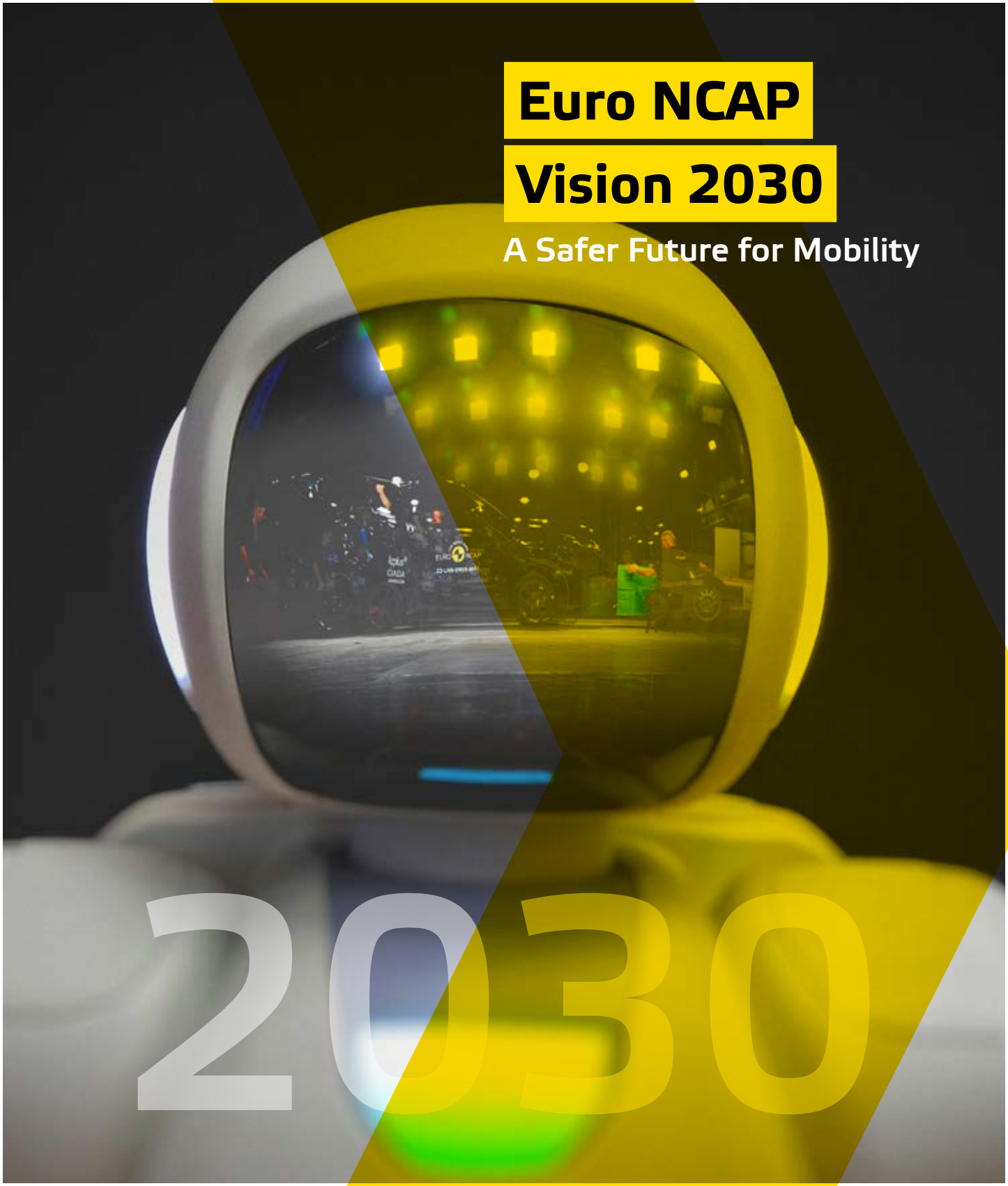
Euro NCAP Vision 2030

A Safer Future for Mobility



FOR SAFER CARS
EURO NCAP

Thank You

Every five years, Euro NCAP brings stakeholders together to examine current realities, predict possible challenges and identify the future opportunities that lie ahead. The result of this discussion is the future course of the organisation and a clear vision for the future: the Euro NCAP Vision 2030.

In the beginning of 2020, Euro NCAP began formulating a new set of strategic goals, with the intention of publishing its Vision 2030 the following year. Like many others, our preliminary plans were disrupted by the global pandemic, consequently limiting our ability to engage with industry and other stakeholders, requiring us to change our outlook and re-evaluate the priorities that were initially set. Despite these challenges, the Euro NCAP team have formulated ideas and been able to discuss them actively, face-to-face with a range of players including automotive manufacturers, suppliers, associations, and research consortia. These meetings have provided valuable feedback and allowed us to better understand future challenges and the path ahead.

We hope that the report provides useful guidance on the future developments and activities of the European consumer safety programme and serves as a valuable reference for the automotive industry and other interested actors.

We would like to sincerely thank all in the sector who provided input for this resulting report.

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IN COLLABORATION WITH ANCAP

Introduction

It is 25 years since Euro NCAP began its work in providing consumer information about new car safety and acting as the catalyst for continuous safety improvements in passenger vehicles, based on Vision Zero principles. Still today, this goal remains at the heart of Euro NCAP's strategy. During this, its 25th anniversary year, Euro NCAP has seen two new members join the association, and a record number of cars rated, many earning top marks in the most up to date tests with even more stringent criteria. These achievements are a testament to the programme's enduring success and relevance, and to the automotive industry's continuing efforts to bring increasingly safer cars to the market.

Euro NCAP firmly believes that it holds the potential to further improve vehicle safety in the next decade in support of Vision Zero

As the programme evolves and safety equipment becomes more prevalent on the market, Euro NCAP faces tough questions: How to keep providing meaningful advice to consumers and continue to make a difference in the marketplace? Car buyers today are facing an increasingly complex landscape of safety technologies, many of which they do not fully understand or appreciate, but all of which are important in achieving the goal of zero fatalities and severe injuries. In this era of social media, consumers are also exposed to huge amounts of information. Car buying habits have also evolved into vehicle leasing and a greater use of company car programmes. With a safety message that is far more complex and nuanced than a decade ago and consumers' attention more difficult to grab, it has become harder to "sell safety" and influence the market.

Another important factor is that the environment in which Euro NCAP operates is seeing major developments. Rapid advances in technology, such as AI and over-the-air (OTA) software updates, are challenging the established traditions in safety testing and the concept of a valid rating. At the same time, significant changes to the European whole vehicle type approval system are being introduced that will make a range of safety technologies, actively promoted, and tested by Euro NCAP, mandatory. Driven by the desire to create a more sustainable and greener future, the automotive sector is transforming into electric, shared, and automated mobility. This transition not only alters the role of users and car companies but also redefines the purpose and target audience of the independent safety information that Euro NCAP is providing. For example, micro-mobility has established itself as a popular alternative to personal car ownership and use. Yet, the sudden appearance of electric scooters on our city streets has brought new road safety challenges.

Despite this evolution, Euro NCAP firmly believes that it holds the potential to further improve vehicle safety in the next decade in support of Vision Zero which strives to eliminate fatalities and the seriously injured in road crashes. With the adoption of the revised EU General Safety Regulation (GSR2, 2019) in the European Union, the type-approval system has caught up. However, the vehicle industry continues to innovate and can already deliver safety systems that go beyond the new legal requirements. By developing timely voluntary standards for advanced safety technology, Euro NCAP still sees an opportunity to act as a catalyst for accelerating uptake and promoting best practice, not just for passenger cars but also in the commercial vehicle fleet. At the same time, it will keep a close eye on the safe roll-out of automated vehicle technology on the market. This is particularly important given the high-stakes nature of today's competitive environment: car makers are investing billions of euros' in developing self-driving technology and are under constant pressure to show progress. Nevertheless, it is highly likely that, in the next decade, autonomous cars, along with a whole host of new mobility concepts, will become a reality in our cities. This means that a wider range of vehicle types, potentially with quite different safety and security problems, could require assessment and fall within the scope of consumer testing.

After emerging from the pandemic-driven slowdown, the economy experienced strong demand as well as supply chain disruptions, which has led to higher prices. These effects have been exacerbated by Russia's invasion of Ukraine and its repercussions.

Every-day consumers in Europe are facing high levels of uncertainty as cost-of-living increases take their toll on household finances. Altogether, this is putting increased pressure on the automotive industry and its ability to innovate.

Against this background, Euro NCAP has set its strategic objectives for the next phase in the development of the programme. The Vision 2030 highlights the main updates to our safety rating scheme but also presents new initiatives that go far beyond safer cars, driving forward innovation and ensuring a safer future for mobility

Dr Michiel van Ratingen,
Secretary General
of Euro NCAP

Dr Niels Ebbe Jacobsen,
President of Euro NCAP

Passenger Car Safety

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The five-star overall safety rating is Euro NCAP's single most important asset, and it is expected to remain a strong indicator for passenger car safety. For 2023 and beyond, several updates have already been announced and these are a good starting point for the introduction of the next strategic objectives.

Front and side crash tests will remain the same, except for the adoption of brain injury risk assessment in the frontal offset mobile barrier test and the phasing in of virtual testing for far-side protection. The Euro Rescue app (Euro NCAP, 2022) will offer post-crash rescue information in all European languages, greatly improving accessibility and ease-of-use for first responders across Europe. A step-function improvement is expected for vulnerable road user protection, as revised subsystem tests will better address cyclist head injuries, and crash avoidance testing will expand including new scenarios with pedestrians, cyclists and, for the first time, powered-two-wheelers. Euro NCAP will develop further crash avoidance performance in crashes involving other cars, testing the systems' capabilities to intervene in cross-traffic at junctions and head-on crashes. Finally, a big leap in the assessment of in-cabin monitoring technology is planned with the addition of rating incentives for Child Presence Detection systems to protect children left accidentally in cars, and Direct Driver Monitoring systems, that monitor driver fatigue, distraction e.g. by phone use, and sudden sickness.

