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In-car HMI UX Evaluations

#635

# In-Car HMI UX Evaluation & Benchmarking

## Lincoln Nautilus

In this edition of the In-Car HMI UX Evaluation and Benchmarking series, the UX team is testing the Lincoln Nautilus.

### COVERAGE



GLOBAL



NA



CHINA



EUROPE

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ANNUALLY



QUARTERLY



CARS PER YEAR

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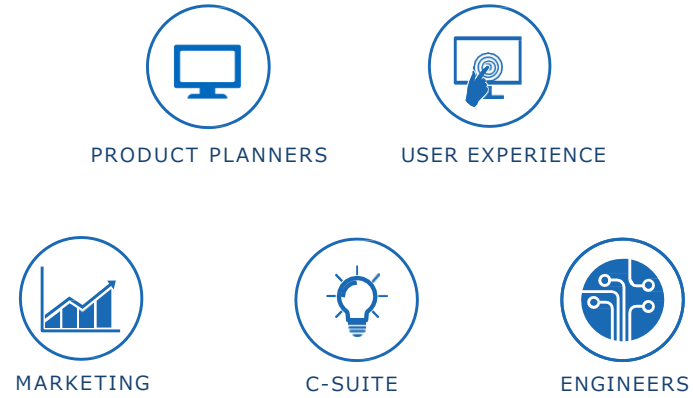
Request price



# Scoring

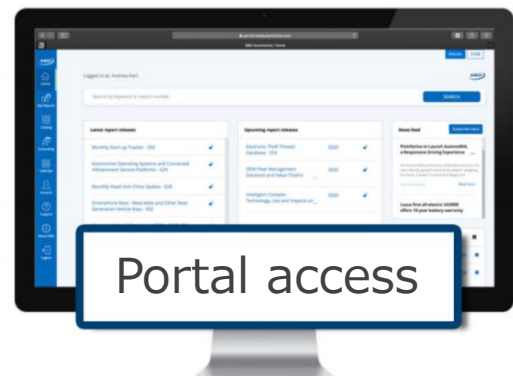
- > **Features and functionality:** evaluating whether the solutions provide features that customers expect, need and solve problems (or provide a wow factor).
- > **Reliability/stability:** evaluating the repeated usability and whether the users can have a similar (positive) experience each time.
- > **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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In-Car HMI UX Evaluation & Benchmarking Lincoln Nautilus

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## In-Car HMI UX Evaluation & Benchmarking Lincoln Nautilus

## 635 - In-Car HMI UX Evaluation & Benchmarking – Lincoln Nautilus

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## Introduction

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# 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 while 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**

