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#635

In-Car HMI UX Evaluation & Benchmarking

In-car HMI UX Evaluations

Lexus NX

In this edition, the UX team is testing the Lexis NX.

One of the most positive takeaways is the general improvement in user experience when compared to previous Lexus systems. The navigation system as a whole is pleasing to use and more intuitive than previous iterations. The removal of a clunky touch pad for the central display and a shift towards dedicated touch input only improves the user interaction and makes for a more enjoyable system to use.

COVERAGE

GLOBAL   NA   CHINA   EUROPE

FREQUENCY

ANNUALLY   QUARTERLY   6 CARS PER YEAR

PUBLICATION FORMAT

PDF   POWERPOINT   EXCEL   ONLINE

PAGES

150

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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).

> **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.
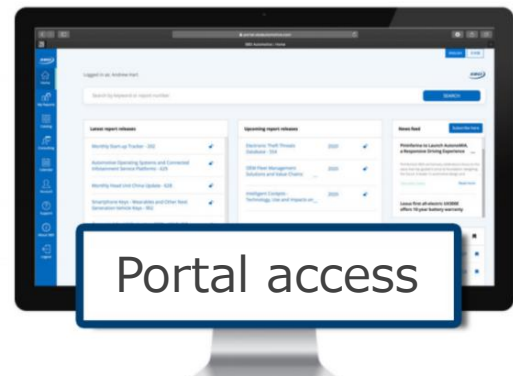
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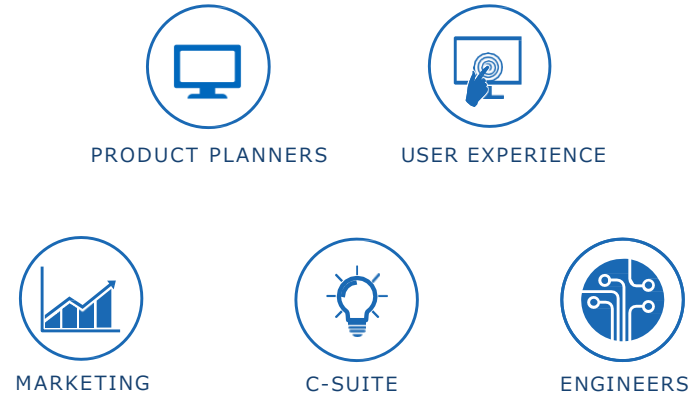
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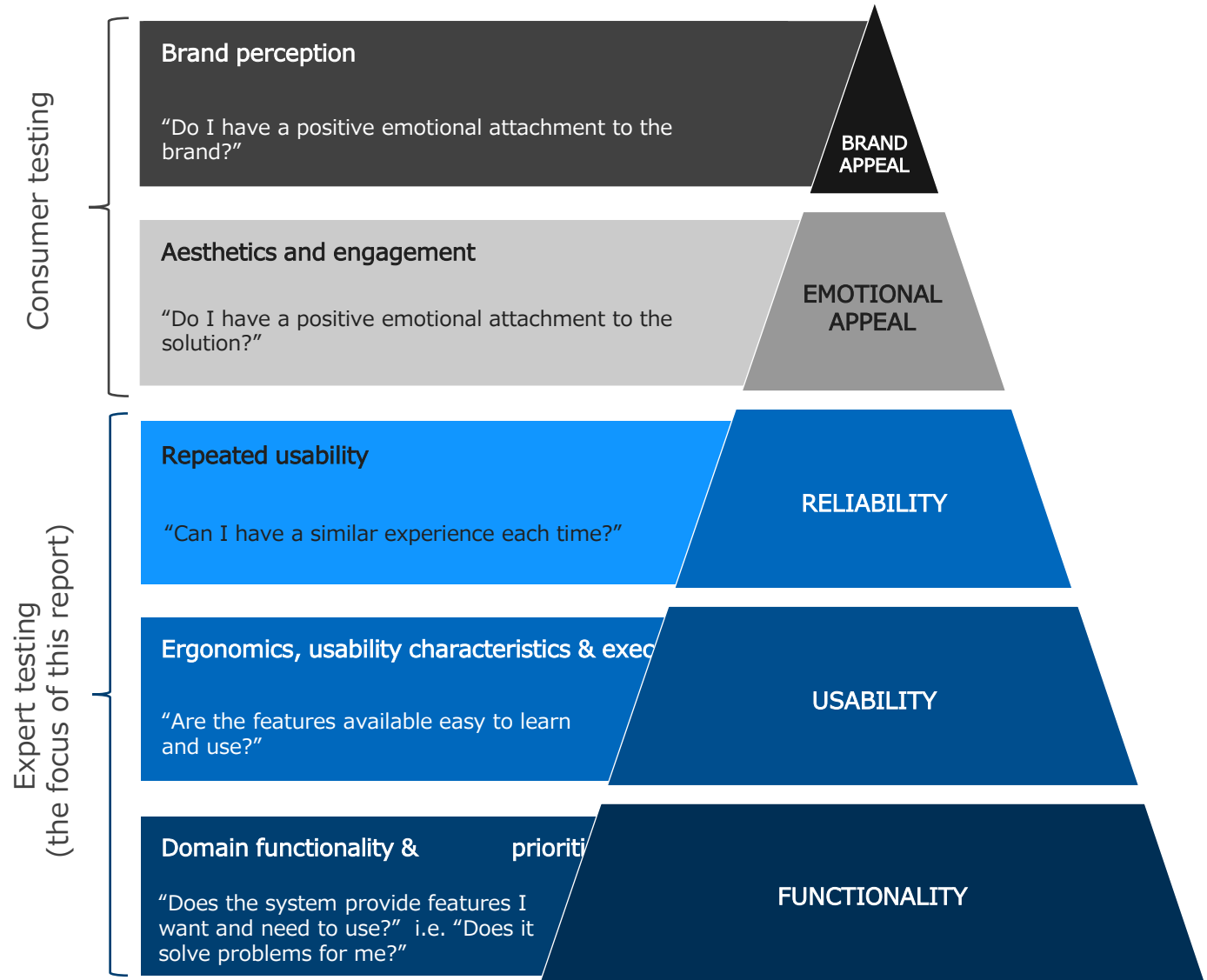Introduction

