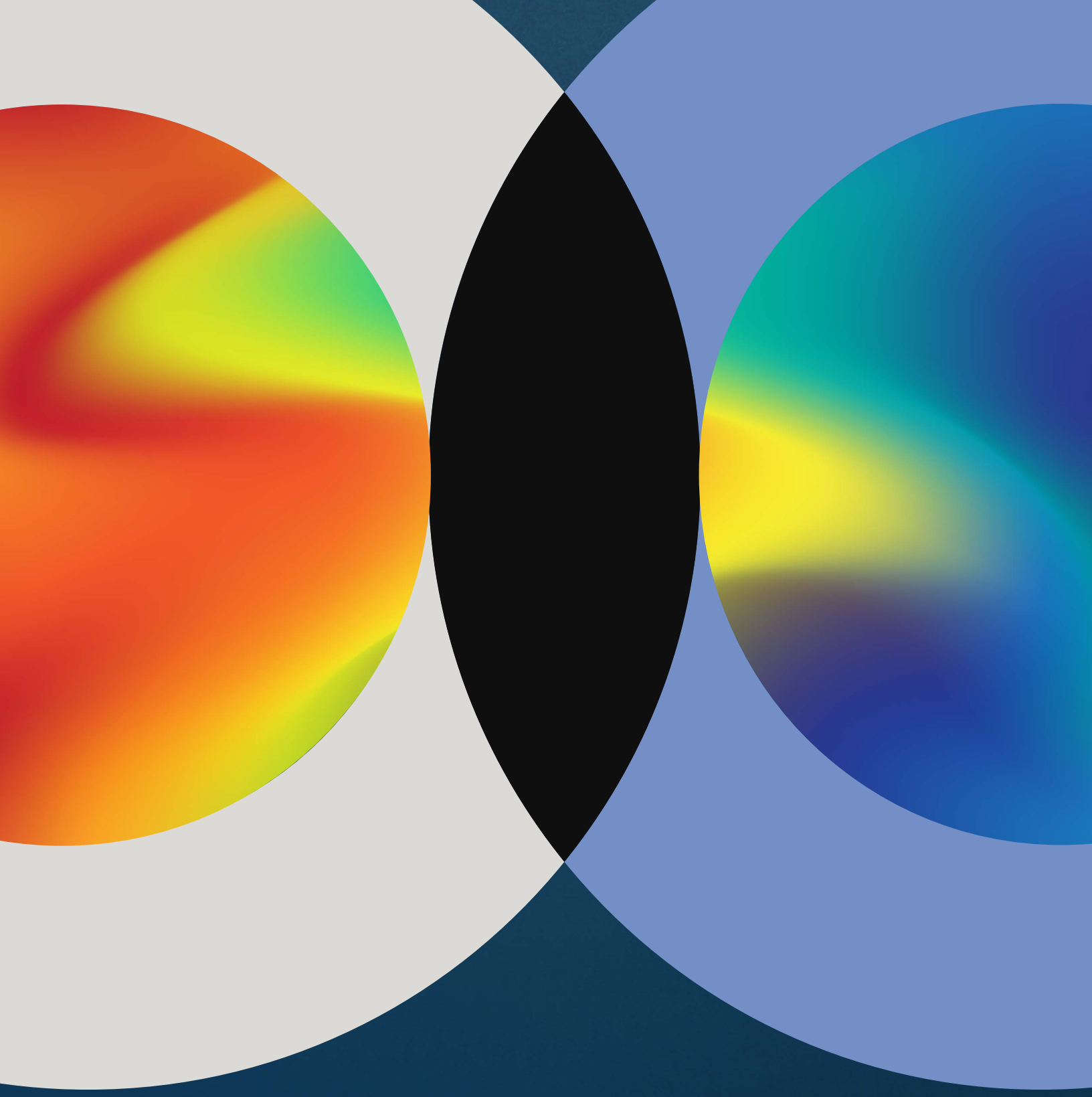

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AUTOMOBILE SAFETY REGULATORS SHIFT to MANDATES to PROTECT PEDESTRIANS at NIGHT

