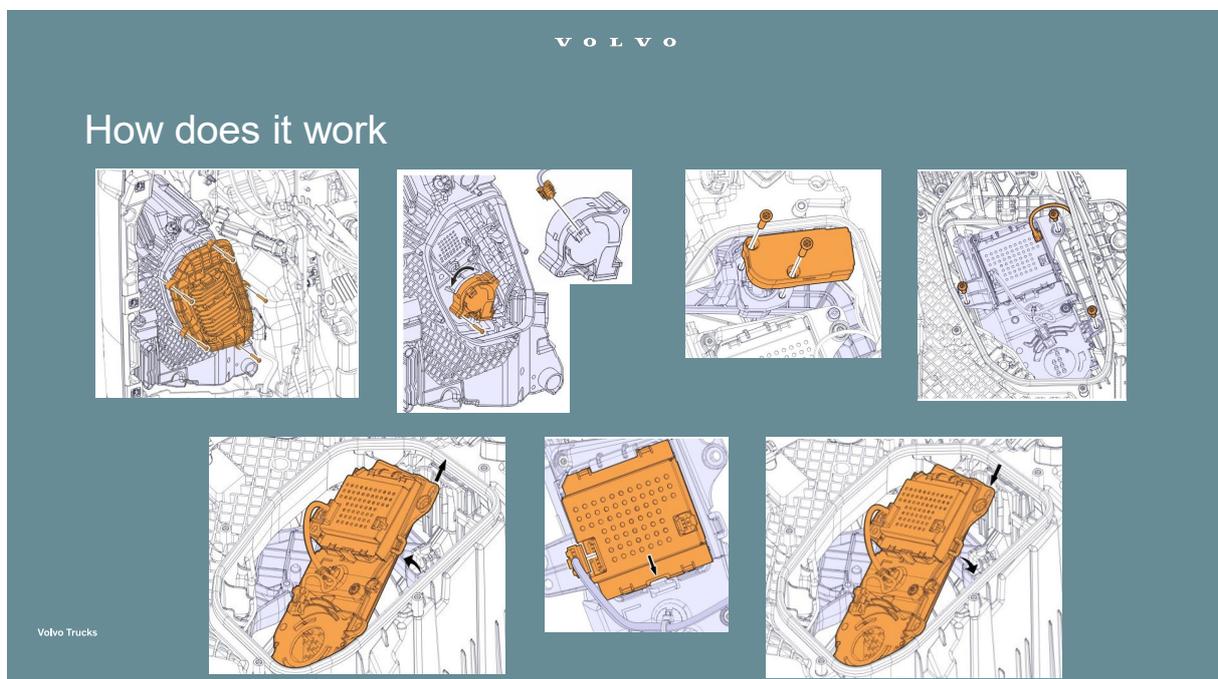
Session : sustainability

Volvo – “Trucks shedding light on sustainable headlamps” Sara Engal, Group Manager & Product Owner Visibility HW

Sara highlighted the differences in usage of lighting between trucks and passenger cars. For trucks the 24/7 availability is essential for customer success. Therefore most users replace halogen LB bulbs once per week to avoid any standstill time.

With the change from halogen to bulbs in 2014 at Volvo the most important part was to design the headlamp for easy replacement of most components without the need for demounting the headlamp. Positive result is that everything beside the failed component can be reused without big effort. One problem in the design phase was the missing experience and design thinking for a sandwich design which is a must for success.

Final solution for the headlamp is that it has access from the side and can be opened just with a screwdriver. The LB reflector with the LEDs can be exchanged separately. The ECU is clipped for easy exchange.



Open challenge is still the access to the High Beam location which is target to be solved in the next model to move forward on the sustainability path.

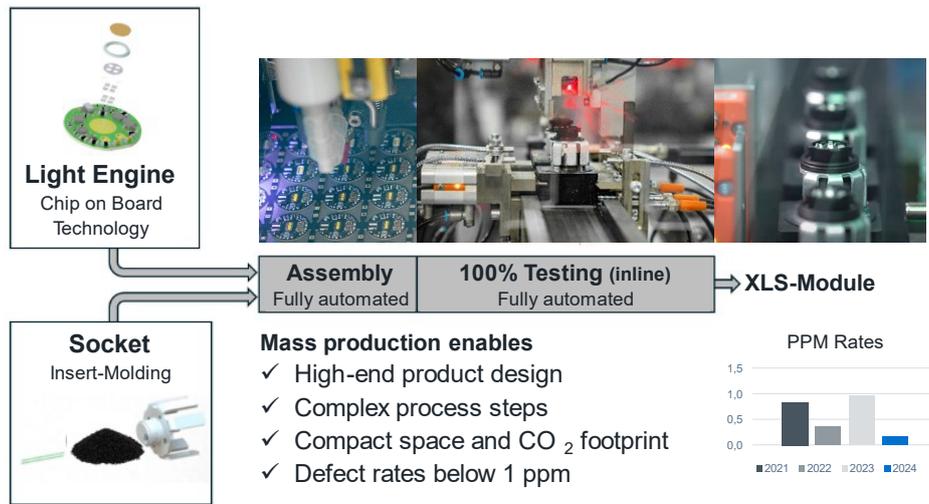
ams OSRAM Group – “Standardized LED light sources to realize simplicity and sustainability across multiple car models”

Stefan Herold, Senior Business Development Manager

Do support the easy exchange of light sources in exterior lighting function Osram has designed a standardized light source with driver electronics on board called XLS in red, amber and white to be used in HL and RL signalling functions and fog. Since 2018 meanwhile more than 50 Mio pieces are on the road. Due to mass production the defect rate is meanwhile below 1ppm. Toshiba is in parallel offering the same portfolio to ensure double source and avoid any risk in availability due to any crisis.

Sustainable Design / Production

Mass Production allows optimized Products and Processes



7



This standardization ensures also lifetime availability of aftermarket parts with easy replacement. Meanwhile even light guide applications are proven to fulfil UN R148 using one single light source

Use Phase: long light guides, limited power consumption

One or two Functions driven by a single Light Source



11

Figure not to scale



Llink Technologies Inc – “Automotive Lighting Assembly Remanufacturing”

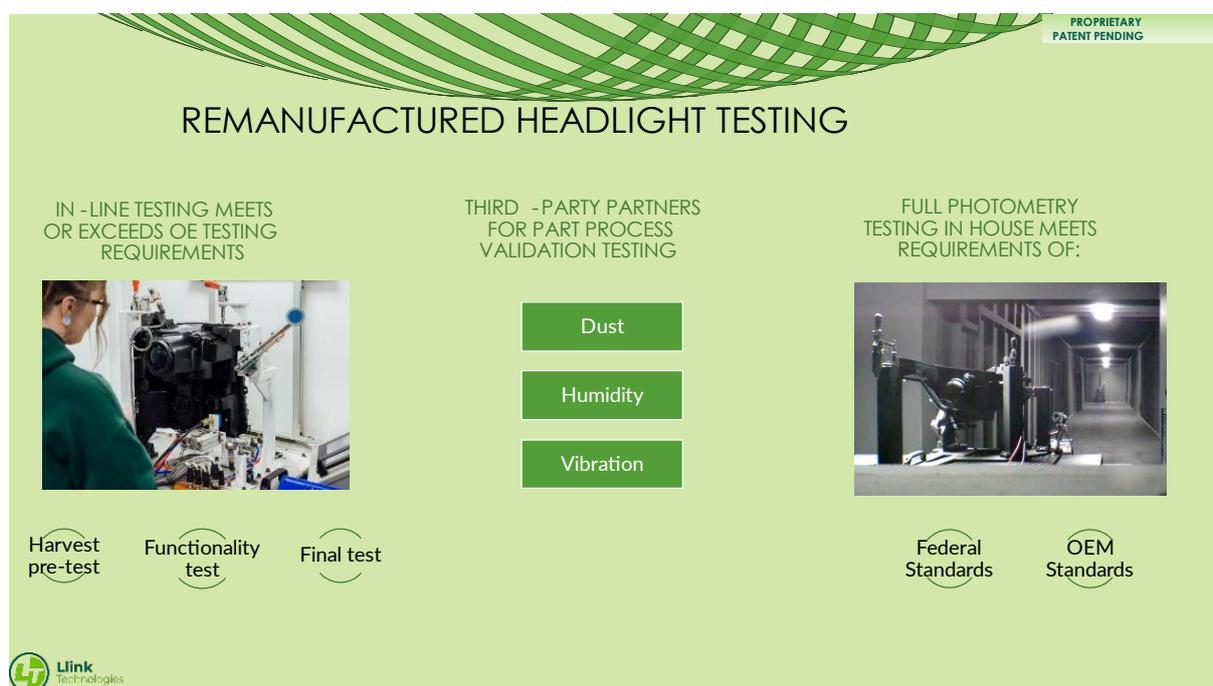
Jeff Goulet, Owner and CEO

Llink has established an assembly remanufacturing of aftermarket headlamps which enables on one hand an adequate reuse of resources and on the other hand in average 40% reduction of costs than using a new headlamp as replacement.

First customer in US is GM for whom up to now 200.000 headlamps had been remanufactured and brought back on the road.

To set this up they needed to create an harvesting and testing method for all interior parts which could be reused.

Second step is a complete assembly and final testing process. This is including pre-assembly, leakage, optical and final test according to original OEM requirements.



For several tests Llink is involving third party partners to achieve optimized validation testing.

After working with GM they started meanwhile a similar program with Stellantis and plan to role out a global footprint to be able to offer this service also outside North America.

Next step will be to apply the same methodology to ADB headlamps, Taillamp and other exterior automotive lighting assemblies.

ZKW Group – “Sustainable, innovative, recyclable material composites for future car headlamps”

Gerald Boehm, Global Responsible for the Advanced Technology Development

ZKW has a clear approach to optimize their CO2 footprint and to establish a supply chain of partners to increase the reuse of used material. Today this supply chain is not established for most locations worldwide as the European activities are happening on an island.