Aim of this report

Welcome to the 2022 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 European, US and Japanese 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.

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 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.

Consumer testing

Brand perception

"Do I have a positive emotional attachment to the brand?"

BRAND APPEAL

Aesthetics and engagement

"Do I have a positive emotional attachment to the solution?"

EMOTIONAL APPEAL

Expert testing (the focus of this report)

Repeated usability

"Can I have a similar experience each time?"

RELIABILITY

Ergonomics, usability characteristics & exec

"Are the features available easy to learn and use?"

USABILITY

Domain functionality &   prioriti

"Does the system provide features I want and need to use?" i.e. "Does it solve problems for me?"

FUNCTIONALITY

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.

Pre-purchase ● — Purchase ● — Activation ● — In-car HMI ● — Driver distraction ● — IoT ●

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, touchscreen 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

- Connected services domain

- Convenience domain

2022 vehicle list

SBD chose six cars to evaluate in 2022, 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. Only one substitution was necessary this year: the Toyota bZ4X had to be replaced with the Lexus NX due to unexpected delays to its scheduled release.

Cars tested

| Lucid Air	Rivian R1T	Renault Megane E-Tech	Xpeng P5	GMC Hummer EV	Lexus NX
▪ Potential disruptor ▪ Multiple displays ▪ US market test	▪ New disruptor ▪ Appears to have an innovative approach to HMI ▪ US market test	▪ LG's new Android Automotive IVI ▪ French market test	▪ High level of ADAS ▪ Advanced voice recognition ▪ Configurable avatar ▪ China market test	▪ GM's new Android OS system ▪ Unreal Engine graphics ▪ US market test	▪ New Lexus system ▪ Cloud-based navi ▪ New voice recognition ▪ UK test, German market car

SBD experience through years of testing in-car solutions

Over the last nine years SBD has evaluated 99 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.
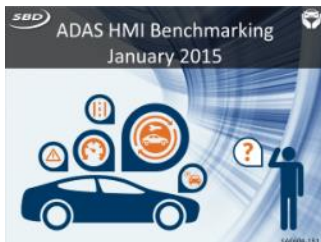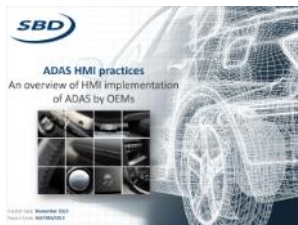
One page methodology overview

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)	✓	✓	✓	✓	✓	✓	✓	

Example slides from the full 150 page report

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Lexus NX

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Unique FAPA complete sequence and configurable HUD

- Wow features in the Lexus NX are extremely limited. No real standout features above and beyond those found in other vehicles in a similar segment.

- FAPA does provide a minor delight feature in the way it communicates the completion of a parking procedure. The unique animation is pleasing and is expected to wow most users.