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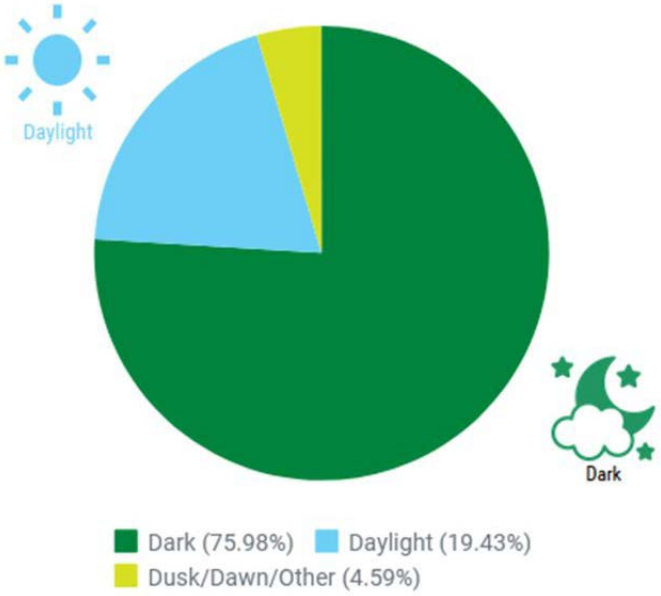
AUTOMOBILE SAFETY REGULATORS SHIFT TO MANDATES TO PROTECT PEDESTRIANS AT NIGHT

A recent report [1] from the Insurance Institute for Highway Safety (IIHS) announced two alarming conclusions:

1. Despite new automotive safety technologies, pedestrian injuries and deaths are still rising.
2. The systems now installed on automobiles intended to protect pedestrians do not work at night when more than three-quarters of the fatalities occur.

In response, regulatory agencies have made changes in automobile safety test protocols so they now require reliable classification methods to identify pedestrians and other vulnerable road users at night. Most significantly, these regulations are no longer voluntary but mandated. The auto industry (manufacturers and their top tier suppliers) will soon be required to implement new safety technologies—for driving both day and night.



Similar fatality statistics are reported worldwide. For example, in Japan, the Transport Ministry reports that 70% of pedestrian fatalities there occur at night.

Efforts to improve pedestrian safety were underway even before the first pedestrian crossing signal was installed in England in 1868 to reduce casualties from strikes by horse-drawn carriages. For the next 130 years or so, the solutions for vehicles of all types concentrated on passive safety systems —removing impaling ornaments, adding lights and horns, and curving the outer vehicle surfaces. Only when cars got computers did the emphasis start to shift to active safety systems as regulators realized that perhaps the car itself could help to avoid collisions.

By the late 1960s, when computers that could survive in the engine compartment became available, use of automotive computers spread rapidly, first for fuel injection control and, 20 years later, in the first dashboard touchscreen. As far back as 1956, closed-circuit cameras were mounted on concept cars to assist in backup viewing but 35 years elapsed before the first production model appeared. Finally, in 2010, national traffic safety regulators mandated the first active system directed at pedestrian safety—backup cameras specifically intended to protect children.

AUTOMOBILE SAFETY REGULATORS SHIFT TO MANDATES TO PROTECT PEDESTRIANS AT NIGHT continued

To support active systems, the computers in cars became powerful enough to integrate signals from a variety of sensors so building vehicles that could operate without drivers became a feasible goal. Distance sensors using radar provided the basis for vehicle-to-vehicle anti-collision systems, raising the hope that if these sensors could accurately locate pedestrians, cyclists, and other VRUs, collisions might be reduced.

GLOBAL NEW CAR ASSESSMENT PROGRAMS

Globally, the primary protocols for regulating the requirements for automobile configuration and performance are New Car Assessment Programs (NCAPs) established in various regions. These programs established standards for testing new vehicles with the goal of assigning safety ratings. When a new safety issue is to be addressed, a test protocol to evaluate vehicles against the requirement is added to the NCAP test suite.

