Tue, 14 May 2024
Weekly Newsletter

DVN Lighting

NEWSLETTER #855

Editorial

Is Not Enough Attention Paid To Glare For Road Users Today?

The Federation Internationale de l'Automobile (FIA) is one of the world's largest non-profit consumer organizations, with over 80 million members across 242 clubs in 147 countries. FIA is huge and powerful, and now they say more and more members are complaining about glare. Ten European mobility clubs, led by the German ADAC, conducted a survey on traffic glare. Some of the organizations sent out a six-page questionnaire via member magazines and social media and received 22,000 responses. The other clubs commissioned a representative survey of 1,000 drivers via a market research company, with the same list of questions. Here are the results from the representative survey:

- 71 per cent of the respondents find the glare 'unbearable' or 'annoying'
- 32 per cent 'almost always' or 'regularly' feel dazzled
- 51 per cent squint or even close their eyes briefly against glare while driving
- 58 per cent have problems perceiving objects in the vicinity of the dazzling light source
- 30 per cent say they still see an afterimage of the light source for some time after passing it, or even feel pain.

(these last two points are indications of hindered perception/vision, i.e., physiological/disability glare)

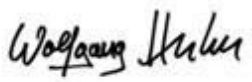
The results of the non-representative surveys were, as expected, even starker. A few respondent comments were highlighted, such as "The balance between seeing and being seen is gone" or "It seems that some vehicles are always driving with their high beams on" and "Colour is a problem, intense white suddenly turns into a blue flash".

The conclusion of the FIA, recently reported at the 90th GRE meeting in Geneva, is that the majority of drivers surveyed feel dazzled in traffic and ¾ of all respondents support changes in legislation to reduce traffic glare.

They put forth some possible causes, with heavy emphasis on the high luminance and contrast of today's headlamps being unaddressed by current regulations, as well as the sensitivity of the eye to blue light; high-mounted headlamps, and slow reaction of ADB systems.

The FIA have recommended that WP.29 establish a task force on glare prevention.

DVN will keep you updated as events develop. Watch for detailed analysis of traffic glare in forthcoming DVNewsletters.



Wolfgang Huhn
DVN Senior Advisor

In Depth Lighting Technology

SIA VISION 2024 Program is ON!

The program for SIA VISION 2024 has just been **published** on the SIA website. The call for papers this year was a great success, with 99 papers received—69 for lighting, and 30 for ADAS—from 46 different companies.

The Scientific Committee gathered on 13 March and selected 54 papers. For the first time this year, we have defined some common sessions and some parallel sessions.

Day one will start with a keynote from **Gilles Vidal**, Renault's Design VP, and then a main session about VRU (Vulnerable Road Users) and sensor integration.

INTRODUCTION

08:30:00	**Welcome Introduction** Paul-Henri Matha - DVN Frédéric Charon - SIA
08:45:00	**Keynote Gilles Vidal** Design VP - RENAULT GROUP

VRU & SENSOR INTEGRATION

09:10:00	**Principles for Effective Lighting for Vulnerable Road User Safety** John D. Bullough - Light and Health Research Center at Mount Sinai
09:30:00	**Challenges in the radome illumination design** Alenka Bajec Strle - Forvia
09:50:00	**High Resolution radar integrated in vehicle lamps to improve driving safety and visibility.** Luca Gioanola - Magna
10:10:00	**Challenges and chances of the sensor integration into headlamps** Florian Krieft - Forvia

After a break will come two parallel sessions: one dedicated to lighting and design, and the other to simulation in ADAS.

DESIGN 1 - LIGHTING		SIMULATION - ADAS	
11:15:00 ›	**New frontlighting of R4 E-Tech - A piece of Art** François Bedu - Renault Group	11:15:00 ›	**Multi-echo adverse weather simulation for LiDAR data in autonomous driving context** Youri Noutatiem - IRT System X
11:35:00 ›	**Kidney Grille Illumination - Iconic Glow as a Brand-Defining Element** Jörg Kälble - BMW	11:35:00 ›	**SOTIF compliant Scenario-based Testing of L4 systems : From ODD definition to final verdict.** Nabile Khoury - BTC Embedded
11:55:00 ›	**Advanced Light Integration on Exterior parts** Yohan Garnier - Flex-N-Gate	11:55:00 ›	**Simulation in a replaying test bench to characterize an ADAS camera** Youri Noutatiem - IRT System X
12:15:00 ›	**Expanding the horizons of Car Body Lighting** Thorsten Anger - Lumileds	12:15:00 ›	**Realistic simulation of an autonomous vehicle equipped with a radar operating** Mikhail Noutatiem - IRT System X

Lunchtime will be mainly used for networking and visiting the exhibition; 30 companies have already confirmed a booth.