ZKW is using public funding to work with local partners on research projects to improve products and processes on sustainability side. Most promising is a program to use biobased material to replace polymers for non-aesthetical parts:



[A member of LG]

ZKW PROJECTS - SUSMAT4CARLIGHT



> **Project Partners**

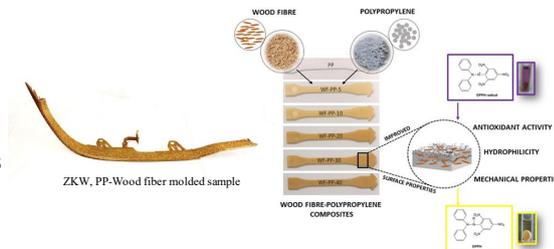
Montan University Leoben
Polymer Competence Center Leoben
Joanneum Research



> **Research Topics**

Innovative Polymer/Bio filler Composites
minimize outgassing, aesthetic quality, low carbon footprint

Sustainable new Manufacturing processes
post consumer/industrial recycled polymers processed with high surface quality, advanced process simulations



Črešnar et al., polymers 2021,13(10), 1535

6



[A member of LG]

ZKW PROJECTS - SUSMAT4CARLIGHT



Innovative Low Fogging Additives

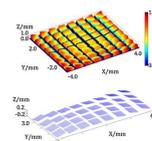
minimize outgassing, (thermo)mechanical property optimization

Functional Coatings

hydrophobic/hydrophilic surface tuning for layer-by-layer polymer coatings & metallization

Free Form Micro Optics

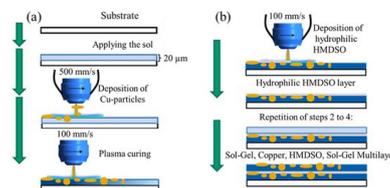
significantly lower material consumption homogeneously distributing the emitted light



Fang et al., CIRP Annals Manuf. Technol. 2013, 62, 823-846



Innovative Low Fogging Additives



Chwatal et al., Gels 2023,9(9), 675

7

Another program is to develop and establish repair processes for headlamps. As part of this the design of headlamps need to be adjusted to allow more and better repair for damaged after market parts.

Renault – “Lightweight Design : Benefits of Mucell Technology for PP-TD housing Francois Bedu, Lighting Expert”

Focus of Renault for headlamps is the weight reduction to improve the CO2 footprint of the car over lifetime. Today housing and outer lens are the highest contributor to the headlamp weight with in average 21% and 19% respectively.

One solution followed by Renault is the usage of Mucell Technology to reduce the used material for headlamp housings.

It is important for this technology to design the product specific to the material constraints. Just exchanging the technology in existing tools is not successful.

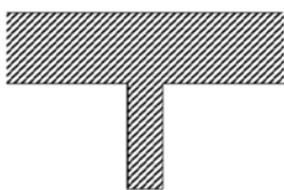
Therefore Renault has set up some outlines to be successful in applying MuCell for headlamp housings.

HOW TO DESIGN WITH MUCELL® TECHNOLOGY

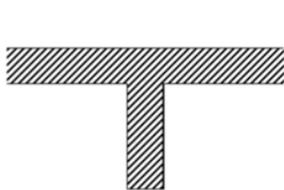
- Reduction of thickness at 1,5mm as the reference
- Use relevant Material card to find weakness by simulation
- Add relevant reinforcement according to analysis and interface

Gas increases fluidity of polymer

New plastic design rules to apply (Rib with ratio 1:1)



Conventional design



MuCell® design

Following these guidelines existing simulations show significant reduction of weight, warpage, clamp force and injection time.

This improvement on cycle time can counterbalance the additional investments on moulding side for the Super critical fluid injector.

An extensive validation plan has been performed on housing and fully assembled headlamp for thermal, vibration, pedestrian crash, hood slamming, water tightness and climatic cycle proving in parallel to the simulation that the material performance is even better than simulated.

Final result is showing:

- 28% of weight saving has been realized with this full redesign.
- Without redesign, weight savings would be around 7% only.
- Cycle time is 20% shorter.
- Possibility to reduce clamping force

Session : sustainability

A2MAC1 – “Power consumption Benchmark”

Arnaud Goy & Franco Marcori

Key Elements:

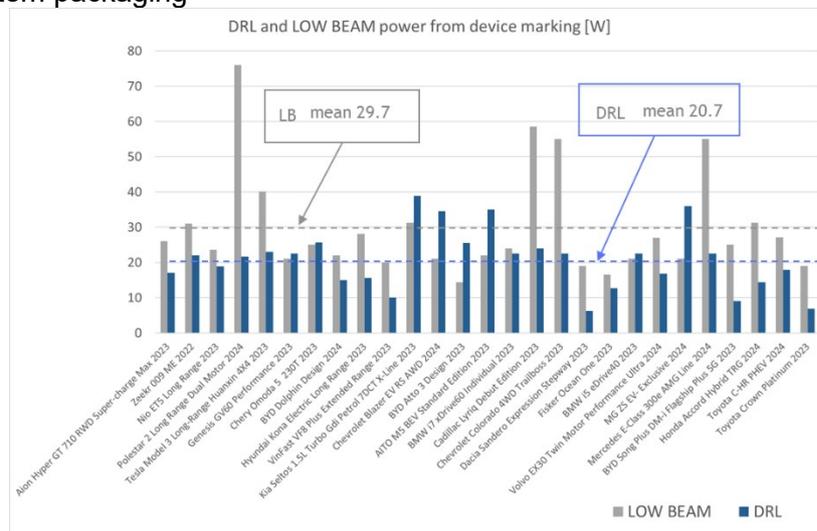
A2MAC1 offers complete Benchmarks of Vehicles. Now with cooperation to LMI this offers the customers a detailed look into the head- and rearlamps. Besides the detailed CAD-Data of selected cars that are purchased and dismantled, lighting elements can be assessed.

Future planning includes

1) measured power consumption DRL, Low Beam, High beam, Front PO, Rear PO, Stop lamps.

2) Signalling Luminance Analysis: Use of LMK camera including Post treatment, Measurements done at $h=45^\circ/v=0^\circ$, Segment analysis

3) Performance Analysis: Measurements at 5m and 20m with a camera (Low beam and High beam) , Investigating alternatives with a goniometer 4) Section Views: Y and Z sections including environment to understand lighting system packaging



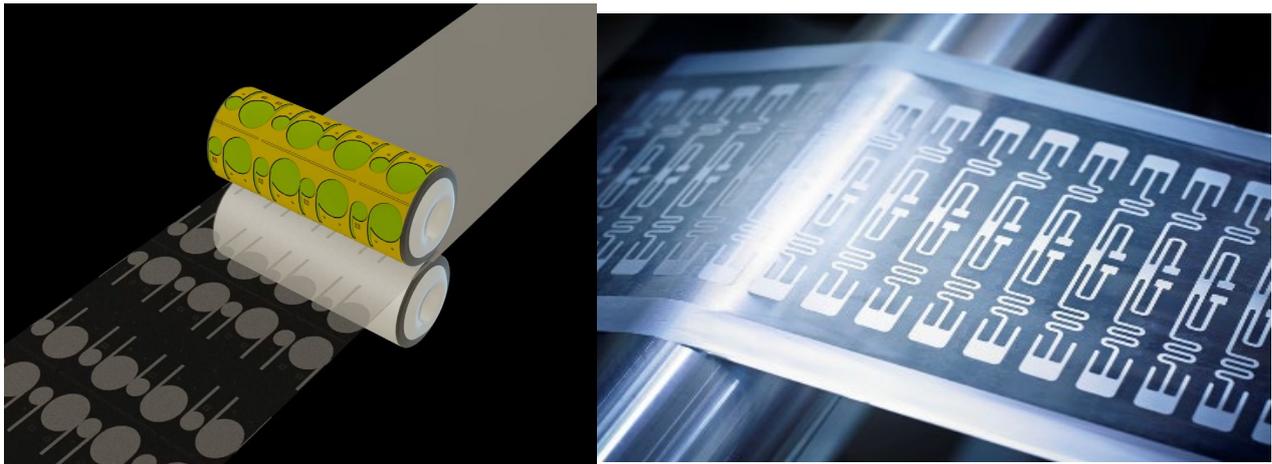
RISE Research Institutes of Sweden – “Material development & production possibilities of electronics to be more sustainable”

David Nilsson

Key Elements:

Printed Circuits are everywhere and production usually is done with boards having high temperature soldering in a reflow oven.

RISE was showing innovative examples like Biobased high frequency paper PCB with bio-based flame retardant. They showed examples of processing methods as enabler for soldering on Al & Cu circuit patterns on paper, recycled plastics etc. Dry phase patterning (DPP) was shown as method of saving up to 90% cost, 99% sources and 98% environmental pollution.



SABIC – “Lighting the Path to Net-Zero Emissions and Enhanced Sustainability with Automotive Thermoplastics”

Erhard Bruss

Key Elements:

Sustainability means reusing of Plastics, weight reduction. Critical is that a network has to be built up to collect “waste” and recycling to new products. Contamination due to elder production with additives makes selection difficult. Challenges are secure consistent (quality, supply) for PCR, certify waste streams and comply with REACH regulations. Recycling methods were presented and evaluated. Mechanically recycled products seem to be the most easy way, but the purity of chemical recycling would bring quasi virgin materials back in the cycle.

VALUE PERCEPTION – AUTOMOTIVE INDUSTRY



MECHANICALLY RECYCLED PRODUCTS	CERTIFIED BIO-RENEWABLE PRODUCTS	CERTIFIED CIRCULAR PRODUCTS
<ul style="list-style-type: none"> Effective GWP & recycle + Physical tangible Material premium limited Large supplier network 	<ul style="list-style-type: none"> + Most effective in GWP Identical to virgin – no part validation 	<ul style="list-style-type: none"> Potential solution for “difficult to recycle” concepts + Identical to virgin Reduced supply risk: CR can be produced with various recycle streams and always virgin alternative
<ul style="list-style-type: none"> - Quality consistency - Performance limitations - Capacity limitations - Concerns REACH 	<ul style="list-style-type: none"> - Material premium high - No contribution to plastic waste removal - Certification/mass balance-claims? 	<ul style="list-style-type: none"> - Material premium high - No GWP reduction (only holistic vs. incineration) - Certification/mass balance-claims?