Although the NCAP does not include mandates requiring specific safety measures in automobiles, the results of testing against the requirements produces a safety rating for each vehicle that can seriously impact its market success. Automobile sales statistics show a strong customer bias towards purchase of models with the highest safety ratings. Thus, when a new requirement enters the test protocol, automobile manufacturers work diligently to assure that their vehicles will score high.

FAILURES OF CURRENT SYSTEMS

Protecting pedestrians from collisions with cars in a variety of situations requires the use of Pedestrian Automatic Emergency Braking (PAEB) systems that do not depend on perception by the driver or reaction of a pedestrian in the car's path.

While the existing systems using cameras and radar can operate well during the day when visibility is good, they fail when vision is obscured by atmospheric conditions, at night in the dark, in the presence of bright backlighting, or in chaotic urban scenes, as depicted in these examples.

Where are the pedestrians? Reducing fatalities at night requires deployment of systems that can detect them.

THE STATE OF VRU REGULATIONS

Protection of vulnerable road users (VRUs), largely pedestrians and cyclists, has primarily relied on signage and instruction to address dangerous VRU behaviors like crossing anywhere or inebriation. Some vehicle modifications like curved hoods and collapsible ornaments intended to reduce the effects of impact have been mandated, but those strategies have done little to reduce the likelihood of impact. Nor have they offset an increase in injuries and fatalities resulting from the growing trend toward the purchase of larger vehicles like light trucks and SUVs. Because these purchases are motivated by the purchaser's desire to improve vehicle occupant safety, a simple return to smaller, lighter vehicles is not likely. Further, drivers are becoming more distracted by the use of cell phones and features on the screens in new cars. A new strategy is needed.

As drivers become more comfortable with safety assistance provided directly by automated systems in their vehicles, regulators can confidently incorporate more technological solutions into their standards. In this progression, automatic emergency braking (AEB) to protect VRUs becomes a natural extension of the automatic braking systems and alerts already in place to reduce car-to-car collisions. Recognizing the alignment of driver expectations and safety agency concerns, regulators have begun to act.

While the European Union (EU) has long been in the forefront of VRU safety regulation, their nighttime testing requirements fall far short of what's needed. The United States has taken note of these shortcomings and has now become the first to revise its NCAP testing program to include true VRU nighttime protection requirements [2] and, most recently to propose a rule requiring AEB systems on all new vehicles. All major regions will be encouraged to follow suit.

• UNITED STATES

For nearly 100 years, the US has treated pedestrian safety as though it were entirely the responsibility of the pedestrian to stay out of the way. In this concept, a crosswalk is an instruction to a pedestrian defining where it is safe to walk. However, rising pedestrian deaths in situations not controllable by pedestrians and the increasing availability of technological solutions have shifted the mindset enough to spur Congress to mandate, in Section 24213 of the 2021 Infrastructure Investment and Jobs Act, the addition by the National Highway Traffic Safety Administration (NHTSA), of (PAEB) systems to its automobile testing program.

The announcement of the congressional mandate in the Federal Register generated over 15,000 responses in its 60-day public comment phase [3], and it now appears that a PAEB test (and tests of several other collision reduction technologies) will be added in the next test sequence update. NHTSA is equipped to do this because the agency has been evaluating PAEB systems since 2018 but not reporting the results as part of its safety ratings.

FMVSS and NCAP—The Federal Motor Vehicle Safety Standards (FMVSS) is a set of rules describing, in detail, the equipment which must be included in motor vehicles of all types. These range from the simple, like child restraint anchor points, to the very complex, like driver assistance systems. These rules are mandates for motor vehicle manufacturers: **Vehicles not meeting them can be pulled from the road**.

• UNITED STATES continued

For consumers, the presence of these systems is not enough to support purchase decisions. Results of performance testing are also needed. This data comes from the NCAP programs in which systems like those intended for crash prevention are tested according to the FMVSS requirements. The list of tests to be performed is set by NHTSA but the testing is done by independent organizations.