After lunch, we will continue the parallel sessions: one dedicated to lighting and design, and the other to lighting regulation and safety.

DESIGN 2 - LIGHTING		REGULATION & SAFETY 1 - LIGHTING	
14:05:00 ›	**Surface Illumination Solution: State-of-the-Art Development and Challenges** Michal Tomeček - ZKW	14:05:00 ›	**A study on the improvement of ADB function for HD Micro LED Headlamp** Yonghee Won - Hyundai Mobis
14:25:00 ›	**Visibility requirements for interior p rojections** Alexander Stuckert - BMW	14:25:00 ›	**Effects of advanced headlights on nighttime vehicle-pedestrian fatal accidents** Shinta Arai - Institute for Traffic Accident Research and Data Analysis
14:45:00 ›	**Headlight Optimization by Freeform Deformations - A Step Towards Enhanced Safety and Efficiency** Kolchiba Mykyta - Koito	14:45:00 ›	**Safety impact or road projections on cyclists** Sébadtien Saudrais - Estaca
15:05:00 ›	**Discrete chip scale package LEDs for slim lens design** Mersida Azdejkovic - Nichia	15:05:00 ›	**Near field ground projection: Challenges to extend visibility from night to day** Félix Freytag - Marelli
15:25:00 ›	**BREAK IN THE EXHIBTION**		

Then comes another break, after which the lighting session will continue, focusing on regulation and safety, while ADAS presentations will focus on validation.

REGULATION & SAFETY 2 - LIGHTING		VALIDATION - ADAS	
15:55:00	**MicroLED HD Matrix on the Road: Series Technology & End-User Survey** Sebastian Schildmann - Marelli	15:55:00	**Accidents in adscene : a specific survey on AD L2+ functions** Thierry Hermitte - Ampere
16:15:00	**Adaptive Glare-Free Low Beam Distribution - The Potential of Multipixel LEDs for Safety Improvement in Severe Weather Conditions** Benedikt Lamontain - Magdeburg-Stendal University of Applied Sciences	16:15:00	**Virtual Objects for real automated driving: management of complex urban intersections** Thomas Heitzmann - Valeo
16:35:00	**Assessing the Correlation Between Headlight Safety Performance Rating (HSPR) and the Visibility Level for the Detection of Critical Objects in Nighttime Driving** Nikolai Kreß - TU Darmstadt	16:35:00	**Systematic SOTIF-aligned approach to explore residual risk in autonomous driving systems** Scharke Heiko - AVL
16:55:00	**US ADB: Results & Learnings from first Driving Test Measurements** Michael Scholl - Marelli	16:55:00	**Holistic approach for development and validation of ADAS/AD systems** Guillaume François - Etas

To close the day, the session tracks will converge, and all attendees will be together in the main session for a regulation and rating session, starting with a keynote from EuroNCAP Technical Manager **Adriano Palao**, then a presentation from Mercedes-Benz about ADS marker lights, an update on regulation status from GRVA and GRE, and a panel discussion.

REGULATION	
17:20:00	**Keynote EuroNCAP** Adriano Palao; Technical Manager - ADAS & AD
17:40:00	**ADS Marker Lamps - Testing insights and activities towards harmonized regulations** Daniel Betz - Mercedes-Benz
17:55:00	**GRVA**
18:10:00	**GRE**
18:25:00	**Round-table: Regulation**
19:25:00	**END OF CONFERENCE - DINNER IN THE EXHIBITION + DEMOCARS**

After that, day one of the congress will close with dinner and the demo-car session in the parking area to be able to see and test the latest lighting and ADAS technologies.

Day 2 will start with a focus on ADAS and two keynote speakers: Mercedes-Benz VP **Martin Hart**, and Mobileye EVP **Nimrod Nehushtan**. Then comes a combined session, "Lighting for ADAS and ADAS for Lighting" which represent perfectly the intent of the VISION congress: bringing together companies and universities working in both technical fields.

