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In-car HMI UX Evaluations

#635

In-Car HMI UX Evaluation & Benchmarking

Mercedes-Benz E-Class

In this edition of the In-Car HMI UX Evaluation and Benchmarking series, the UX team is testing the Mercedes-Benz E-Class.

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Scoring

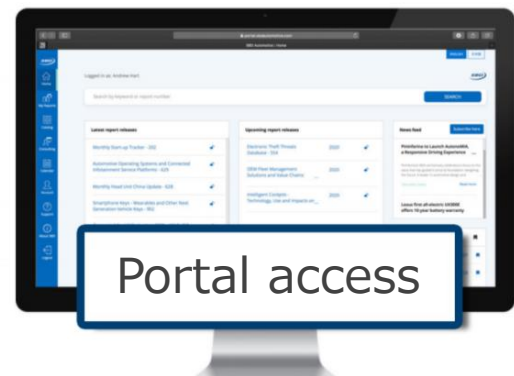
- > **Features and functionality:** evaluating whether the solutions provide features that customers expect, need and solve problems (or provide a wow factor).
- > **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time.
- > **Usability:** evaluating whether the features available are easy to learn and use. This considers areas such as ergonomics, legibility, usability characteristics and how the system implements the various features.
- > **Perceived quality:** evaluating the potential perception in quality of the HMI components and how this contributes to the overall customer experience.

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Introduction



Report Introduction

Welcome to the 2024 HMI benchmarking report series. This report has been created to provide a fair, unbiased and objective view of the latest in-vehicle HMI solutions in the US, European, and Chinese markets. Evaluations are carried out by SBD usability experts with a deep understanding of CASE domains such as the Connected Car and ADAS & autonomy domains.

SBD supports clients throughout the development of new HMI and products from a relatively simple companion app to a more complex multi-domain infotainment solution. The methodologies used in these reports take into account many years of experience with consumer testing and custom client projects to provide a fair and, as much as possible, objective methodology.

All viewpoints and analysis within the report are aimed defining areas of concern through a data driven approach. This report aims to benchmark and score solutions whilst also being able to provide actionable recommendations to design and development teams.

Please note that due to the ever-evolving automotive technology market, SBD updates it's methodology each year, but does not update scores from the previous years. Therefore, please assume a slight drop in scores for both user experience (UX) and functionality from the previous year.



