

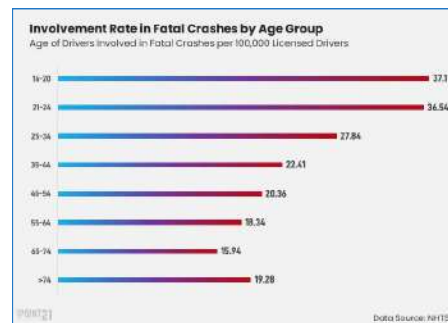
ASST-DRIVER is a revolutionary system designed to support novice drivers through real-world challenges. Whether you're new to driving or navigating in a new country, ASST-DRIVER simplifies complexity with AI-guided notifications on right-of-way and traffic laws. The AI system offers personalized guidance and route directions using both visual and verbal cues, helping novice drivers confidently navigate the road with a reliable companion.

Research

User research for ASST-DRIVER was conducted through a combination of **qualitative and quantitative methods**. Secondary research, including **literature reviews**, informed the early stages. Primary research, including **surveys, user interviews, and expert interviews** were employed to understand the pain points and preferences of novice drivers, international drivers and experts in automotive industry. This multi-faceted approach ensured a comprehensive understanding of user needs and expectations.

Novice drivers (Beginners and international drivers) are vulnerable due to lower sensitivity to road changes and difficulties understanding road signs.

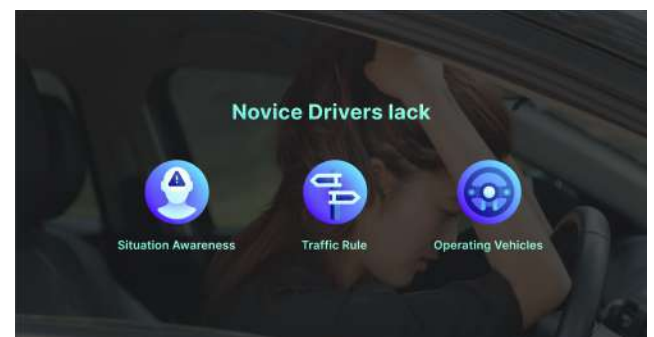
- Novice drivers are particularly vulnerable, as evidenced by a 17% increase in traffic fatalities among young drivers from 2019 to 2020 (NHTSA, 2022).
- Expert drivers demonstrate heightened sensitivity to changes in road environments compared to novice drivers (Underwood, 2007).
- Recognizing traffic signs is particularly challenging for foreign drivers, as highlighted by Dissanayake & Lu (2001), who reported difficulties in understanding road signs among both expert and novice foreign drivers.



Situation in the real world

User Pain Points – Novice drivers often lack situational awareness, knowledge of traffic rules, and experience in operating vehicles.

New drivers (Beginners and International Driver) often feel lost on the road. Research shows that compared to experienced drivers, beginners are not as quick to spot dangers ahead. Understanding road signs can be a struggle, too. In one study, many of us couldn't even interpret basic signs like 'Divided Highway Ends.' And reacting to yellow lights? Let's say we're still learning. (Dissanayake & Lu, 2001)



How To Help Novice Drivers (Beginners and International Drivers) ?

Experts suggest that the **AR interface can enhance sensation, attention, situational awareness, and decision-making while reducing the mental workload of novice international drivers.**

Rane, P., Kim, H., Marcano, J. L., & Gabbard, J. L. (2016, September)

The evaluation found that the **AI-enhanced AR HUD system was preferred by 90% of users, as it significantly reduced mental and physical demand, minimized stress, and improved perceived performance and collision avoidance.**

Bram-Larbi, K. F., Charissis, V., Khan, S., Harrison, D. K., & Drikakis, D. (2020)

Drivers find existing AR-HUDs distracting !!

Augmented Reality Head-Up Displays (AR-HUDs) integrate HUD and AR features, allowing users to access information without diverting their attention from the road. Research suggests that drivers may find **AR elements obstructive and more distracting than traditional HUDs**, highlighting the need for improved design and user training (Maag et al., 2023).