PLENNARY	
08:00:00	**Keynote Mercedes** Martin Hart; director Driver assistance system and active safety
08:25:00	**Keynote Mobileye** Nimrod Nehushtan; EVP of Strategy and Business Development

LIGHTING FOR ADAS AND ADAS FOR LIGHTING	
08:50:00	**From ADB with high-resolution micro LED pixel emitter arrays to camera-controlled adaptive light distributions for different situations in nighttime traffic - a data driven approach** David Hoffmann - TU Darmstadt
09:10:00	**Lighting and ADAS - ADAS and Lighting** Benoît Reiss - Ichikoh Industries
09:30:00	**AHEAD - Light Distributions for camera-based automated driving - in simulation and validated in real world scenarios** Rainer Kauschke - Forvia / Hella
09:50:00	**HD Lighting for Camera Perception with ADAS Sensors** Jungsub Lim - Hyundai Mobis

After a break, the parallel sessions will be back; one with focus on lighting and technology, and the other on ADAS and sensors.

TECHNOLOGY 1 - LIGHTING	
10:55:00	**Digital Matrix Light - How µLED arrays are pushing the limits of Adaptive Digital Light Distribution (ADLD) design** Anil Erkan - Audi
11:15:00	**HD-ADB, Illuminated Emblems & Letterings: Not only available at premium cars** Philipp Roeckl - Stellantis
11:35:00	**Investigation of Technologies for Fully Dynamic Ground Projections: Performance, Criteria and Use Cases** Mikayel Musheghyan - ZKW
11:55:00	**Matrix Headlights and Surface Properties: A New Way to Boost Computer Vision and Save Energy for Automated Vehicles** Nathalie Müller - TU Dortmund University

SENSORS - ADAS	
10:55:00	**Automatic Emergency Braking : expending Operational Design Domain to low visibility conditions with affordable thermal camera integrated behind the windshield** Sébastien Tinnes - Lynred
11:15:00	**Guaranteeing Performance in AI-Driven Image Compression and Object Detection Pipelines** Jérémy Jaspar - Stellantis
11:35:00	**Enhancing Sensor Robustness in Automotive Systems: A Multimodal Generative Approach** Mustapha Bounoua - Ampere
11:55:00	**Enhancing Autonomous Vehicle Safety and Perception with Thermal Camera Real Time Simulation: An Integration of Ansys AVxcelerate and Teledyne FLIR thermal camera Technologies** Sandra Gely - Ansys

After lunch, the lighting track will continue to focus on technology, while the ADAS presentations will focus on systems.

TECHNOLOGY 2 - LIGHTING		SYSTEM - ADAS	
13:45:00	**Digitalization and Customization of Signaling Functions** Michael Rosenauer - OPmobility	13:45:00	**Minimizing Parameters, Maximizing Safety: A Deep Learning Approach to Real-Time Distracted Driver Identification** Georgios Markos Chatziloizos - Ampere
14:05:00	**New Bi-LED front lighting concept for A - B segment and LCV vehicles and its Integration in Stellantis' Architecture** Nadia Costa - Stellantis	14:05:00	**Automatic checking and correction of landmarks in HD map with onboard perception systems** Rémy Huet - Heudiasyc, CNRS
14:25:00	**Adapted LED Chip Design for Efficiency-Improved Slim Headlamp Systems** Michael Brandl - Osram	14:25:00	**Operational Design Domain Monitoring through Uncertain Observations** Thibault Charmet - Renault Group
14:45:00	**MiniLED - A driver for Pixelisation of Exterior Signaling Function** Nils Benter - Seoul Semiconductor	14:45:00	**Understanding the cost-effective integration of sensors and computing in automotive advancements** Pierrick Boulay - Yole Group

To close the day, the ADAS track will focus on regulations and safety, while the lighting session will be focused on sustainability with lectures about circular economy and reliability.