Intuitive



Supportive



Flexibility



Consistency



Brevity



Depth



Presentation

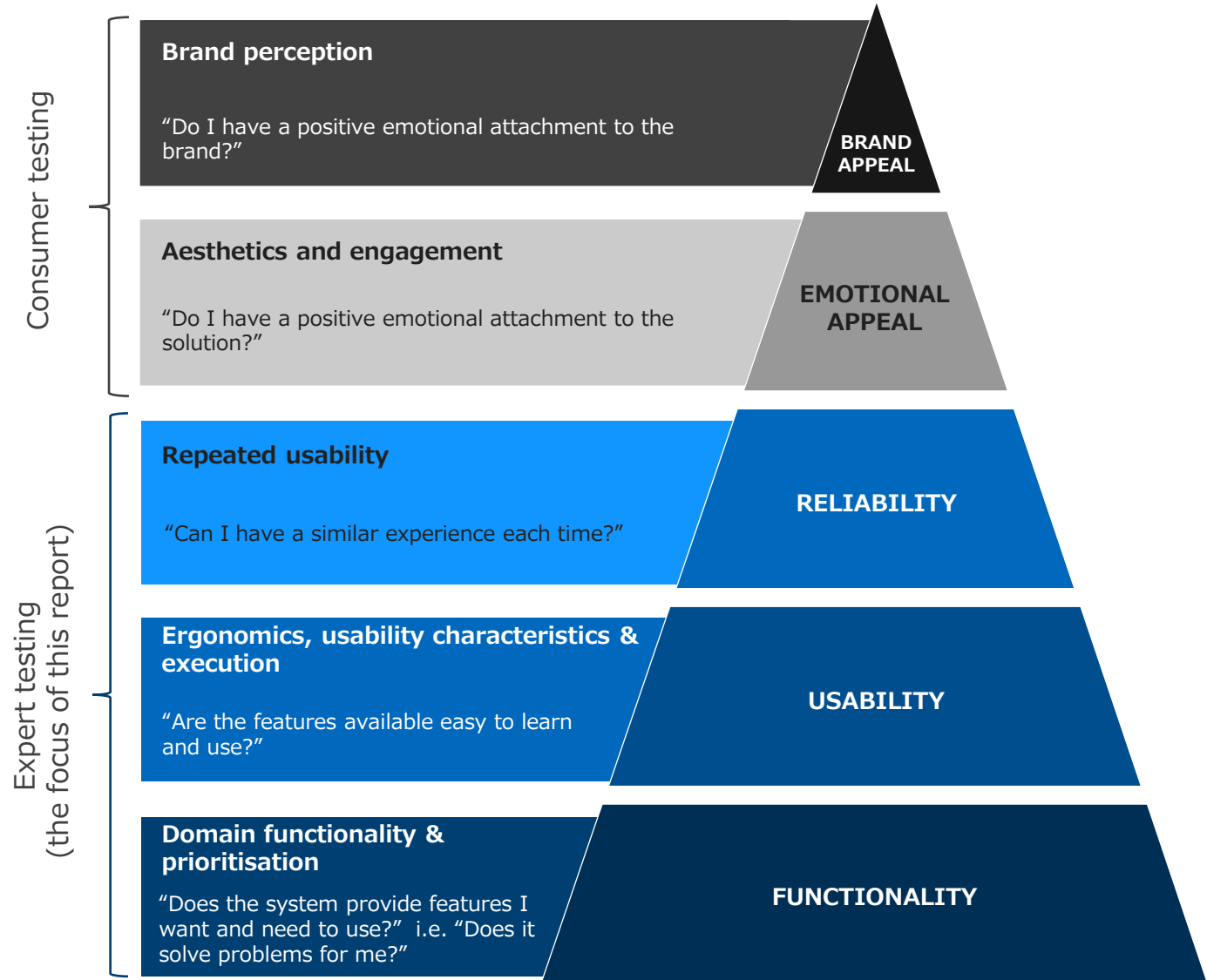
Section	Content
Birds Eye View	An overview of the key findings from SBD's various CX related and adjacent reports.
Executive Summary	Presents key highlights and conclusions from the report.
The Basics	What do you need to know about SBD's CX evaluation methodology?
Analysis	Analysis of report findings by SBD experts.
Features and functionality	Overview of key features and functionality by domain.
Execution	Assess success of implementation and overall execution of various system elements.
Perceived quality	Scoring and analysis of interior perceived quality levels.
ADAS domain	Highlight and analysis of key positive and negative points within the ADAS domain.
Infotainment domain	Highlight and analysis of key positive and negative points within the infotainment domain.
Navigation domain	Highlight and analysis of key positive and negative points within the navigation domain.
Voice recognition domain	Summary and scoring of various aspects of the voice recognition system.
Convenience domain	Summary of various convenience focussed features.
Future Outlook	Seven UX principles are considered against drivers and barriers into the future of this reports test vehicle.
Next Steps	Can SBD help you with any unanswered questions?



Aim of this report

One of the core goals of these studies is to provide a true indication of what the final customer experience of each solution could be. To do this evaluations are focused on providing scoring and analysis in the following areas:

- **Features and functionality:** evaluating whether the solutions provide features that customers expect & need, and solve problems (or provide a wow factor)
- **Usability:** evaluating whether the features available are easy to learn and use. This considers areas such as ergonomics, legibility, usability characteristics and how the system implements the various features
- **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time
- **Perceived quality:** evaluating the potential perception in quality of the HMI components and how this contributes to the overall customer experience



SBD's view on the hierarchy of needs for CX benchmarking



Scope of report: focus on in-car HMI evaluations

The scope of evaluations in this report are constrained to the in-car HMI experience, in both static and dynamic conditions. One notable element is driver distraction which SBD covers at only a high level in this study as carrying out a full driver distraction evaluation requires biometrics test equipment to ensure the collected data is unbiased and objective.



A full evaluation of the end-to-end customer experience is not within scope of this report, but it is something which SBD has many years experience in from both a consumer and expert perspective. Other areas such as the companion app, online portal and in-home smart devices are not in scope as they are defined as “out of car” experiences.