To date, almost all new technologies implemented to reduce collisions were primarily initiated by the automakers, motivated by the need to reduce the number of vehicle occupant casualties and to develop autonomous vehicles. Recent studies by the American Automobile Association (AAA), the Insurance institute for Highway Safety (IIHS) and others have raised the pressure on regulators to include testing at night for PAEB systems and to include the results in the NCAP safety ratings.

In response, NHTSA has stated that "pedestrian mannequins, test speeds, the specified lighting conditions and the number of test trials required for each test condition" will be modified to include a broader range of hazardous conditions, including unlighted roadways at night. However, NHTSA has also noted that **full implementation** of desired PAEB functionality **depends on the availability of suitable technologies**.

The new proposed rule, which would be added to the FMVSS mandates, requires new automobiles to include PAEB systems that work both day and night at speeds up to 62 mph. In proposing this rule, NHTSA has indicated that it is confident that the necessary technologies will soon be available. At the latest, this mandate would cover all cars made after September 1, 2028. Once the rule is in effect, testing of the new PAEB systems would be included in the NCAP program.

• EUROPEAN UNION

The European New Car Assessment Program (Euro NCAP) began testing car-to-car AEB systems and reporting the ratings in 2014. PAEB testing began in 2016 for front collisions and in 2020 for reversing collisions.

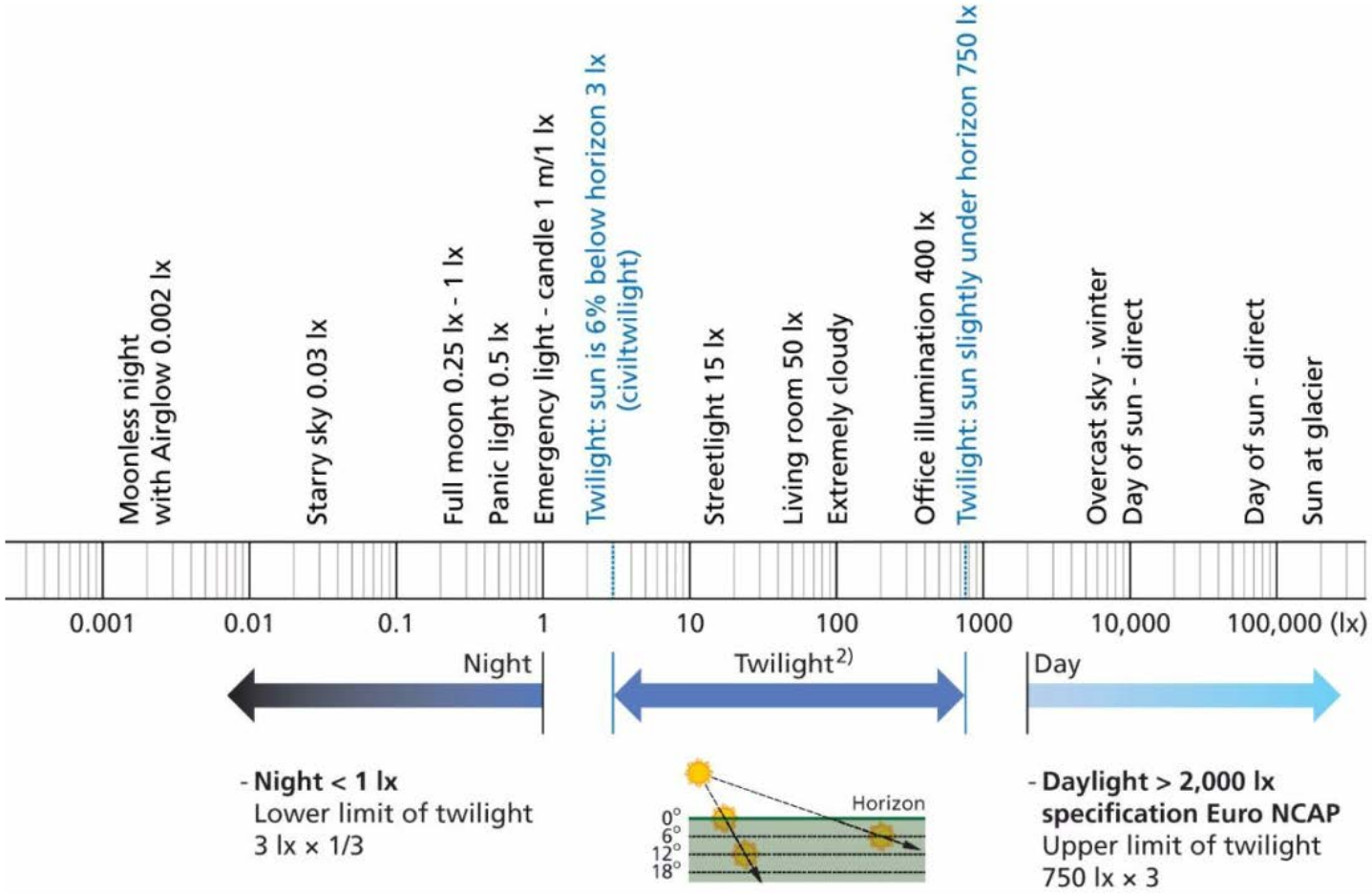
The new protocol for evaluating the effectiveness of AEB systems mandated these condition requirements beginning in January 2023:

- **Weather** – "No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1 km. Wind speeds shall be below 10m/s to minimize VRU target and VUT (vehicle under test) disturbance."
- **Daytime** – "For daytime testing, natural ambient illumination must be homogenous in the test area and in excess of 2000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT or VRU target. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight."
- **Nighttime** – Requires compliance with EN 13201, the European Standard for road lighting. At least 5 lux at 4500K is required along the VRU path. No testing is required for unlighted routes.

• EUROPEAN UNION continued

Recognizing the shortcomings of the current protocol, the European Traffic Safety Council (ETSC) has stated, “New tests show AEB systems need to work better in wet, fog, and low-light situations” and Euro NCAP, in its Vision 2030 report, committed to extending its AEB test requirements **as soon as viable solutions are identified**.

This is the lighting chart from the Euro NCAP standard:



Euro NCAP does not require testing at light levels lower than 5 lux (significantly brighter than the lower end of twilight) or testing in adverse weather or testing where the sun or direct artificial light may obscure vision.

• JAPAN

Japan announced late in 2019 [4] that its Transport Ministry would make AEB systems capable of detecting other cars and pedestrians mandatory on cars made and sold domestically beginning in November 2021. Imported cars and existing domestically manufactured cars are to be retrofitted by 2026. Additionally, all AEB systems installed after 2024 must also detect cyclists. Both pedestrian and cyclist testing are included as of 2022 in the Japanese NCAP (J-NCAP) protocol.

Recently, the Council for Transport Policy in Japan stated, "About 70% of fatal accidents involving pedestrians occur at night. Current NCAP includes an evaluation of AEBS performance at night (with/without streetlights), thereby promoting AEBS through competition among vehicle manufacturers in technological development and the publication of performance evaluation results to motorists."

They conclude, "To further reduce the number of FSI (fatalities and serious injuries) in traffic accidents, we should **accelerate the improvement of nighttime detection technology** and implement it in more vehicle models, while considering the enhancement of the safety regulation for AEBS, which are already made mandatory, so they work also at night."

• CHINA

In 2022, for the first time, several Chinese car models qualified under the Euro NCAP testing program. This work was prompted by the desire of Chinese car manufacturers to be a major export car supplier by 2025. Inside China, the protocol used is almost identical to Euro-NCAP so it may be expected that the adoption of nighttime VRU detection will follow the European lead.

• SOUTHEAST ASIA

ASEAN NCAP was formed to comply with the Euro NCAP requirements and currently follows the Euro NCAP protocol as of September 2020 for AEB testing covering the daylight, clear weather scenario only. A study to determine the feasibility of including nighttime AEB testing is included in their 2026-2030 Roadmap to Improved Safety.