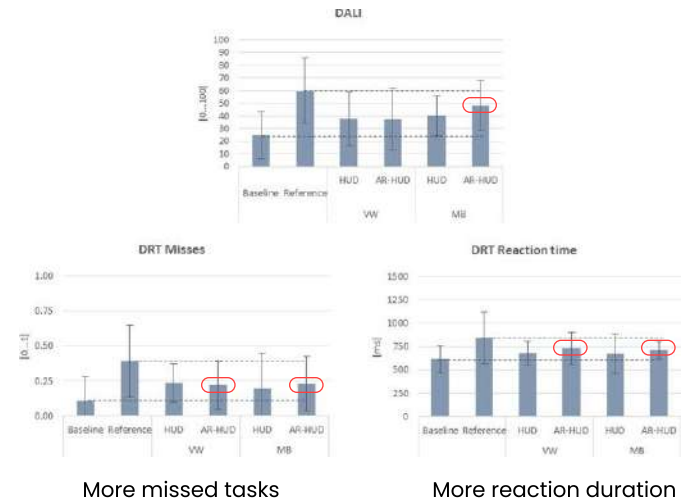


Mercedes AR-HUD



Volkswagen AR-HUD

Higher workload



More missed tasks

More reaction duration

Restructuring the Information Architecture is essential to optimize the AR-HUD experience for drivers.

Ensuring effective HCI principles and visual design in AR-HUD development is crucial for enhancing cognitive resource allocation and driving safety (Ma et al., 2021).

To streamline cognitive efficiency during driving, it's essential to prioritize information within the interface. In the study, information is classified into three levels (as shown in Figure 2): the priority group, which significantly influences user behavior and necessitates immediate comprehension and feedback; the secondary group, requiring timely awareness but not immediate feedback; and the primary group, with minimal impact on driving behavior and can be ignored by users. (H Zhang et al, 2022)

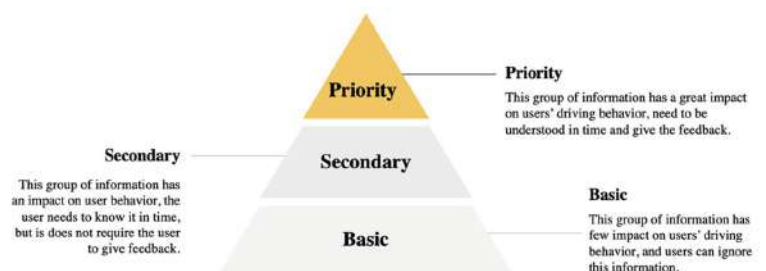


Fig. 2. Priority classification model of AR-HUD interface information

Information Architecture for Novice Drivers

Zhang's research delves into developing the information architecture (IA) of AR-HUDs tailored for beginners and experts across various driving environments. Through a comprehensive analysis, they categorized scenarios into four distinct types: Urban, Countryside, Highway, and Residential. Additionally, the study identifies the specific information required on the windshield based on drivers' behaviors within each environment.

Environments	Driving instructions	Information structure	
		Priority group	Secondary group
Urban	Go straight	Speed, departure warning, distance reminder	Speed limit, pedestrian's information, other vehicles, driving route, safe distance reminder, traffic condition ahead
	Change lanes	Lane change instructions, speed, other vehicles	Speed, speed limit, change route reminder, safe distance reminder, distance reminder, driving route, turn path visualization
	Turn left	Turn instructions, speed, distance reminder	Lane change instructions, driving route, distance from destination, change route reminder, time to destination, direction visualization, safe distance reminder, speed reminder, pedestrian's information, other vehicles, turn path visualization
	Overtaking	Other vehicles, speed, lane change instructions	Distance reminder, driving route, change lane reminder, safe distance reminder, speed reminder
	Turn right	Change route reminder, turn instructions, speed	Distance reminder, lane change instructions, driving route, other vehicle, pedestrian's information, direction visualization