Within the vehicle, any HMI element the user interacts with is evaluated including steering wheel controls, touch screen displays, voice control, HUDs and digital keys. The features and services on offer have been broadly grouped into the following domains (or test areas):

- ADAS domain
- Infotainment domain
- Navigation domain
- Voice recognition domain
- Convenience domain





2024 vehicle list

SBD has chosen nine cars to evaluate in 2024, based on two selection categories. New/interesting UX focuses on systems with to never-seen-before features or functionality, or the implementation of a solution that has previously been a challenge or pain-point for end-users. New mass-market UX includes vehicles in segments that are sold in high numbers and are entering a new generation of UI for that vehicle. While we make best efforts to adhere to the chosen cars and schedule, the last two years have seen release dates slipping significantly, so it may be necessary to make substitutions.

Group A

Cars tested



BMW X1

- First BMW to be released with iDrive9
- Android based system
- US market test



Mercedes-Benz E-Class

- All-new MBUX Superscreen
- Unique features, apps and games
- German market test

Priority target vehicles for 2024



Hyundai Kona/Kona Electric

- 12.3-inch cluster and central display
- New Bluelink+ services
- US market test



Volvo EX90

- Volvo Pilot Assist
- 14.5-inch central display
- EU or US market test



Ford F-150 Lightning

- BlueCruise hands free
- EV truck
- US market test

Group B

Other vehicles being considered for 2024



Xiaomi SU7

- Xiaomi's first vehicle offering
- New vehicle from CE company
- Xiaomi Pilot MAX
- Chinese market test



Audi Q6 e-tron

- All-new "Digital Stage" infotainment system
- AR HUD integration
- EU market test



Acura ZDX

- Google built-in
- AcuraWatch 360+ with hands free cruise
- US market test



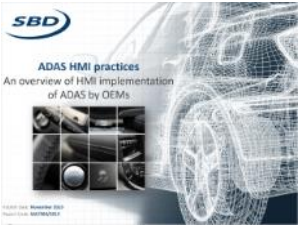
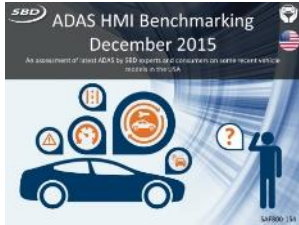
Avatr 12

- Harmony 4.0 OS
- Huawei ADS 2.0 (ADAS)
- Innovative displays
- Chinese market test



SBD experience through years of testing in-car solutions

Over the last ten years SBD has evaluated over 100 solutions from a Connected Car or ADAS perspective for our public report series (many more for private client evaluations). This current report series is an evolution of both test methodologies to provide a holistic view of in-car HMI. Furthermore, custom evaluations methodologies used across the globe for SBD clients have been included where applicable to enhance to overall approach.





One page methodology overview

One of SBD's core goals of this report is to be as objective, fair and as transparent as possible. To achieve this, various methodologies are used throughout the testing to evaluate different areas of the solution in various conditions.

These methodologies are a mix of different types of tests:

- **Objective tests:** where the value provided is not influenced by a tester's viewpoint e.g. response time
- **Subjective tests:** the test score is based on the expert testers' viewpoints e.g. task ease of use
- **Task-based:** evaluations carried out based on a predefined task list e.g. navigate to a pizza restaurant near location X
- **Freeform:** random free testing by the tester with no clear pre-defined task list. This allows the testers flexibility to dig deeper into various parts of a solution when needed
- **Scoring range:** ranges and definitions of how to score a test element e.g. poor depth and accuracy score = the results provided are not in line with what is reasonably expected by the user
- **Static:** tests are carried out when the vehicle is not moving
- **Dynamic:** tests are carried out when the vehicle is moving in various road conditions and locations e.g. motorways/highways, cities, villages, country roads etc.
- **Misuse/failures:** carried out to evaluate the stability of the solution in unusual conditions e.g. repeatedly pressing the voice command button

This document does not provide a detailed description of the methodology and this page serves to provide an overview of the approach.