During negotiations on these protocol updates, several items needed to be postponed to a rating revision at a future date and sometime requirements were softened to ease the introduction of a new technology. Nevertheless, the challenges of the 2023 rating requirements will still be insurmountable for some manufacturers

Overall Safety Rating

In 2023, the current overall rating system (van Ratingen, 2009) will have been in place for 15 years. At the time of introduction, the overall rating combined the existing star ratings on adult protection, child protection and pedestrian protection, with the new and emerging area of safety assist. The approach adopted was to continuously update contents and requirements in each of the four areas and adjust thresholds to encourage better performance and keep the 5 stars within reach. In general, this strategy has paid off as the system has remained stable and cars have become significantly safer and better equipped as a result. The obvious pitfall, however, is that, over time, the rating scheme has become increasingly complicated.

The main question is whether the current rating methodology is fit for a future where cars can assist the driving task to a high degree and even automate (parts of) the driving. As the potential safety benefits of such technologies becomes clearer, it is more obvious that **assisted and automated technologies** will play an increasingly important role in reducing traffic accidents and, hence, a new approach for rating vehicles will be needed to reflect the transition from crash mitigation to crash avoidance.

Euro NCAP intends to retire the current four box system and replace it with a new system in 2026. The new scheme, inspired by the Haddon matrix (Peden, 2004), will identify tests according to the **four distinctive phases of an accident: safe driving, crash avoidance, crash protection and post-crash safety.** The new rating scheme allows testing of the relevant functions contributing to each phase, but also can deal with technology covering more phases by creating links between them. Transitioning to the next-generation rating method starts with adopting a new structure and classifying and consolidating existing protocols, avoiding a too-radical impact on the overall stars of future car models. Subsequently, new content will be added, including, initially a link to assisted driving systems.

As is the case now, the rating will apply to all passenger car categories as well as business and family vans. However, Euro NCAP will migrate to a **three-year update cycle, starting in 2026,** that provides more time for development of protocols and test equipment. It will also strengthen its procedures around carry-over ratings and put a policy in place to deal with OTA software updates that affect overall vehicle performance. The dual rating policy will be retained and updated.

In 2026, testing will be identified according to four distinctive phases of an accident: safe driving, crash avoidance, crash protection and post-crash safety

Besides the adoption of important new driver support technology, the content changes to the rating scheme are driven primarily by real-world evidence, i.e., the need to improve overall robustness of safety systems and to make our tests reflect real-life situations more accurately. In passive safety, this means a greater focus on gender equality and the aging population of car drivers and occupants, especially for MAIS3+ and impairing, long-term injuries. In active safety, tests will become less idealised, will simulate real traffic environments more closely and will take best practice in human machine interface design into account. Driver and occupant monitoring technology will not only facilitate attentive driving and address impaired driving but may also enable other safety functions, for instance smarter restraint deployment. Finally, expected advancements in sensing, software, and connectivity will make it possible to address new critical scenarios and emerging priorities in road safety.

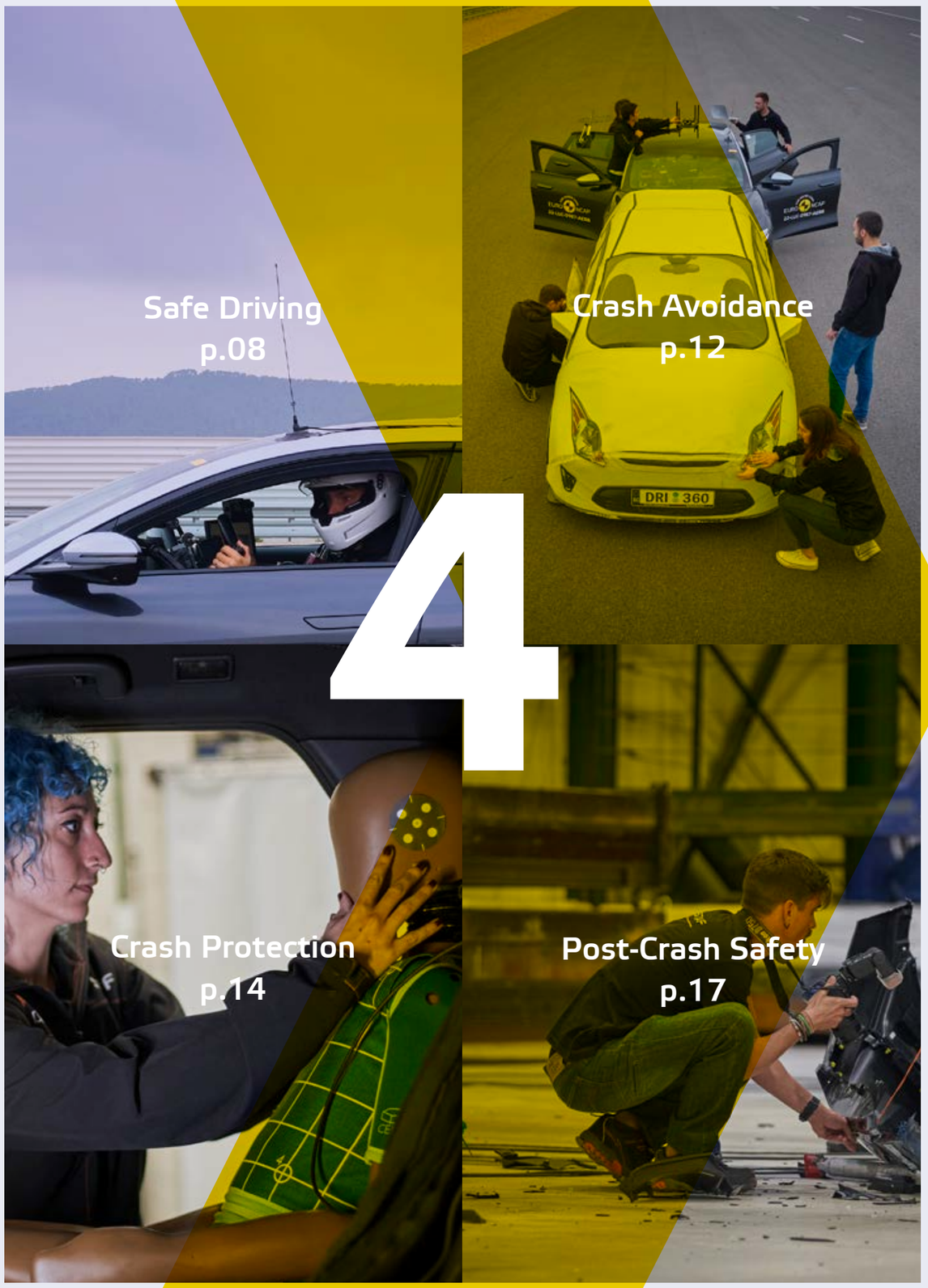
To deliver on these objectives, Euro NCAP must also innovate the way testing is performed. It will further step up the use of **virtual testing,** complementary to crash tests in the laboratory, tests on the track and on the road. Subsystem testing, for instance using a body-in-white on a sled, can also provide additional insights in performance of restraint systems under more variable conditions. While these tests add value and will help keep the programme feasible and manageable, they require trust and cooperation with the vehicle manufacturer, and their outcome and application in the rating must be carefully weighed.

Besides built-in car sensors, car safety will increasingly benefit from 4G/5G car-to-network communication as well as from direct car-to-car, car-to-VRU and car-to-infrastructure communication. **Euro NCAP intends to accommodate all forms of connectivity** and the various technical communication standards in the rating by evaluating each safety function in a technological neutral way.

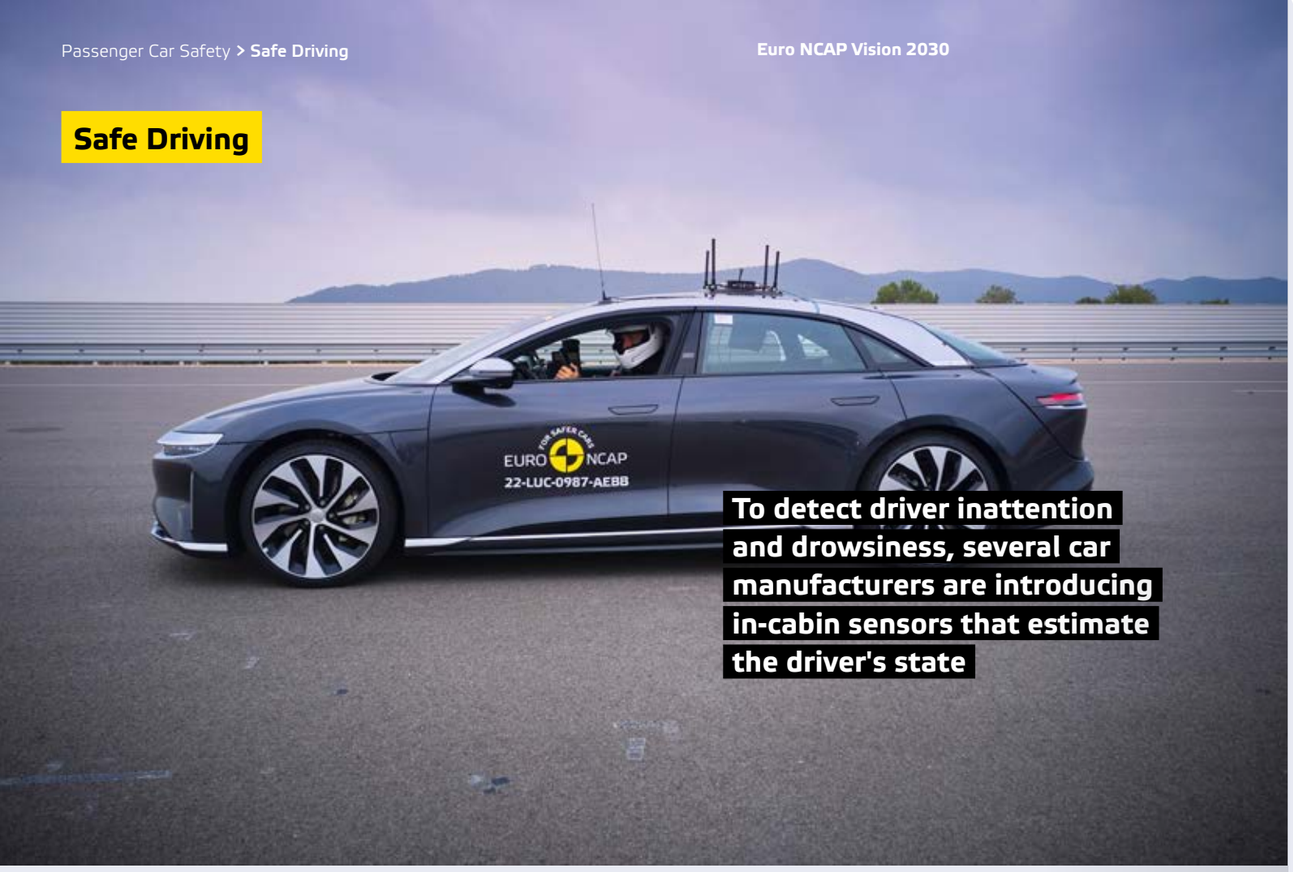
In the short term, Euro NCAP will capitalize on existing industry investments in connected services and promote systems that improve driver information, raise situational awareness, and warn of imminent hazards. Eventually, also more advanced, more complex and more safety-critical scenarios may be tackled, for example potential crashes involving pedestrians or cyclists that are obstructed from the view of the car's sensors. Also in circumstances, where vehicle action to support the driver or ultimately automatic interventions are required, direct communication between cars, based on the ITS-G5 and/or C-V2X communication standards, could support effective countermeasures.