15:05:00	**BREAK IN THE EXHIBITION**		
SUSTAINABILITY - LIGHTING		**SAFETY & REGULATION - ADAS**	
15:35:00	**High Resolution Display Reliability Approach for Automotive Applications** Antoine de LAMBERTERIE - Valeo	15:35:00	**Managing EU's challenging ADAS/AD law to ensure compliance with type approval requirements.** Bastian Prugger - AVL
15:55:00	**Transfer of Exterior Lighting products to the circular economy** Christian Schmidt - Forvia / Hella	15:55:00	**Safety-Coach: a new safety function to address the real road safety issues** Thierry Hermitte - Ampere
16:15:00	**Circular Lighting : Embrace the full life cycle from sustainable design to recycling** Grégory Planche - Valeo	16:15:00	**Which Regulation for ADAS and Automated Driving** Karim Yahia - Stellantis
16:35:00	**TO THE MAIN AMPHITHEATER**		
16:40:00	**Conclusion ADAS et Lighing, takeaways** Luc Bourgeois - SIA Paul-Henri Matha - DVN		

I hope you will enjoy the new format of the event, with a better balance between lighting and ADAS.

We are expecting more than 600 participants on 16 and 17 October in Paris, France.

Lighting News

New DVN Lighting Consultants

LIGHTING NEWS



The DVN team are happy to have welcomed three new senior consultants to our team from January 2024. Eric Blusseau brings his great knowledge about lighting regulations; Hans Schwabe his knowledge in light source technology, and Franco Marcori his knowledge in rear lighting and lamp development. That's three new consultants, from three different countries—France, Italy, and Germany—in three different lighting domains. A lot of benefit for our team and, thus, to the DVN community!

Here we present their background and expertise so you can see the high level of these experts working to serve you:

Hans Schwabe

Hans studied and graduated in electronic engineering and business administration in Berlin and Munich in 1987. He has worked over 30 years in the lighting business, after working initially for four years as a strategic consultant for Siemens. He started with Osram as a Senior Product Manager for vehicle lighting, responsible for HID and halogen light sources from 1991 to 1997. From 1997-2001 he held managerial roles with increasing responsibilities in R&D, product management, and sales & marketing in the special industrial lighting business unit. From 2002-2005 he was the Managing Director of Osram Taiwan, responsible for all lighting business in that country. From 2005 to 2008 he managed the global Display Optic business unit in Berlin, including plant operations and sales. In 2009 he successfully merged the global vehicle lighting and display optic business units into the Specialty Lighting Unit, and was appointed Executive Vice President and CEO SP. From 2018 on, he focused on the vehicle lighting business unit as CEO, with global responsibility including the supervisory role for the JV with Continental. In 2023 he handed over his global responsibility to his successor Adam Wu, and stepped out of Osram to concentrate his further activities on executive and strategic consulting in lighting.

Franco Marcori

Franco graduated in electronic engineering in 1996, developing a thesis on the design of diffractive optics for partially-coherent light at Seima Italiana (Tolmezzo, Italy), which later became part of Marelli Automotive Lighting. He has worked in the vehicle lighting business for 20 years, holding various managerial roles of increasing responsibility from

optical engineering to electronic design, from innovation and technical marketing to applied research. In 2012 became Technical Director of CRP, a research centre owned by AL and the regional government, and his work centred on applied research in opto-electronics and plastics. From 2004 to 2012 he was the company's regulatory manager for rear lamps, participating in the activities of CUNA (Commissione Tecnica di Unificazione nell'Autoveicolo, the Technical Commission for Unification in the Automotive Industry) and GTB, tasks he supported also in the following four years as a consultant.

From 2016 to 2022 he gained important experience outside the automotive sector as Director of Operations and R&D in the lighting business line of Gewiss in Cenate Sotto (Bergamo, Italy), a company specialized in electrotechnical solutions and products for industrial, tertiary, and residential applications.

From May 2022 to December 2023, he returned to the automotive design as Senior R&D Manager at Olsa in Rivoli (Turin, Italy), responsible for all product development activities of Magna Lighting on rear lamps in Europe.

Eric Blusseau

Eric made most of his career at Valeo Lighting. He spent more than 30 years in Optics and Regulations.

He started in research and developments at Bobigny for 13 years in the development of complex shape reflectors and elliptic modules. He was a key player in the development of HID lights in the '90s, and was

appointed optical expert in 1997 and senior expert in 2000. In 2001, he moved to Angers to create the Optical Development Department. His work entailed hiring and training optical engineers; implementing design and simulation tools; creating the 25-metre dark room and the optical laboratory, and managing the approval of new lamps.