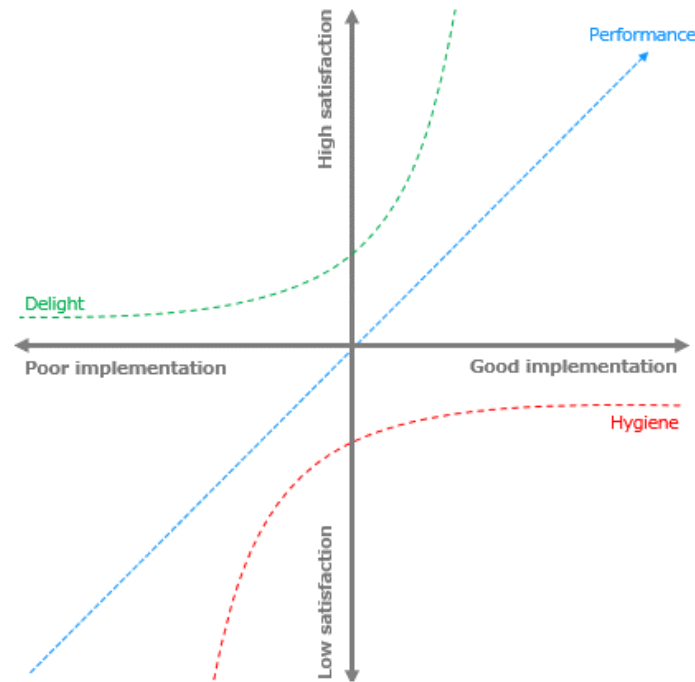
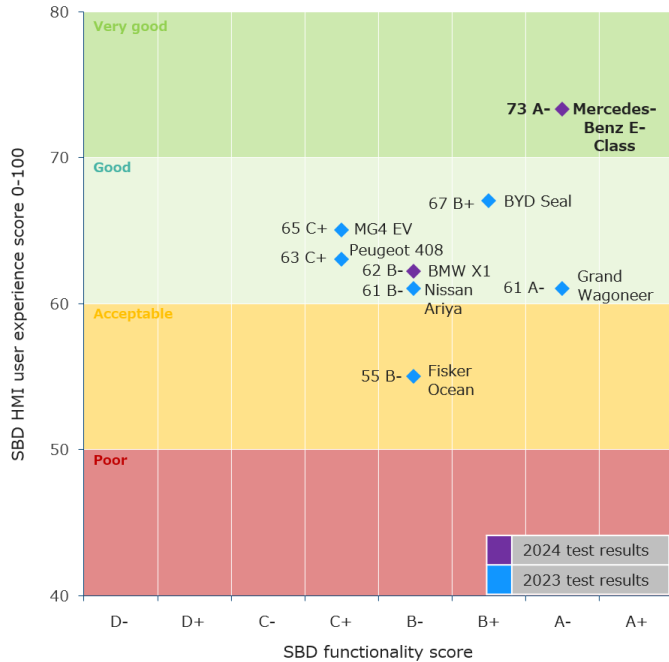
For a detailed discussion and presentation of SBD's methodology please [contact us](#).

Test area	Type of tests							
	Objective	Subjective	Task based	Freeform	Scoring range	Static	Dynamic	Misuse/failures
First impressions		✓		✓		✓	✓	
Static tasks	✓	✓	✓		✓	✓		
Dynamic tasks	✓	✓	✓		✓		✓	
Random free	✓	✓		✓		✓	✓	✓
Navigation specific tests	✓	✓	✓		✓		✓	✓
Voice recognition	✓	✓	✓	✓	✓	✓	✓	✓
Performance & response	✓		✓			✓	✓	✓
System Usability Scale (SUS)		✓			✓			
Final SBD UX score	✓	✓			✓			
ADAS	✓	✓	✓		✓	✓	✓	
UX heuristics	✓		✓			✓	✓	
Execution		✓			✓			
Ergonomics	✓	✓	✓			✓	✓	
Legibility & readability	✓		✓			✓	✓	
Perceived Quality (PQ)	✓	✓	✓	✓	✓	✓	✓	

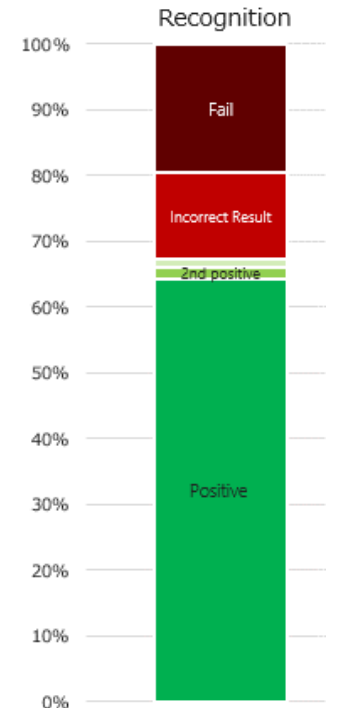


Report structure and how to interpret certain data sets

Throughout the testing and evaluation process SBD uses multiple methodologies to align to the situation and test area. Outputs from these evaluations can be broadly grouped into the following three types of report outputs - SBD's goal with these options is to ensure understanding of the results are as clear and fair as possible.