➤ Industry prefers mechanical recycling.
 Acceptance of advanced recycling will depend upon upcoming legislation.

Covestro – “Illuminating the Circular Economy: Material Innovations for the future of Automotive Lighting”

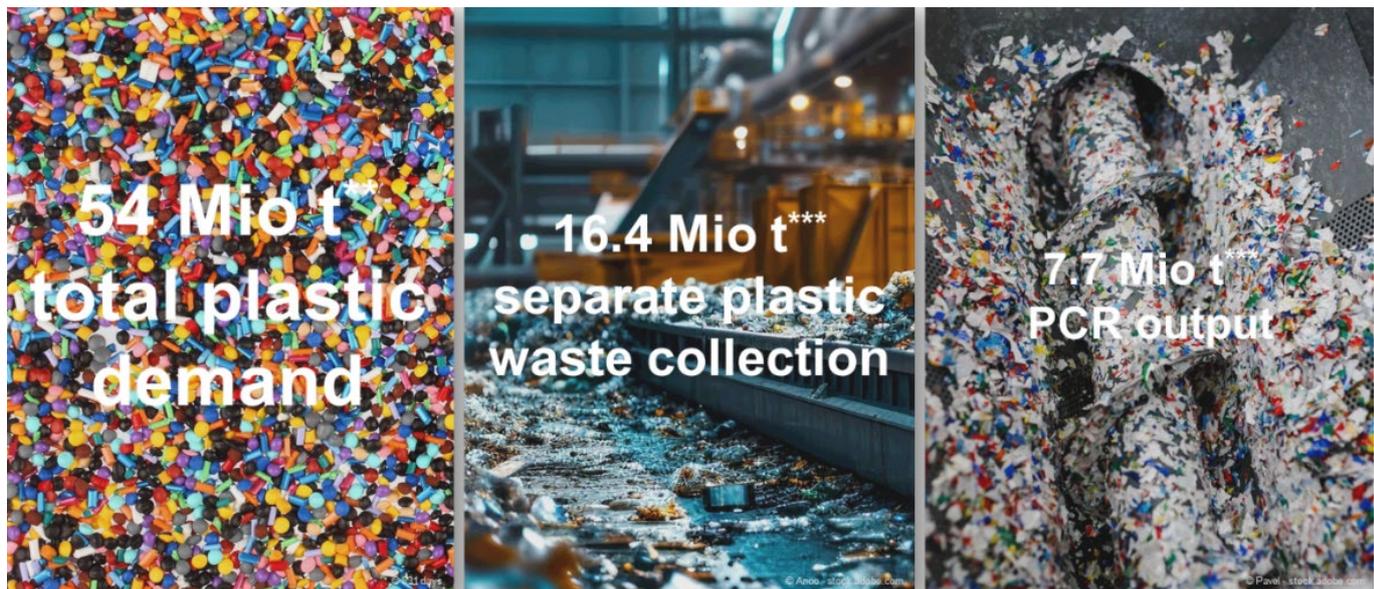
Jan Helmig

Key Elements:

2022 data showed that about only 15% of plastic are used for PCR output (7,7 mio tons)

A supply gap of 2.4 million tons until 2023 was shown. Mechanical recycling will not be sufficient. Quality expectations are high, but used plastic shows a quality gap: because of application-specific additives, application related ageing and optical / AMECA requirements.

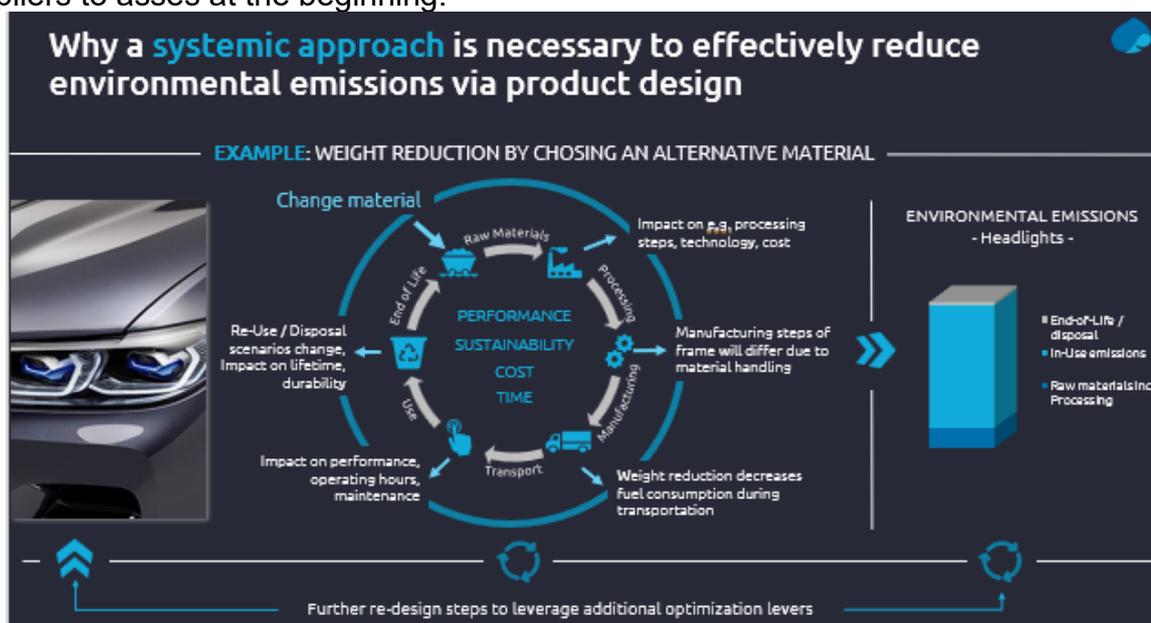
Cooperations are shown. Headlamps are collected, UV and antiscratch coating will be removed. Covestro will process it into high-quality PCR materials for automotive engineering applications. RE and RP grades are needed for virgin and “near to virgin” quality needs in Lenses, heatsinks and bezels.



Capgemini Engineering – “Sustainability Performance through Data, Engineering & Innovation” Dorothea Pohlmann

Key Elements:

Typical triangle quality, cost and performance must be changed in a diamond shape. NOW Sustainability needs to be considered as additional and equally important constraint. Chosen material must be integrated considering design and energy efficiency. Requirements must be integrated with sustainability in the design phase. Data (engineering, manufacturing, cost etc) must be available to assess the regulation compliance and life cycle ability. OEM must integrate life cycle data of suppliers to assess at the beginning.



SAATI SpA – “Breathing Sustainability: PFAS-Free Venting Solutions for the Lighting Industry” Roberto Momentè

Key Elements:

SAATI is a rather new company in automotive, coming from textile elements. Departing from the conventional PTFE membrane approach, SAATI has developed a line of sustainable solutions by designing a PFAS-free membrane. Their engineers have found a material and membrane that is free of PTFE. This material is Halogen free and provides in special constellation high temperature resistance. As there is the possibility of a ban of PTFE in some regions, SAATI believes they could offer an alternative.

Gore – “Balancing Reporting and Action: Leveraging Life Cycle Assessment (LCA) for supply chain decarbonization and beyond”