In 2009, he took responsibility for the regulation and approval department of Valeo Lighting. He created and managed the regulation network inside Valeo Lighting Systems with one Regulation Manager in each development centre: Angers, France; Martos, Spain; Le Hainault, Belgium; Seymour, Indiana, USA; Wuhan, Foshan, China; Pianezza, Italy; São Paolo, Brazil; Queretaro, Mexico; Chennai, India; and Isehara, Japan.

He was a French Delegation Expert at GTB, and a member of the GTB delegation at GRE. In 2017, he was appointed Chair of the GTB Front Lighting Working Group. Along all his career, he was inventor or co-inventor of 48 patents.

ZKW Headlamp on New Audi Q8

LIGHTING NEWS

The Q8 comes with LED headlamps as standard, with optional HD Matrix lamps with 24 LEDs and one high-performance laser diode on each side of the car. As a special innovation, four different digital daytime running light signatures can be selected. The basis for this is a daytime running light cover with a double microstructure, which ZKW developed together with Audi, integrated in a sophisticated manner.

In the top version of the Q8 headlamp, a high-performance laser diode powers a reflector-optic high beam booster available for use at speeds above 70 km/h, which significantly increases the high beam range. The laser high beam is visually recognizable by a blue LED light guide integrated in the headlamp.

ZKW use a new production method, the Cobot System, in the production of the Q8 headlamp. Assembly personnel work together with a collaborative robot, which positions the daytime running light components in preparation for subsequent manual completion. The daytime running light unit is also prefabricated on a separate assembly line in order to meet the high quality requirements and complex assembly process.

The new 2025 BMW M4 CS

LIGHTING NEWS

BMW has just revealed the new 2025 M4 CS, and it bears really interesting lamp technology. The rear lamps were presented at events including DVN Munich and CES 2024, and now we focus on the headlamp and its yellow daytime running light, which gives the car a different look.

This is not the first car with yellow DRLs; the BMW M3 and M4 CSL editions are equipped.

DVN India: One Day Left in Call for Papers

LIGHTING NEWS

The India DVN Workshop will be on 4-5 September this year, and **tomorrow, 15 May is the last day to submit a paper** for consideration. Feel free to **email us your abstract**.

For the event, we have defined three sessions:

- Indian vehicle and lighting market: design and technical trends, LEDification, softwarisation
- 2- and 3-wheeler lighting specification: design, technology, cost
- India-specific lighting requirements: design, reliability, contamination, usage

We will also have three panel discussions:

- Regulation, with participation by GTB, ARAI, ICAT, and an Indian GRE delegate
- Design, with automaker designers
- Tier-1 CEO round table

We have already received around 20 lectures from automakers, 2-wheeler makers, lighting makers, tier-2 suppliers, test houses, and authorities, and the docket will be finalized by the end of May. We'll publish an agenda the first week of June. This will be a very interesting workshop to learn more about the Indian lighting ecosystem. The vehicle lighting business in India currently represents between $2bn and $3bn, with strong growth potential; expected growth from 2023 to 2030 is around 8 per cent per year.

Driver Assistance News

New IIHS Partial-AD Ratings: Industry Has Work To Do

DRIVER ASSISTANCE NEWS

Partial driving automation is a convenience meant to make long drives easier, but humans are terrible at passively paying attention as required by these more-or-less L^2 systems. There's no evidence they make driving safer, and they can create new risks by setting up the perfect conditions for the driver's attention to wander. That's why it is essential that all partial driving automation systems incorporate robust safeguards.

But many of them don't, and so the U.S. Insurance Institute for Highway Safety has launched a new rating program to evaluate the safeguards built into partial driving automation systems. They evaluate driver monitoring, attention reminders, emergency procedures, and other aspects of system design. A system may be assigned a rating of Good, Acceptable, Marginal, or Poor for its safeguards.

There are still a lot of issues with driver monitoring, emergency procedures, and safety features. Of the first 14 systems tested—from BMW, Ford, General Motors, Genesis, Lexus, Mercedes-Benz, Nissan, Tesla and Volvo—11 earned a Poor rating. Two were found Marginal, and only one earned an Acceptable grade.