UX heuristic	Score
Cockpit clutter	Good
GUI clutter	OK
Display quality/size	Good
Map aesthetics	Very good
Map layout	OK
Navigation routing	OK
Instrument cluster	Good
General system HMI	OK



UX & functionality score

Final usability scored based on a 100-point scale with solutions scoring less than 40 defined as "not fit for purpose" with major user complaints expected and score above 80 defined as "exceptional".

Functionality score based on eight core feature set areas: delight features, performance features, hygiene features, navigation feature, ADAS, IoT integration, music, entertainment and info features.

Modified Kano feature analysis

Features plotted against three lines based on their implementation and satisfaction levels:

- **Delight** features: "wow" features likely to provide high satisfaction even with poor implementation
- **Performance** features: as the level of implementation increases so does the customer satisfaction
- **Hygiene** features: poor implementation provides low satisfaction, but good implementation may not provide positive satisfaction as it can be considered as expected functionality

Subjective & objective scores

Scoring across multiple areas through subjective scoring with pre-defined ranges, definitions, and comparison to past results.

Objective scoring generally based on a pass/fail criteria or time-based considerations. SBD attempts to minimize subjectivity as much as possible with results aimed at being fair and reasonable with a minimal level of bias.



Example slides from the report

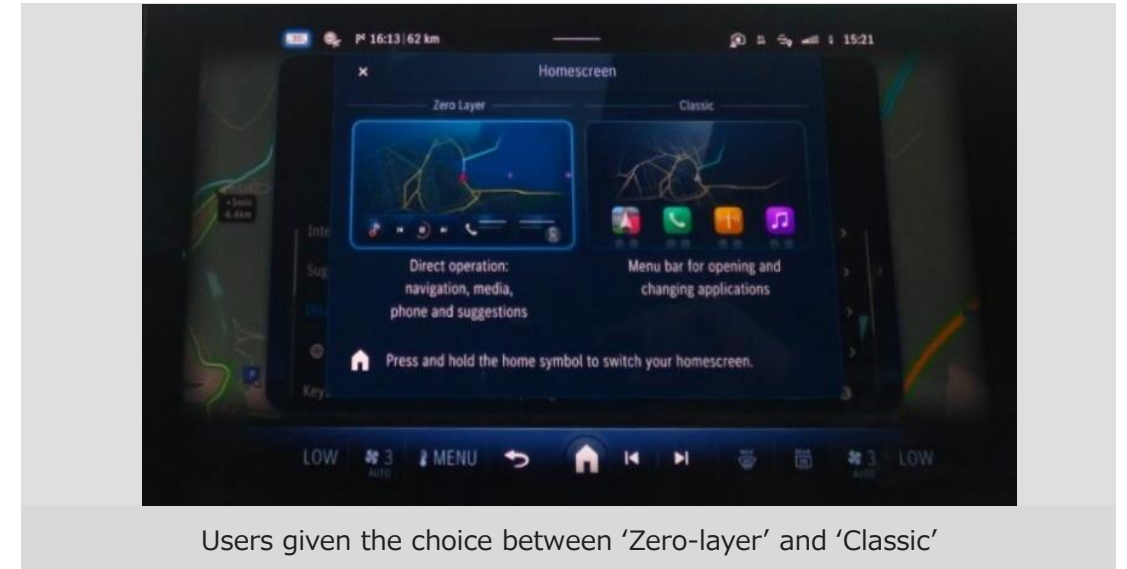
An example slide from a report. The top half of the slide features a photograph of a car's interior, showing the steering wheel with the Mercedes-Benz logo, the dashboard, and the center console. Below the photograph is a dark blue banner containing the SBD logo on the left and the text 'In-Car HMI UX Evaluation & Benchmarking Mercedes-Benz E-Class' on the right. At the bottom of the slide is a large, rounded rectangular button with a blue gradient, containing the text 'Request price' and a white right-pointing chevron symbol.