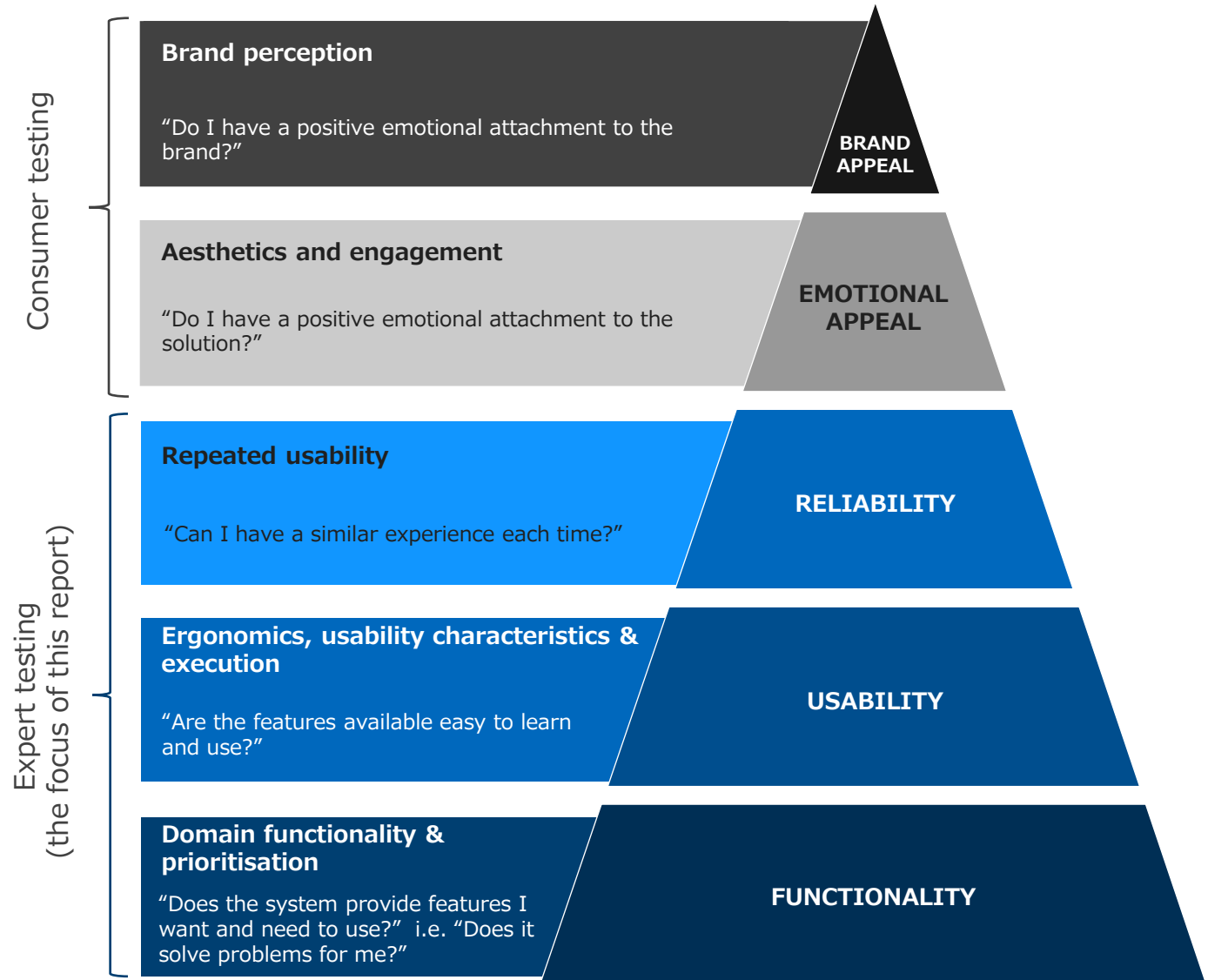
Section	Content
<b>Birds Eye View</b>	An overview of the key findings from SBD's various CX related and adjacent reports.
<b>Executive Summary</b>	Presents key highlights and conclusions from the report.
<b>The Basics</b>	What do you need to know about SBD's CX evaluation methodology?
<b>Analysis</b>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



**Lincoln Nautilus**

- BlueCruise hands free
- Digital Experience
- All-new infotainment system
- US 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

## Group B

### Cars tested



**Xiaomi SU7**

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

### Other vehicles being considered for 2024



**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



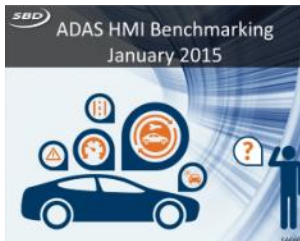
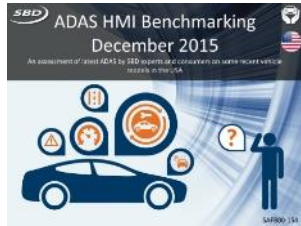
**Avatr 12**

- 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.