• UNITED NATIONS

The UN authored regulations are part of an international effort to harmonize traffic safety requirements. These documents are constructed by the UNECE World Forum for the Harmonization of Vehicle Regulations (WP.29, link below), with the expectation that, as nations extend their traffic safety legislation, the UN documents will be adopted as written or at least serve as a basis for local regulations. To guide its work on regulations for driver assisted and full autonomous vehicles, WP.29 has issued a framework document, which says this about VRUs:

"Object Event Detection and Response (OEDR): The automated/autonomous vehicles shall be able to detect and respond to objects/events that may be reasonably expected in the Operational Design Domain (ODD/OD)". That is, timely detection and appropriate automatic response is mandatory.

Adoption in their entirety of UN regulations has been announced by only 40 countries (mostly Japan and members of the EU) but the content of these documents is almost universally regarded as useful guidance. In some cases, a UN regulation will become a Global Technical Regulation (GTR) and become included under the requirements of a treaty under which each of the signatory nations will enact corresponding local laws or regulations.

https://unece.org/wp29-introduction

ALL AGREE - BETTER TECHNOLOGY IS NEEDED FOR NIGHT TIME DRIVING

While development of standards intended to reduce collisions with pedestrians is bound to be beneficial, recent testing of systems already meeting these standards has revealed a critical flaw—they don't work reliably at night. In fact, the standards themselves acknowledge this disturbing shortcoming when they specify minimum illumination levels for testing. Because this limitation is in stark conflict with the accident statistics, traffic safety agencies around the world are under pressure to address it as evidenced by the rapidly growing list of articles, videos and studies pointing out the failures in graphic detail.

While everyone from researchers to the popular press and to national traffic safety agencies understand that performance of AEB systems is severely compromised at night and in adverse weather conditions, revising the standards does not improve performance because the problem is technological: most of the sensors currently installed on cars simply cannot provide the data at night that AEB systems need to operate reliably.

New technologies will be needed to provide reliable VRU detection and ranging after the sun has gone down. We at Owl AI believe the Thermal Ranger® system is a prime candidate to fill the gap.

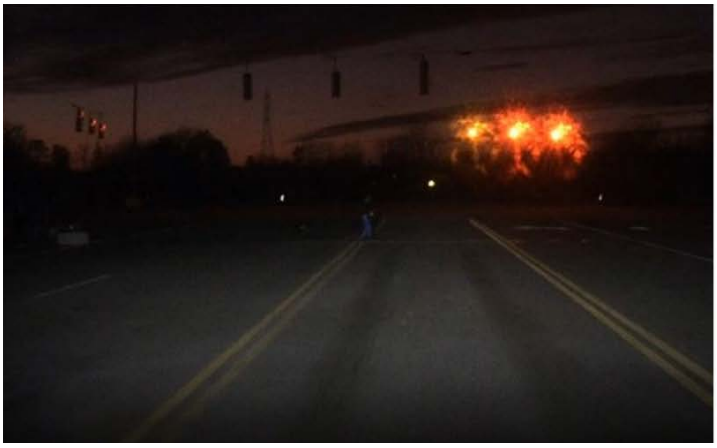
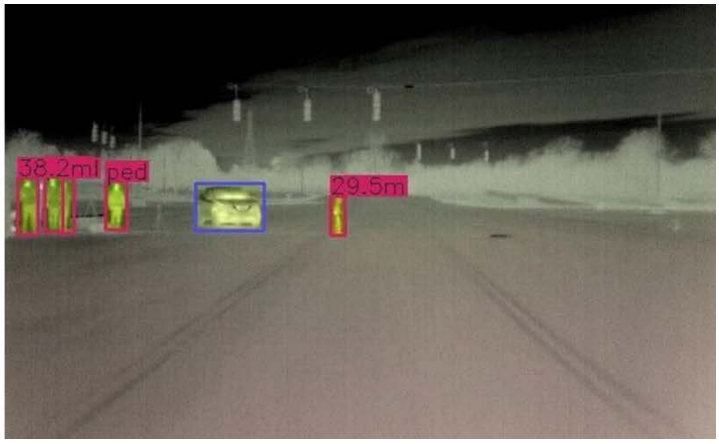
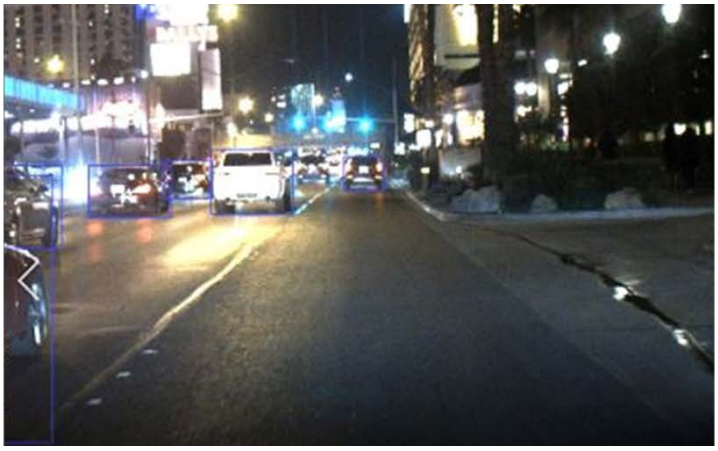
HOW OWL AI CAN CONTRIBUTE TO IMPROVED SAFETY