Euro NCAP is aware of the rising costs of the programme and will adopt a "scrap and build" approach where possible going forwards, at the same time guaranteeing a robustness in its systems. For example, the pole test is currently under review in this respect. A more in-depth overview of the planned updates is provided for each of the parts of the new rating scheme. Overview and timeline are not meant to be all-encompassing, nor are they set in stone, but are intended to provide general guidance on the overall strategic direction of the programme

Passenger Car Safety > **Overall Safety Rating** Euro NCAP Vision 2030



Safe Driving



To detect driver inattention and drowsiness, several car manufacturers are introducing in-cabin sensors that estimate the driver's state

In-Cabin Monitoring

Driver distraction and driver inattention are major contributing factors in car incidents and crashes (Klauer et al., 2006), and naturalistic driving studies have demonstrated that the highest risk may be associated with visually demanding tasks (Victor et al., 2014). To detect driver inattention and drowsiness, several car manufacturers are introducing in-cabin sensors that estimate the driver's state by analysing driver movements such as steering input, head motion, gaze, and eye opening. Euro NCAP has evaluated first-generation Attention Assist technology since 2020 and is introducing more elaborate requirements for more advanced Driver Monitoring systems in 2023.

At the present time driver monitoring technology is still in its infancy, but significant advances, such as enhanced detection of drowsiness, are expected in the coming years. More efficient and robust systems can be encouraged by expanding noise variable requirements e.g., extreme seating positions, specific noise variables for each driver state; incorporating alternative approaches to facial monitoring specifically to track phone usage, linking situational awareness to ADAS activation; and rewarding Human Machine Interaction (HMI) best practices that reduce unnecessary distraction, help build well-calibrated trust, and promote system acceptance. Euro NCAP's spot testing regime will gradually evolve to take these developments into account.

Next to this, Euro NCAP seeks to explore new areas related to driving safely, such as the safe use and accessibility of general controls. This approach follows up on recent developments within vehicle design and feedback received from the public. Criteria may target general ergonomics as well as human factors topics.

In Europe around 25% of all road fatalities are alcohol related (Avenoso, 2019). A key real-world priority for the midterm therefore is to expand the scope of **driver impairment** adding specific detection of driving under the influence and sudden sickness with advanced vision and/or biometric sensors and introducing more advanced requirements for risk mitigation functions. In the long term, systems may be able to deal with stress detection and cognitive distraction, i.e., when the driver takes his or her mind from the driving task due to another mentally demanding task (Hamilton & Grabowski, 2013). Tackling cognitive distraction, however, is technically very challenging and effective systems are still hope for the future.

Through **occupant classification** and the monitoring of vehicle occupancy during driving, in-cabin monitoring technology also can enable more robust performance of other safety functions. Examples that Euro NCAP will consider are airbag deployment parameters and seatbelt load limiter adapted to occupant size, weight, and body type; improved use, routeing, and out-of-position optimisation of seatbelts and head restraints (posture monitoring); advanced airbag deactivation and reliable occupancy information for advanced eCall/dCall.

Preventing child heat stroke deaths in cars is a unique challenge but falls into the same category. Child Presence Detection (CPD) systems can sense the presence of a child and alert the carers of the child left alone in a car (Mousel et al., 2017). Euro NCAP has released its first CPD protocol for implementation in 2023, which permits indirect and direct sensing solutions to score points. The protocol stipulates that from 2025 onwards, only direct sensing systems, capable of effectively detecting a living being, will be rewarded.

Euro NCAP speed assistance requirements will continue to evolve as systems are getting smarter, more confident, and precise.

Speed Assistance

Speed is a major factor in overall road safety performance. Excessive and inappropriate speed is accountable for about one third of fatal collisions and is an aggravating factor in most collisions. According to the European Transport Safety Council, 2,100 lives could be saved each year if the average speed dropped by only 1 km/h on all roads across the European Union and the United Kingdom (ETSC, 2019). Acknowledging the importance of speed, Euro NCAP has successfully promoted speed assistance technology in cars since 2009.

Intelligent Speed Assistance (ISA) is one of the vehicle safety technologies included in the EU's new General Safety Regulation for motor vehicles (European Union, 2021). There are many similarities between Euro NCAP's protocol and the new regulation, but also a few differences. In general, Euro NCAP's latest technical requirements are going beyond those laid down in GSR2, as they include speed control and advanced functions such as the identification of conditional and implicit speed limits, adaption to road features (e.g., roundabouts, traffic lights etc.) as well as communication based local hazard information and warnings (e.g., construction zone, accident ahead, wrong way driver, etc.). These additional features enhance the user acceptance and improve the real-world efficacy and robustness of speed assistance technology.

It is expected that the Euro NCAP speed assistance requirements will continue to evolve as systems are getting smarter, more confident, and precise. Euro NCAP plans to overhaul the protocol, removing any overlap with type approval requirements and focus on complementary performance and functions only. Key will be the shift from encouraging "advisory" systems only to "intervention" systems that actively reduce the speed, while maintaining driver acceptance. Updated requirements may include stricter speedometer and speed sign recognition accuracy, verified by Euro NCAP; a smaller speed offset speed tolerance; and updated scoring for Speed Limit Information Function (SLIF) and Speed Limit Warning Function (SLWF). Advanced functions related to local hazards, right way (intersection) and red-light violations, etc. are already included in the latest protocol, but will be further expanded and be given a stronger focus. In the short term, these functions aim at raising driver awareness by providing information and/or warnings and could be facilitated by connected services. It is especially critical that fleet operators are aware of these innovations and so can easily adopt advanced speed assistance requirements as part of their fleet policies