- The HUD provides a clear display of critical information. Three varying levels of display detail can be selected.

- Some ADAS suffer from increased risk of misoperation due to unlabelled touch buttons located on the steering wheel.

- Routing accuracy and roundabout guidance are delivered and integrated well, giving support when needed, especially the roundabout guidance with well timed and easily understandable announcements.

Parking complete animation

When a parking procedure using FAPA is complete, a unique 3D animation plays in the central display. Using a computer generated representation of the vehicle, a camera flies out of the interior and completes a 360° walkaround of the vehicle before ending. By utilising the surround view camera, this small feature not only gives a useful perimeter check of the parked vehicle but also adds a small wow factor.

HUD

The HUD delivers a crisp and clear display, reflected onto the windscreen. The depth of information shown in the HUD depends on the settings chosen but can include, turn-by-turn navigation, incoming calls, ADAS and steering wheel button layout. ADAS icons are replicated exactly between the cluster and HUD while providing all the information necessary without becoming overwhelming and cluttered.
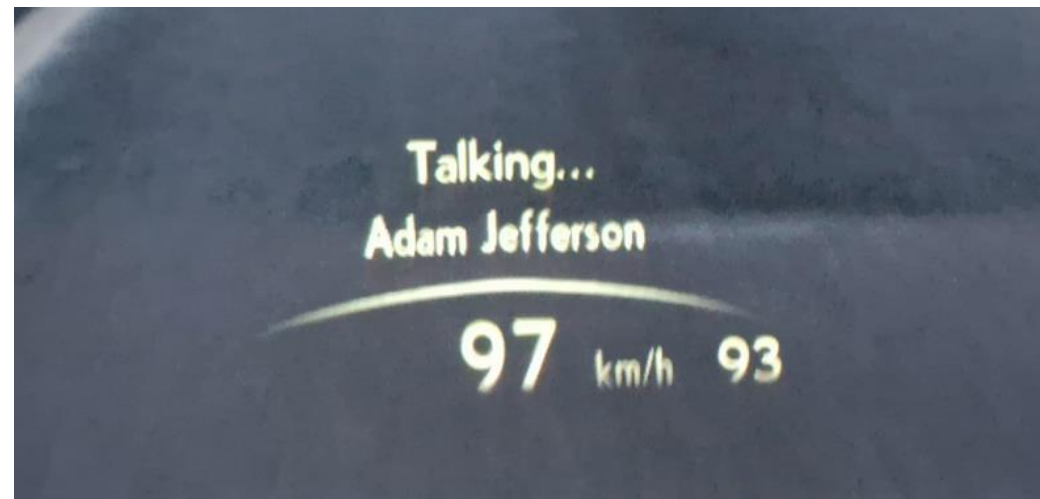
Poor Incoming call teams call UI

2. Phone

Incoming Teams call showed the phone number pad in the central display with the option to pause or reject the call but not answer it. On rejecting the call, "Talking... Adam Jefferson" remained stuck on screen. This repeating issue became frustrating.

Frequency	Low	Medium	High
Severity	Minor	Major	Critical

Inconsistent traffic display

6. Navigation

When dragging the map view around or zooming in and out, an inconsistency in when traffic colouring is displayed. At some zoom levels, traffic colouring will clearly be present on the roadway, after zooming, this can disappear.

Frequency	Low	Medium	High
Severity	Minor	Major	Critical

Key lowlights

Unintuitive steering wheel buttons

Confusing dynamic steering wheel buttons

Touch buttons result in regular misoperation

The steering wheel buttons have no clear icon labelling at a glance. The user must place a finger or thumb on the surface to reveal a diagram of the button layout in the cluster or HUD. This layout can change depending on chosen configuration.

While driving, especially on roundabouts or bends, the user's hand is susceptible to brushing over the touch pad and led to significant frustration due to the visibility of the diagram. This was a regular occurrence during testing.

Perceived Quality: Tactile

Level 1	Tactile
SBD viewpoint	**Stiffness & looseness:** No noticeable concerns with buttons, switches, stalks or panels being too stiff or too loose, all feel as expected. **Force feedback:** Mechanical feedback is pleasing and feels as expected. Some inconsistencies between the volume and temperature rotaries, the temperature one has detents, whereas the volume rotary does not, but it offers sufficient resistance to give an impression of good quality. **Material quality:** All materials are pleasing to the touch and give an impression of appropriate quality. **Material harmony:** Tactile quality is pleasing throughout the vehicle cockpit and meets expectations. **Geometric & Positioning:** The placement of the capacitive touch steering wheel controls leads to persistent misoperation, causing graphics to show on the HUD on most corners and roundabouts. This is likely to cause significant annoyance and lower the perception of a high-quality implementation.