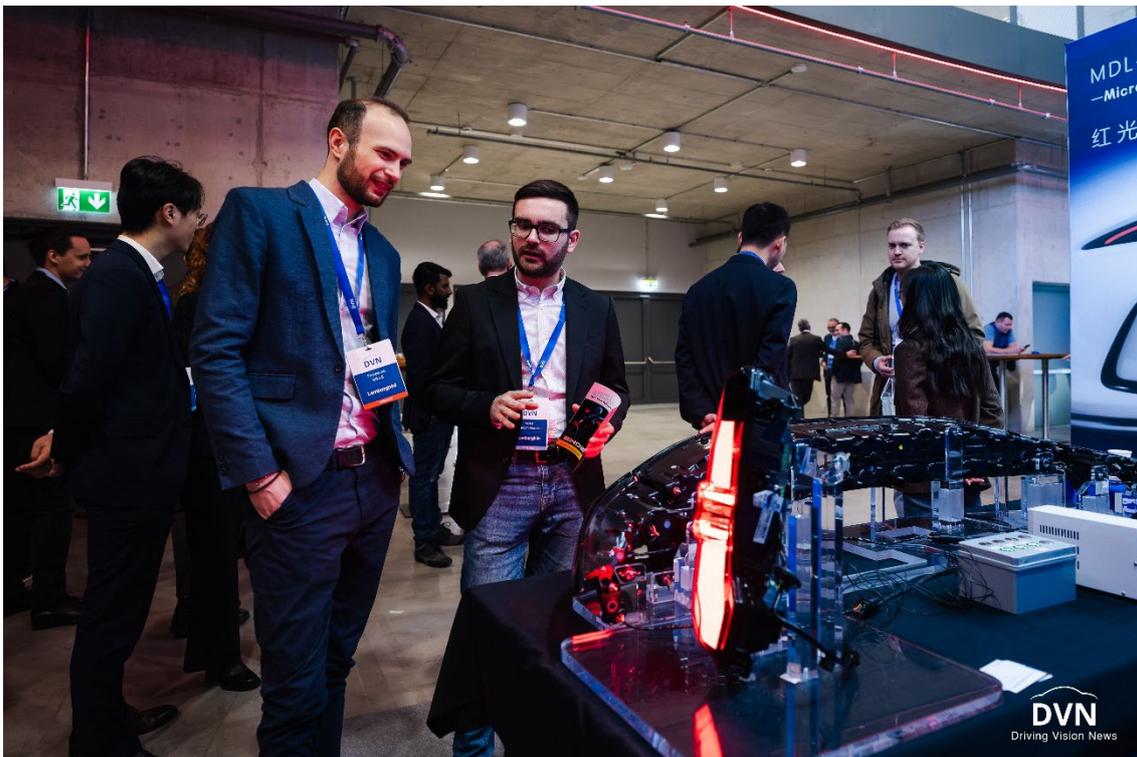
Joachim Aigner

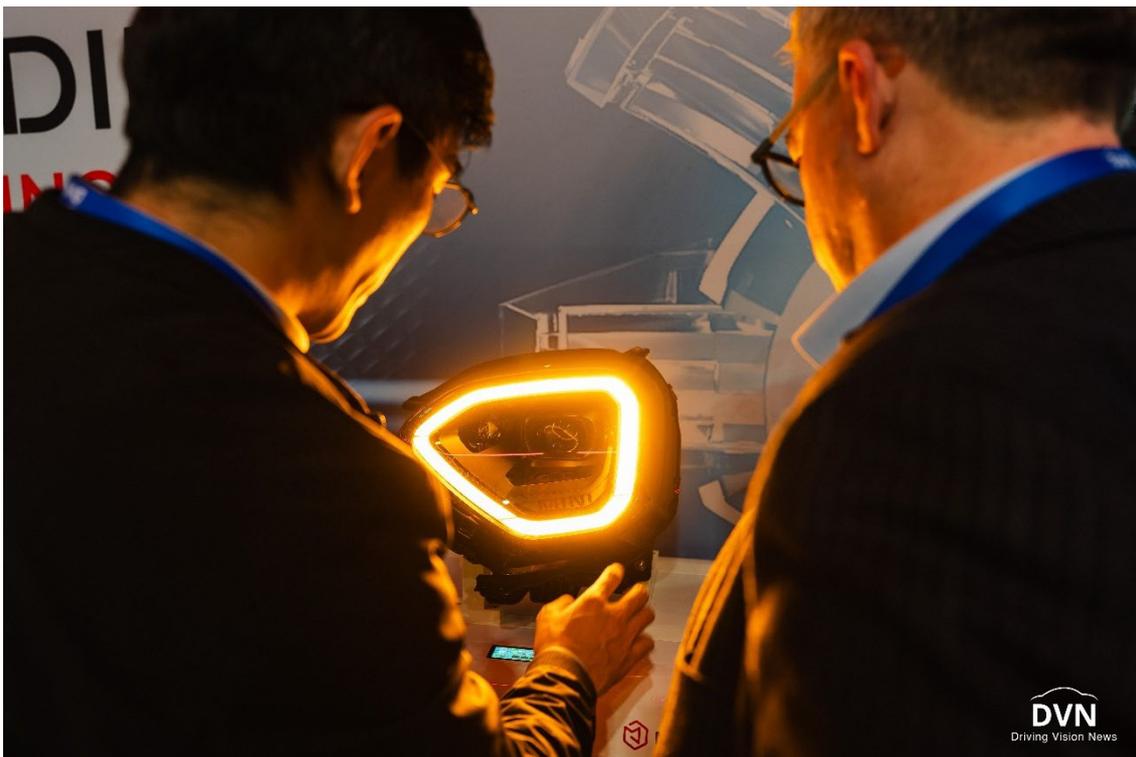
Key Elements

Challenges are to provide data in whole supply chain. Learning curves will come to assess data. Supplier-specific data is not automatically more accurate—while it can provide more supply-chain specific insights, it may also introduce inconsistencies due to variations in data quality, methodology, allocation, and assumptions. Gore plans a full life cycle perspective - “cradle-to-grave” or “cradle-to-cradle”. This could connect a product’s footprint with its “handprint” and performance characteristics as well as potentials avoided emissions, which is critical for a fair comparison and helps to avoid regrettable substitutions. Automation and AI will not replace the organizational learning curve and structural changes necessary to integrate new data and metrics into decision-making processes.

Pictures of the 2025 DVN Munich Workshop











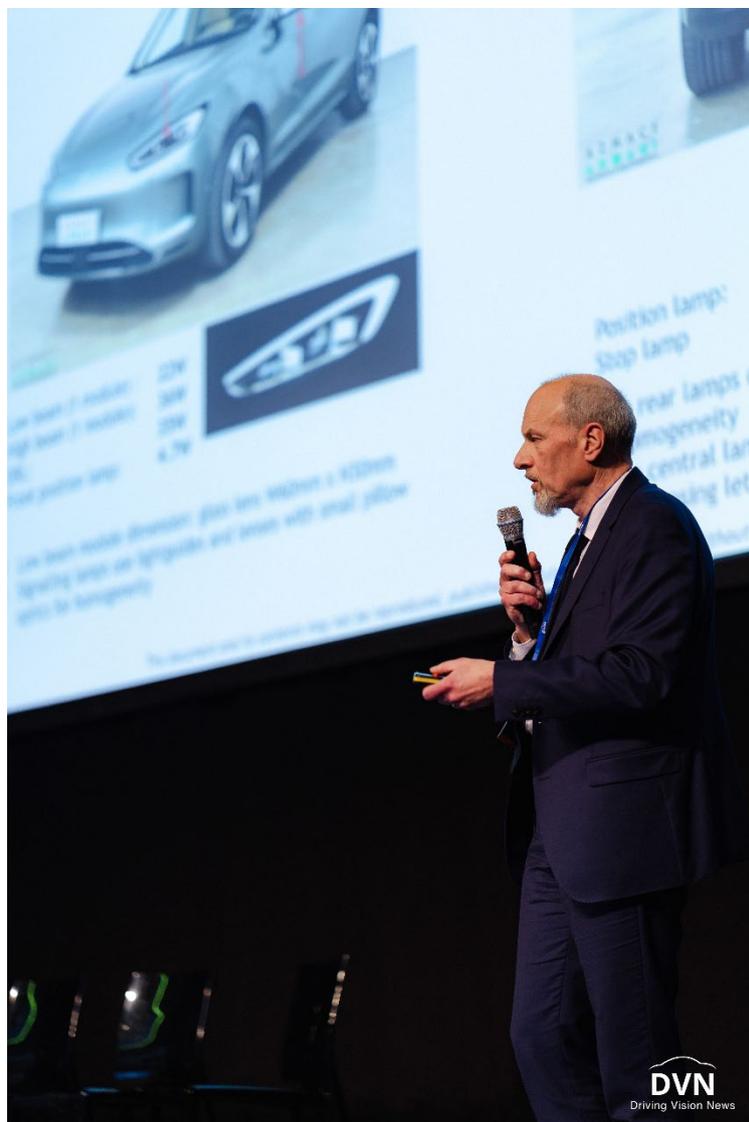


Exhibitors Innovations

A2Mac1

A2MAC1, in partnership with LMI, provides a comprehensive Benchmarking database for Exterior Lighting. It integrates mechanical and electronics BOMs, functional evaluation, costing, and CO2 estimates. Current performance assessment relies on lamp markings to indicate power consumption by function. Differences across markets, segments are striking. They are mostly explained by technological differences (LED, MatrixLED, OLED, bulbs) and efficiency of their optical design (reflection / projection systems, lightguides, diffusive materials).

For example, DRL consumption ranges from 7W to 39W, averaging 20W, highlighting an optimization opportunity since DRLs remain on during WTLC test cycles. The low beam function varies between 15 and 75W with an average 30W. Stop lamps range from 2W to 43W, averaging 14W. In 2025, A2MAC1 and LMI will expand their analysis with additional test measurements, including consumption, luminance, and photometry, enhancing benchmarking capabilities for OEMs, Tier 1 suppliers, and the broader supply chain.



ams Osram

ams OSRAM showcased its latest innovations in automotive lighting technology, emphasizing high-performance, sustainable, and design-oriented solutions for the evolving market.

Headlamp Technologies: At the booth, ams OSRAM displayed its cutting-edge **EVIYOS FLEX** technology, which enables **flexible light distributions and reduced power consumption**. This technology bridges the gap between standard and high-resolution lighting systems, offering adaptable beam patterns for enhanced safety and efficiency. Additionally, the ultra-slim **Hi/Low beam modules** demonstrate how compact yet powerful lighting solutions align with the latest global styling trends.

Signaling and Design Innovations: ams OSRAM introduced its advanced **ALIYOS LED-on-Foil** technology, integrated with **Functional Foil Bonding (FFB)**, enabling **ultra-thin, highly customizable lighting solutions**. This innovation enhances both the aesthetics and functionality of vehicles, offering seamless surface illumination with sharp segmentation.

Projection and Adaptive Lighting: The company also presented its **road projection solutions**, illustrating how **dynamic signaling can improve communication between vehicles and pedestrians**. These advancements align with upcoming **UNECE regulations** and reinforce ams OSRAM's commitment to safety and innovation.

Open System Protocol / Ambient Lighting: Open System Protocol (OSP) was developed by ams OSRAM to enable dynamic lighting applications and more. The flexibility of OSP allows the implementation of Dynamic Lighting Applications for decoration, warnings, and communication, or even for the integration of interactive functions like in Smart Surfaces by the integration of sensors and actuators.

XLS Demonstrator: ams OSRAM showcased its **XLS (eXchangeable LED Light Source) demonstrator**, highlighting the versatility of **ECE standardized light sources**. The exhibit featured **LW7, a high-luminous flux light source**, enabling long light guide applications up to **1 meter** for daytime running light.

Additionally, a **dual-color XLS module** was presented, demonstrating its application in **daytime running lights (DRL) and turn signals**, contributing to greater functionality and design flexibility.

With these groundbreaking technologies, ams OSRAM continues to shape the future of automotive lighting, delivering intelligent, sustainable, and visually striking solutions for modern mobility.