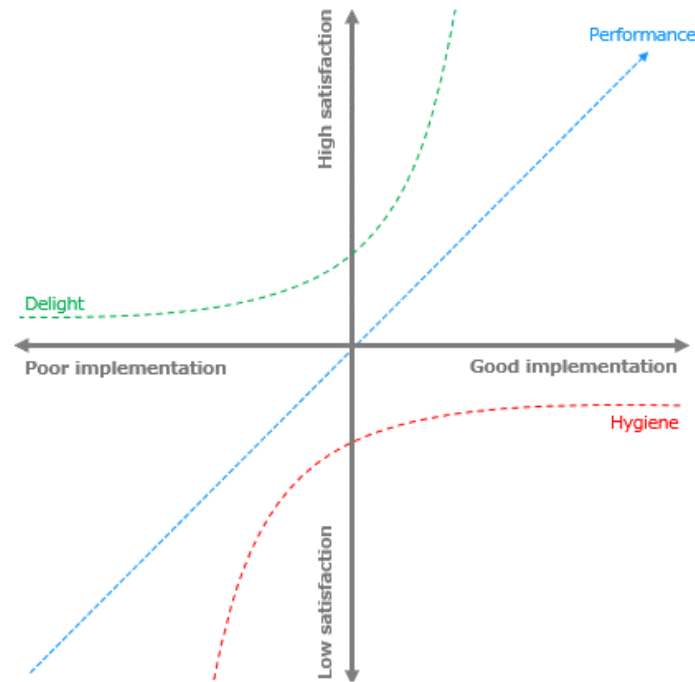
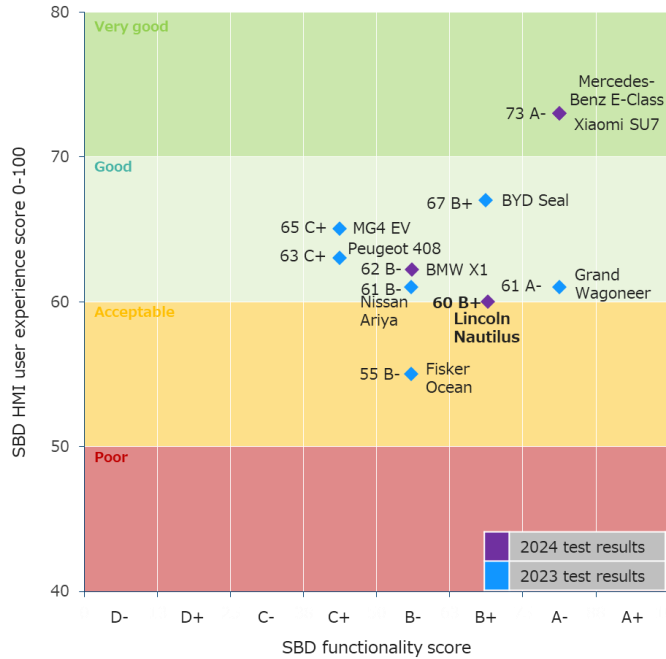
For a detailed discussion and presentation of SBD's methodology please [contact us](#).

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)	✓	✓	✓	✓	✓	✓	✓	

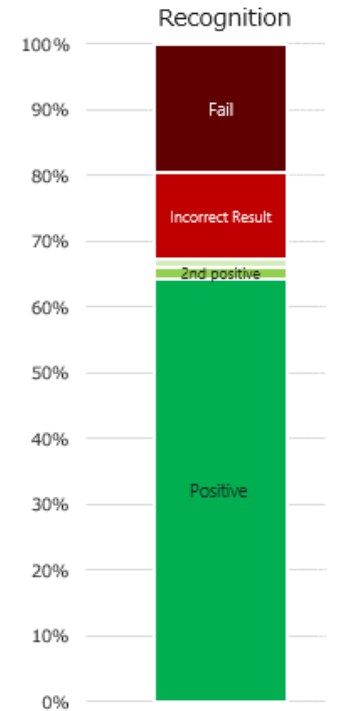


# Report structure and how to interpret certain data sets

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

This is an example slide from the report, enclosed in a white border. The top portion of the slide features a photograph of a car's interior, specifically the dashboard and steering wheel area, with a digital display showing navigation and vehicle information. Below the image, on the left, is the SBD logo. To the right of the logo, the text reads "In-Car HMI UX Evaluation &amp; Benchmarking" followed by "Lincoln Nautilus" on the next line. At the bottom of the slide is a blue button with the text "Request price" in white, followed by a white right-pointing chevron symbol (&gt;).



## Overall, a holistic system

# Good consistency across displays and throughout the cabin

- Typically when comparing consistency between displays in a cockpit, like the instrument cluster to the central display or the head-up display (HUD) to the instrument cluster, there are some obvious differences between displays noted for the same feature. Making it obvious that the displays were designed by two different design teams. However, this is not the case for the Lincoln Nautilus when comparing consistency between the panoramic display and the central display.
- Most of the features for the Nautilus are mostly consistent in look and feel between the panoramic display and the central display, giving the impression that both displays were designed by the same team, or the two teams did really well communicating with each other during the design process. For example, radio and media, and navigation are all very similar between the displays to provide one cohesive system. Things like Android Auto and Apple CarPlay integration are also well thought out and integrated to support this.
- Along with the displays, there's consistency throughout the rest of the cockpit with things like material and build quality. Making sure the core features are well thought out and integrated consistently across displays goes a long way with consumers and helps to provide an overall positive user experience. This also helps to elevate impressions of overall perceived quality of the vehicle.