Capacitive touch steering wheel controls lead to misoperation

Minor inconsistencies among temperature and volume rotaries

Level 2 scoring				
Stiffness & looseness	Force feedback	Material quality	Material harmony	Geometric & positioning
Good	Good	Good	Good	Fair

SAE Level 0 ADAS: System usage

System usage: LKA

Non ADAS display

ADAS display

Lane tracking status shown at all times in cluster

System usage: BSM

BSM icon illuminated in side mirror during warning

System usage: RCTA

Good visual warning in central display

System usage: LKA

LKA Warning

PD Active

LKA warning and PD active have very similar HMI
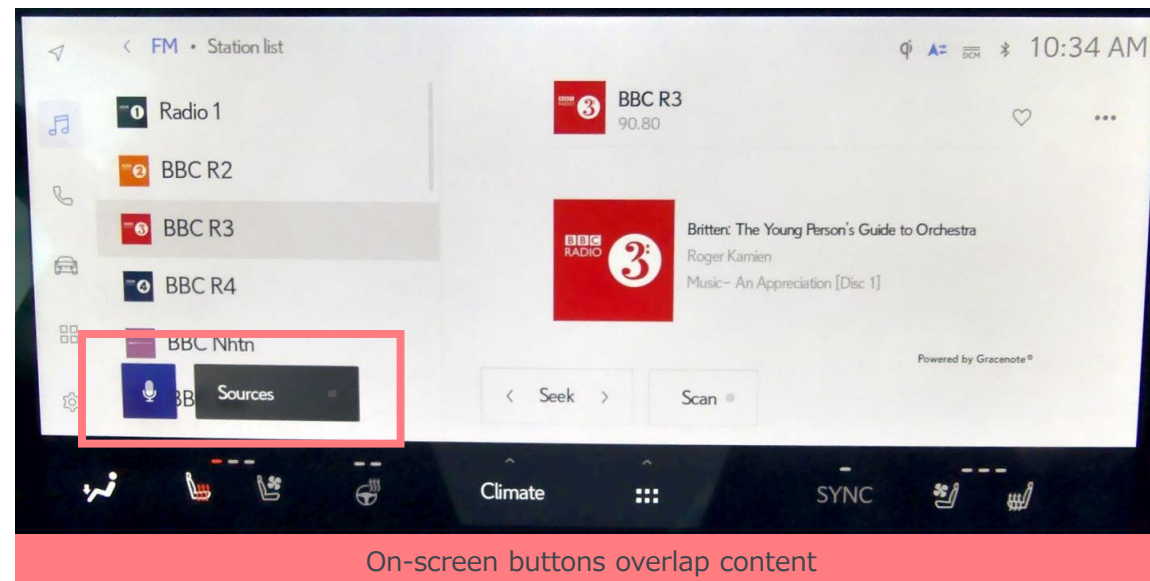
Large central display is a wow factor

Category	General system
Description	Central display in top specification model is large and capable

SBD viewpoint

The NX comes standard with a 9.8-inch touchscreen display, but the top-specification model comes with a 14-inch touchscreen display.

- For mid-specification models, the 14-inch touchscreen display is offered as a cost option.
- The 14-inch touchscreen provides a wow factor in this vehicle, particularly in navigation view.
- Also, this central display is slightly angled towards the driver, but manages not to be detrimental for the passenger.

The 14-inch central display trends on the larger side for screen size in the market today, so this is viewed as an attention grabber and standout feature.

Large 14-inch central display for top specification model

UX impact	Major negative	Minor negative	No impact	Minor positive	Major positive
					Major positive

Overlapping on-screen buttons, negatively impacting usage

Category	General system
Description	Some on-screen buttons overlap content, effectively reducing usable screen area

On-screen buttons overlap content

SBD viewpoint	On the lower left side of the central display, some on-screen buttons overlap content. • The voice recognition button presents the most significant issue, being visible on almost all screens. • Depending on the screen, an additional button may be shown next to the voice recognition button, also overlapping content. For example, on the radio/media screen, the 'Sources' button is shown, and on the phone screen, the same button is used for 'Devices'. These overlapping on-screen buttons block both visibility and functionality, effectively reducing usable screen area of the central display.

UX impact	Major negative	Minor negative	No impact	Minor positive	Major positive

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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 or discuss with your local account manager below.

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