Marelli

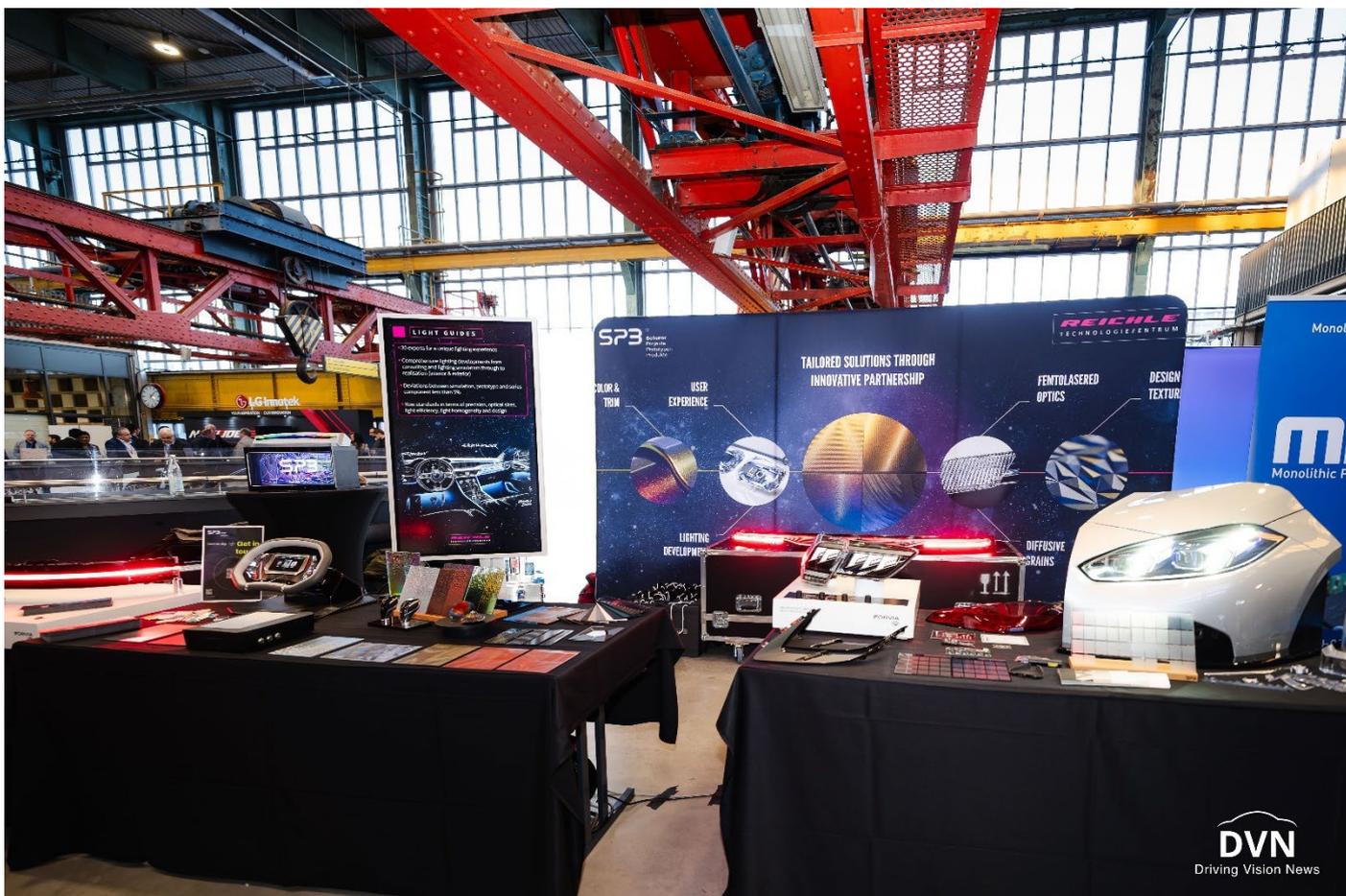


Marelli exhibited some of their latest cutting-edge technologies in innovative series products.

The new Grandland's front lighting set presented at the booth, carries the new Opel Vizor brand face featuring lighting technology from Marelli. Illuminated 3D Logo, three-dimensional lit "Vizor" and all-digital micro-LED headlights are the highlights of the front lighting system. The over 50,000-pixel headlights that Opel calls Intelli-Lux HD light include the compact and energy-efficient h-Digi® microLED modules using amsOSRAM's full-range EVIYOS® 2.0 light sources.

In addition, the attractive New Volkswagen TAYRON's rear lamp was showcased at the booth. It includes the latest Marelli "Folia-LED" series application, an illuminated Volkswagen emblem and animation features. Finally, Marelli demonstrated "Software-defined lighting", including the electronic control of HD technology, running on a Marelli series zonal computer unit (ZCU) to underline "Marelli's approach of lighting within zonal architectures".

Reichle Technologiezentrum GmbH



At DVN, Reichle showcased their expertise in laser technology for lighting applications, reinforcing their position as a leading provider in Europe. With state-of-the-art laser systems, including femto laser systems, they develop innovative solutions for both interior and exterior lighting, setting new standards in precision, efficiency, and design.

Their technology enables high-quality surfaces, precise light diffusion and outcoupling structures, and cost-efficient manufacturing. Special femto and nano laser processes allow for fine textures, sharp details, and advanced 3D structures, shaping modern lighting trends.

By ensuring repeatable, simulation-proof results and global standardisation, they help customers achieve consistent quality from prototyping to mass production. Sustainability is also key, with energy-efficient processes and minimal material waste.

With their expertise and cutting-edge technology, they showcased how their work is shaping the future of lighting innovation.

Murata



Murata showcased its innovative headlight levelling solution, redefining traditional methods with cutting-edge technology. Traditionally, headlight levelling has relied on mechanical chassis and suspension sensors, which require extensive wiring and may be cumbersome to customize for different vehicle models. Murata's solution leverages MEMS (Micro-Electro-Mechanical Systems) inertial sensors, enabling system-level simplification, weight and cost savings, and compliance with UNECE static levelling regulations. Additionally, the system supports dynamic levelling for systems seeking for beam-steering functionalities beyond the regulation.

Murata's offering includes inertial sensor hardware paired with software license for an extended Kalman filter-based algorithm. This algorithm provides a headlight control signal and road grade information that can be directly applied to beam actuation. At the event, Murata demonstrated the system using a miniature model and offered attendees a ride in a vehicle equipped with a real-time demo for visualization.

Murata's innovative approach highlights its commitment to delivering advanced, customizable solutions that meet modern automotive industry demands while ensuring regulatory compliance and cost efficiency.

Melexis

Melexis showcased its extensive portfolio of LED driver products on the stand. The range of integrated LED driver products covers automotive interior lighting applications such as ambient, overhead, trim, dome, roof and corner lighting. Exterior use cases for the products include grille illumination, logo lighting, charging port lighting and rear combination lamps including DRL and turn signals. Melexis' LED drivers offer flexibility to automotive OEMs by supporting LIN networks as well as UART and UART over CAN interfaces with their MeLiBu® protocol.

Melexis presented a paper on trends and innovations in automotive exterior displays. Given the requirements of such an application, it is clear that modern LED driver chips must first support the control of a large number of LEDs. In addition, modern multi-channel automotive LED drivers should be seamlessly integrated into the vehicle network, for example via a 10BASE-T1S endpoint device.



Maradin



At DVN, Maradin was honored to present its newest laser projection technology - a solution optimized for both automotive interior and exterior lighting applications. Using its proprietary laser scanning, Maradin's technology creates dynamic new market opportunities through high-impact, high-resolution videos and images designed to entertain, inform and even protect both drivers and passengers alike. Maradin laser scanning provides unmatched color, vibrancy and stability that current generation DLP and LED lighting cannot hope to achieve. With Maradin technology, light can be projected around and throughout the vehicle in new and innovative ways, all without distracting (and potentially dangerous) light leakage. Lighting powered by Maradin provides information, decoration, and visual appeal that can be personalized according to the driver/passenger mood and need at the time. The exterior lighting showcased at DVN was a dynamic ground projection - integrated into a digital side mirror - showcasing the large sharp display that is fully capable of fine and complex characters. The very compact size of the projection unit itself enables it to be integrated in many different possibilities throughout the car body. The interior lighting showcase was a dashboard display - integrated behind the sun visor in the roof cover - demonstrating dynamic, colorful, and sharp content on uneven surfaces as well as its potential integration with other sensors for unique user experiences. Lastly, Maradin shared its insights on the main stage regarding laser projection, its uniqueness and primary differences from current state-of-the-art technologies.

Sony DADC



Sony DADC showcased its innovative micro-optics technologies at the DVN Munich workshop, engaging over 500 industry professionals. As a forward-thinking partner in automotive lighting, Sony DADC presented its cutting-edge solutions for signaling applications. Highlighting the potential of polymer-based optics and MLA (micro-lens array) technologies, the company demonstrated how these solutions address the growing demand for high-performance, durable lighting in automotive design.

We also presented a fully functional demonstrator for the safety-critical blinker projection application based on our micro-optics at the event. We are now awaiting a favorable decision from the legislator (represented by GTB) to make this safety feature a common sight on our roads. Sony DADC's commitment to delivering advanced, scalable solutions for the automotive industry was recognized, and the company was nominated for the DVN Innovation Award. The event provided an invaluable platform to explore new collaborations and showcase the future of automotive lighting technologies.

Etendue Lighting

Etendue Lighting is a South Korea startup specializing in innovative lighting solutions for the mobility industry. They are showcasing their cutting-edge headlamp module, **PIXEL**.

PIXEL is an **LED bi-function projector** with a **modular design** and **three beam patterns**, offering customizable lighting solutions to meet the needs of **L-category vehicles**.

The **PIXEL** enhances both vehicle performance and design through its flexibility and **high visibility**. Furthermore, the **modular approach** reduces development costs and shortens development time, making it the ideal solution for **L-category vehicle manufacturers** seeking efficiency and cost-effectiveness.



OP Mobility



At this year's DVN Munich Workshop, OPmobility impressed with two standout presentations and cutting-edge demos, showcasing their latest innovations in exteriors, lighting, and integrated solutions. Beyond enhancing vehicle aesthetics, functionality, and safety, the leading supplier emphasized their commitment to boosting OEM efficiency in development and manufacturing.

Key highlights:

Modular Projector Platform: A versatile solution integrating multiple projector designs into a single standardized platform, including Low-/High Beam, bi-functional, and various ADB Matrix options for state-of-the-art, yet cost-efficient front lighting.