Good consistency between displays overall



Apple CarPlay integration well thought out for both displays



# Few delight features, serious performance feature issues

- Panoramic display offers visually impressive delight feature as well as bringing information up closer to the driver's line of sight.
- Configurable fragrance box allows drivers the ability to personalize the fragrance within the cabin.
- User can download and use conferencing apps within the vehicle including Webex.



## Panoramic display dominates cabin

The panoramic display stretches from pillar-to-pillar and offers an impressive visual element to the cabin. While the left-hand side houses the cluster and cannot be customized, the right-hand side does allow for a limited amount of customization. In addition to being something that many users are likely to get a wow-factor from, it also brings information up closer to the driver line of sight while driving, minimizing the glance down angle to obtain important information.

- Changing functionality of steering wheel controls impact multiple systems including ADAS.
- Route guidance issues include the system guiding down closed roads and indicating illegal turn maneuvers.
- The voice recognition system fails to take into account other input methods such as touch input.



## Unlabeled steering wheel buttons

The lack of labelling and changing functionality of steering wheel buttons is one of the key negative issues regarding the entire HMI. This causes confusion and high risk of misoperation while driving. Not only is this frustrating but it is also likely to negatively impact confidence levels of new users. Providing intuitive icons and labelling would allow users to glance at the buttons and understand their functionality immediately rather than having to touch them first in order to bring up a legend in the cluster screen.





# Perceived Quality: Visual

Level 1

## Visual

**Harmony/alignment:** The main negative aspect that disrupts the visual harmony is the obvious line down the middle of the panoramic display.

**Geometric:** Slight concern surrounding the circular volume dial on the lower center console. The shape and location suggests it may be a gear selector, when in fact it controls volume. In addition, the gear selection buttons are not in shape and position that would suggest their functionality. Also, the buttons on each side of the volume dial give the impression that their toggle switches, when in fact, they're just push buttons.

**Spatial harmony:** Some elements of the on-screen HMI including the media screen and HVAC bar can appear cluttered and squished. Some of this clutter is cause for small touch targets, making it difficult to select/adjust, especially while driving.

**Branding:** Branding is very minimal throughout the cabin and the HMI, but the visual appearance of the HMI seems to match the brand identity and ethos of Lincoln and the car.

**Output HMI:** Unique integration and usage of ambient lighting on the inside of the doors in which it changes color based on whether the door is open or closed.

**Interior lighting:** Very nice settings offering for ambient lighting, many different color choices offered, and many different intensity/brightness levels offered. Good illumination of buttons and dial in the dark.



SBD viewpoint



### Level 2 scoring

Harmony/alignment	Geometric	Spatial harmony	Branding	Output HMI	Interior lighting
Fair	Fair	Fair	Good	Good	Good

# Good directional warning, but could utilize mirrors too

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>Infotainment and other volume is reduced when an RCTA warning is given in order to prioritize critical information for the driver. While the volume is not completely muted, this is a good addition to information prioritization. The visual warning provided in the panoramic display is directional providing extra context for the driver. A clear and concise warning message is also shown. When the system detects a collision is imminent, automatic braking is applied without the need for driver intervention. This proactive feature helps to avoid collision that the driver may not be quick enough to mitigate themselves.</p>	
UX impact	Minor Positive	
SBD viewpoint	<p>When detecting obstacles behind the vehicle, no obvious distinction between vehicles and pedestrians is given. While this isn't essential, it does help to provide extra context for the driver in a warning situation. The color used on the directional graphic warning is red, while the color used on the warning icon is orange. The mismatch could be confusing and suggest that two different system are active and providing a warning.</p> <p>RCTA does not utilize any visual warning in the side mirrors. This is a potential missed opportunity to enhance the level of visual warning in an area that the user is likely to be looking while reversing.</p>	
UX impact	Minor Negative	

RCTA event warning in panoramic display

No use of warning in mirror



# Good integration of Apple CarPlay/Android Auto with panoramic display

SBD viewpoint

Wireless Apple CarPlay and Android Auto are offered for the infotainment system.