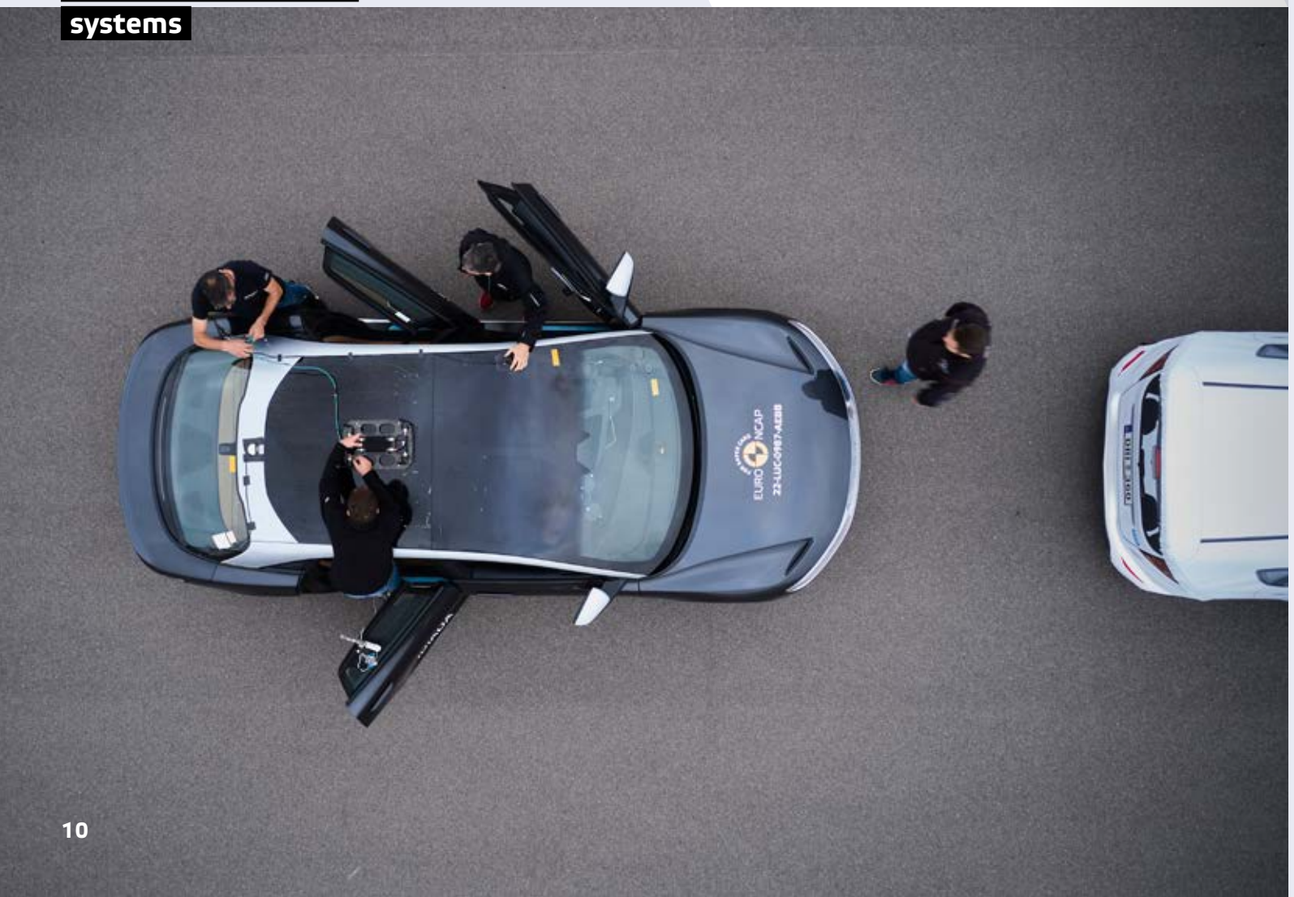
Assisted and Automated Driving Systems

Cars are becoming more advanced as manufacturers work towards their goal of autonomous vehicles. We are not yet living in an era of fully self-driving cars but, thanks to an increasingly present on-board sensor set, driving support technologies are becoming widespread. These so-called assisted driving systems are intended to help the driver to maintain a steady speed, to keep a safe distance from the car in front and to keep the vehicle lane-centred combining (intelligent) Adaptive Cruise Control (ACC) with Lane Centring (LC) technologies. If implemented in a safe manner, the benefit for drivers is that they are fully supported in driving safely. However, if poorly designed, they can also present a safety risk, by creating false expectations about the vehicle's abilities to deal with critical situations and driver overreliance.

In 2020, Euro NCAP launched a stand-alone grading scheme (Euro NCAP, 2020) for assisted driving systems, focussing on two important areas: Assistance Competence – a balance between Vehicle Assistance and Driver Engagement, and Safety Backup, the car's safety net in critical situations. The objective of this grading schemeis twofold: firstly, to educate consumers that assistance systems are not automated and always require the driver's oversight, and, secondly, toensure that systems offered by vehicle manufacturers provide robust assistance and do not create new crash risks. The latter is evaluated by exploring system's design limits and assess the way the vehicle is keeping the driver engaged. As the grading only indirectly relates to casualty reductions and considers both optional and standard systems, it was purposely kept separate from the star rating.

The first series of tests of Highway Assist systems have revealed the limitations of these systems and the different approaches taken by manufacturers in ensuring the driver remains alert behind the wheel. In the next step, the assessment will be broadened from motorway driving to other off-highway domains. This means expanding ACC requirements, including testing of Car-to-Motorcycle and longitudinal VRU scenarios, and incorporating the most recent advancements in Speed Assistance such as recognition of implicit, conditional, and dynamic speed limits, road features and local hazards. At the same time, the assessment parts related to driver engagement and safety backup will be updated, including "eyes on/ hands off" functionality of Dynamic Control Assistance Systems (DCAS) once they are legally permitted.

Given the importance of assisted driving technologies, Euro NCAP will adopt a penalty/ rewards approach for cars that offer these systems



In the mid-term, further iterations of the assisted driving test and assessment protocol are anticipated in line with technological progress. It is too early to say whether the grading approach can also be extended to automated systems, that under certain conditions can take over the driving task without driver oversight, but where the driver must be able to respond to a takeover request from the system (United Nations, 2021). The definition of such systems in the Automatic Lane Keeping Systems (ALKS) regulation is broad, and at this time still very few systems have been confirmed for market introduction. However, there are multiple corner cases possibly falling outside of the minimum required ALKS tests, which could be used to benchmark systems offering a similar automated function. The decision whether this is a feasible, and, if so in what time frame, largely depends on the functional domain and limitations on which basis their regulatory approval was granted.

The assisted driving gradings will, for the time being, remain complementary to the overall rating and continue to be published separately from the star rating. Given the importance of the technology, its potential safety benefits, but also its associated risks, Euro NCAP will adopt a penalty/rewards approach for cars that offer assisted driving systems, whether fitted as an option or standard. Where the system is made standard and achieves a high-level grading, this will be reflected in a higher Safe Driving score. On the other hand, where such system scores poorly in the driver engagement assessment, even if it is only offered as an option, a penalty will be applied. This policy will be periodically reviewed and, when a positive impact on road crash reductions can be confirmed by real-world data, may be replaced by full integration in the overall rating. Recognizing Driver Engagement as a fundamental pillar to ensure the safe deployment of Assisted Driving systems, a thorough update on this area becomes essential. This will include specific provisions on Driver Monitoring, more specific requirements on System Status. With market entry of automated vehicles around the corner, it becomes increasingly important for consumers that a clear distinction is made between assisted driving and automated driving, both in human machine interaction design as well as in consumer information. This importance for safe driving will be reflected in the update for assisted driving systems.

Other Safe Driving Technology

Technologies such as Driver State Monitoring, Speed Assistance and Assisted Driving aim to provide a safe driving environment and prevent normal driving situations from turning critical. This is also the case for other proactive driving assistance systems, such as obstacle anticipation or deceleration assistance. These systems support the driver in maintaining a safe distance from vulnerable road users, obstacles, and other vehicles by applying anticipatory, driver-like steering and/or braking corrections. The technology, however, is new to market and thus far no firm decision has been taken to include such systems in the rating

Crash Avoidance

Lane Support Systems, Automatic Emergency Braking and Steering for Cars and VRU

In recent years, significant progress has been made in the adoption and capabilities of Lane Support systems (LSS), Autonomous Emergency Braking (AEB) and Autonomous Emergency Steering (AES) systems. The dynamic interaction between industry innovation and the pull of ever more demanding consumer tests has resulted in the swift arrival of more capable LSS, AEB and AES systems, with performance already outstripping the requirements of the new GSR2 regulation. This means that there remains scope for differentiation between competing car models and brands when it comes to these crash avoidance technologies.

There are not many scenarios where crash avoidance technology would not typically reduce the impact and improve the outcome for those involved in crashes. In 2021, about 18,900 traffic fatalities occurred in Europe, of which 44% were car drivers or occupants and 48% vulnerable road users, including pedestrians, cyclists, motorcycle riders and users of powered standing scooters (CARE 2021). Euro NCAP is committed to promoting and improving crash avoidance technology for all relevant target populations.

In accordance with this philosophy, the AEB test suite in Euro NCAP has evolved since its introduction in 2014. On one side, it increased complexity, starting from low speed rear-end crash scenarios to turn-across-path, reverse, crossing and head-on crashes, eventually including steering interventions as well. On the other side, new crash opponents from passenger cars to pedestrian, cyclists, and powered-two-wheelers (PTW) were added. The aim was to accelerate the update to systems and increase their capability, keeping the tests themselves relatively straightforward and as reproducible as possible. Inevitably, Euro NCAP ended up with a sizable test matrix and a grid approach and smart testing had to be adopted to keep the process cost-effective.

In the short to medium term, there is scope for further improvements along the same advancement principle. This might include, for example adding further turning cyclist scenarios; developing PTW test situations such as at a higher approach speed to cover more real-world cases and introducing micro mobility injury incidents **for example, scenarios with new powered standing scooters (PSS)** such as crossing and dooring. Even further, more obstructed VRU scenarios that evaluate safety and non-safety critical vehicle actions, based on communication technology could also be added. These and other incremental updates to the AEB and LSS test matrix are technically feasible but would require lead time to robustly validate new test tools and to make the necessary amendments to test tracks, if required.

Still, the above would not guarantee **safety technology robustness** in the real-world under all circumstances, as track tests continue to be carried out under very idealised conditions. For this reason, Euro NCAP will put a larger focus on the variation of test conditions, such as lighting and weather changes, target appearance, and interaction with other road objects and infrastructure. Some of these variations, such as changing the looks of the test target, could be relatively small but would have an immediate impact in the real-world. This is also true for extended night-time testing including scenarios with an oncoming car with headlights and promoting efficient countermeasures like high beam assist technology. With sufficient time, introduction of some of these variations would not present too many challenges, the only real concern being the ever-increasing number of tests that would need to be run. This evolution in testing, therefore, will have to be conditional on our ability to reduce the test burden in other scenarios, e.g., by expanding the grid and smart testing approach, introducing virtual testing with spot testing and removing more basic scenarios covered by GSR2.

Other variations such as weather conditions, e.g., rain, fog, low sun conditions, are meaningful and important from a real-world perspective, but are difficult to test in general, let alone repeatably and reproducibly. As a first step, evidence demonstrating reduced ADAS functionality due to adverse weather will be investigated.

Finally, consumers must be able to trust that a five-star rated car can also be operated safely. **In other words, that its human machine interaction is designed in such a way that it allows the driver to interact with the vehicle, while driving safely and avoiding over-trust.** As car sharing becomes more popular and drivers are exposed to ever more assistance systems, the need emerges to adopt a common approach and design language across industry. Based on research and best practices, criteria for human machine interaction and human factors will be added to existing test and assessment protocols, related to Collision Avoidance, maximizing the intuitiveness/effectiveness of the warnings issued to the driver, for example the interplay between visual, auditory, haptic/tactile and kinematics.

In 2021, of

18,900 traffic fatalities in Europe

44% were car occupants

48% were vunerable road users[1]

CARE 2021.