Digital Front System: An innovative approach to vehicle design, integrating smart lighting, a sound system and display technologies for new aesthetics and car2x communication.

RBG Signal Lighting: A pioneering solution enhancing visibility and providing standard lighting functions with advanced styling options.

One4You: All-in-one solutions ranging from illuminated panels to extended exterior modules, allowing a single body with multiple silhouettes realized at the end of the manufacturing line.

For more information, visit the OPmobility website:
www.opmobility.com

DBM Reflex



DBM had the opportunity to present its innovative technology solutions at the 2025 DVN in Munich. Through all groundbreaking offered, Micro Cones stands out.

Leveraging their expertise in plating, DBM can produce micro-sized cones with clean, sharp geometries that are impossible to achieve using standard machining techniques.

Renault's new 5 headlight system, developed by Valeo, was on display, showcasing the capabilities of the Micro Cones technology, which is perfectly suited for creating a stylish and unique signature.

Also featured at DBM's booth was the Texilit™ product line, displayed with the Chevy Traverse taillight developed by Magna.

By combining our plating expertise, high-accuracy 5-axis CNC milling, and optical proficiency, DBM has developed a proprietary optical structure.

This optical solution is not only fully homogeneous but also meets regulatory requirements for positions, stop lamps, and other functions.

Additionally, DBM introduced Micro Cata, a cutting-edge alternative to the standard reflex elements commonly found on vehicles.

This innovation offers a new path for styling design, providing an exciting alternative to traditional solutions.

DBM continues to drive forward with groundbreaking technologies, offering advanced solutions for the automotive and lighting industries.

ARRK SPG: Advancing Automotive Lighting Prototyping

ARRK SPG, a division of the ARRK Corporation, specializes in pre-series tooling and prototyping services for the automotive industry. The company focuses on producing high-quality, production-representative prototypes for automotive lighting components, such as optical lenses, lighting housings, and other intricate parts. ARRK SPG helps bring design concepts to life quickly and efficiently.

The company offers a range of advanced in-house capabilities, including CNC machining, rapid injection molding, and 3D printing, enabling them to deliver prototypes that closely resemble final production parts in terms of performance and appearance.

Core Capabilities:

- **Speed to Market:** ARRK SPG helps reduce development time by providing prototypes that enable fast design validation.
- **Precision and Accuracy:** With extensive experience in the automotive sector, the company ensures that prototypes meet high industry standards.
- **Flexible Production:** Whether for individual prototypes or small-scale production runs, ARRK SPG adapts its services to the specific needs of its clients.
- **Sustainable Practices:** The company incorporates sustainable manufacturing techniques and new material innovations into its prototyping processes.

A Reliable Partner for Automotive Lighting Prototyping

ARRK SPG's expertise in automotive lighting prototyping supports the development of innovative lighting solutions. By offering high-quality prototypes with fast turnaround times, the company helps clients move from design to production more efficiently.



ZKW

ZKW is a leading specialist in premium lighting and electronic systems for the global automotive industry. A proud member of the LG family since 2018, ZKW presented its latest highlight headlamps at DVN Munich 2025.

Among the highlights was the Cupra Terramar headlamp – the first on the road to feature HD microZ modules with 25,000 pixels for ultra-precise ground projection. Additionally, ZKW showcased the latest Volvo Truck headlamp, one of the first in its class to integrate Matrix lighting for optimal visibility during night drives.

This headlamp also includes a specially designed, easily replaceable main light module, extending the product's lifespan and making it more environmentally friendly than comparable models. Lastly, in collaboration with REHAU Automotive, ZKW introduced the latest development of the "Illuminated Bumper," which now meets the required light values to function as a standalone position light.



Endego

Endego showcased its innovative approach to nearshoring, emphasizing the added value of collaboration with our company. Under the theme of partnership, intra-market cooperation, and maximizing mutual potential, we presented a demonstrator developed jointly by Endego's engineering team and our partners from OE Industry. Integrating cutting-edge technologies such as the ultrathin fiber lightguide from L.E.S.S. and OLED panels from OLEDWorks into a cohesive design, we introduced a compelling product concept. At Endego, we demonstrated that a nearshore partner is not only about access to skilled engineers but also to advanced technology, innovation, and a creative approach to product development. This combination provides a competitive edge to every project we engage in.



Inova



On this year's DVN in Munich, Inova Semiconductors presented its ISELED® and ILaS® products, based on Inova technology that significantly reduces costs and effort in software defined lighting application. These products allow streaming of lighting information via UTP cable from a central controller directly or via an Ethernet network to lighting elements distributed throughout the vehicle.

The INLT220Q ILaS® cable transceiver supports segmented daisy-chains of up to 4079 fully color-calibrated ISELED® Smart RGB LEDs within an ILaS® network (ISELED® Light and Sensor Network). It includes a DCDC buck controller for an efficient power supply from 12V battery voltage. ISELED® Lightstrips or LED matrix segments may be interconnected using a single INLT220Q transceiver. 14 different ISELED® LEDs in various intensities are now available from 7 manufacturers as well as a tunable white LED.

For small lamp applications, the new ILaS® RGB LEDs are modules that integrate RGB LEDs with a temperature compensated & calibrated LED driver, DCDC buck converter and ILaS® cable interface into a single tiny component. The stand-alone 3-channel LED driver INLT301Q with 3x 150mA drive strength supports external mid-power LEDs or strings of LEDs for exterior applications such as rear combination lamps.

Elmos

Elmos presented numerous demos with new products at the DVN Workshop Lighting in Munich. Above all, our new multi-channel (O)LED driver E522.96 with high speed CAN/FD interface combined with OLED modules provided a very positive response.

Another highlight was our Dynamic LIN demonstrator based on our static LIN/RGB LED-driver E521.39. DynamicLIN redefines lighting control, seamlessly bridging static and dynamic ambient light functions for OEMs at lower costs. With 10ms RGB refresh across multiple LIN modules, it enables real-time, fluid animations updated over the air (OTA) — no flashing required. Its intuitive interface lets users craft intricate lighting effects using specialized commands for color, intensity, and dynamic modulation. The built-in synchronization ensures flawless coordination across devices, creating cohesive, stunning visuals, all powered by Patent applied DynamicLIN control.

We are thrilled and deeply honored to receive the DVN Award in the category “Best Lighting Technology 2024”, which underlines our claim to further expand its position as technology leader for LED drivers in the areas of ambient vehicle interior lighting and LED rear lighting



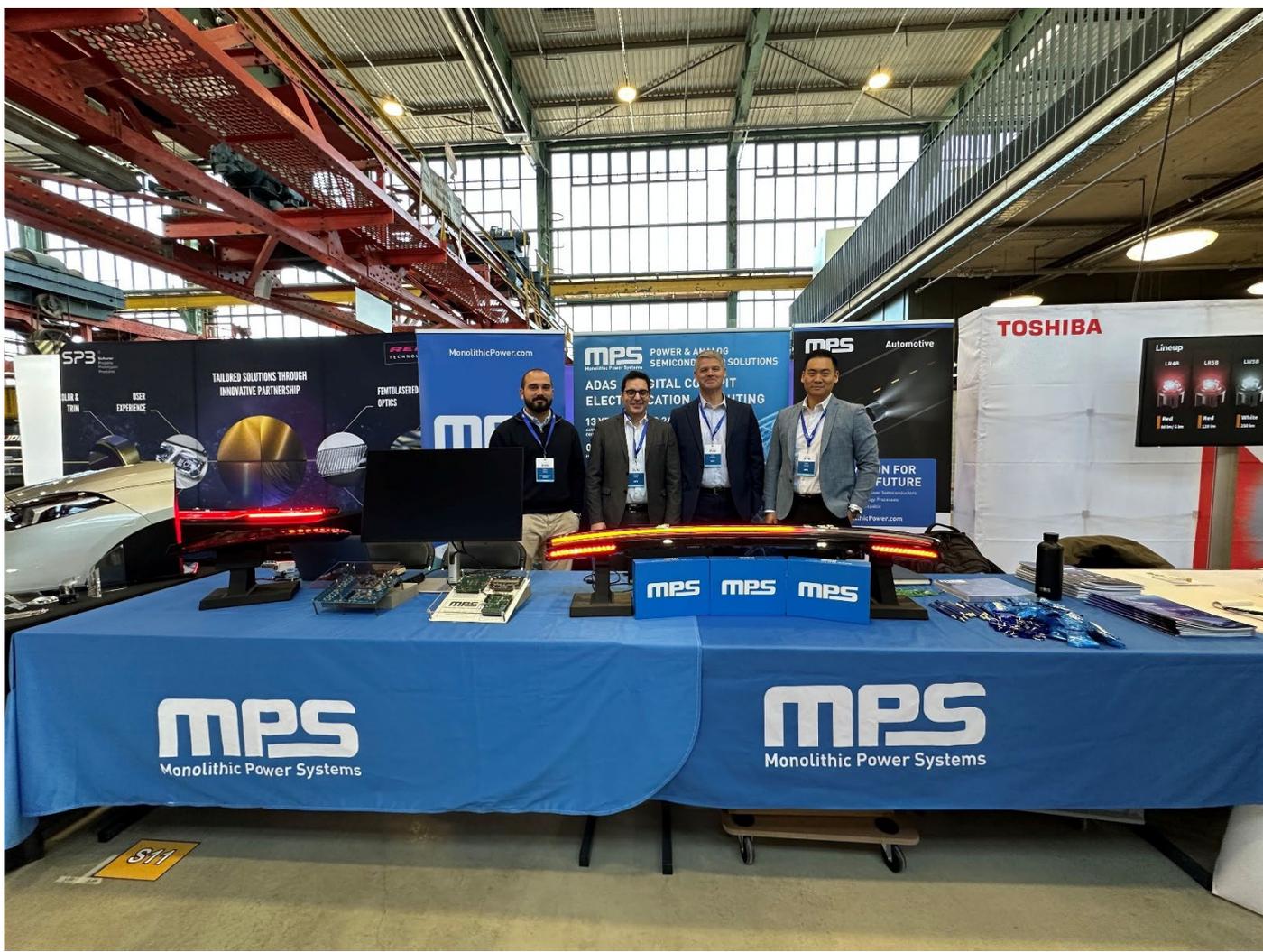
MPS

MPS's comprehensive catalog of power semiconductors drives the future of automotive LED lighting, including headlights, rear lights, LED ECUs, and high-definition (HD) micropixel lights.