Environments	Driving instructions	Information structure	
		Priority group	Secondary group
Countryside	Go straight	Speed, departure warning, traffic condition ahead	Speed limit, other vehicles, driving route, safe distance reminder, distance reminder
	Change lanes	Lane change instructions, speed, change route reminder	Speed, speed limit, other vehicles, safe distance reminder, distance reminder, driving route, turn path visualization
	Turn left	Turn instructions, speed, pedestrian's information	Distance reminder, lane change instructions, driving route, distance from destination, change route reminder, time to destination, direction visualization, safe distance reminder, speed reminder, other vehicles, turn path visualization
	Overtaking	Other vehicles, speed, lane change instructions	Distance reminder, driving route, change lane reminder, safe distance reminder, speed reminder
	Turn right	Change route reminder, direction visualization, speed	Turn instructions, distance reminder, lane change instructions, driving route, other vehicle, pedestrian's information, direction visualization
Highway	Go straight	Speed, departure warning, distance reminder	Speed limit, other vehicles, driving route, safe distance reminder, distance reminder
	Change lanes	Speed, lane change instructions, change route reminder	Speed limit, other vehicles, driving route, safe distance reminder, distance reminder
	Overtaking	Distance reminder, speed, other vehicle	Driving route, change lane reminder, safe distance reminder, speed reminder
	Convergence	Other vehicle, driving route, speed	Speed limit, other vehicles, safe distance reminder,

Environments	Driving instructions	Information structure	
		Priority group	Secondary group
	Overtaking	Distance reminder, speed, other vehicle	Driving route, change lane reminder, safe distance reminder, speed reminder
	Convergence	Other vehicle, driving route, speed	Speed limit, other vehicles, safe distance reminder,
Residential	Go straight	Speed, distance reminder, Pedestrian's information	Other vehicle, speed limit, road restrictions
	Turn left	Turn instruction, direction visualization, pedestrian's information	Speed, distance reminder, other vehicle, road restrictions
	Turn right	Turn instruction, direction visualization, pedestrian's information	Speed, distance reminder, road restrictions

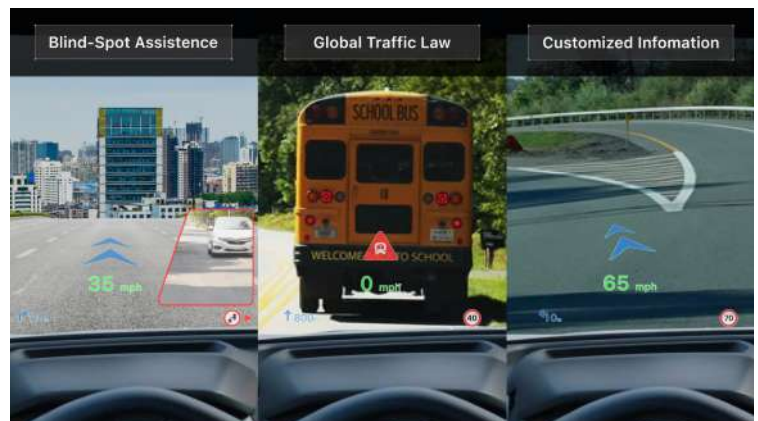
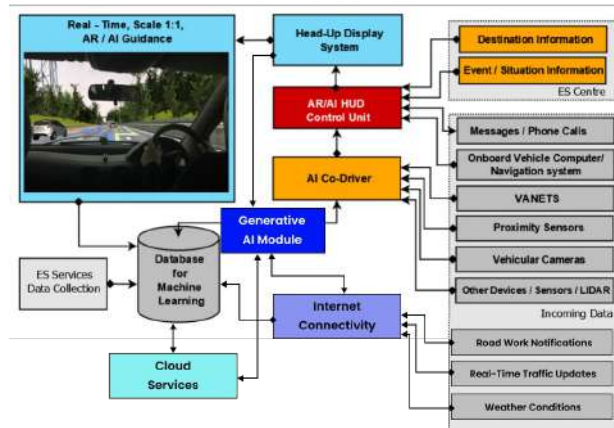
Design Concept

ASST-DRIVER utilizes artificial intelligence to integrate vehicle data, cloud data, and user driving behaviors, simplifying driving information for the user. Additionally, it familiarizes novice and international drivers with traffic laws, thereby boosting their confidence in complex traffic scenarios.

AI-Guidance

Our AI-driven AR navigation enhances driving safety with real-time 3D graphics that adjust to the vehicle's surroundings, displaying lane markers, GPS arrows, and alerts for collisions or cyclists. Updates occur in less than 300 milliseconds. AI algorithms provide predictive insights and hazard notifications while integrating global traffic laws to help new and international drivers avoid fines and accidents. Additionally, AI and vehicle sensors display side-view video on the HUD for safe lane changes and blind spot monitoring.