Pedal Misapplication

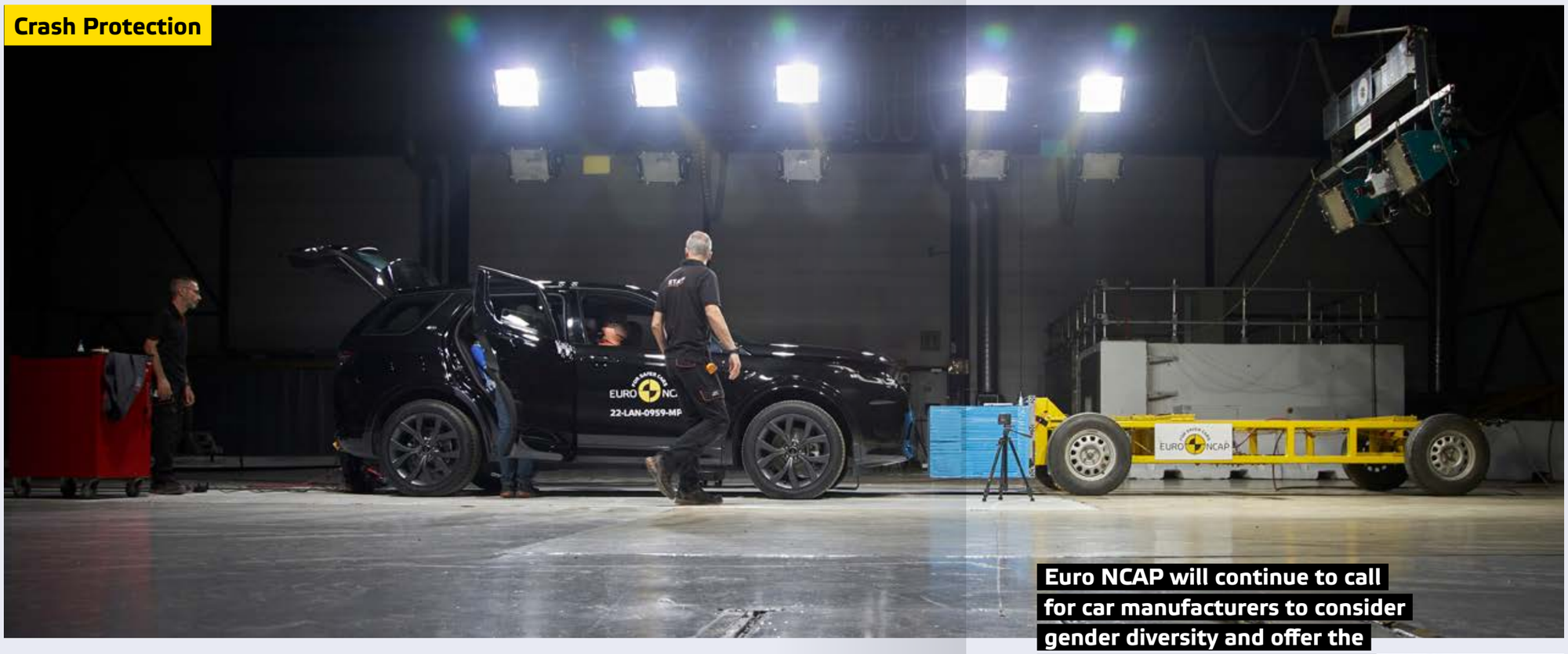
The term “pedal misapplication” (PMA), although lacking a standardised definition, is commonly used to refer to crashes caused by unintentional, uncontrolled use of the accelerator pedal, mostly at very low speed manoeuvres (starting, backing, parking, turning). Evidence suggests that elderly drivers are more likely to misapply the pedals than younger drivers, and that misapplication can happen regardless of the type of powertrain or gear in the car (Lococo, 2012), although it appears more frequent with automatic gearboxes and electric vehicles. In Europe, statistically speaking, pedal misapplications are still relatively rare (and under-reported), but this is likely to change in the next decade when one considers the situation in Japan, which is already a “super-aging" society, and the European driving population following suit.

Since 2018, Japan New Car Assessment Program (JNCAP) has rewarded pedal misapplication prevention technology as part of their safety rating (NASVA, 2018). This technology controls sudden acceleration or warns the driver in cases where the accelerator pedal is strongly depressed while there is an obstacle in the path of or behind the car. Recently, JNCAP has announced an update to their test addressing pedestrians, which can be the starting point for Euro NCAP’s PMA evaluation method.

Euro NCAP anticipates that no significant additional hardware will be needed for cars equipped with AEB and AEB reverse and, like Japan NCAP, intends to reward manufacturers who can successfully mitigate the consequences of pedal misapplication

Euro NCAP will evolve testing to meet safety concerns of all in a variety of conditions

Crash Protection



Protection of Adults and Children in Front and Side Crashes

In 2021, there were on average 45 road deaths per million inhabitants on European roads, representing a 6% increase compared to 2020 but a 13% decrease compared to 2019 (European Commission, 2022). This significant decrease of fatalities compared to pre-pandemic levels is welcome news and hopefully signals a further downward trend for the years to come. Still, for every life lost, five more people suffer serious injuries with life-changing consequences. Despite the benefits of vehicle automation and driver assistance technologies, it is good to remember that a majority of the vehicle fleet does not have or has very basic crash avoidance technology on board, and that crashes in many cases cannot be prevented. This underlines the importance of good crash protection above all.

It is no news that differences are observed in crash frequency and crash-related injuries between **age groups, gender, and body types.** Some of these differences can be attributed to frequent critical events that involve some type of drivers more than others, such as speeding or going off the road (EC SafetyNet, 2018). Forman et al. (2019) suggested, however, that there is a more systemic gender-bias in the way cars have been engineered. Similar studies involving newer cars in the US, taking car properties into account (Brumbelow and Jermakian, 2021; Noh et al., 2022) and Europe (Ostermaier et al, 2022) did not find significant gender differences in overall protection for severe injuries, but it was observed that injuries to extremities were notably more frequent for female than male occupants in frontal impacts. The discussions around these field data studies have amplified calls for better consideration of **population diversity** in the crash tests, making them more inclusive for occupants of all types.

Because car design is directly influenced by the results of safety testing, any bias in the way that cars are crash-tested translates into the way cars are manufactured. Restraints optimised for the average-sized driver do not necessarily work equally well for shorter or taller drivers, or, for that matter, for obese or more vulnerable older drivers. For this reason, many car manufacturers and restraint suppliers have applied different sized crash dummies. The question is whether, given the basic properties of these dummies, is that enough to close any gap?

Euro NCAP is already testing with crash dummies of different type and stature in frontal impact protection. Not all dummies used, however, are state-of-the art. Underscoring the concept of a car "designed for all", it proposes to adopt the latest generation THOR 5F small female and THOR 50M mid-size male crash dummies. Both dummies will be used as driver and front passenger, respectively, in a revised low severity full-width barrier test, applying criteria and injury limits that promote restraints that better protect elderly occupants. The move to more sophisticated, next generation dummies, however, has its challenges. Some technical concerns with the mid-sized THOR 50M dummy linger and would need to be solved before the smaller female THOR 5F can be introduced. Also, the biomechanical criteria, especially for chest injury risk assessment, will need to be updated.

Passenger Car Safety > **Crash Protection**

Euro NCAP Vision 2030

Euro NCAP will continue to call for car manufacturers to consider gender diversity and offer the highest levels of protection to occupants of all sizes

The mid-sized male Hybrid-III 50M front passenger will eventually be replaced by THOR 5F in the Mobile Progressive Deformable barrier (MPDB) test as well. Euro NCAP plans to review the severity of this moderate offset test considering the weight increase of European average passenger car fleet and update the protocol, if the evidence suggests the current severity is no longer representative of crashes occurring on the road.

Full-scale testing will be complemented by sled testing and virtual simulations to evaluate lower extremity injury risk, submarining and the robustness of (adaptive) restraint systems, covering more variations in driver characteristics (age, gender, weight, and stature), seating postures (such as reclined seats) and crash severity. In the long term, crash dummy models will be replaced by digital human body models that offer enhanced biofidelity and higher levels of injury prediction and diversity.

Virtual testing – which will include variations in impact angle, (reclined) seating positions and as soon as appropriate models are available, occupant size and gender – will also become an integral part of the far-side protection assessment once the monitoring phase ends. As soon as viable human models with assessment criteria are available, they will replace WorldSID crash dummy models. The pole test will remain the same for the moment but will be carried out by default with both driver and passenger dummies (dual occupancy) unless there is no countermeasure for occupant-to-occupant protection available.

The pole test, for the moment, will remain the same but will be carried out by default with both driver and passenger dummies (dual occupancy) unless there is no countermeasure for occupant-to-occupant protection available. By standard deployment of (long inflatable) curtain airbags, even without a preceding side impact, higher level of occupant protection in roll over crashes can be achieved. This and other technical innovations, such as pre-crash activation of side impact restraints based on side-looking sensors and improved deployment strategies for off-zone impacts, will be considered as part of a broader side impact review.

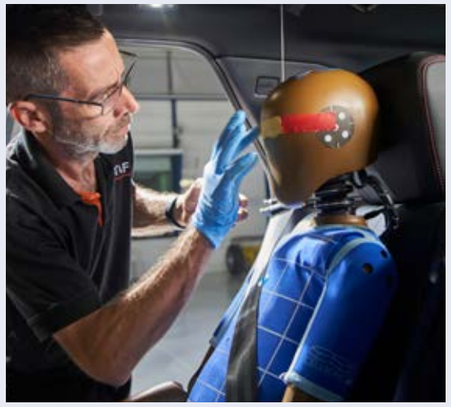
Lastly, we will continue to encourage car manufacturers to offer the highest levels of **protection to children of all ages.** For the foreseeable future, the protection of the 6- and 10-year-old child will continue to be used in the frontal offset and side barrier crash tests, with improved biomechanical criteria and limits. The assessment of Q10 chest injury will be based on chest deflection and Viscous Criterion (V*C) rather than acceleration, and the Q6 measurements will include abdominal injury risk based on a pressure sensor. The Euro NCAP assessment of child occupant protection remains focussed on the practical use of child restraint systems for infants and toddlers in cars, encouraging standard child safety provisions and, finally, helping parents navigate their way through the information labyrinth, helping them to search out what is the safest solution for their own needs.