Whether whole systems like Tesla's so-called 'Autopilot' and 'Full Self Driving'; GM's Super Cruise, and Ford's Blue Cruise, or feature bundles providing similar capabilities, today’s partial driving-automation technology uses cameras, radar, or other sensors to "see" the roadway and other vehicles. The setups in question include adaptive cruise control, lane centering, and various other driver-assist features. Adaptive cruise maintains a driver-selected speed, but will automatically slow to keep a set following distance from a slower vehicle ahead and then accelerate when the way is clear. Lane centering continuously adjusts the steering to help the driver keep the vehicle centered in the travel lane. Automated lane changing is also becoming more common. And driver monitoring is a crucial piece, to make sure the driver is always paying attention and ready to take control as soon as it's needed.

Rated systems

	Overall rating	Driver monitoring	Attention reminders	Emergency procedures	Driver involvement: Lane change	Driver involvement: ACC resume	Driver involvement: Cooperative steering	Safety features
Lexus Teammate with Advanced Drive 2022-24 Lexus LS	A	M	G	A	G	A	G	G
General Motors Super Cruise 2023-24 GMC Sierra	M	P	G	G	P	A	P	G
Nissan ProPILOT Assist with Navi-link 2023-24 Nissan Ariya	M	M	A	M	G	G	G	A
BMW Active Driving Assistant Pro 2023-24 BMW X1	P	M	P	A	G	P	G	A
Ford BlueCruise 2021-24 Ford Mustang Mach-E	P	A	G	M	G	M	G	P
Ford Adaptive Cruise Control with Stop & Go and Lane Centering Assist 2021-24 Ford Mustang Mach-E	P	A	G	M	G	G	G	P

	Overall rating	Driver monitoring	Attention reminders	Emergency procedures	Driver involvement: Lane change	Driver involvement: ACC resume	Driver involvement: Cooperative steering	Safety features
Genesis Smart Cruise Control/Lane Following Assist 2023-24 Genesis G90	P	P	P	P	G	G	G	P
Lexus Dynamic Radar Cruise Control with Lane Tracing Assist 2022-24 Lexus LS	P	P	P	P	G	G	G	M
Mercedes-Benz Active Distance Assist DISTRONIC with Active Steering Assist 2022-23 Mercedes-Benz C-Class	P	M	P	A	G	G	G	P
Nissan ProPILOT Assist 2.0 2023-24 Nissan Ariya	P	P	A	M	G	G	G	G
Tesla Autopilot, Version 2023.7.10 2021-23 Tesla Model 3	P	P	P	A	G	P	P	P
Tesla Full Self-Driving (Beta), Version 2023.7.10 2021-23 Tesla Model 3	P	P	A	A	P	P	P	P
Volvo Pilot Assist 2022-24 Volvo S90	P	P	P	M	G	G	G	P

Requirements for a good partial automation safeguard rating

- Monitors both the driver's gaze and hand position

- Uses multiple types of rapidly escalating alerts to get driver's attention

- Fail-safe procedure slows vehicle, notifies manufacturer and keeps automation off limits for remainder of drive

- Automated lane changes must be initiated or confirmed by the driver

- Adaptive cruise control does not automatically resume after a lengthy stop or if the driver is not looking at the road

- Lane centering does not discourage steering by driver

- Automation features cannot be used with seat belt unfastened

- Automation features cannot be used with automatic emergency braking or lane departure prevention/warning disabled

Driver monitoring

Effective driver monitoring is essential to making partial automation safe. Systems should be able to detect if the driver's head or eyes are not directed at the road and whether the driver's hands are on the steering wheel or ready to grab it if necessary.

To evaluate this, IIHS engineers record what happens in the following cases: the driver monitoring camera lens is blocked, the driver's face is obscured, the driver is looking down, and the driver's hands are not on the steering wheel. For systems that allow hands-free driving, the engineers also record what happens when the driver's hands are holding a foam block the approximate size of a mobile phone. Systems should not activate under these conditions, and if they're already switched on, they should issue an alert.