Revised Bram-Larbi, K. F., etl (2020) AR / AI Infrastructure + Cloud Services, Internet and Generative AI



AI-Guidance Scenarios



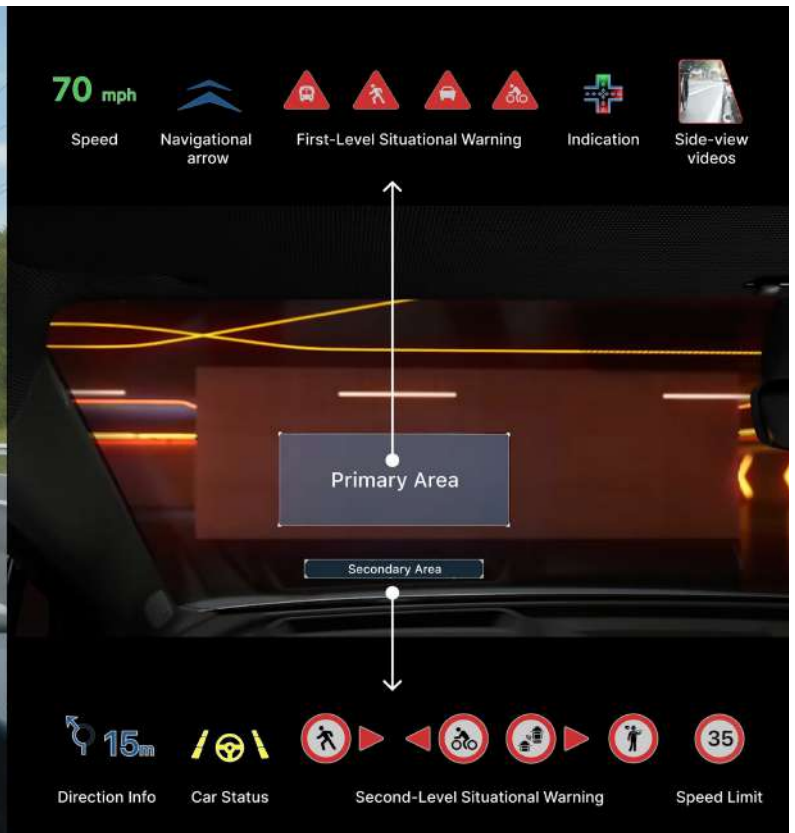
Right-of-Way

ASST-DRIVER incorporates traffic laws to assist both novice and international drivers. For example, in a four-way stop scenario, drivers face diverse situations requiring tailored responses. Our system features an educational mode to help novice drivers learn and confidently navigate intersections.



All visual elements are research-backed and crafted from the user's perspective

The information architecture, tailored for novice drivers, draws from research by experts like Han Zhang. Colors, including Green, Red, Blue, and Yellow, are selected based on recommendations for optimal use on AR-HUD. Additionally, the white outline is implemented based on research suggesting that it aids users in accessing information quickly and efficiently.



• Harpoon Design

Harpoon concept is the best because it is less dominant
Schneider, M. (2021).

• Without "tilt animation"

Variation tilt cannot be recommended for application in
an automotive HUD

Pfanmüller, L., Kramer, M., Sennler, B., & Bengler, K. (2015).



70 mph

• Chosen Colors

Blue, Green, Red and Yellow had apparent visibility



Gabbard, J. L., Smith, M., Merends, C., Burnett, G., & Largo, D. R. (2020).

• Outline

The visibility with a white outline is highest.

Zhong, X., Cheng, Y., & Tian, L. (2022, October).