Whiplash Protection

Poor understanding of the aetiology remains the biggest roadblock to further progress on Whiplash injury reduction. This lack of biomechanical insight is compounded by a complex interconnection of non-design issues, including individual, legal, and socioeconomic factors, that may influence outcomes. Over the years, several research questions have been raised about the differences in risk between males and females and the role of head out-of-position, for instance. However, consistent, high quality and (especially) up-to-date data to further substantiate these concerns are lacking. Unfortunately, European research funding available to study Whiplash related disorders has declined significantly. Recent Euro NCAP data analyses has been inconclusive.

An update to UN Regulation No. 17 has been agreed, and the expectation is that all cars will have to meet new requirements by 2025. The dynamic seat test, however, is optional and unlikely to be followed by many. If this remains the case, consumer testing of head restraints in its current form will still add value over type approval. However, Euro NCAP's geometric modifier (mid & lowest position) and back set criteria of the whiplash test position have been called counterproductive for the whiplash protection of females, a situation which must be addressed in the short term.

In the longer term, addressing the relative injury risk between females and males could potentially be an important discriminator, by applying virtual testing with human models, for example (European Commission VIRTUAL project, 2020). To proceed, however, recent data would be needed from cars with good whiplash ratings to confirm findings drawn from older statistics. In addition, biological or anthropomorphic **gender differences** would need to be more clearly identified as the main contributors to the problem. Given that low speed AEB will soon have achieved a significant market penetration, it is important to better understand and quantify the lingering problem with Whiplash related disorders today.



Pedestrian and Cyclist Safety

Euro NCAP has been a leading motivator in the improvement of protection for vulnerable road users. Since 2010, major efforts have been made into making the original EEVC-based pedestrian subsystem tests more realistic, reproducible, and exacting. The final step, scheduled for 2023, includes an extension to the headform test zone that better addresses cyclists and the introduction of the aPLI with new biomechanical limits.

Euro NCAP acknowledges the benefit of a safer front-end design, especially for crashes at lower speed, but does not plan any significant changes to the current procedure in the short term. Nevertheless, it will continue to **review the injury patterns, test method and the criteria,** considering the reported higher injury risk for females and emerging micro-mobility solutions. To make the testing more repeatable and effective in addressing real world fatalities and injuries, the grid approach and scoring used for headform testing must be revised to provide a higher incentive for A-pillar protection and extended to bonnet leading edge and bumper testing. In addition, the activities in the CoHerent project (Klug et al., 2019) to improve Euro NCAP Technical Bulletin TB24 will continue, ensuring that the human models, criteria and generic vehicle models being applied are representing the state-of-the art and promoting deployable systems for pedestrians, standing powered scooters and cyclists

Post-Crash Safety

Rescue, Extrication and Safety

Euro NCAP has significantly invested time in understanding post-crash safety and the critical role of first responders at the scene of an accident. This understanding was used to create a new mobile app delivering basic ISO 17840 Rescue Information in all European languages and to develop incentives for post-crash technology, such as multi-collision brake and advanced eCall.

Euro NCAP will closely follow the development of ISO 17840 and, where necessary, complement the standard. This is particularly true for (Lithium-Ion) **battery electric, fuel-cell, and hydrogen cars, which pose specific safety risks to first responders, such as thermal runaway,** battery reignition and stranded energy (CTIF, 2021). It will also support the rollout of extended eCall functionalities, smarter blue light dispatching, and en-route support built on communication services. This includes intelligent eCall or dCall services, a system for dispatching doctors, based on calculations of probability of risk to driver and passengers. This calculation can be done either by the vehicle, which can then send the probability of injury with the e-Call message, or the PSAP can derive the injury probability, or urgency, from vehicle delta-v using a centralised and standardised method (such as the algorithm and parameters under review in ISO TC22/SC36/WG7) relevant to the European market. Other supported advanced eCall services may include the inclusion of VRU accidents, such as pedestrians and bicycle, and automatic notification of thermal incidents, with or without the occurrence of a crash. Looking to the future, it is possible that internal sensors could transfer live the images and vital life signs of injured persons, such as heart rate, breathing etc., taken from in-cabin sensors, allowing for instance an assessment of driver consciousness (Glasgow Coma Score)

Commercial Vehicle Safety

Euro NCAP's new rating programme provides essential safety information, potentially reducing the long-term cost burden for operators

(Light) Commercial Vans

Vans are business tools, so the total cost of ownership is extremely important. Fuel consumption, price and maintenance costs are decisive factors for customers. By contrast, safety systems are often deprioritised, citing a van's long average lifespan, the costs related to technologies and the resulting economies of scale. This seems paradoxical, given improving in-van safety systems could potentially reduce the long-term cost burden when one considers the unscheduled downtime from road incidents for driver, vehicle and the other road users involved. Furthermore, it is evident that most manufacturers already offer advanced safety systems as an option.

In 2020, Euro NCAP launched a **new rating programme** designed to provide information to van operators and others about commercial vehicle safety, with the goal of encouraging the fitment of advanced safety technologies and complement regulatory approaches. Fleet owners, safety managers and maintenance officers then can understand what's available on the market and what systems make the most sense for their business operations. The approach is to update rating results annually for the most popular commercial vans and, every three years, adjust the underlying test procedures and criteria. From 2026 onwards, only standard equipment will be considered in the rating, but information about the availability of optional equipment in each market will continue to be made public. The objective is that relevant (active safety) test procedures would by then be fully aligned with passenger cars.

Medium and Heavy Trucks

In 2018 there were 3,310 fatalities reported from collisions involving heavy trucks in the European union, representing 14% of all EU road fatalities. Most fatalities in truck crashes occur outside of the vehicle – this is not surprising given their size, weight, and their design. As is the case for commercial vans, on-board safety systems have the potential to enhance heavy truck safety.

Trucks come in all shapes and sizes but can generally be categorized according to usage: urban & regional distribution, long haul, construction, and utility. Trucks in different categories see different urban and inter-urban usage and are consequently involved in different types of incidents. When it comes to improving truck safety, it therefore makes sense to distinguish between advanced safety features effective for urban crash types, and those for motorway and regional road crash types.

In 2020, Euro NCAP started work on the concept of a **new European-wide truck label,** as a stand-alone instrument enabling road authorities, cities, and operators to scale up urban truck schemes, complementing regulatory requirements. The label will primarily be constructed around crash avoidance technology but will eventually also include other aspects of safety, such as seatbelt usage, front-end compatibility, front and side underrun protection and rescue information for first responders. At the same time, safe trucks with low- and zero-emission vehicles will also be credited as clean. The label will clearly discriminate between "city" and "highway", allowing operators to prioritise the aspect most important to their operation.

For its success, Euro NCAP clearly needs to profile "the safe and cleanest" choice as the most profitable decision for operators, launching the label in close collaboration with European cities and road authorities and targeting a new audience: the fleet market[1]

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[1]More information will be made available in the forthcoming "Roadmap for the Assessment of HGV Safety".

[2] European Commission.

Powered Two-Wheeler Safety

Powered Two Wheeler motorcycles and mopeds are an increasingly popular mode of transport. In Europe, there are nearly 37 million PTW in circulation and their number is rising. Despite the risks of driving this form of motorised transport and the vulnerability of riders, PTW riders have not benefited to the same extent as car occupants from the many developments in vehicle safety.

Advanced Rider Assistance Systems (ARAS) have been introduced to the market decades ago, and yet it has taken time for riders to accept assistance functions such as anti-lock brake systems (now mandated), traction control systems, combined brake systems, Blind Spot Information System (BLIS), corner anti-locking braking system (ABS) and other stability aids. In most cases, such assistance systems, if at all offered, are optional and the uptake remains low. In terms of passive safety, the main rider protection is the use of personal protective equipment (PPE) and, exceptionally, airbags. Motorcycle helmets must meet safety standards, but consumer information programme SHARP (Department for Transport, 2017) has shown that despite these standards, there is a large difference in performance between the lowest and best performing helmets. And while it is compulsory use of helmets in all European countries, the use of additional PPE such as protective jackets, pants or gloves varies largely between different countries and user groups.

Euro NCAP is already targeting motorcycle incidents by expanding crash avoidance testing to include PTW crash scenarios. As mentioned earlier it is planned to evolve these tests in the future, i.e., by increasing test speed, but also by introducing PTW scenarios to the Commercial Van and Assisted Driving assessment. It has been suggested that Euro NCAP could also provide guidance for PTW riders by assessing safety systems like those mentioned above and recommending those with the highest safety impact, starting with a test campaign. It could also highlight other needs, such as eCall for PTWs.

However, there are significant challenges. To evaluate ARAS, Euro NCAP would need to modify UN Regulation No. 78 in relevant sections and develop meaningful test procedures and criteria. To rate PPE, it would need to set up a programme of aftermarket product testing, an area in which Euro NCAP is not as familiar. To be able to successfully reach end users, new and relevant communication channel(s) for the campaign would need to be established. Combined these challenges require significant investment and, it remains unclear how well a safety campaign will be received by the motorcycle community compared to audiences in other driver segments.

Adding motorcycle safety to Euro NCAP's portfolio is, on the surface, an appealing prospect, as we broaden our horizon to include other forms of mobility; however, this can only be pursued successfully if a safe system approach is followed, recognising not only the contribution of motorcycle design and equipment, including new technology such as motorcycle connectivity, but also from other road vehicles, road infrastructure and riders. It requires that sufficient resources are committed, and the support and cooperation of the motorcycle industry and international partners

Safety Assurance for Shared and Autonomous Mobility

Self-driving cars can be radically different in their design to traditional cars, but that does not mean that their safety is less of a priority

Safety Assurance for Shared and Autonomous Mobility Euro NCAP Vision 2030

Mobility as a Service (MaaS) is a concept whereby users purchase a package of options to travel from A to B, depending on their needs, with very convenient access, in general from a user's mobile device.