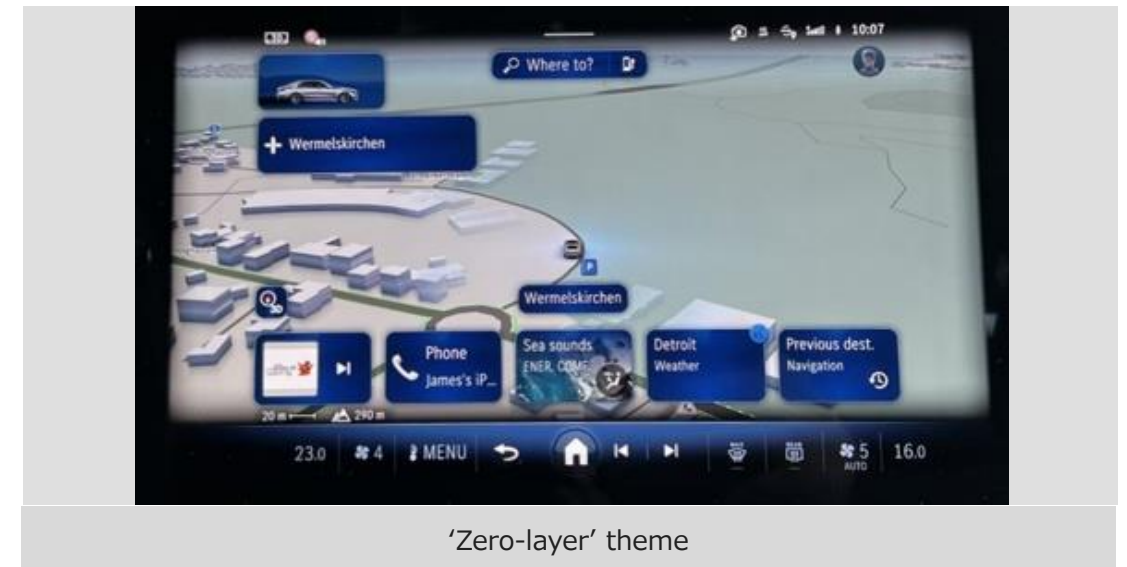
User given the choice to adopt 'Zero-layer' theme

Giving users the choice and flexibility right from the start

- The 'Zero-layer' theme intends to minimize menu depth and levels throughout the system by allowing users to interact with frequently used features and apps from the top menu level. The 'Zero-layer' suggests varying features and shortcuts based on past user behavior and habits.
- When setting up a profile for the first time, the user is presented with the choice to select the 'Zero-layer' theme or select the 'Classic' theme. Progression beyond this point cannot be made without choosing one of the options. Each option is clearly depicted with call outs showing the properties of each.
- This level of personalization and choice early on in the user journey allows the selection of a theme that best meets the needs and preferences of the user. Alternatively, if the system had simply defaulted to the 'Classic' theme and left the user to discover an alternate theme on their own, the uptake of 'Zero-layer' is likely to be much lower.



Users given the choice between 'Zero-layer' and 'Classic'

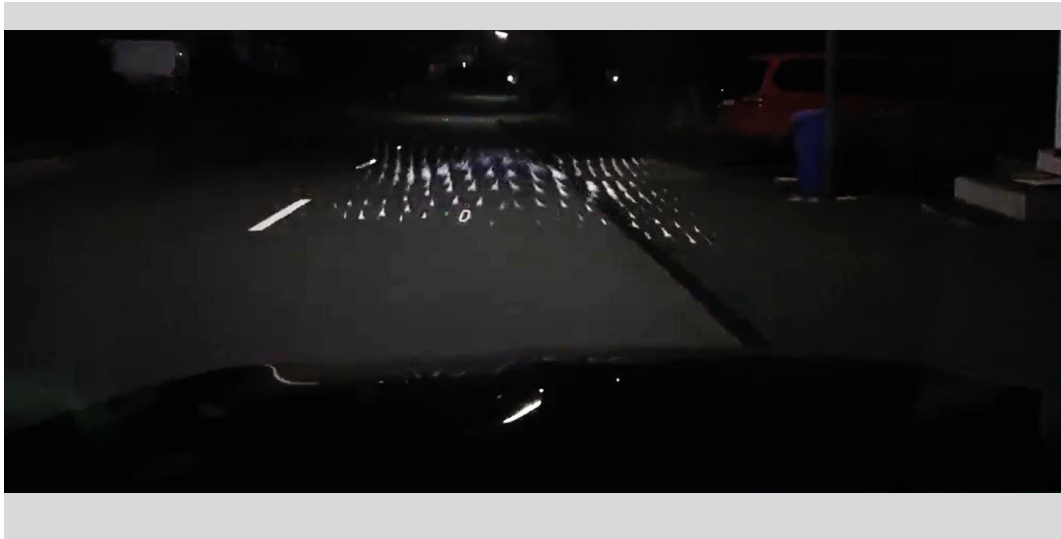


'Zero-layer' theme



Significant wow factor throughout, issues with performance features

- An abundance of delight features are integrated into this vehicle. These features are likely to create a wow-factor for users and create a lasting positive impression of the brand.
- Some of the features include a passenger display, ambient lighting that can react to music, digital headlights with animations, Superscreen integration, games, selfie camera and 4D sound.