Conventional thermal cameras have been shown to be effective in detecting pedestrians at night and under adverse weather conditions, but they do not provide depth information. During the day, fused data from an RGB visual camera and a radar together can often identify VRUs and tag each with a distance, but that combination fails at night. Adding a thermal camera could provide nighttime detection but the very low spatial resolution of radar would simply carry over the daytime location ambiguities into the night.

The Owl AI Thermal Ranger system changes the paradigm by equipping a high-performance thermal camera with a neural network capable of extracting distance information from a single image. In this arrangement, the identification and distance data are automatically aligned so the system can immediately format the combined information for the car to use to make automated braking decisions. The images on the following page in a side-by-side comparison, clearly demonstrate the Owl Thermal Ranger system advantage—**ambient visible on the left, Owl Thermal Ranger system on the right**.

Regulators recognize the need for PAEB systems that work at night and the pictures show that the technology is available to meet their requirements. It is now only a matter of time until the technologies in the Owl Thermal Ranger system enable reductions in nighttime pedestrian injuries and death.

HOW OWL AI CAN CONTRIBUTE TO IMPROVED SAFETY continued

Ambient Visible	Owl Thermal Ranger System
	
	
	

Where are the pedestrians? The Owl Thermal Ranger system finds the pedestrians, classifies them, and marks their distances.

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YouTube LINKS

FROM THIS WHITE PAPER

Proposed NHTSA PAEB rule announcement:
https://www.c-span.org/video/?528421-1

The urban scene comparison:
https://youtu.be/TmfzYcGRH_Y

Autobrake performance slips after sundown - IIHS News:
https://youtu.be/liQxaeGPHJg

Euro NCAP Puts Autonomous Pedestrian Detection to the Test:
https://youtu.be/FTKxCE5qmQM

Testing Automatic Emergency Braking with FLIR Thermal Cameras:
https://youtu.be/o7LGmX2AopM

DEMONSTRATIONS OF OWL AI TECHNOLOGIES

November 2022 NHTSA Nighttime ACM Pedestrian Test:
https://youtu.be/wQ5VdMJPOvw

April 2022 Pedestrian Demonstration:
https://youtu.be/JaaTngahIms

November 2021 Pedestrian and Automobile Classification:
https://youtu.be/BMGLgnxNI6M

Example videos of our **THERMAL RANGER®** system in action can be found on our **YouTube Channel** at this link >>>>>>>>>>

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