With a subscription model allowing users access to a variety of mobility options (shared bikes, taxi and public transport), users can choose the best means of transport for a given journey. This concept helps to optimize each transport mode and does not prioritise one mode against the other. It seeks to reduce private ownership of vehicles and to promote the use of shared fleets or taxis.

Sustainability is a key element of the value proposition promoted by the MaaS Alliance (maas-alliance.eu, 2022) and improving road safety is a keystone of the strategy. Initially using vehicles currently available on the market, MaaS operators may gradually introduce more autonomous vehicles, such as driverless passenger shuttles that are currently being tested in a range of countries. At this present time, such vehicles are not subject to a particular safety relevant regulation, even though they will, in the foreseeable future, share the road with private and public vehicles.

Self-driving cars (Automated Vehicles, AVs) can be radically different in their design to traditional cars, for example they may lack a steering wheel, a driver's seat, etc. and may potentially offer unconventional seating arrangements. But that does not mean that their fitted safety systems should be compromised, or that safety is less of a priority. Self-driving cars are engineered to operate safely in a precise, vehicle-specific operational design domain (ODD) and therein lies the difficulty: the conditions and constraints for which these vehicles are designed and validated may differ from one vehicle type to another or from one operational domain to another.

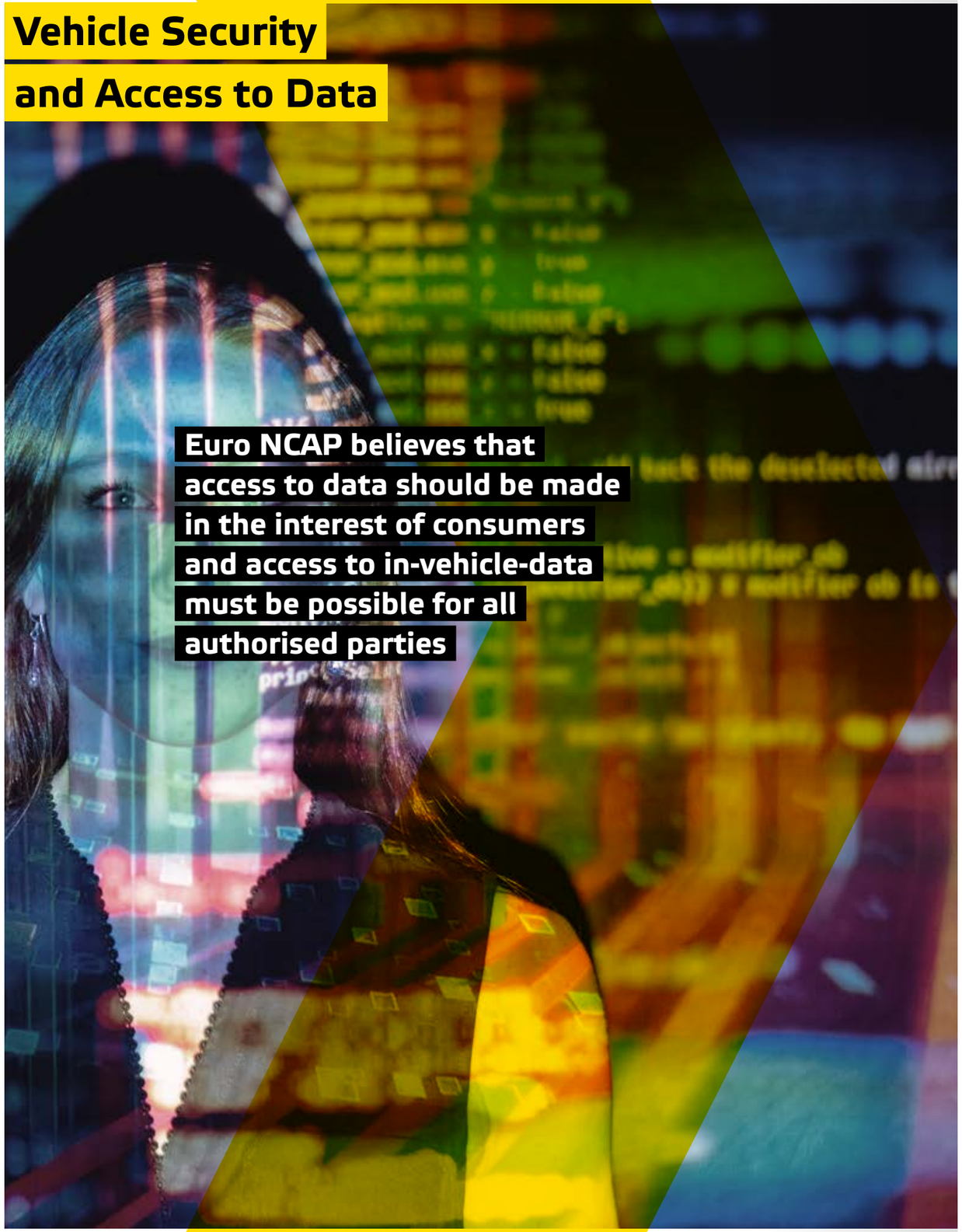
Shared and automated mobility are likely to drive the market more towards a fleet model than a personal ownership model. The effects this might have on the engagement of consumers with the safety characteristics of the vehicles they travel in are complex and not yet known. They may become disengaged with vehicle brands and the safety characteristics they offer, instead basing their choice of operator on how reliable and fast the service is or how easy it is to use their app. This could make it harder for Euro NCAP to influence safety outcomes.

Alternatively, expectations of safety from commercial automated fleets may become so high that regulators begin taking more of an aviation industry approach and demanding even higher standards, so that the role of Euro NCAP is not as necessary. The first signs, however, are that authorities are shying away from taking steps too early, in the fear that innovation may be stifled. To bridge the gap that is emerging, several self-driving car companies, such as Waymo, Uber and ZooX, have applied voluntary safety standards, based on a variety of benchmarks and recommendations.

What is clear is that there is little information in the public domain, and that an internationally recognised framework for evaluating the safety of AVs is lacking. Euro NCAP would like to support the nascent AV industry, develop, and advocate best practice recommendations for evaluating safety, and publish transparent requirements for AVs on which a **Voluntary Safety Assessment (VSA)** can be undertaken. The "one size fits all" approach of Euro NCAP's overall rating for traditional passenger cars may not be appropriate to rate the safety of self-driving vehicles. Still, many of the underlying tests are meaningful if the requirements could be better adjusted to the operational design domain.

In this direction, Euro NCAP hopes to define a more dynamic set of protocols and objective requirements, and a safety assurance scheme, tailored to the needs of the self-driving company and future operators, that will support ongoing safety efforts and pave the way for meaningful regulation of the safety of AVs. This will focus on highway and pavement collision avoidance for vehicles and VRUs, occupant collision protection – crashworthiness, (alternative) seating postures, restraint systems and compatibility, VRU collision protection and emergency response. To help us with fact finding, understanding the industry's best practice and create a win-win-win situation for manufacturers, operators and users, Euro NCAP welcomes partnerships and cooperation with relevant stakeholders in this emerging market

Vehicle Security and Access to Data



Euro NCAP believes that access to data should be made in the interest of consumers and access to in-vehicle-data must be possible for all authorised parties

Vehicles have rapidly become computers on wheels with software controlling braking, steering, driving and advanced safety functions along with the inevitable on-board infotainment systems. Further connecting vehicles to the cloud has enabled vehicle manufacturers to offer real-time information to drivers and provide services such as functionality upgrades, remote diagnostics, and software updates over the air.

The role of software and telematics has become so dominant that the industry is becoming a hyper-connected, software-driven one where data has become key to growing revenue, not just for automotive manufacturers but for many suppliers of products and services that sit adjacent to manufacturers. Consequently, what happens with the data generated by drivers and their vehicles, and who should have access has become a burning question for European legislators.