Abundance of delight features

When turning on or off the car, a series of animations are played through the headlights on the road ahead. These can include a wave of three-pointed stars and the text Mercedes-Benz. The 4D sound feature utilizes small actuators in the front seats to accentuate the bass from media to create a more immersive experience. Users can take photos and videos and save to external memory cars using the built-in camera on top of the dashboard. Ambient lighting has a diverse range of colors and themes to choose from. It can be set to react to music if desired.

- Verbal lane guidance given during active route guidance is often too late or too early, resulting in the driver making mistakes and entering the wrong lane.
- Steering wheel controls are cumbersome to operate accurately and intimidating for new users.
- POI data can sometimes be out of date while certain POI sub-categories can be difficult to navigate to.





Cumbersome steering wheel controls

The capacitive touch nature of the steering wheel controls mean the risk of misoperation is high. The button can be unintentionally triggered by the driver palm or thumb when turning the steering wheel.

In addition, the set of button dedicated to operating the central display are difficult to use and often lead to frustration. Trying to use these buttons while driving is distracting and adds to the cognitive load of the driver.

Warning is good, but could be improved using existing elements

Category	System usage	
System	RCTA	
SBD viewpoint	<p>Once the system has been turned ON via the central display, activation is automatic when reverse gear is chosen by the driver.</p> <p>Cross traffic warnings are provided for both the rear of the vehicle and the front of the vehicle. If the system senses that a collision with a detected obstacle passing by is imminent, harsh automatic braking is applied to mitigate contact. The visual warning shown in the central display is overlaid over the rear camera view and is directional in nature. The RCTA warning icon is shown on the left or right of the image depending on the direction of the approaching object. The audio warning provided is clear and distinctive from other audio warnings used throughout ADAS.</p> <p>Some level of differentiation is provided between vehicles and pedestrians, with different warning messages provided for each.</p>	
UX impact	Minor Positive	
SBD viewpoint	<p>The side mirrors are not utilized to show visual warnings for RCTA. Considering this is a potential location that users may be looking when reversing, utilizing the BSM icon in the mirror may provide an additional level of warning to grab the users attention.</p>	
UX impact	Minor Negative	

Visual and audio warning, along with automatic braking

BSM warning in mirror not utilized for RCTA

Highly customizable instrument cluster

SBD viewpoint

The instrument cluster offer various layouts and themes to meet the users' preferences.

- Five main layouts can be chosen in the cluster using the steering wheel buttons. These are Sport, Standard, Navigation, Assistance and Vehicle Information. Each layout prioritizes different types of information and uses different color schemes.
- Within the Standard cluster display, various information can be toggled through in the center of the cluster. These include, trip computer, media, navigation, eco display, consumption and attention assist.

Having various layouts and information available to be displayed within each allows the user to tailor the system to meet their needs and preferences while prioritizing information that is important to them.



Multiple cluster layouts

UX impact	Major negative	Minor negative	Minor positive	Major positive
-----------	----------------	----------------	----------------	----------------

Steering wheel button implementation presents high risk of misoperation

SBD
viewpoint

The shape, layout and use of capacitive touch makes the steering wheel buttons difficult to use.

- The steering wheel button design uses four panels with multiple capacitive touch buttons across each panel relating to different systems. The upper two panels on each side of the steering wheel have the same icons but in reverse layout. This is visually confusing and take some time to understand the differing functionality.
- The capacitive touch nature of the buttons paired with the need to press some of the buttons make for a confusing experience. Some controls require a swipe such as SET+/SET- and some require a tap.
- Misoperation of these buttons is frequent when holding the steering wheel. The driver thumb can often graze the outer most buttons and trigger a response in the cluster or central display.
- The shape of the buttons presents issues with heavy reflection of the curved surface from the glass roof and windshield. Fingerprint build-up is also noticeable but does not present as much of an issue as on the central display.

The buttons layout and capacitive touch technology make for control panel that is initially intimidating for a new user. Frequent misoperation is not only frustrating but also presents a safety risk considering the nature of some of the controls positioned on the out most edge.