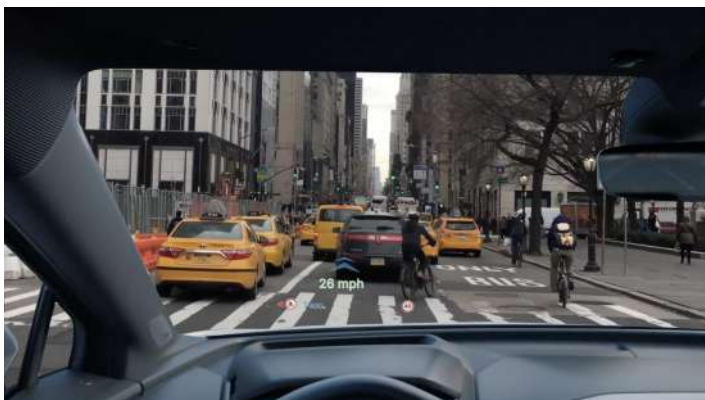
Implementing progressive notifications for **visual and auditory warnings** can enhance user acceptance of the system

The progressive notification strategy uses both auditory and visual alerts. Initially, the system provides subtle visual warnings and gentle audio cues for distant obstacles. As objects draw nearer, the alerts become more prominent, with more explicit visual warnings and faster-paced auditory alerts. This approach aims to enhance user awareness and responsiveness, improving overall receptivity.

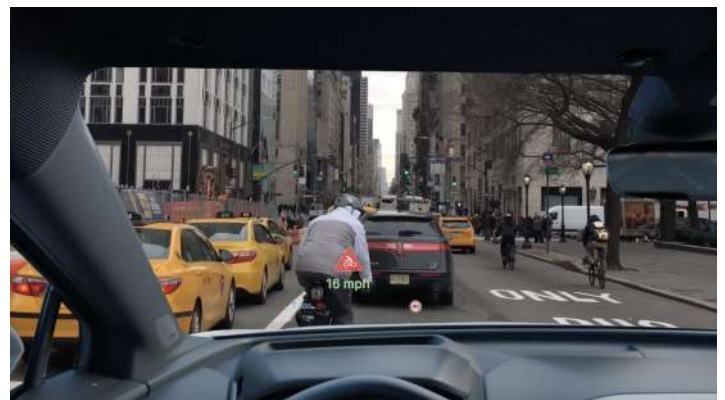


Design Development

80% of participants prefer using this system over existing warning systems via AR-HUD.