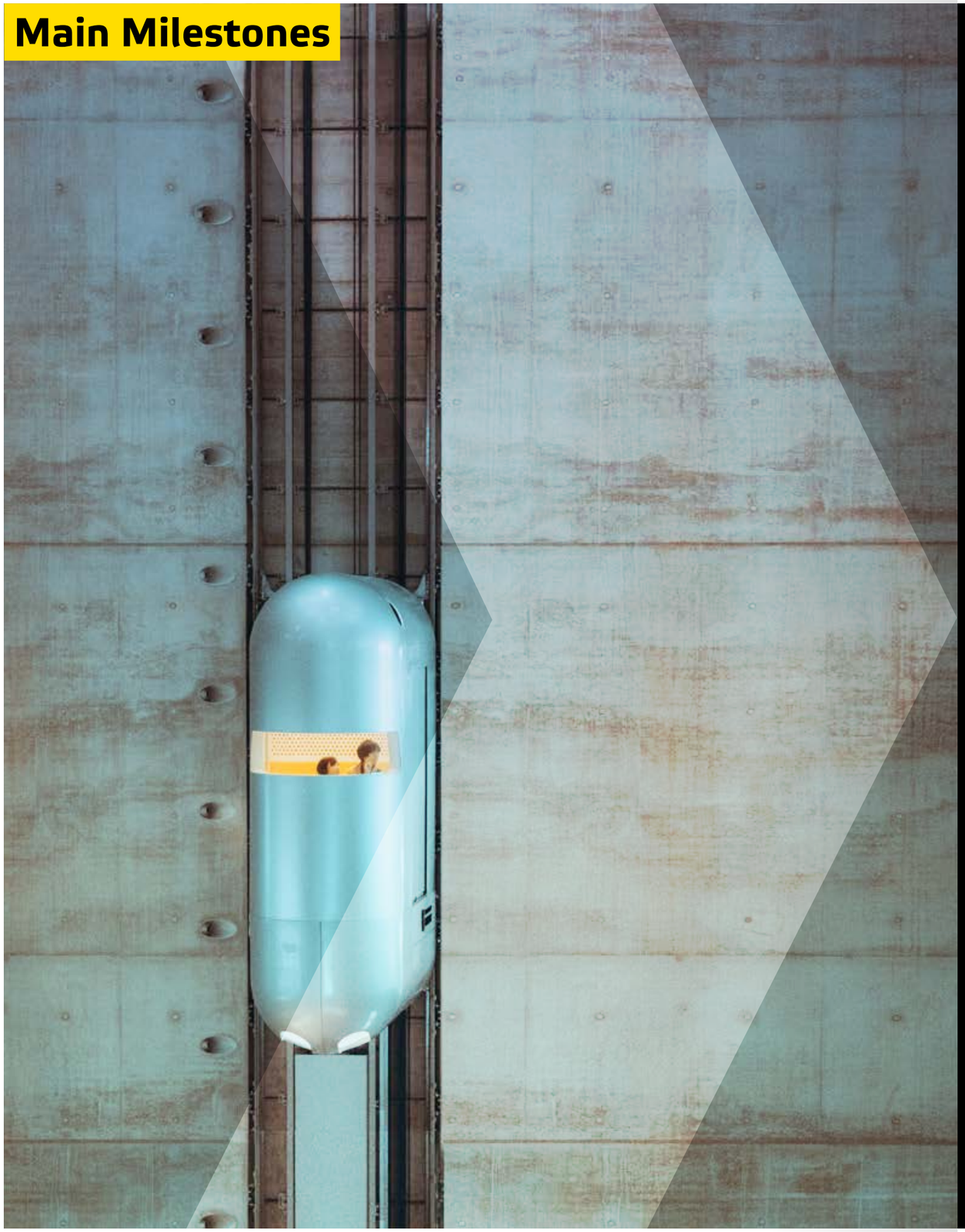
Further connecting vehicles to the cloud has enabled vehicle manufacturers to offer real-time information to drivers and provide services such as functionality upgrades, remote diagnostics, and software updates over the air. The role of software and telematics has become so dominant that the industry is becoming a hyper-connected, software-driven one where data has become key to growing revenue, not just for automotive manufacturers but for many suppliers of products and services that sit adjacent to manufacturers. Consequently, what happens with the data generated by drivers and their vehicles, and who should have access has become a burning question for European legislators.

By connecting cars to the internet-of-things, they became demonstrably more vulnerable to hacking, cyber-attacks, and remote manipulation. The recent UN regulation No. 155 on Cyber Security and Cyber Security Management Systems (CSMS) and No.156 on Software Updates and Software Updates Management Systems represent an important step in the right direction to better cope with remote risks and threats. However, these regulations focus more on update procedures and organisational processes and less on the security of the product, the vehicle, itself. Connected vehicles could be at risk of being hacked, which results in access to the driver's personal information and even more troublesome, the hacker may take actual control of the connected vehicle.

As a consumer-focused organisation concerned with assessing safety performance of new vehicles and promoting the uptake of new advanced technologies, Euro NCAP thinks that vehicles entering the market must meet at least basic vehicle security requirements. It also believes in the premise that that access to data should be made in the interest of consumers and that access to in-vehicle-data must remain possible for all authorised parties. This includes the use and monitoring of car data and functions during independent consumer testing.

To make sure that is the case, and to support the roll-out of legislative initiatives in this field, vehicle manufacturer security systems could be benchmarked against a state-of-the-art approach, such as the Common Criteria Certification developed by ENISA (2021) or the On-Board Telematics Platform (OTP) approach, put forward by TUV-IT (Bartsch et al., 2020). This would help alleviate concerns of consumers about the security of (connected) vehicles, foster a culture of security and allow us reward early adopters of new regulations and security standards. Finally, vehicle security and data access are very broad and complicated issues, and part of an evolving sector which Euro NCAP will continue to remain aware of

Main Milestones



2026 2029 2032

Safe Driving

- M1 Beyond Intelligent speed assistance
- M2 Driver Awareness: impaired driving to cognitive distraction
- M3 AD Grading: Domain extension and driver engagement

Crash Avoidance

- M4: Improved robustness and real-world effectiveness
- M5: Leveraging vehicle connectivity
- M6: Pedal misapplication

Crash Protection

- M7: Senior protection: low severity testing with sled
- M8: Far-side and side pre-crash incentives
- M9: Protection equity through modelling
- M10: Whiplash protection parity
- M11: Passive VRU protection – A-pillar and micro-mobility

Post-Crash Protection

- M12: Next-gen updates including D-call and thermal scanning

References

Avenoso, A. (2009). Safe & Sober. European Transport Safety Council, Berlin (https://etsc.eu/wp-content/uploads/02_-Antonio-Avenoso.pdf).

Bartsch, M., Wahner, M., Wagner, M., Niehöfer, B., Bobel, A. (2020). On-board Telematics Platform Security (Rep.). Retrieved https://www.fiaregion1.com/wp-content/uploads/2020/06/ 20200615_FIA_vehicle_security_report.pdf.

Brumbelow, M., Jermakian, J. (2021). Injury risks and crashworthiness benefits for females and males: Which differences are physiological? 10.13140/RG.2.2.11646.72009.

Department for Transport. (2017). The Helmet Safety Scheme. SHARP. Retrieved October 20, 2022, from https://sharp.dft.gov.uk.

European Automobile Manufacturers' Association (ACEA). (2021). Vans: what they are and why they are so important. www.acea.auto.

European Commission. (2018). Traffic Safety Basic Facts 2018 – Gender, 2018. EC SafetyNet.

European Commission. (2018). VIRTUAL - Open access virtual testing protocols for enhanced road user safety. Horizon 2020, No 768960. doi: 10.3030/768960.

European Transport Safety Council. (2019). Reducing Speeding in Europe (PIN Flash 36).

European Union. (2019). GSR2 - Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles […], as regards their general safety and the protection of vehicle occupants and vulnerable road users.

European Union. (2021). Commission Delegated Regulation (EU) 2021/1958 of 23 June 2021 […] laying down detailed rules concerning the specific test procedures and technical requirements for the type-approval of motor vehicles with regard to their intelligent speed assistance systems […].

European Commission. (2022). Road Safety: European Commission Rewards Effective Initiatives and publishes 2021 figures on Road Fatalities. Mobility and Transport. Retrieved October 20, 2022, from https://transport.ec.europa.eu/news/road-safety-european-commission-rewards-effective-initiatives-and-publishes-2021-figures-road-2022-10-17_en.

European Union Agency for Cybersecurity (ENISA). (2021). Retrieved October 17, 2022, from https://www.enisa.europa.eu.

Euro NCAP. (2020). Euro NCAP Launches Assisted Driving Grading. European New Car Assessment Programme.

Euro NCAP. (2022). Euro Rescue 2022 (Version 1.12.0.212416) [Mobile app]. Play Store.

Forman J., Poplin G.S., Shaw C.G., McMurry T.L., Schmidt K., Ash J, Sunnevang C. (2019). Automobile injury trends in the contemporary fleet: Belted occupants in frontal collisions. Traffic Inj Prev. 2019;20(6):607-612. doi: 10.1080/15389588.2019.1630825.

Hamilton, B., Grabowski, J. (2013). Cognitive Distraction: Something to Think About (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

International Association of Fire & Rescue Services (CTIF). (2021). Member Survey.

Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D., Ramsey, D.J. (2006). The impact of driver inattention on near-crash/crash risk: an analysis using the 100-car naturalistic driving study data. Report No. DOT HS 810 594, National Highway Traffic Safety Administration, Washington, D.C.

Klug, C., Feist, F., Schneider, B., Sinz, W., Ellway, J., van Ratingen, M. (2019). Development of a Certification Procedure for Numerical Pedestrian Models. In Proceedings of the 26th International Technical Conference on the Enhanced Safety of Vehicles, Eindhoven, Netherlands.

Lococo, K. H., Steplin, L., Martell, C. A., & Sifrit, K. J. (2012). Pedal Application Errors (DOT HS 811 597). National Highway Traffic Safety Administration.

Maas-Alliance – The Mobility as a Service Alliance. (n.d.). Retrieved September 25, 2022, from https://maas-alliance.eu.

Mousel, T., Larsen, P. and Holger, L. (2017). Unattended Children in Cars – Radiofrequency-Based Detection to Reduce Heat Stroke Fatalities. In Proceedings of the 25th International Technical Conference on the Enhanced Safety of Vehicles, Detroit, USA.

NASVA. (2018). Japanese New Car Assessment Programme. Website: https://www.nasva.go.jp.

Noh, E. Y., Atwood, J. R. E., Lee, E., & Craig, M. J. (2022). Female crash fatality risk relative to males for similar physical impacts (Report No. DOT HS 813 358). National Highway Traffic Safety Administration.

Ostermaier I., Ostermaier M., Sandner. V, Kolke, R. (2022). Restraint Systems for all Car Occupants. Parts 1 and 2. In: VKU Verkehrsunfall und Fahrzeugtechnik, Vol. 60. Issue Number: 2&3, Springer Automotive Media, Springer Fachmedien München GmbH, ISSN: 0724-2050 (in German).

Peden, M. et al. (2004). World report on road traffic injury prevention. World Health Organization. Ed. by Margie, 2004. Geneva: ISBN 9241562609.

van Ratingen, M.R. (2008). The Changing Outlook of Euro NCAP. In Proceedings of the Airbag 2008 9th International Symposium & Exhibition on Sophisticated Car Occupant Safety Systems, Karlsruhe.

Victor, T. (2014). Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk, National Academic Press.

United Nations. (2021). Regulation No. 157 - Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems, ECE/TRANS/WP.29/2020/81.

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About Euro NCAP

Established in 1997, Euro NCAP is composed of seven European Governments as well as motoring and consumer organisations in every European country

Euro NCAP provides consumers with an Independent assessment of the safety level of the most popular cars sold in Europe.

Euro NCAP has rapidly become a catalyst for encouraging significant safety improvements to new car design. We hope that when buying a new car Euro NCAP will help you choose for safety.

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