Misoperation via thumb or palm

UX impact

Major negative

Minor negative

Minor positive

Major positive



Good integration of sharing route and location

The user can opt to share route and destination information to mobile devices via SMS.

- User can share their journey by pressing the share option in the central display. Options include sharing a current location, destination, route or estimated time of arrival.
- When sharing live tracking via SMS, the recipient will receive a link to a website from which they can track live journey progress.
- When sharing a journey, a number of options are provided on how long the information is shared before. For example, the user can choose from share once, share until arrival at destination, share for 15 minutes or share for one hour.

Giving the user the option to share location and journey information allows them to keep contacts outside of the vehicle updated on progress and arrival times. Not only is this a convenience and safety enhancement but it also prevents users from using their phone to share the same information, potentially while driving.

SBD
viewpoint



Journey sharing options

UX impact

Major negative

Minor negative

Minor positive

Major positive



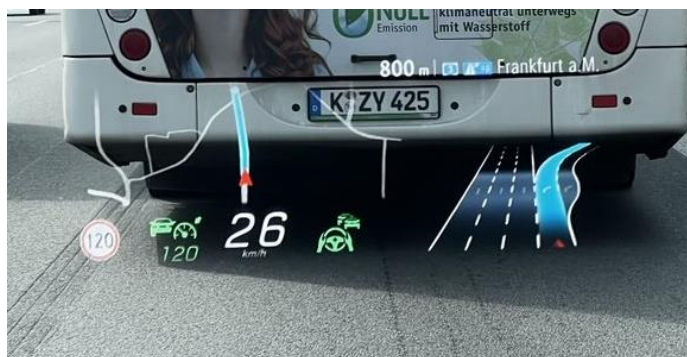
Head-up Display (HUD) summary (1/2)

The HUD in the 2024 Mercedes-Benz E-Class uses a projection method to display information on the windshield. The user can choose to customize the layout and content based on their own preferences. Layout options include Minimal, Sport and Standard View. Settings including height, brightness and layout can be adjusted.

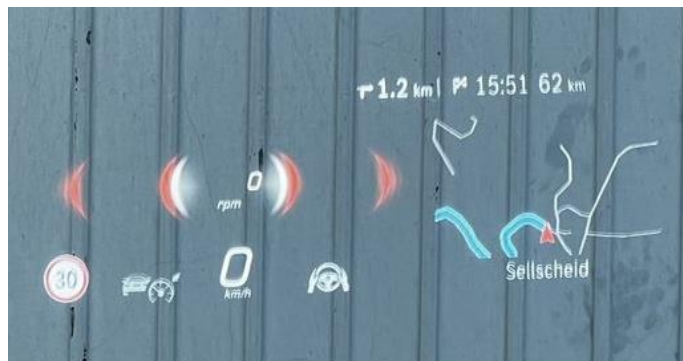
Consistency between the HUD and the cluster is mostly good with only a few slight differences. The HUD does not display a constant LKA status icon like the cluster. Color conventions are followed correctly and can be understood easily.

While the user has the option to display information and status from various systems in the HUD, the layout can become overwhelming and cluttered, especially when route guidance is active. Information such as the road name, ETA and distance to next direction all feel squashed in the top right hand-corner of the HUD.

Overall, the HUD is consistent in its display and provides a good level of information for ADAS and navigation without the need for the driver to take their eyes away from the road. However, at times this rich level of information can become distracting and overwhelming, especially at night.



Active route guidance in HUD




Sport display

Content Options	
Domain	Content
Navigation	Turn by turn
	Lane guidance
	Map view
	Street name
	Distance to current command
	ETA
	Distance remaining
ADAS	ADAS icons
	Speed limit
	Current speed
	Set speed
	FAPA information



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the full report



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The thumbnail features a photograph of a Mercedes-Benz E-Class car interior, showing the steering wheel with the Mercedes-Benz logo, the instrument cluster, and the central infotainment screen. Below the image is a blue banner with the SBD logo and the text 'In-Car HMI UX Evaluation & Benchmarking Mercedes-Benz E-Class'. At the bottom of the thumbnail is a blue button with the text 'Request price' and a white right-pointing chevron symbol.



Contact SBD Automotive

Do you have any questions?

If you have any questions or feedback about this research report or SBD Automotive's consulting services, you can email us at info@sbdautomotive.com or discuss with your local account manager below.



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