MPS showcased the Leapmotor C10 and Kia EV6 tail lights, powered by the MPQ7225. This advanced 16-channel linear LED driver is designed for animated and dynamic lighting applications, drives a class-leading 200mA/channel, and operates seamlessly across extended PCB distances with a high-speed, CAN-compatible interface. Adaptive feedback control (AFC) is featured for real-time voltage headroom manipulation to maximize efficiency.

MPS also presented our headlight reference design, featuring adaptive driving beam (ADB) technology. This comprehensive solution integrates an ideal diode, dual buck converters, boost converters, and matrix managers to offer scalability, in addition to ISO 26262 ASIL-B Functional Safety and high performance with great thermals.

Experience the future of LED lighting with MPS at [MonolithicPower.com](https://www.MonolithicPower.com)



ASAP

The ASAP Group introduced innovative approaches to functional validation of exterior lighting, with a particular focus on TestSphere, an advanced end-to-end validation framework developed by ASAP. In her expert presentation, "How to Validate Exterior Lights in an Evolving Automotive Ecosystem," Christina Riebl, Project Lead Software | Virtual Validation, highlighted how TestSphere is setting new industry standards for user-friendliness and traceability in the validation process.

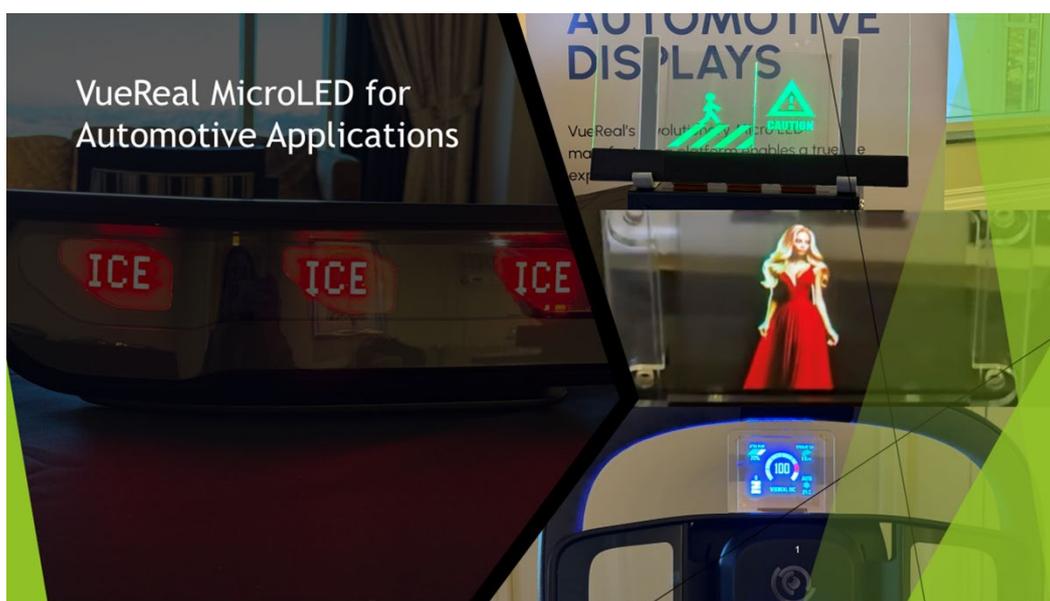
The TestSphere validation framework stands out due to its automated test execution, standardized test design across multiple test systems, and enhanced test process quality. It ensures seamless harmonization and centralized visualization of data and information – from requirements to test reports – within the tool-independent TestSphere Editor. Through integrated bridges, TestSphere connects effortlessly with ALM tools, system architecture tools, and customer-specific test systems, which enables testers to continue working with their preferred tools while simultaneously reducing costs and improving efficiency in the validation process. This positions TestSphere as a future-proof solution that guarantees compliance and reliability in the validation of exterior lighting.

The ASAP group, a subsidiary of HCLTech, offers a comprehensive range of automotive engineering services – Electrics/Electronics, Software, Consulting & Service, Testing & Validation and Vehicle Engineering – concentrating on mega trends such as e-mobility, autonomous driving and connectivity.



VueReal

VueReal presented its latest MicroLED product roundup focused on key highlights: transparent displays, communicative tail light assemblies, and VueReal's ability to provide full red bright lights for braking applications. VueReal's innovative MicroSolid Printing™ platform transforms automotive with ultra-thin, high-bright lighting solutions that are exceptionally energy efficient and deliver ease of integration. MicroLED is not just a "future" technology. Instead, it is a viable, cost-effective solution for automotive applications today.



Microrelleus

Microrelleus showcased several production projects where micro-optics or light-diffusion textures were engraved directly into the production tool inserts using femtosecond laser technology. Among the presented examples were the Cupra Formentor, Renault Rafale, Fiat Topolino, and Lancia Ypsilon — all leveraging the unique benefits of femtosecond lasers, such as ultra-precise microstructures, superior surface quality, sharp-edge definition, and highly homogeneous appearance.

Additionally, Microrelleus presented their Microscatt technology for controlled light diffusion, their anti-glare textures and a captivating demonstration of image-shifting micro-prisms, where the visual effect changes depending on the viewing angle — all achieved by directly engraving the tool.

Femtosecond laser technology continues to unlock new design possibilities in automotive lighting, enabling next-level optical performance straight from the production tool.



MPLD

MPLD is a leading and independent manufacturer of vibration fixtures and validation jigs for quality tests. Thanks to the know-how we gained in more than 20 years of experience, the continues investments in technology and human resources, we offer high quality products and services with certified processes according to ISO9001.

Most of our manufacturing takes place internally in our departments of R&D, production, assembly, dimensional control and dynamic validation.

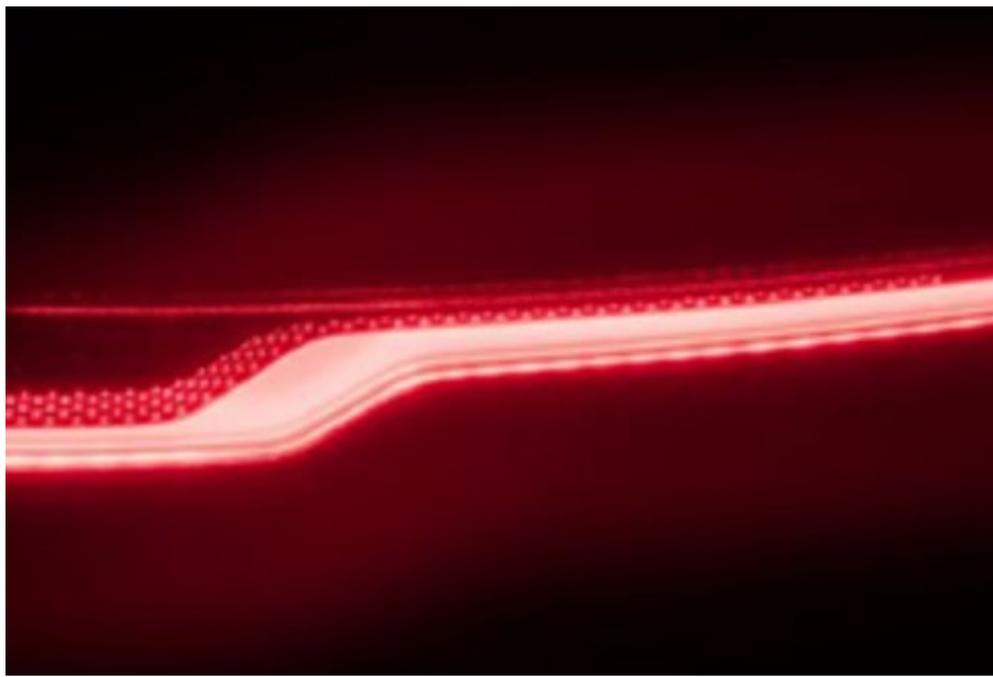
We like to work with our customers as a consultant in the whole validation process to define together the jigs necessary to validate the product in order to optimize all the cost parameters.

Each fixture is realized in order to maximize performance, ensure repeatability, minimize time setup and facilitate the work of the validation engineers.



Luminit

Luminit presented its spatially variable micro-optic technology, which enables the replication of different multiple diffusion angles and orientations seamlessly integrated across the surface of a single part. Our in-house mastering, greyscale photolithography, and advanced microscopy tools allow pixel-by-pixel custom design and write capabilities for a full-range of micro-optics solutions at high volume production levels, replicated on a variety of AMECA-approved plastic and glass substrates depending on thickness, temperature, and volume requirements. Luminit's spatially variable micro-optics can combine a variety of shapes, orientations, and angles to create unique designs across a single part, making a custom look while keeping install simple. With auto-certified IAF16949, industry compliant RCL and DRL designs available, Luminit is a one-stop-shop, design-to-fabrication light guide module service.



Toshiba

Toshiba Lighting & Technology Corporation has proposed socket-type LED light sources that maintain the ease of use of incandescent bulbs while accommodating a variety of designs. This product simplifies lamp design and shortens the time required for evaluation and mass production. Installation is as easy as that of incandescent bulbs, and in case of malfunction, only the light source part needs to be replaced. The lineup includes UNECE standard products, and the more powerful 6 series is compatible with long lamps and wide-area lighting fixtures. Additionally, customized solutions for individual customers are available. For example, it is possible to combine light sources that were previously needed for different functions, such as position and turn signals, into a single light source, reducing the number of parts and lowering costs for customers.