- A new shortcut button appears on the left-side controls which allow users to quickly swap between the native and phone systems.
- When navigation is set, the map on the panoramic display will swap from Google Maps to Apple Maps and show the navigation when CarPlay is connected. When Android Automotive is used, the panoramic display will keep the Google Maps.
- When playing media while using Apple CarPlay or Android Auto, the media screen on the panoramic display will indicate it is playing audio from Apple CarPlay or Android Auto, as opposed to Bluetooth.

Having common third-party solutions well integrated into the system is a plus for consumers. Allowing the user to choose which system they want to use (native/Apple CarPlay/Android Auto) provides flexibility.



Apple Maps appears in place of Google Maps on the panoramic display

UX impact	Major negative	Minor negative	Minor positive	Major positive
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# Many inaccuracies experienced with navigation

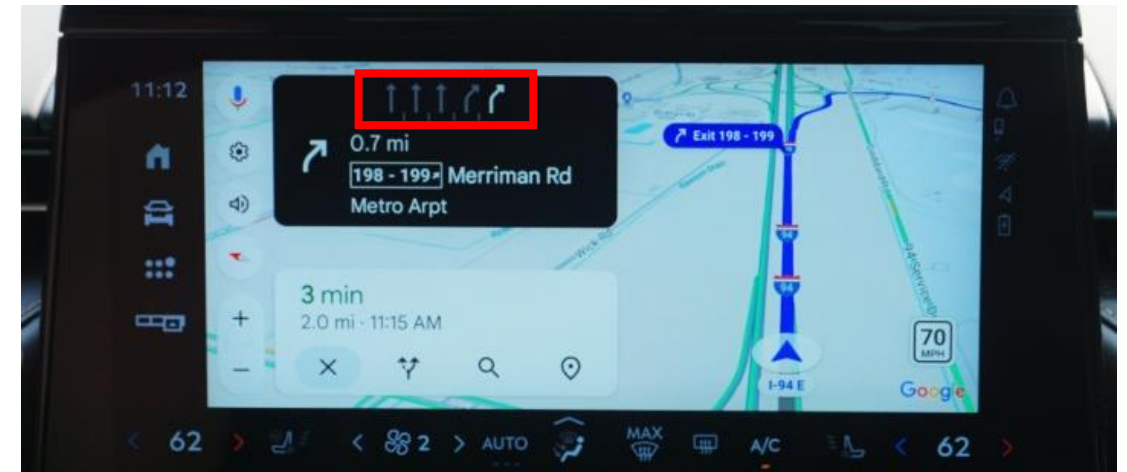
During testing, there were inaccuracies observed in the navigation system. These included the following points.

- While navigating through downtown Detroit, twice the system provided route guidance that included illegal turns. One was marked by a no left turn sign at an intersection and the second was an illegal U-turn where one was not possible to be made.
- Occasional instances were recorded where the lane guidance did not reflect ground truth (i.e. 5 lanes shown when the road was only 4 wide).
- One instance was recorded where navigation set the destination far away from the actual desired building (Henry Ford Museum).