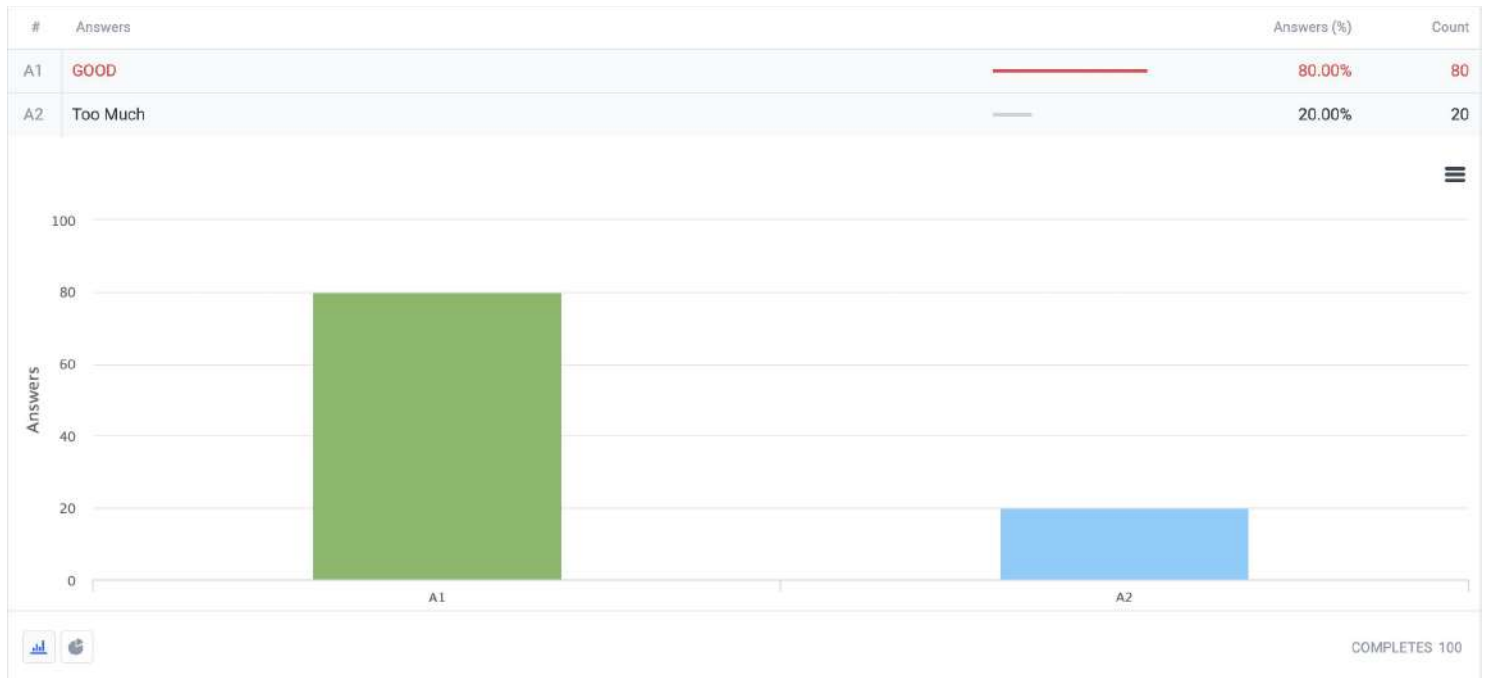
Second-Level Warning



First-Level Warning

In scenarios involving cyclists navigating busy urban environments, the AR-HUD system employs varying levels of notification prompts to ensure driver awareness and cyclist safety. In situations with minimal notification prompts, the system provides subtle cues, such as gentle visual indicators or non-intrusive auditory signals, to inform drivers of nearby cyclists without causing distraction. Conversely, in scenarios with heightened risk or increased cyclist activity, the system delivers strong notification prompts, utilizing bold visual cues or prominent auditory alerts to immediately capture drivers' attention and prompt proactive measures to ensure safety and prevent accidents.

participants experienced driving in a busy city with a cyclist approaching, where the prompt consisted of icons accompanied by verbal warnings. **Data analysis reveals that 80% of participants preferred this warning system.**



Implementing different audio alerts, such as verbal and non-verbal warnings, for specific situations via AI system.



Second-Level Warning



First-Level Warning

In the second scenario, participants navigated driving in a busy city with frequent lane changes by other vehicles entering their lane. This scenario featured an increased frequency of verbal audio warnings compared to the first scenario. Thus, data analysis indicates that 57% of participants found this higher frequency of warnings excessive, expressing annoyance towards the system.



For the second round of testing, a **non-verbal** audio warning will be introduced to assess user acceptance compared to verbal audio warnings. Non-verbal audio is expected to be less dominant, providing valuable insights into user preferences. Two different sounds will be utilized: a beep sound to signify the presence of an obstacle, with increased frequency as the distance decreases; an "ok" sound to convey information efficiently; and symbolic visuals will also be included to compare user preferences between icons and symbolic designs.

The scenario involves driving in a busy city, where many cars change lanes to your lane. **The data shows that 61% of participants would like to use this technology and think it can help them when driving.**

GROUPED ANSWERS			
#	Group name	Answers (%)	Count
✓ G1	Yes	61.00%	61
✓	because i like the brand much more	3.00%	3
✓	yes i would like to use the technology	1.00%	1
✓	yes because the audio	1.00%	1
✓	yes i would definitely use it because it can help me indicate if i'm getting to close to the other vehicle	1.00%	1
✓	i would because it would someone like me with adhd to be more fully engaged	1.00%	1
✓	yes i would like to use it because is very good and amazing	1.00%	1
✓	i would like to because it seems easy to follow and understand	1.00%	1
✓	yes because it's good. i want to be able to use it.	1.00%	1
✓	yes it makes drivisafer for you and everyone around you	1.00%	1
✓	because i am working on the same thing so please	1.00%	1
✓	i wouldn't mind trying such technology. it may prove to be useful.	1.00%	1
✓	because everything else is automatically available for the feature	1.00%	1

Integrating novice right-of-way concepts into the system simultaneously facilitates novice and international drivers in driving and learning (Educational Mode)

The system offers distinct modes tailored to drivers' needs. The educational mode utilizes symbolic illustrations to convey traffic laws comprehensively, aiding novice and international drivers in understanding complex scenarios, such as navigating a 4-way stop. ASST-DRIVER provides a mode to assist and educate drivers simultaneously.



In the educational mode, **65% of participants appreciated the design**, mentioning its intuitive nature and ease of learning from the symbolic design in response to open-ended questions.