Mind



MIND Optoelectronics is recognized as a premier lighting specialist within the global automotive industry. Since 2024, the company has expanded its offerings to include Advanced Driver Assistance Systems (ADAS) camera and 4D imaging radar components. At the 2025 Munich DVN, MIND presented an array of innovative products, such as the Stargazer, Storm Eye, and various multiple shadow logo prototypes, alongside mass-produced components including the BMW Mini headlamps, rear lights, the all-new DS N°8 headlamp, and Z12mm ultra-slim headlight modules family.

The BMW Mini headlight and rear light exemplify a stylish and dynamic design that adheres to the design language of the MINI family. The all-new DS N°8 headlamp showcases a striking light signature, comprising three modules with a narrow configuration that accommodates AFS modes, bending light, digital left-hand/right-hand traffic configuration, LB booster, and HB ADB functionality. The Storm Eye Prototype demonstrates the company's 2nd-generation Mechanical Movement technology, including functional enhancements such as HB and LB Boost and bad weather light feature. MIND also unveiled a new design concept that seemingly integrates Z12mm super-slim lighting modules with signaling functions, which meets the latest global styling trends; This innovative approach is complemented by advanced transparent display technology, enabling a personalized front appearance.

Edag



EDAG attended the DVN event in Munich to showcase its comprehensive 360-degree portfolio for the development and validation of automotive lighting systems. A key highlight was EDLight, a state-of-the-art demonstrator featuring fully automated testing with AI-driven function recognition, underlining EDAG's commitment to innovation.

In addition, EDAG unveiled its new lighting laboratory, designed to accurately measure large lighting systems over 1.5 metres, particularly for decorative lighting applications. The company's innovations result in significant cost and time savings for customers.

Another highlight was the ZPL night driving simulator, which enables realistic night driving based on IES files, simulating different weather and environmental conditions. EDAG continues to set new standards in automotive lighting development.

Liaowang

Liaowang attended 2025 Munich DVN event with two rear lamp samples that represent its extensive product range from cost-effective LED solutions to advanced, cutting-edge technologies. The Changan Deepal G318 rear combined lamp features a homogeneous lit appearance achieved with fewer LEDs and diffuse material bezel. Iconic styling and good lit appearance are efficiently attained at a relatively low cost. Another standout is the SAIC IM L6 rear combined lamps, which have been put into mass production in China since 2024. These lamps incorporate Liaowang's original tech solution in interaction lighting field, MDL technology, with over 2000 LEDs independently addressable. While the pixel pitch has been reduced to 4mm, the product can also support OTA upgrades and constant communication. In the near future, Liaowang plans to introduce to market its next-generation MDL technologies. Promising higher resolution, improved contrast ratio, and multi-color display capabilities, there is much more to come!



List of main DVN Monthly Reports

Main reports launched in 2008-2020

Koito company profile
 China lighting market
 The Wonderful World of Passenger Car lighting
 Tier 2 and 3 contribution on automotive lighting
 ZKW company profile
 Simulations in automotive lighting
 Mercedes-Benz profile
 LED technologies in automotive lighting
 LEDs Thermo-Electrics
 Interior Lighting BMW
 and lighting Lighting and
 ADAS Materials in lighting
 Laser Head lighting
 Automotive lighting Regulations
 worldwide Israeli Startups
 Jaguar Land Rover and lighting
 Engineering companies involved in lighting
 Japanese lighting market
 Status of w/w Regulations
 Korea Lighting Market
 SL Corp profile
 ADB/Matrix Beam
 India Car Industry and Lighting Market
 Vision of lighting 2025-2030
 Automotive lighting Regulations worldwide
 Vehicle Lighting in USA
 New ADB technologies Interior
 Lighting Camera technologies
 Varroc profile
 Volkswagen profile
 US automotive lighting industry
 Materials in Vehicle Lighting
 The Future of Exterior Lighting
 IAA Frankfurt Autoshow
 DVN Munich WS
 GENEVA
 Autoshow US
 Lighting Marelli
 AL Profile
 50 years Light
 Styling ADAS and Lighting

Main reports launched in 2021

Evolution of LEDs
 New Models July-October
 2020 Audi Lighting & ADAS
 Lighting in development countries
 ADB Update
 DVN Shanghai WS
 Innovations in Rear Lighting
 Global Landscape of Automotive LED Suppliers

Reports launched in 2022

Technologies presented in CES 2022
 Laser light automotive lighting
 ISAL report
 DVN US workshop
 Worldwide Demographic Development
 Models launched May to August DVN
 Shanghai report
 VISION congress
 Paris Autoshow + last Vehicle models
 L.A. Autoshow

Reports launched in 2023

CES Report
 TU Darmstadt Lighting Institute
 DVN Paris Workshop
 Universities and Lighting
 MLA Technology
 Models launched in H1-2023 DVN Tokyo
 Workshop ISAL Report
 DVN US Workshop Osram Company Profile
 DVN Shanghai Workshop

Reports launched in 2024

CES
 New cars of the semester
 DVN Munich Workshop
 OLED Technology Beijing Autoshow Display
 Week
 2024 DVN Detroit Workshop ALE, June 2024
 Indian vehicle lighting market
 DVN Pune Workshop summary
 New cars 2024
 Nichia company profile Test houses
 Shanghai DVN event summary

Reports to be launched in 2025

CES and Bharat Mobility Global Expo
 Regulation UNECE 155 & 156
 DVN Munich event summary
 Dekra testhouse
 Company Profile
 ALE + Shanghai motorshow report
 Czech Republic automotive lighting
 ecosystem
 RGB leds status

DVN ecosystem and scientific community

DVN is a reference in the world of Lighting, Interior comfort and Lidar

Car Makers

Audi
Avatr Technology
Bentley
BMW
Ferrari
Ford
Ford Otosan
General Motors
Genesis
Hero MotoCorp
Honda
Hyundai
Jaguar-Land Rover
Kia
Lotus cars
Lucid Motors
Mazda
Mercedes-Benz
Mitsubishi Motors
Nio
Nissan
Renault
Rivian
Seat
Stellantis
Subaru
Toyota
TVS
SAIC Volkswagen
Volvo Cars
Zoox

System Suppliers and Tier 1s

Adient
Anrui
Appotronics
Aspöck Systems
Braslux
Cepton
Ceres Holographics
Chongqing Rebo
Continental
Creat
Diode Dynamics
Elba
F2J Industry
Feka
Fiem Industry
Flex-N-gate
FORVIA designLED
FORVIA HELLA
GHSP
Grupo Antolin
Hascovision
Hitachi
Ichikoh
J.W. Speaker
Keboda
Koito
Lightworks
Lumax

Luxit
Maier
Magna
Marelli
Marquardt
Mind
Mobileye
Mobis
Muth Mirror Systems
Nordic Lights
Odelo Farba
OPmobility
Panasonic
Polycontact
Prettl group
Rehau
SL Corporation
SMR Automotive
Stanley
The Lighting Consultants
Toyota Boshoku
Uno Minda
Valeo
Varrac
Weidplas CH
Xingyu
Zanini
ZKW
Zodiac

Light Source Suppliers

ams OSRAM
APT Electronics
Brightek
Dominant Opto Tech.
Everlight Electr.
HC Semitek
Kyocera SLD Laser
LG Innotek
Liteon Technology
Lumileds
Nichia
OLEDWorks
Refond
Samsung LED
Seoul Semiconductor

Tier 2s and service providers

A2Mac1
Ascorium
AML Systems
Ansys
ASAP
ASYST Technologies
Auer Lighting
BASF
Bluebinaries
Brightview Technologies
Capgemini
CLM Search

Coindu
Covestro
Dajac
DBM Reflex
Delo
Die haptiker GmbH
Docter Optics
Dow
Edag
Elmos
Endego
Ennostar
Euro Moulders
EV Group
Focuslight
Fusaware
Grewus
HJ Optics
Huawei
Idemitsu
Infineon
Inova Semiconductors
Instrument Systems
Integrity
Joysonquin
Leonhard Kurz
L.E.S.S.
LMT
Luminus
Mekttec
Microvision
Maxell Frontier
MD Group
Melexis
Microchip
Microrelleus
Mitsui Chemicals
Mocom
Nalux
NBHX Trim
Oerlikon
ON Semiconductor
Polyrise
Preh
Ray Group
S&P Global Mobility
Sabic
Seaborough
Seoyoneh-Ewha
Shihu
SP3
Sunny Automotive
Optech
Suzhou Senbo
Synopsys
TechnoTeam
Toshiba lighting
TQ Technology
Uni Tooling
Ventura
W.L. Gore & Associates
WLOPT
X2F
Xunchi

Universities, NGO and labs

Alliance for Automotive Innovation
ARAI
Automotive Research Association of India
BMDV
Bundesministerium für Digitales und Verkehr
CATARC
China Automotive Technology and Research Center
CEA Leti
Darmstadt university
DEKRA
Department for transport, UK
DTI
Danish Technological Institute
Estaca
École supérieure des techniques aéronautiques et de construction automobile
Fraunhofer (FEP, IAP, ILT, IMS)
Fudan university
GTB
Hannover Leibniz
Hochschule Aalen
Hochschule Magdeburg-Stendal
Icahn School of Medicine at Mount Sinai
Light and Health Research Center
ICAT
International Centre for Automotive Technology
Idiada
Institut d'Optique
JASIC
Japan Automobile Standards Internationalization Center
KBA
(Kraftfahrt-Bundesamt)
KATRI
Korea Apparel Testing & Research Institute
KIT
Karlsruhe Institute of Technology
Kotsa
Korea Transportation Safety Authority
LCOE
Laboratorio Central Oficial de Electrotecnia
L-LAB
MLIT
Ministry of Land, Infrastructure, Transport and Tourism
NHTSA
National Highway Traffic Safety Administration
OICA
International Organization of Motor Vehicle Manufacturers
Pacific Northwest National Laboratory
RDW
RISE Research Institutes of Sweden
Sapphire STS
SMMT
Society of Motor Manufacturers And Traders
SMVIC
Shanghai Motor Vehicle Inspection Certification
TNO
Traficom
Transport Canada
UMTRI
Université Gustave Eiffel
UTAC
VDA
Verband der Automobilindustrie
VEDECOM
Vrije Universiteit Brussel
YoungNam University