None of the 14 tested systems met all these requirements, though the Ford systems came very close. Ford's BlueCruise and Adaptive Cruise Control with Stop & Go and Lane Centering Assist immediately issued alerts when the driver's face or the camera lens was covered, for example, but failed to detect when the driver's hands were occupied with another task. The BMW system didn't react when the camera lens or driver's face was covered, and the Mercedes-Benz system lacks a driver-monitoring camera altogether, though both vehicles were able to detect when the driver's hands were not on the steering wheel.

Attention reminders

Timely and persistent attention reminders are also key. When a partial automation system detects that the driver's eyes aren't directed at the road or their hands aren't ready to take over the steering, it should begin a dual-mode alert within 10 seconds, such as an audiovisual warning. Before the 20-second mark, it should add a third mode of alert or begin an emergency procedure to slow the vehicle.

Lexus Teammate, both Ford systems, and GM Super Cruise meet all these requirements. For example, when the test driver deliberately looked away from the road and held the foam block in both hands, Teammate began audiovisual alerts after four seconds, and began an emergency slowdown procedure after 16 seconds.

Both the hands-on Nissan Propilot Assist with Navi-link and the hands-free Propilot Assist 2.0 systems and Tesla 'Full Self-Driving' performed almost as well. The hands-on Nissan system, for example, provided audible and visual alerts about six seconds after driver disengagement, but didn't provide a third type of alert until around 21 seconds had passed, when it pulsed the brakes. Seven other systems didn't even provide dual-mode alerts within the first 15 seconds.

Emergency procedures

Partial automation systems need appropriate emergency escalation procedures to minimize the danger to occupants and other road users if the driver does not respond to those attention reminders. Regardless of how many different modes of alerts they issue, systems should begin a slowdown procedure within 35 seconds of driver disengagement. Drivers who ignore alerts for this long are either in distress or misusing the system. The system should send an SOS message to emergency responders or a 24-hour help center, and the driver should be prevented from restarting the automation for the remainder of the drive.

Of the 14 systems tested, only GM's met all these requirements. Five systems include two of the three emergency procedures, and five include one of them. Lexus' combination of Dynamic Radar Cruise Control with Lane Tracing Assist system and the

two Genesis systems all fail to take any emergency action if the driver disengages from driving and does not respond to repeated warnings.

Driver involvement

Another group of requirements is aimed at ensuring drivers stay involved in decision-making. All lane changes should be initiated or confirmed by the driver. When traffic causes the adaptive cruise to bring the vehicle to a complete stop, it should not automatically resume unless the system can confirm the driver is looking at the road and no more than two minutes have passed. The lane-centering feature should *not* switch off automatically when the driver makes manual steering adjustments within the lane, as that can discourage drivers from being physically involved in the driving, and physical involvement can help prevent mental disengagement.

More systems performed well in these categories than any of the others. GM's Super Cruise and Tesla's 'Full Self-Driving' are the only ones that would make a lane change without any driver input. Super Cruise and both Tesla systems switched off lane centering when the driver does any manual steering.

Many systems allow ACC to resume automatically after a stop of more than two minutes or when the driver is not looking at the road. Both Tesla systems and BMW Active Driving Assist Pro will resume ACC in both scenarios, for example, while several others will restart in one of the two situations. Volvo Pilot Assist is one of seven systems that will not automatically resume in either scenario.

Safety features

There is little evidence that partial automation has any safety benefits, so it’s essential that these systems can only be used when proven safety features are engaged. These include seat belts, AEB, and lane departure prevention. For a good rating in this category, a partial automation system should not switch on if the driver is unbelted or AEB or lane departure prevention is not active. If already in operation and the driver unfastens their seat belt, the system should immediately begin its multi-mode, driver-disengagement attention reminders. Finally, it must be impossible to switch off AEB or lane departure prevention if the automation is engaged.

The hands-free Nissan Propilot Assist 2.0, Lexus Teammate, and GM Super Cruise systems are the only ones that meet all these requirements. The hands-on Nissan Propilot Assist with Navi-link and the BMW system come close, but they deactivate without issuing an alert when a key safety feature is disengaged. This is dangerous, because the driver may not be aware that they need to resume full control of the vehicle.

Most of the systems fail multiple safety feature requirements. Volvo Pilot Assist, for example, deactivates without an alert when the driver unbuckles, can be activated with lane departure prevention turned off, and also remains active if that feature is switched off mid-drive. The two Genesis systems fail all safety feature requirements.