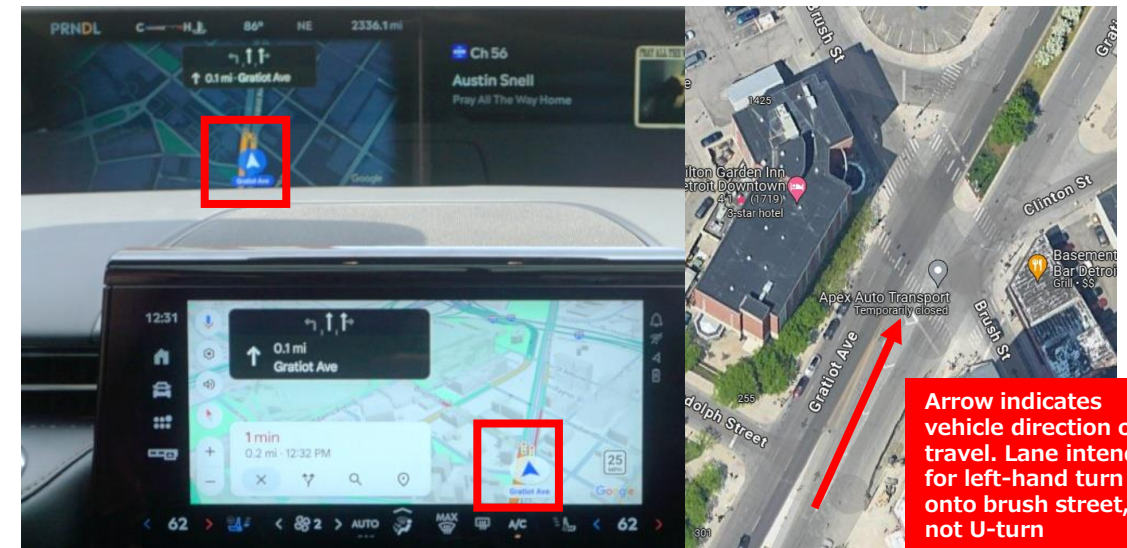
These inaccuracies, especially illegal turns, is a cause of concern. Most competent drivers would be able to deal with these issues, but users would expect more out of a premium vehicle system.

SBD viewpoint

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



Road is 4 lanes wide including turn lanes, not 5 according to lane guidance



Arrow indicates vehicle direction of travel. Lane intended for left-hand turn onto brush street, not U-turn

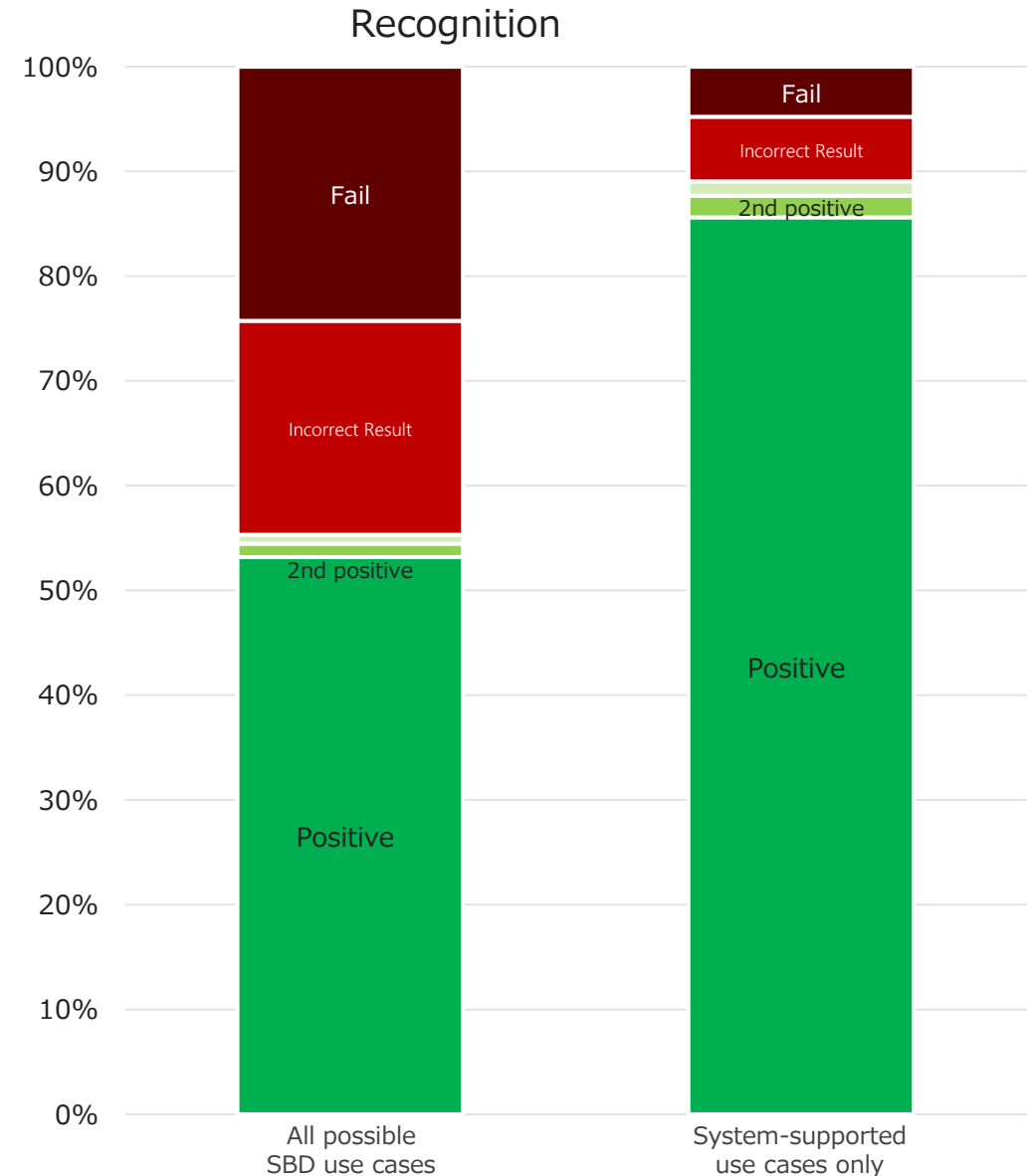
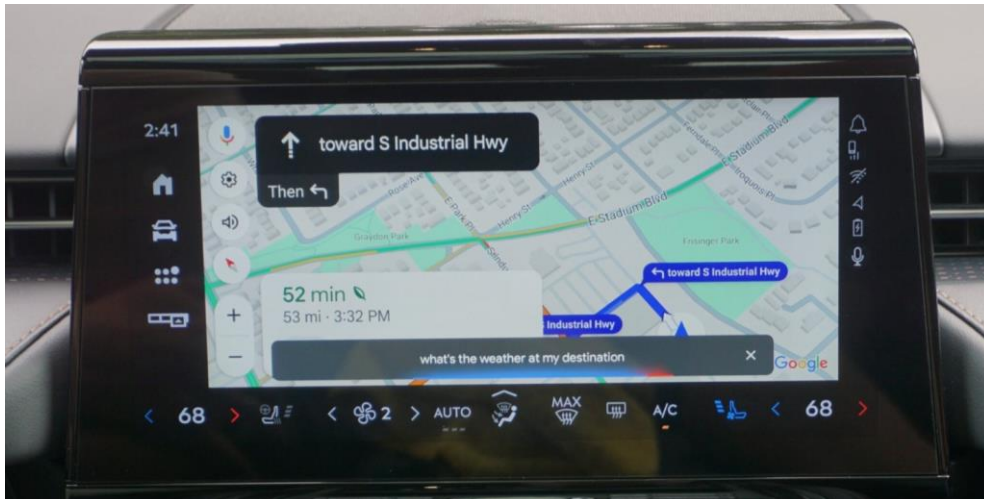
Navigation suggests a U-turn where it is not possible



# SBD recognition score: C

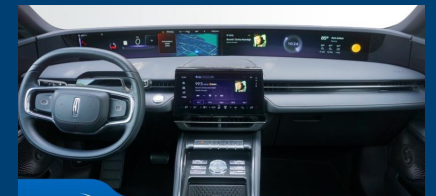
Recognition results are based on the rate of utterance recognition of the solution. Currently the solution is scored as "C" overall for performance.

- At 55% overall positive recognition score, the system is rated as "C+" for recognition. With unsupported use cases removed from the recognition stack, the rate of accuracy increases to 89%, showing a significant improvement to the recognition rate.
- When looking at all possible SBD use cases, most recognition failures occur within inferred meaning, phone and vehicle control use cases.
- HVAC and Navigation use cases demonstrate a particularly strong rate of positive recognition with the majority of use cases passing successfully.
- A small number of second positives are noted within media use cases and calendar use cases within integration tasks. Within media, this is due to the system giving a choice of sources to play from when asking for a specific artist. Once the user has replied with a preferred source, the system will play the requested artist.





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In-Car HMI UX Evaluation & Benchmarking  
Lincoln Nautilus

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# 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](mailto:info@sbdautomotive.com) or discuss with your local account manager below.



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